REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

REGIONAL REPORT

JULY 2019

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ABBREVIATIONS & ACRONYMS

AECF	Africa Enterprise Challenge Fund
AEEP	Africa-EU Energy Partnership
AELG	African Energy Leaders Group
AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
AFREA	Africa Renewable Energy Access Program
AGF	African Guaranty Fund
AMADER	Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale (Mali)
ANCEE	African Network of Centers of Excellence in Electricity
AREI	Africa Renewable Energy Initiative
ARSO	African Organization for Standardization
ASD	African Solar Designs
ASER	Agence Sénégalaise d'Electrification Rurale (Senegal Rural Electrification Agency)
AUC	African Union Commission
BEAC	Banque des Etats de l'Afrique Centrale (Central Bank of Central African States)
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
BOAD	Banque Ouest Africaine de Développement (West African Development Bank)
BoP	Base-of-the-Pyramid
BTG	Beyond the Grid
C&I	Commercial and Industrial
CAPP	Central African Power Pool
CAR	Central African Republic
CBEA	Crossboundary Energy Access
CDP	Community Development Program
CEADIR	Climate Economic Analysis for Development, Investment, and Resilience
CEDAW	Convention on the Elimination of All forms of Discrimination Against Women
CEIF-MTDF	Clean Energy Investment Framework Multi-Donor Trust Fund
CEMAC	Communauté Économique et Monétaire de l'Afrique Centrale (Economic and Monetary Community of Central Africa)
CEP	Common Energy Policy
CET	Common External Tariff
CI-Dev	Carbon Initiative for Development
CILSS	Comité permanent inter-État de lutte contre la sécheresse au Sahel (Permanent Interstate Committee for Drought Control in the Sahel)
CLSG	Côte d'Ivoire-Liberia-Sierra Leone-Guinea (Power Transmission Project)
COMELEC	Comité Maghrébin de l'Electricité (Maghreb Electricity Committee)
DANIDA	Danish International Development Agency
DCA	Development Credit Authority
DFI	Development Finance Institution
DFID	Department for International Development
DNICE	Direcção Nacional da Indústria Comercio e Energia (National Directorate of Industry, Commerce and Energy)
EBID	ECOWAS Bank for Investment and Development
EC	European Commission
ECCAS	Economic Community of Central African States
ECOSHAM	ECOWAS Standards Harmonization Model
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Center for Renewable Energy and Energy Efficiency

EDF	Électricité de France
EDFI	European Development Finance Institution
EEP	ECOWAS Energy Protocol
EIB	European Investment Bank
EnDev	Energizing Development Program
EREF	ECOWAS Renewable Energy Facility
EREP	ECOWAS Renewable Energy Policy
ERERA	ECOWAS Regional Electricity Regulatory Authority
ERD ZIRGO	Decentralized Rural Electrification of Ziro and Gourma Provinces Project
ERPA	Emissions Reduction Purchase Agreement
ERUDI	Électrification rurale décentralisée interrégionale en Mauritanie
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
ETLS	ECOWAS Trade Liberalization Scheme
EU	European Union
EUEI PDF	EU Energy Initiative Partnership Dialogue Facility
EUR	Euro
EVA	Energio Verda Africa
FDI	Foreign Direct Investment
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion
FI	Financial Institution
FMO	Dutch Development Bank
FOB	Freight on Board
FRES	Foundation for Rural Energy Services
FX	Foreign Exchange
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany Development Agency)
GOGLA	Global Off-Grid Lighting Association
GSMA	Global System for Mobile Communications
GW	Gigawatts
GWH	Gigawatt Hours
HC	Health Center
HDI	Human Development Index
HEURA	Household Energy and Universal Access Project
HH	Household
ICT	Information and Communication Technology
IDA	International Development Association
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LTO	Lease-to-Own
LDCs	Least Developed Countries

LEDS	Low Emission Development Strategies
LV	Low Voltage
MCC	Millennium Challenge Corporation
MFI	Multilateral Financial Institution
MNO	Mobile Network Operator
MTF	Multi-Tier Energy Access Framework
MV	Medium Voltage
MW	Megawatt
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NDF	Nordic Development Fund
NGO	Non-Governmental Organizations
NREAP	National Renewable Energy Actions Plan
O&M	Operations and Maintenance
OCEF	Off-Grid Clean Energy Facility
OGE	Off-Grid Electric
OGS	Off-Grid Solar
OMVG	Organisation pour la Mise en Valeur du fleuve Gambie
OPIC	Overseas Private Investment Corporation
PANER	Plan d'Action National pour les Énergies Renouvelables (National Renewable Energy Action Plan)
PASER	Plan d'Action Sénégalais d'Électrification Rurale (Senegal Rural Electrification Plan)
PAYG	Pay-As-You-Go
PDER	Plan Directeur d'Electrification Rurale (Rural Electrification Master Plan)
PIDA	Program for Infrastructure Development in Africa
PIDG	Private Infrastructure Development Group
PNER	Programme National d'Électrification Rurale (National Rural Electrification Program)
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PUE	Productive Use of Energy
PV	Photovoltaic
RE	Renewable Energy
RECP	Renewable Energy Cooperation Programme
REA	Rural Electrification Agency
REACT	Renewable Energy and Adaptation to Climate Change Technologies
REASL	Renewable Energy Association of Sierra Leone
REF	Rural Electrification Fund
REMP	Renewable Energy Master Plan
REPP	Renewable Energy Performance Platform
RESIP	Rural Electrification Strategy and Implementation Plan
RESMP	Rural Energy Strategy and Master Plan
RET	Renewable Energy Technology
RISE	Regulatory Indicators for Sustainable Energy
ROGEP	Regional Off-Grid Electrification Project
RREA	Rural and Renewable Energy Agency
SEED	Sustainable Energy for Economic Development
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SDG	Sustainable Development Goals
SDIP	Sustainable Development Investment Partnership
SHS	Solar Home System

SIDA	Swedish International Development Cooperation Agency
SLGP	Small Loans Guarantee Program
SME	Small and Medium Enterprise
SMG	Standard Microgrid
SOGE	Scaling Off-Grid Energy
SREP	Scale-Up Renewable Energy Program
TA	Technical Assistance
TAF	Technical Assistance Facility
T&D	Transmission and Distribution
UEMOA/WAEMU	Union Economique et Monétaire Ouest Africaine / West African Economic and Monetary Union
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USADF	United States African Development Foundation
USD	United States Dollar
VAT	Value Added Tax
WAGPA	West African Gas Pipeline Authority
WAMI	West African Monetary Institute
WAMZ	West African Monetary Zone
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak

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Togo	Laurent Kossivi Domegni

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 lanterns[5]
- 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

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

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

WEST AFRICA AND THE SAHEL

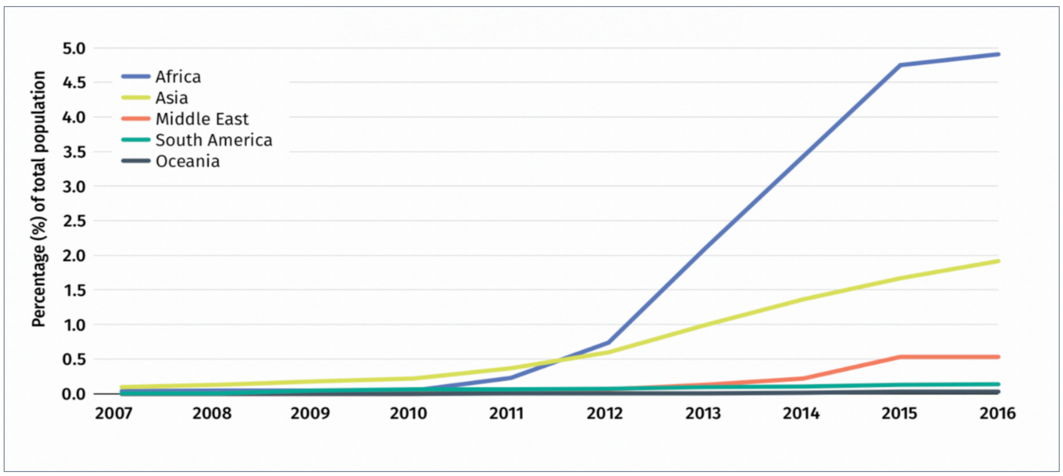
The term "West Africa and the Sahel" as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina 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.

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[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 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]

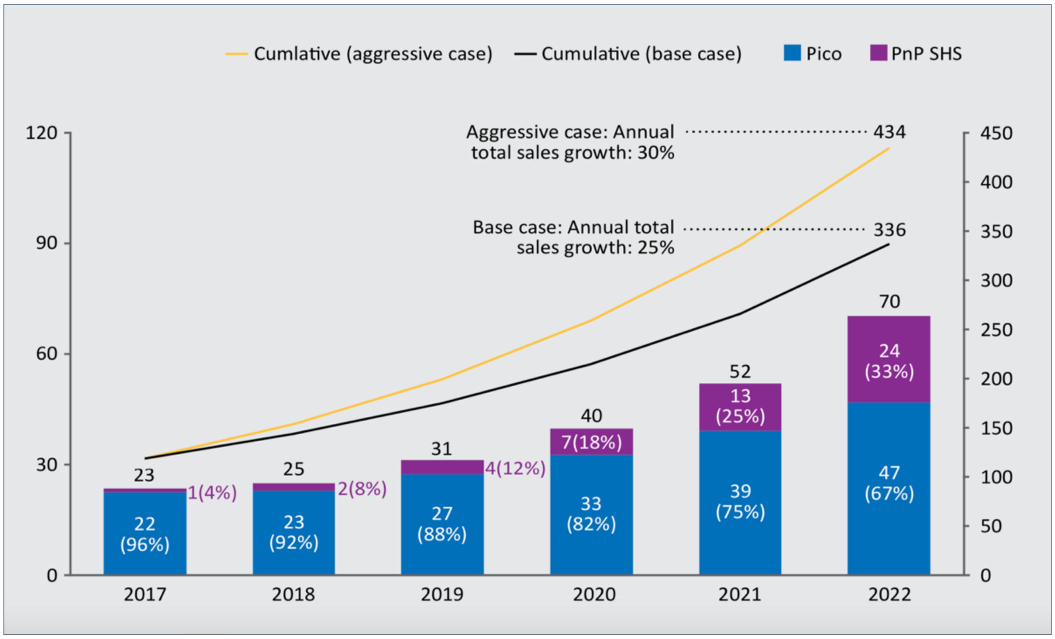
[13] IEA Energy Access Outlook, 2017.

[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

[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

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, who understand 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 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]

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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.bbhub.io/bnef/sites/4/2016/10/BNEF_WP_2016_10_07-Pay-as-you-go-solar.pdf
21 UNDP and ETH Zurich, 2018.

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 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 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]

These cohesive regional efforts fit into several larger global frameworks and development initiatives to address the challenges of energy poverty, energy security, climate change and sustainable development. The Sustainable Development Goals set by the UN 2030 Agenda for Sustainable Development is a universal effort to end all forms of poverty and combat climate change by ensuring access to affordable, reliable, sustainable, and modern energy for all.[24] The UN Framework Convention on Climate Change prioritizes sustainable development as a key component of its global initiative to address climate change; many ECOWAS member states have pledged to increasing the share of renewable energy in their power sectors under their Nationally Determined Contributions (NDC) to the UN under the Paris Climate Agreement. These large-scale global policy initiatives will continue to strengthen and direct sustainable development efforts at the national and local level across Sub-Saharan Africa.

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[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

[24] "The Sustainable Development Agenda," United Nations, (2016): http://www.un.org/sustainabledevelopment/development-agenda/

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 **Section 3.2.5** as well as in **Section 6.7.3** of this report, including a summary of findings from across the region and 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 main sections that correspond to Tasks 1-3 described in the scope of work above (Task 4 was prepared in a separate report). **Sections 2-5** cover the enabling policy and market environment for the OGS sector. This includes a summary of off-grid development initiatives (**Section** 2), an overview of the status of the on-grid and off-grid markets (**Section 3**), an analysis of off-grid energy policy and regulation and gaps in the existing framework at the regional (**Section 4**) and national (**Section 5**) level. The results of the least-cost electrification analysis are included in **Section 3**.

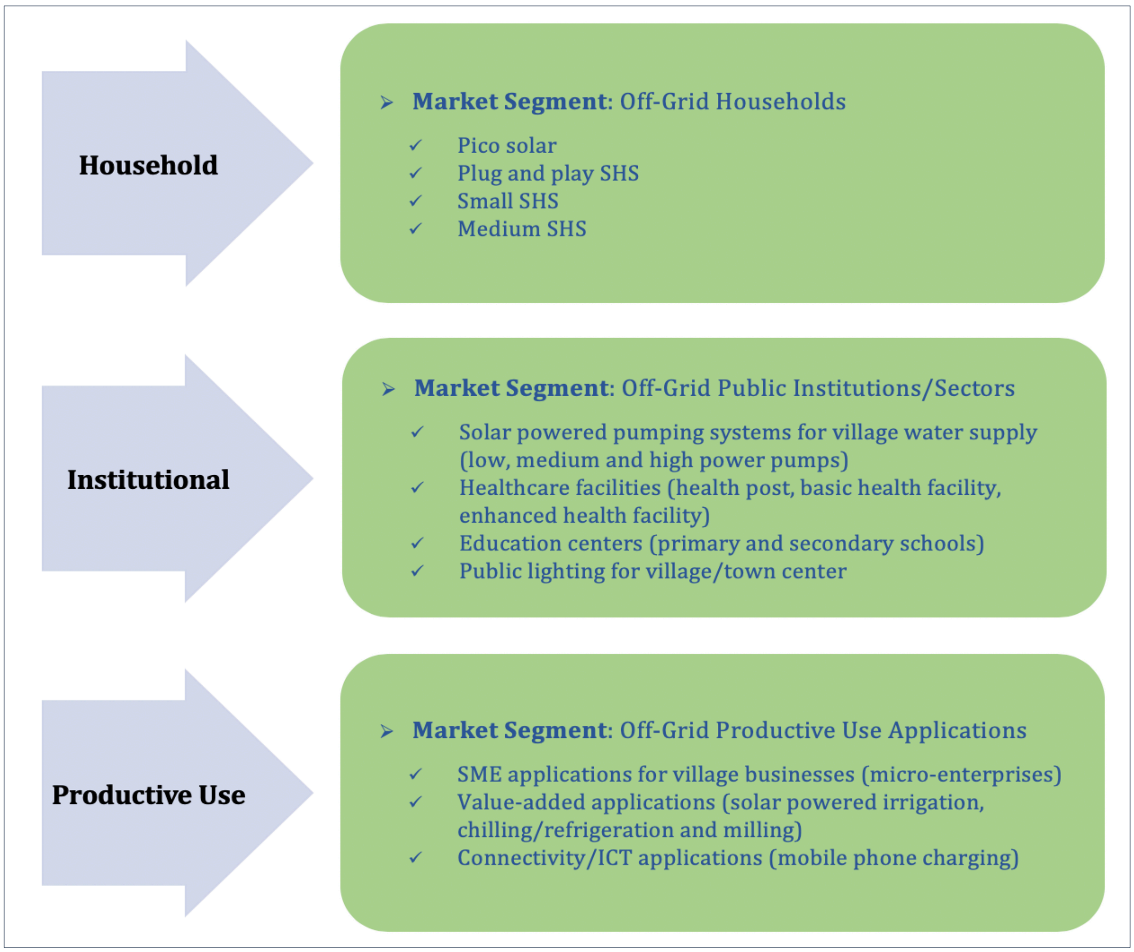
Section 6 estimates the potential market for off-grid solar products and systems by assessing potential demand from the household, institutional and productive use market segments (**Figure ES-3**), followed by an analysis of the supply chain. The household market sizing utilizes results from the least-cost 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 **Section 6.1: Overview of Market Segments** 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 7 assesses the role of financial institutions (Task 3).[25] This section includes a summary of financial products for the off-grid sector, an overview of the regional financial market, and a summary of 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

[25] A separate Task 3 report assesses the willingness and capability of national and regional FIs to provide commercial and/or consumer financing to the off-grid solar sector in each country.

III. EXECUTIVE SUMMARY

A. REGIONAL OVERVIEW

West Africa and the Sahel has long suffered from large deficits in the supply of and access to electricity. As of 2016, over 200 million people across the 19 countries – more than half of the region's population – lacked access to electricity. This figure represents nearly one-third of Africa's total unelectrified population and the region as a whole has among the lowest rates of access in the world.[26] Rates of urban and rural electrification vary widely across states, with the average rate of access more than three times higher in urban areas (60%) when compared to rural areas (18%).[27] Even where grid connections exist, power supply is often unreliable. On average, less than one-third of firms and households in West Africa and the Sahel reported reliable electricity supply when surveyed.[28]

ECOWAS has pursued an ambitious regional energy agenda to promote cooperation and development and increase the collective energy autonomy of the sub-region.[29] The implementation of this regional agenda began in 1999 with the establishment of the West African Power Pool (WAPP), a regional transmission network and the foundation for all interstate electricity trading in the region. Outside of ECOWAS, Chad, Cameroon, and CAR are all members of the Central African Power Pool (CAPP), while Mauritania is a member of COMELEC (Comité Maghrébin de l'Electricité), a regional network in northern Africa.

The 2003 ECOWAS Energy Protocol sought to promote long-term cooperation, increase complementarity, and attract investment to promote regional energy development. ECREEE was established in 2010 as a regional body to further the implementation of the Energy Protocol. The creation of a regional electricity market has proven to be challenging, as the level of development of electricity markets at the national level varies widely by country, ranging from vertically integrated, state-owned electricity sectors, to partially and fully unbundled and/or privatized power markets.

While significant investments have been made to boost energy production across the region, nearly every country continues to struggle to meet rapidly increasing electricity demand. With few exceptions, the energy markets in West Africa and the Sahel remain highly dependent on expensive thermal power. The current installed capacity in the 19 countries is approximately 25 GW (although not all of this is operational capacity), with thermal power representing about three-quarters of total installed capacity and large hydropower comprising nearly all of the remaining balance.

Meanwhile, electricity demand forecasts estimate that demand across the region will exceed 40 GW by 2030, with Nigeria accounting for more than half (about 23 GW) of this total. In the WAPP, 85% of total demand presently comes from just four countries – Nigeria, Côte d'Ivoire, Senegal, and Ghana. Relative to 2010 demand levels, expected demand in 2050 is projected to increase by a factor of more than six. To meet this massive growth in demand, the WAPP's current generation scenario is based largely on additions of large hydropower and natural gas capacity, with a small but gradually increasing share of non-hydro renewable energy. Regional infrastructure has the potential to drive down electricity prices and power generation costs in the long run; however, the poor state of national grids and markets both in net-producing and net-consuming countries remains an obstacle to further integration and prevents convergence among countries in the short-term.

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[26] IEA Energy Access Outlook, 2017.

[27] Ibid.

[28] 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

[29] "ECOWAS Energy Policy," ECOWAS: http://allafrica.com/stories/201311191358.html.

To address some of the regional challenges, under its Community Development Program (CDP), ECOWAS announced plans in 2017 for sub-regional development projects worth nearly USD 30 billion between 2018-2022 to cover infrastructure, energy, agriculture and health sectors.[30] There are three priority projects in the energy sector under the CDP, including (i) ROGEP, (ii) a USD 1.34 billion transmission project linking seven countries across the region, and (iii) the constriction of three solar power plants and two wind power plants totaling over 800 MW of renewable energy capacity at an estimated cost of USD 1.25 billion.[31]

B. ENABLING POLICY AND MARKET ENVIRONMENT

Off-grid electrification remains a policy priority for governments across the region. Many countries have adopted long-term electrification targets, with most committing to a goal of achieving universal access by 2030 under their SEforALL Action Agendas. If governments are successful at achieving these targets, electricity access rates across West Africa would reach 90% by 2030.[32] To achieve these ambitious objectives, governments will need to develop and implement supportive off-grid policy and regulatory frameworks. To date, some countries having established comprehensive policies, plans, incentives, schemes and regulations to support off-grid development, while other countries have lagged behind.

A useful barometer to measure whether countries have made improvements to the enabling policy environment for the off-grid sector is to assess levels of improvement (or regression) in a country's World Bank's Regulatory Indicators for Sustainable Energy (RISE) energy access score (**Figure ES-4**). The highest scoring country in the region was Cameroon, followed by Ghana, Cote d'Ivoire, Togo and Benin. Between 2015 and 2017, several ROGEP countries improved their score, with the most notable improvements in Togo, Niger, Burkina Faso, Sierra Leone, Nigeria and Benin. The largest improvement was in Togo, as the country's score more than doubled between 2015 and 2017. On the other end of the spectrum, several countries in the region still have extremely limited energy access regulatory frameworks, namely Chad, CAR, Liberia, Mauritania.[33]

Senegal was the only country to significantly regress between 2015 and 2017 in its energy access score. This can largely be attributed to the country's slowed progress in rural electrification due to the underperforming results of the Rural Electrification Action Plan (Plan d'Action Sénégalais d'Électrification Rurale, PASER), which experienced a series of challenges and obstacles in its implementation and was consequently replaced by the recently adopted National Rural Electrification Program (Programme National d'Électrification Rurale) in 2018.[34]

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[30] "ECOWAS to Spend US$ 29 Billion on Development Projects in West Africa," AllAfrica, (28 December 2017): https://allafrica.com/stories/201712290145.html

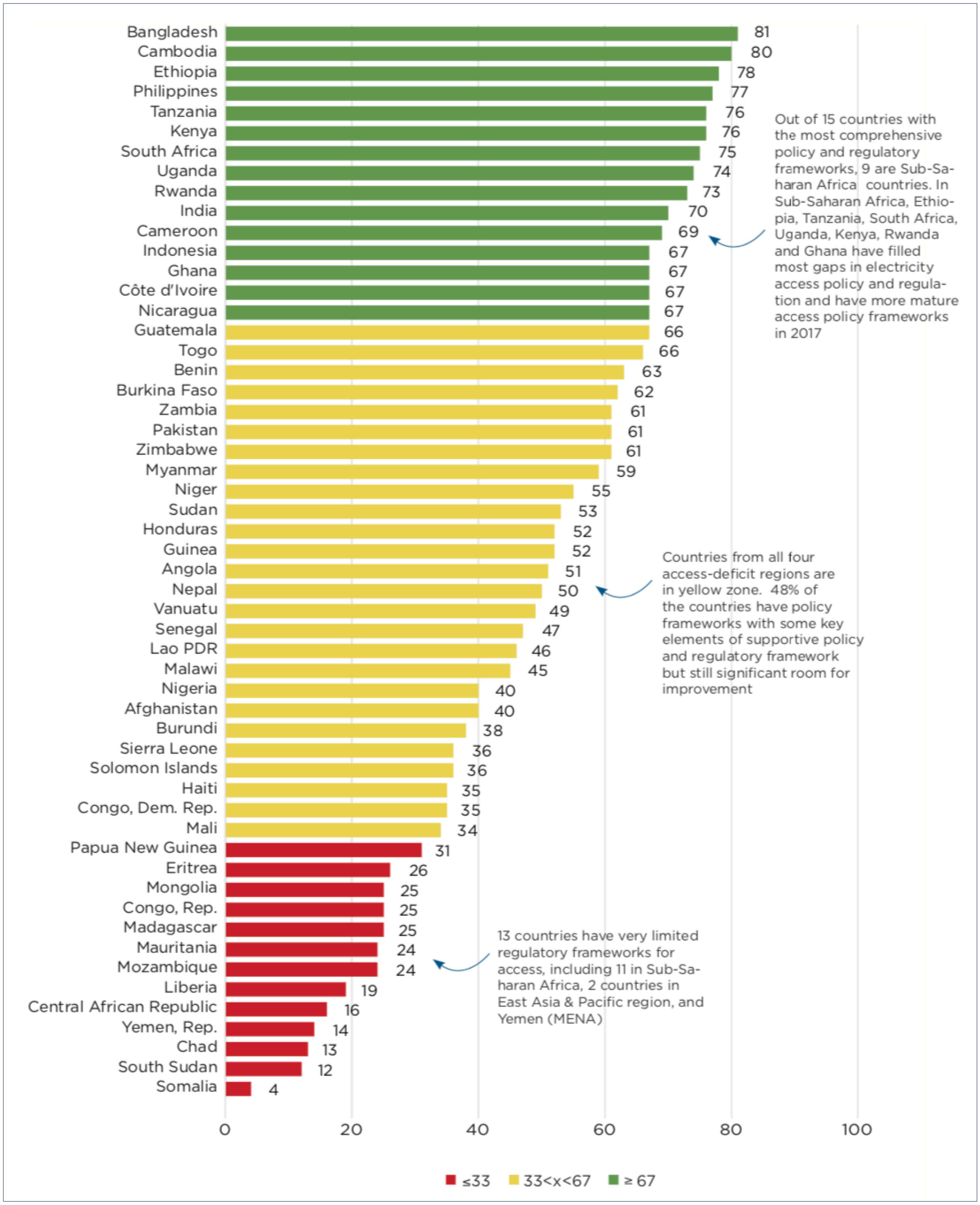
[31] "ECOWAS Community Development Programme (CDP) Priority Projects," ECOWAS: http://ecowas-events.ecowas.int/cdp-conference/wp-content/uploads/2016/06/Projects-English.pdf

[32] "From Vision to Coordinated Action: Consolidation of SEforALL Action Agendas, National Renewable Energy Action Plans, and National Energy Efficiency Action Plans," ECREEE, (2017): http://SEforALL.ecreee.org/sites/default/files/final_report_on_SEforALL_consolidation.pdf

[33] "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

[34] "Senegal's SE4ALL Rural Electrification: Action Agenda and Investment Prospectus," Gesto Energia, SA, (June 2018): http://gestoenergy.com/wp-content/uploads/2019/04/Gesto_Senegal_EN.pdf

Figure ES-4: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017[35]



Source: World Bank Regulatory Indicators for Sustainable Energy

[35] "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

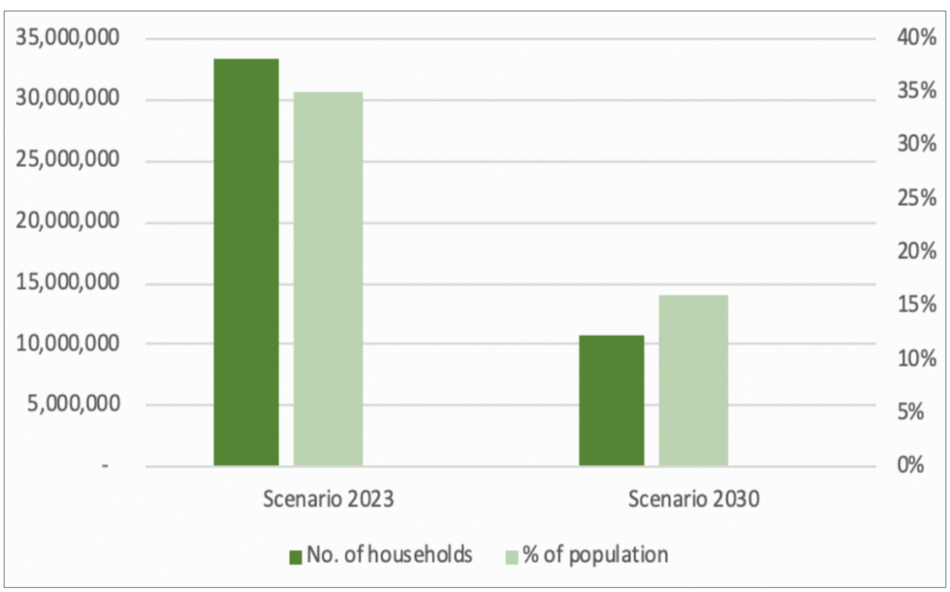
For the off-grid market segment to grow, it requires a comprehensive enabling environment to be in place, with clear plans, supportive laws, regulations and financial incentives, and the implementation of a robust set of quality assurance standards and long-term technical capacity building support measures. With support from ECREEE, countries in the region have started to develop national energy policies with increased emphasis on off-grid solutions. However, to date, with the exception of a few countries, policies and targets have yet to translate into concrete action plans with clear mandates to address all of the policy and regulatory barriers that hinder off-grid market growth. In other cases, where policies and incentives are adopted, the allocation of financial or technical resources to support program implementation has often been insufficient. For national electrification programs to succeed, funding and support is needed from government and development partners, while extensive engagement with and participation of the private sector is critical to the long-term sustainability of the sector.

C. LEAST-COST ELECTRIFICATION ANALYSIS

The least-cost electrification analysis estimated the share of the population in each country that could be connected to the national electrical grid in 2023 and 2030, as well as the corresponding share of the population suitable for off-grid solutions. In general, when comparing the results of the analysis with national electrification targets in each country, it is evident that in many countries, off-grid solutions – both mini-grids and stand-alone systems – will play an important role in achieving national electrification objectives.

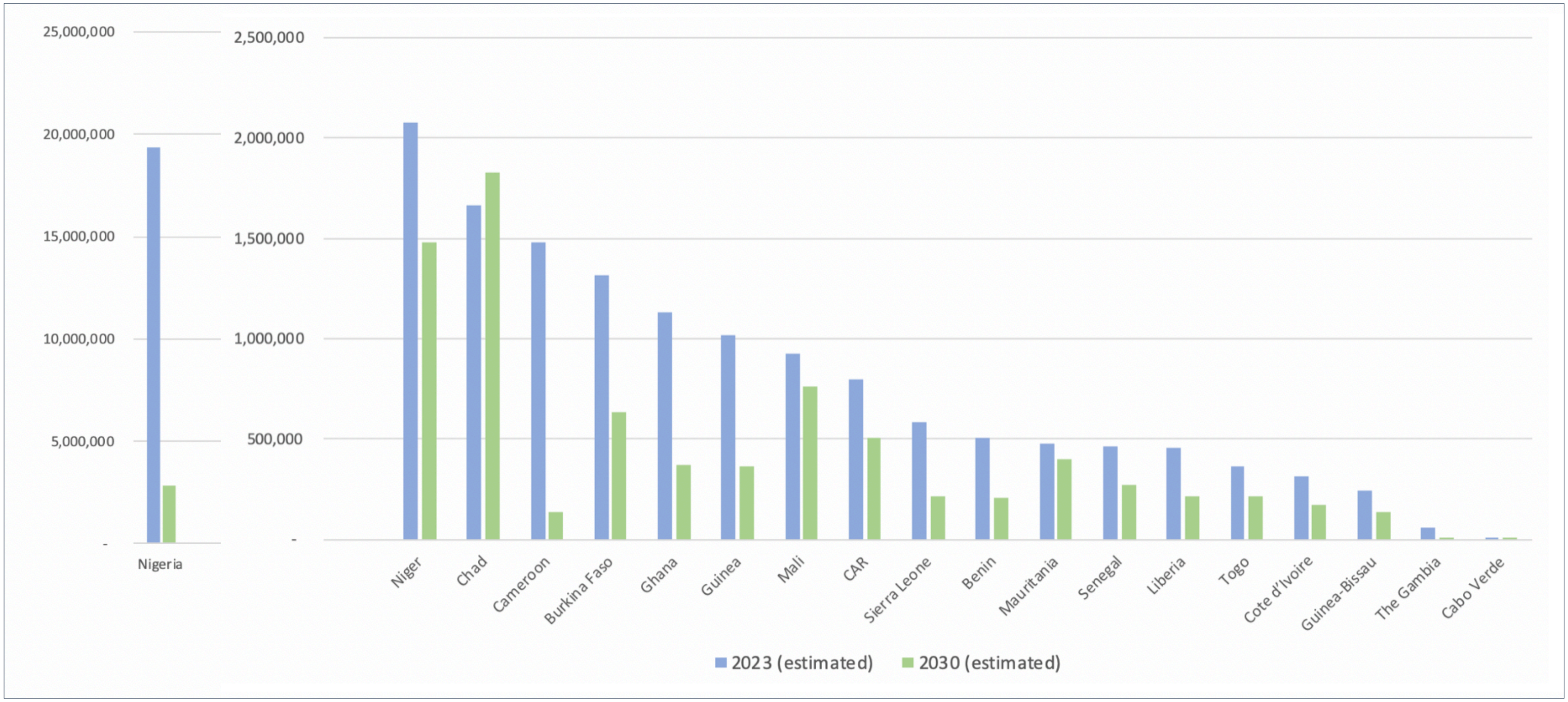
The least-cost study found that by 2023, about 166 million people, 33 million households and an average of 35% of the population across West Africa and the Sahel will be suitable for stand-alone systems. These figures will decrease to about 60 million people, 11 million households and an average of 16% of the region's population by 2030 (**Figure ES-5, Figure ES-6** and **Figure ES-7**). These estimates are based on the assumption that all planned grid extensions will be completed by 2030.

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



Source: Energio Verda Africa GIS analysis

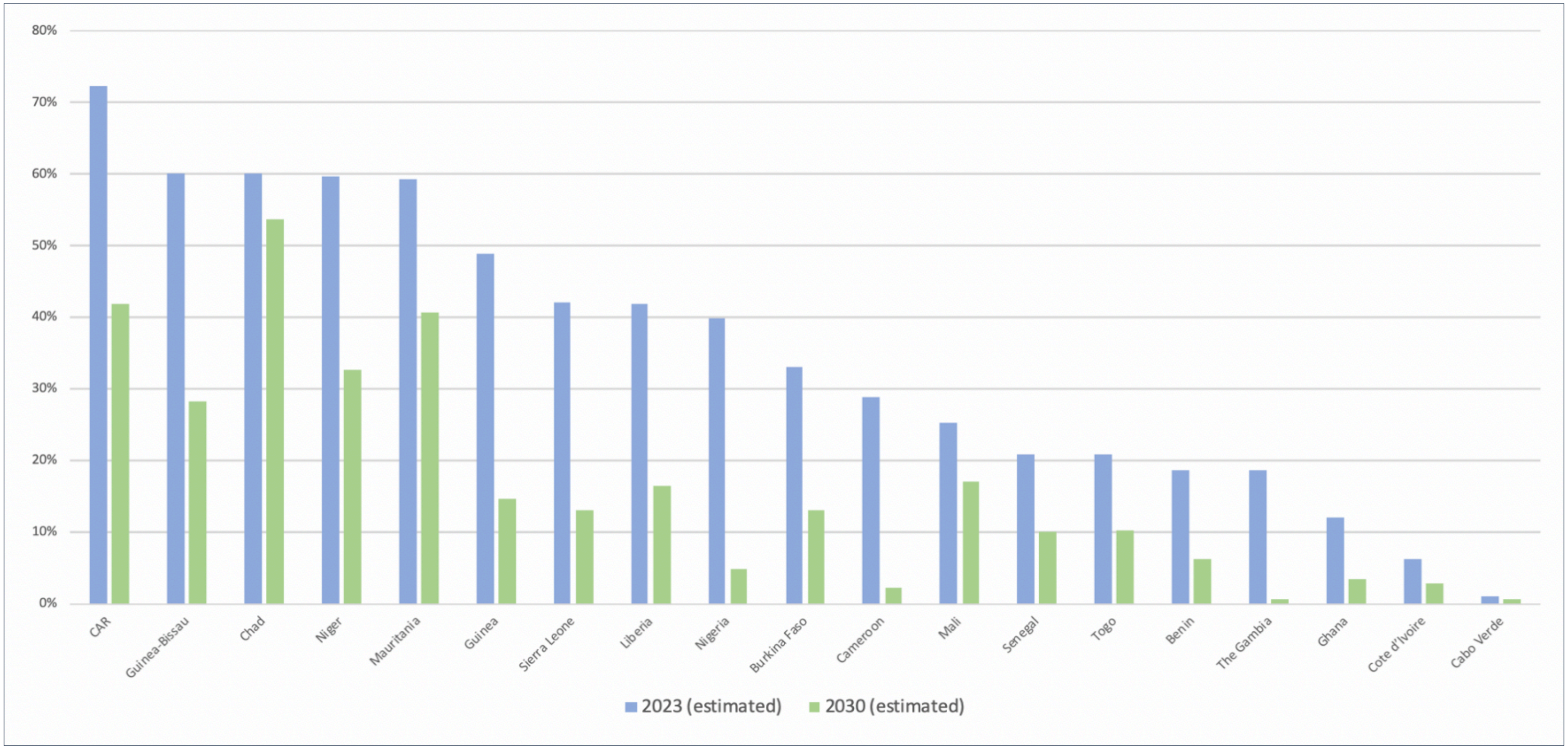
Figure ES-6: Estimated Number of Households Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

According to the least-cost electrification analysis, in 2023, Nigeria will have the largest number of households suitable for stand-alone systems (19.3 million), followed by Niger (2 million) and Chad (1.6 million). By 2030, Nigeria will still have the largest number of households (2.8 million), followed by Chad (1.8 million) and Niger (1.5 million). Chad is the only country in the region that will witness an increase in the number of off-grid households between 2023 and 2030.

Figure ES-7: Estimated Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

According to the least-cost electrification analysis, in 2023, Central African Republic will have the largest share of its population suitable for stand-alone systems (72.3%), followed by Guinea-Bissau, Chad, Niger and Mauritania (all with about 60% of their populations suitable for OGS). By 2030, Chad will have the largest share of its population suitable for stand-alone systems (53.7%), followed by CAR (41.9%) and Mauritania (40.6%).

D. OFF-GRID SOLAR MARKET ASSESSMENT

➢ COUNTRY CATEGORIZATION

The countries in West Africa and the Sahel have a diverse range of market characteristics. Several indicators are important to off-grid solar product market development. To estimate the potential size of the market for OGS products and systems, this assessment examined factors such as population without access to electricity and GDP per capita. Population density was also analyzed, as this is an important indicator for market attractiveness to suppliers, based on distribution and maintenance costs. Using these demographic indicators, countries were grouped into market segments as shown in **Figure ES-8**.

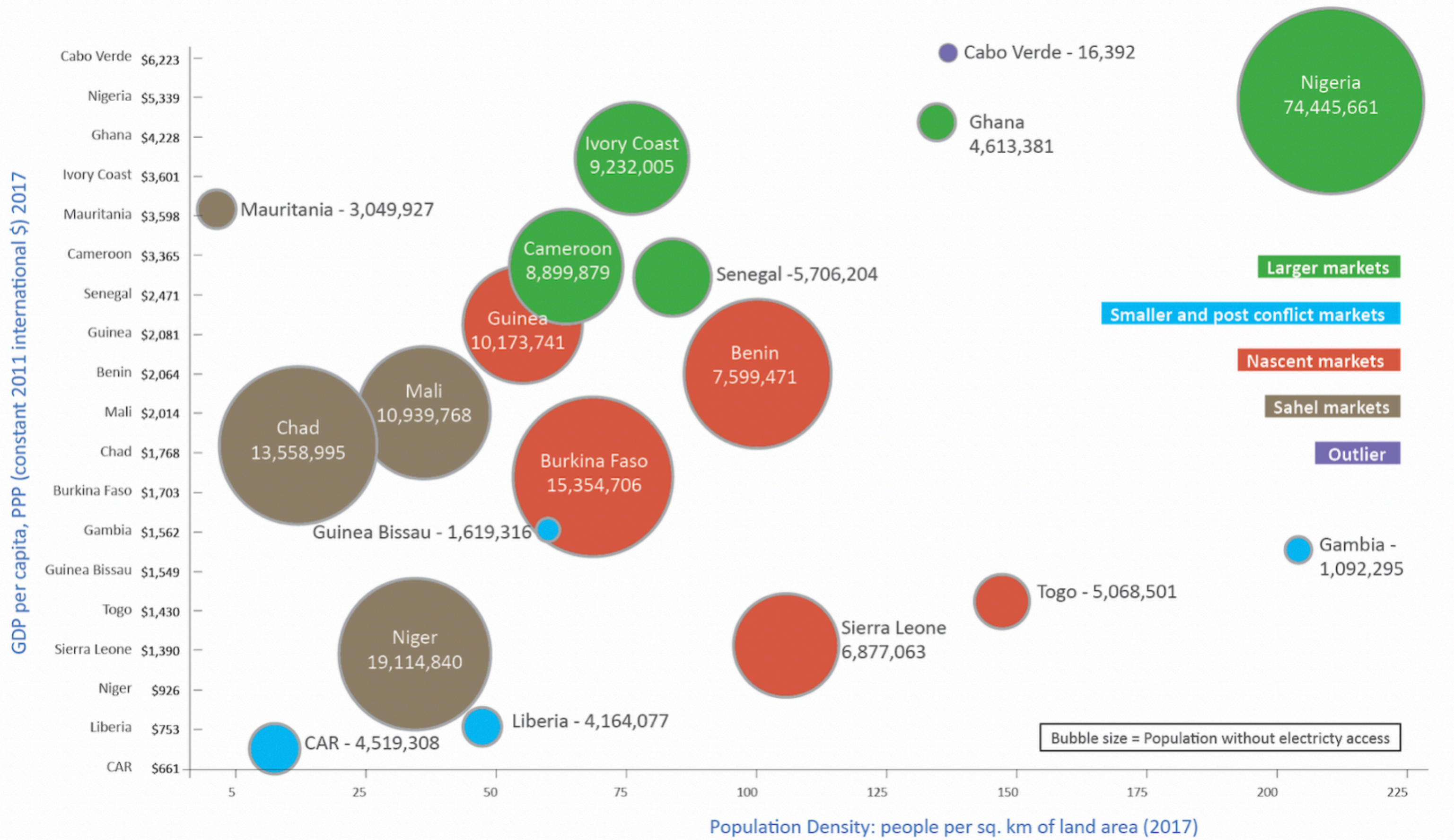
Larger markets are those with relatively high GDP per capita, large populations without access to electricity, and higher population density. These are generally more diverse economies with stronger infrastructure. Most of these markets are already reporting growing sales of quality-verified OGS products. Nascent markets are poised for growth, with large off-grid populations, slightly lower GDP per capita rates and some reported OGS sales. Smaller markets present more challenging characteristics, including small population, low GDP per capita and low population density. Countries categorized as Sahel markets fall into a distinct category, with low population density but large off-grid populations with a range of GDP per capita levels. Cabo Verde is in a category of its own as an outlier market given how unique it is from the rest of the countries in the region as an island nation, with a very high electrification rate and higher income level. The analysis presented in this section will refer to this country categorization to support regional segmentation of the off-grid solar market.

➢ ESTIMATED TOTAL MARKET DEMAND

The results of the overall market assessment for off-grid solar products and systems across the West Africa and Sahel region are presented in **Table ES-1**, which includes a summary of potential demand for OGS equipment in each of the analyzed market segments in 2018 – **household** (modeled for both cash and financed purchase potential), **institutional** for public institutions such as schools and health facilities, and **productive use** of electricity to generate economic activity and increase productivity. The results of the analysis suggest that there is significant off-grid solar market potential, with the largest cash demand coming from the productive use sector (USD 1.8B), followed by households (USD 907M) and Institutional users (USD 213M). The estimated annualized cash market potential for the entire region is nearly USD 3 billion, with more than 16 million units sold (686 MW equivalent).

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 realties, 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.

Figure ES-8: Country Categorization by Electricity Access, Income and Population Density



Market definitions	GDP per capita	Population Density	Population without electricity access
Larger markets	>$2,500	>75	>5 million
Nascent markets	$1500 - 2500	>50	>5 million
Smaller and post conflict markets	$0-1500	Varies	<5 million
Sahel markets	Varies	<20	>10 million
Outlier	>$5000		<50,000

Table ES-1: Indicative Total Off-Grid Solar Cash Market Potential in West Africa and the Sahel, 2018

Off-Grid Market Segment	Units	kW Equivalent	Cash Value (USD)
HOUSEHOLD			
Pico solar	9,978,800	29,937	$449,046,106
Plug and play	3,310,212	33,103	$413,776,330
Small SHS	137,451	6,874	$34,362,608
Medium and Large SHS	16,559	4,150	$10,374,256
Estimated Regional Household Cash Market Potential	**13,443,062**	**74,064**	**$907,559,300**
Pico solar	359,236	1,078	$16,165,641
Plug and play	1,334,607	13,347	$166,825,867
Small SHS	4,261,681	213,084	$1,065,420,256
Medium and Large SHS	2,597,536	649,384	$1,623,459,999
Estimated Regional Household Financed Market Potential	**8,553,060**	**876,893**	**$2,871,871,764**
INSTITUTIONAL			
Water supply	18,919	71,375	$178,424,250
Healthcare facilities	8,500	4,666	$11,659,375
Primary and secondary schools	8,246	6,413	$17,681,235
Public lighting	3,449	1,726	$5,173,875
Estimated Regional Institutional Cash Market Subtotal	**39,114**	**84,180**	**$212,938,735**
PRODUCTIVE USE			
SME applications for micro-enterprises (barbers and tailors)	691,466	172,867	$432,166,625
Connectivity / ICT (phone charging)	206,036	82,414	$177,602,737
Value-added applications (irrigation, milling and refrigeration)	1,642,952	272,532	$1,252,030,852
Estimated Regional Productive Use Cash Market Subtotal	**2,540,454**	**527,813**	**$1,861,800,214**
ESTIMATED ANNUALIZED REGIONAL CASH MARKET POTENTIAL	**16,022,630**	**686,057**	**$2,982,298,249**

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

Source: African Solar Designs analysis

- **HOUSEHOLD DEMAND**[36]

  - **Estimated Household Cash Market**

The cash purchase model estimated the number of off-grid solar products and systems households can afford to purchase based on income levels. From this output, the estimated cash value and kW equivalent of these units was calculated. According to the analysis, the total regional off-grid solar cash market potential for households in 2018 is USD 907.5 million, decreasing to USD 842.5 million and USD 84.9 million in 2023 and 2030, respectively. The largest country markets by cash value are Nigeria, Chad, Burkina Faso and Guinea. The majority of the estimated cash market is dominated by potential sales of pico solar lighting and plug-and-play solar home systems.

- ✓ According to the household market assessment, in 2018, Nigeria represents the largest household cash market in the region (USD 523M) – accounting for more than half of the region's total demand – followed by Chad (USD 60M), Burkina Faso (USD 49M), Guinea (USD 45M) and Niger (USD 43M).
- ✓ In 2023, Nigeria will represent the largest household cash market in the region (USD 605M) – accounting for an even larger share (about 70%) of the region's total demand – followed by Cameroon (USD 34M), Guinea (USD 33M), Niger (USD 30M) and Burkina Faso (USD 28M).
- ✓ By 2030, Mali will represent the largest household cash market in the region (USD 13M), followed by Niger (USD 12.5M), Guinea (USD 10.7M), Burkina Faso (USD 10.4M) and Ghana (USD 9M).

  - **Estimated Household Financed Market**

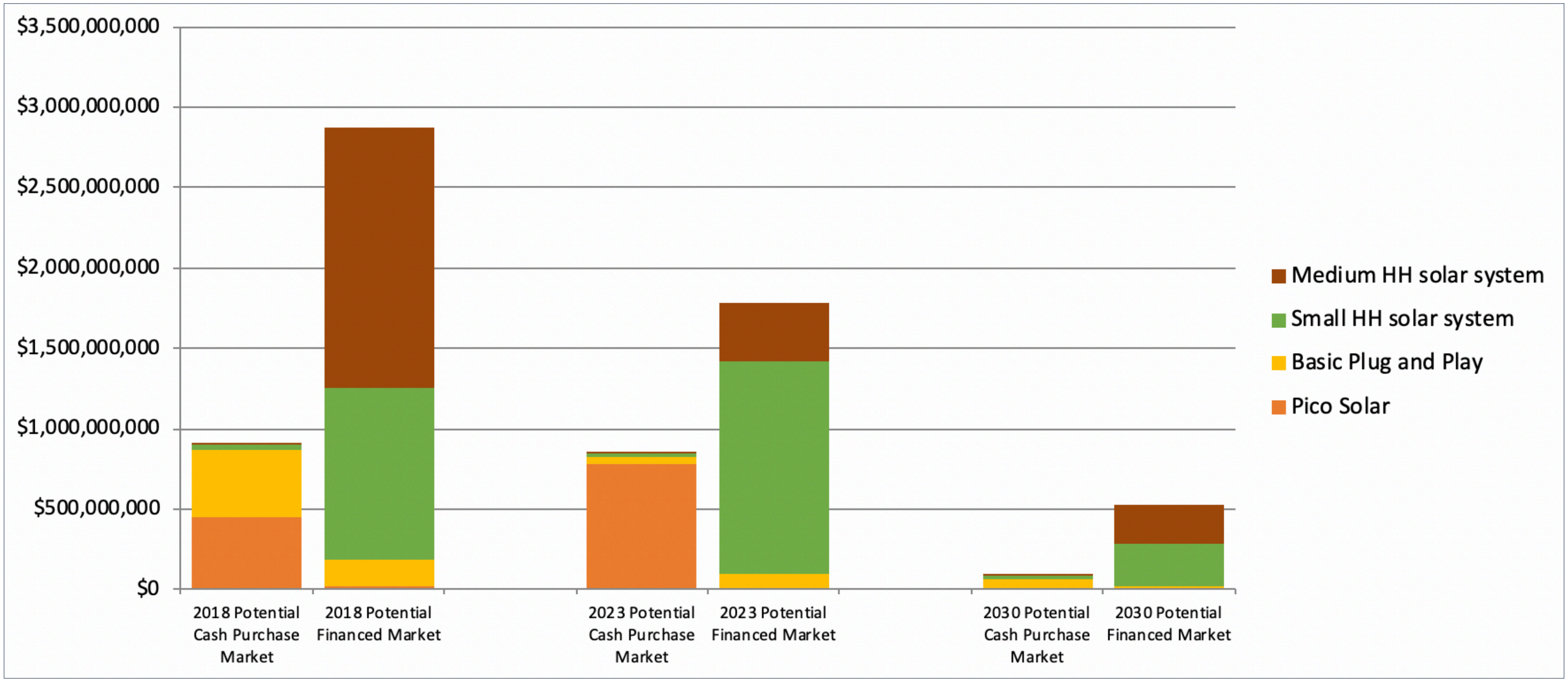
Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. According to the analysis, consumer financing has the potential to unlock a much larger market, with an estimated total regional off-grid solar financed market potential of USD 2.8 billion in 2018 – more than triple the estimated cash market value in that year – decreasing to USD 1.7 billion and USD 523 million in 2023 and 2030, respectively **(Figure ES-9**).

- ✓ According to the household market assessment, in 2018, Nigeria represents the largest financed market in the region (USD 1.4B) – accounting for half of the region's total demand – followed by Burkina Faso (USD 190M), Chad (USD 176M), Niger (USD 163M) and Côte d'Ivoire (USD 146M).
- ✓ In 2023, Nigeria will represent the largest financed market in the region (USD 1B) – accounting for about 80% of the region's total demand – followed by Niger (USD 97M), Guinea (USD 85M), Cameroon (USD 81M) and Burkina Faso (USD 76M).
- ✓ In 2030, Nigeria will again represent the largest financed market in the region (USD 175M) – accounting for one-third of total demand – followed by Niger (USD 72M), Chad (USD 52M), Mali (USD 37M) and Guinea (USD 30M).

In addition to the cash and financed market estimates, the study also assessed the number of households able to afford different OGS system types with and without consumer financing. The analysis found that consumer financing allows a significant share of the region's lower income population to afford OGS products and systems. Without financing, an estimated 30 million households across the region can afford an OGS system in 2018 (representing 78% of all households without electricity access). However, with the addition of consumer financing, an estimated 39 million households across the region are able to purchase at least one OGS system (accounting for nearly 100% of all households without electricity access), as shown in **Figure ES-10** and **Figure ES-11**. Innovative financing models (i.e. PAYG, lease-to-own, energy-as-a-service) would need to be widely deployed for this market potential to be realized, recognizing that challenges exist in many of the ROGEP countries surrounding the availability of consumer financing.

[36] See **Section 6.3** for a complete summary of findings; see **Annex 2** for the household market sizing methodology.

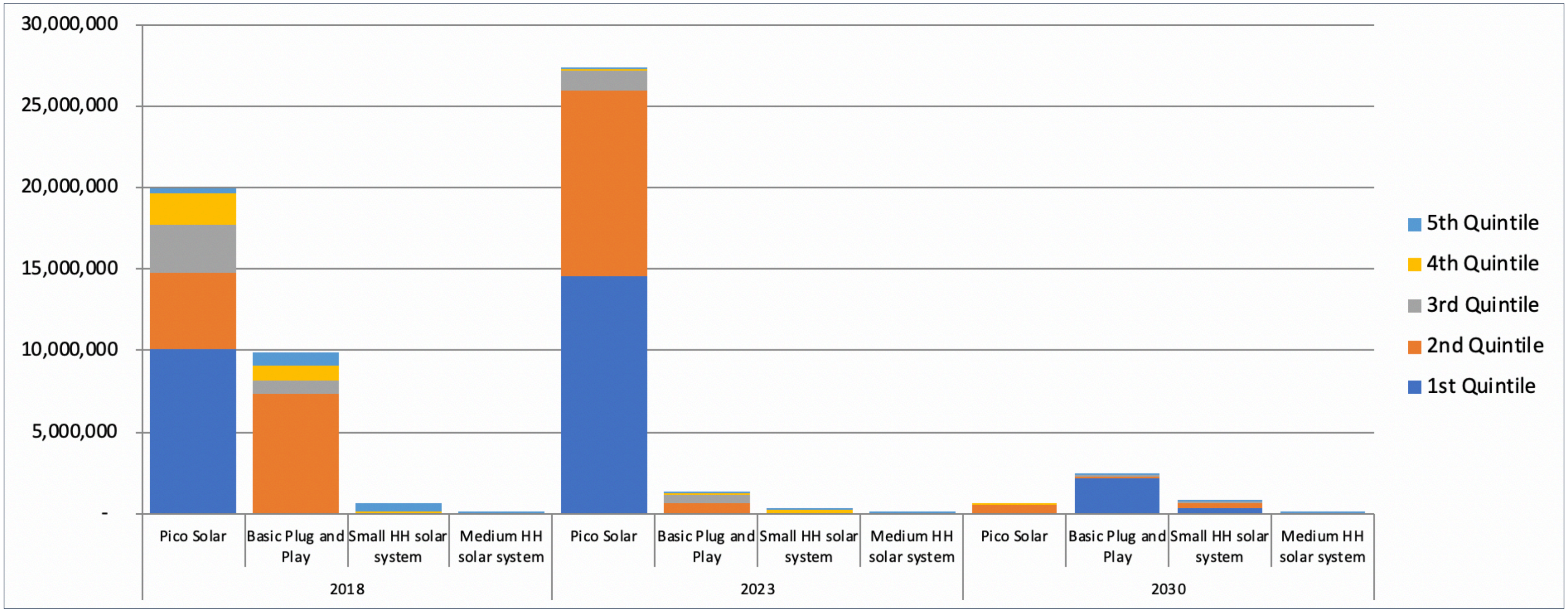
Figure ES-9: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type in West Africa and the Sahel



Source: African Solar Designs analysis

As presented in **Figure ES-9**, with the addition of consumer financing, the estimated regional OGS market in 2018 triples in size from USD 907 million to USD 2.8 billion, mainly due to the larger systems that households are able to purchase. Similar trends can be observed in 2023 and 2030.

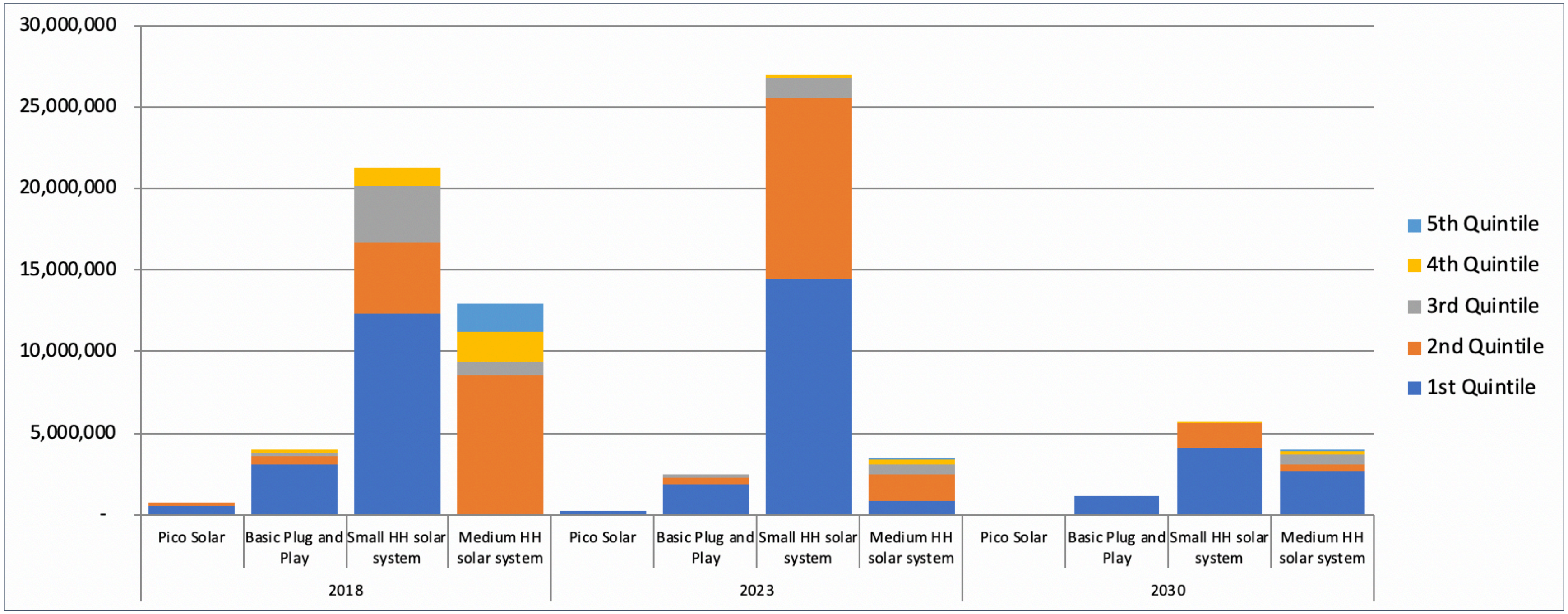
Figure ES-10: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems in West Africa and the Sahel



Source: African Solar Designs analysis

As presented in **Figure ES-10**, pico solar and basic plug-and-play systems are the most common OGS solutions for the cash market across the region under all three scenarios (2018, 2023 and 2030).

Figure ES-11: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems in West Africa and the Sahel



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure ES-11**, with financing, small to medium solar home systems are the most common OGS solutions across the region under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

- **PUBLIC/INSTITUTIONAL DEMAND**[37]

The institutional sector analysis evaluated potential demand from four public/institutional market segments in each country – water supply for off-grid communities, healthcare facilities, education centers (primary and secondary schools) and public lighting. According to the analysis, the annualized regional off-grid solar cash market potential for the institutional sector is USD 212.9 million. The market segment with the largest potential is village water supply (USD 178.4 million), followed by education (USD 17.6 million), healthcare (USD 11.6 million) and public lighting (USD 5.1 million). With an estimated market potential of USD 83.5 million, Nigeria's institutional sector accounts for more than one-third of the region's total demand.

The availability and quality of GIS data to perform the institutional sector assessment was limited. For countries where GIS data was insufficient to identify off-grid water points, health facilities, and/or schools, per capita comparisons were made using data from countries in the same country category (**Figure ES-8**) to estimate off-grid solar demand accordingly.

- **Water Supply**

The water supply sector analysis considered the electricity needs for water supply for communities in off-grid areas. The potable water points that were analyzed cover a wide range of sources, from wells to boreholes, each of which has different energy supply needs. Thus, to estimate the market size, solar pumping systems were categorized by their size (low, medium and high power systems). According to the analysis, the annualized regional off-grid solar cash market potential for the water supply sector is USD 178.4 million. With an estimated market potential of USD 72.5 million, Nigeria accounts for about 40% of the region's total demand for off-grid solar water pumping systems. Niger has the next largest estimated market potential (USD 21.6 million), followed by Chad (USD 16.4 million) and Mali (USD 14.5 million).

- **Healthcare**

The healthcare sector analysis considered the electricity needs for off-grid health facilities in each country. Available GIS data identified off-grid health centers (HC) categorized by their size – health post (HC1), basic health facility (HC2), and enhanced health facility (HC3) – that could be electrified by stand-alone systems. According to the analysis, the annualized regional off-grid solar cash market potential for the healthcare sector is USD 11.6 million. Nigeria (USD 4.8 million), Niger (USD 1.7 million) and Chad (USD 1.3 million) account for two-thirds of the region's total demand

- **Education**

The education sector analysis considered the electricity needs of off-grid primary and secondary schools. Available GIS data identified off-grid primary and second schools that could be electrified by stand-alone systems. According to the analysis, the annualized regional off-grid solar cash market potential for the education sector is USD 17.6 million. With an estimated market potential of USD 4.6 million, Nigeria accounts for about 25% of the region's total demand. Liberia has the next largest estimated market potential (USD 1.7 million), followed by Niger (USD 1.5 million) and Burkina Faso (USD 1.6 million).

- **Public Lighting**

The public lighting analysis assessed the lighting needs for off-grid villages and market centers (it did not assess public street lighting). District population figures from each country were used to determine the

[37] See **Section 6.4** for a complete summary of findings; see **Annex 2** for the institutional market sizing methodology.

number of market centers per district. Each market center was assumed to have two public lighting points. According to the analysis, the annualized regional off-grid solar cash market potential for the public lighting sector is USD 5.1 million. The analysis found that Nigeria (USD 1.5 million), Senegal (USD 549,450), Mali (USD 561,825) and Chad (USD 533,925) represent the largest public lighting markets in the region.

- **PRODUCTIVE USE DEMAND**[38]

The productive use of energy (PUE) is an important and emerging field of study, as off-grid solar applications have the potential to generate economic activity, increase productivity and transform rural livelihoods. This is particularly relevant for West Africa and the Sahel, where a large share of the region's population lives in rural areas and relies on the agricultural sector, which can benefit from a wide range of off-grid solar solutions. Focus group participants noted that productive use applications in the agricultural, food processing and informal sectors already exist in several countries, including solar powered lighting, mobile phone charging, refrigeration and chilling, water pumping, irrigation and agricultural processing. The assessment found that there is a sizeable market for productive use applications across the region. According to the analysis, the annualized regional off-grid solar cash market potential for the productive use sector is USD 1.8 billion, with the largest market potential coming from value-added applications (USD 1.25 billion), followed by applications for microenterprises (USD 432 million) and connectivity/mobile phone charging (USD 177 million).

- **SME Applications**

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. According to the analysis, the estimated annualized regional off-grid solar cash market potential for barbers and tailors is USD 432 million. With an estimated market potential of USD 419 million, Nigeria accounts for nearly all of the region's total demand, followed by Côte d'Ivoire (USD 5.6 million) and Cameroon (USD 2 million).

- **Connectivity Applications**

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) in each country. According to the analysis, the estimated annualized regional off-grid solar cash market potential for mobile phone charging enterprises is USD 177 million. With an estimated market potential of USD 76 million, Nigeria accounts for over 40% of the region's total demand, followed by Ghana (USD 14.9 million), Mali (USD 11.6 million), Côte d'Ivoire (USD 9.7 million), and Burkina Faso (USD 9.2 million).

- **Value-Added Applications (not included in annualized market potential)**

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

[38] See **Section 6.5** for a complete summary of findings; see **Annex 2** for the productive use market sizing methodology.

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 region's economic development, particularly given the sector's importance to GDP in many of the countries. According to the analysis, the estimated annualized regional off-grid solar cash market potential for value-added applications is USD 1.8 billion, with the largest potential in irrigation, followed by milling and refrigeration. With an estimated market value of more than $800M, Nigeria represents nearly half of the region's total PUE demand.

It should be noted that 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 does with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry out this market sizing analysis does not incorporate the specific considerations that pertain to the agricultural product value chain in each country.

- **SUPPLY CHAIN**

In addition to the assessment of market demand, the study analyzed the supply chain for off-grid solar products and services across the region, including an overview of key actors, solar products and services, business models, and sales data in each country. The study also examined the role of informal market players and the impact of uncertified products and assessed the local capacity 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. The tier system developed by ECREEE to classify solar companies throughout the region is detailed in **Table ES-2**.

Table ES-2: Solar Company Tier Classification

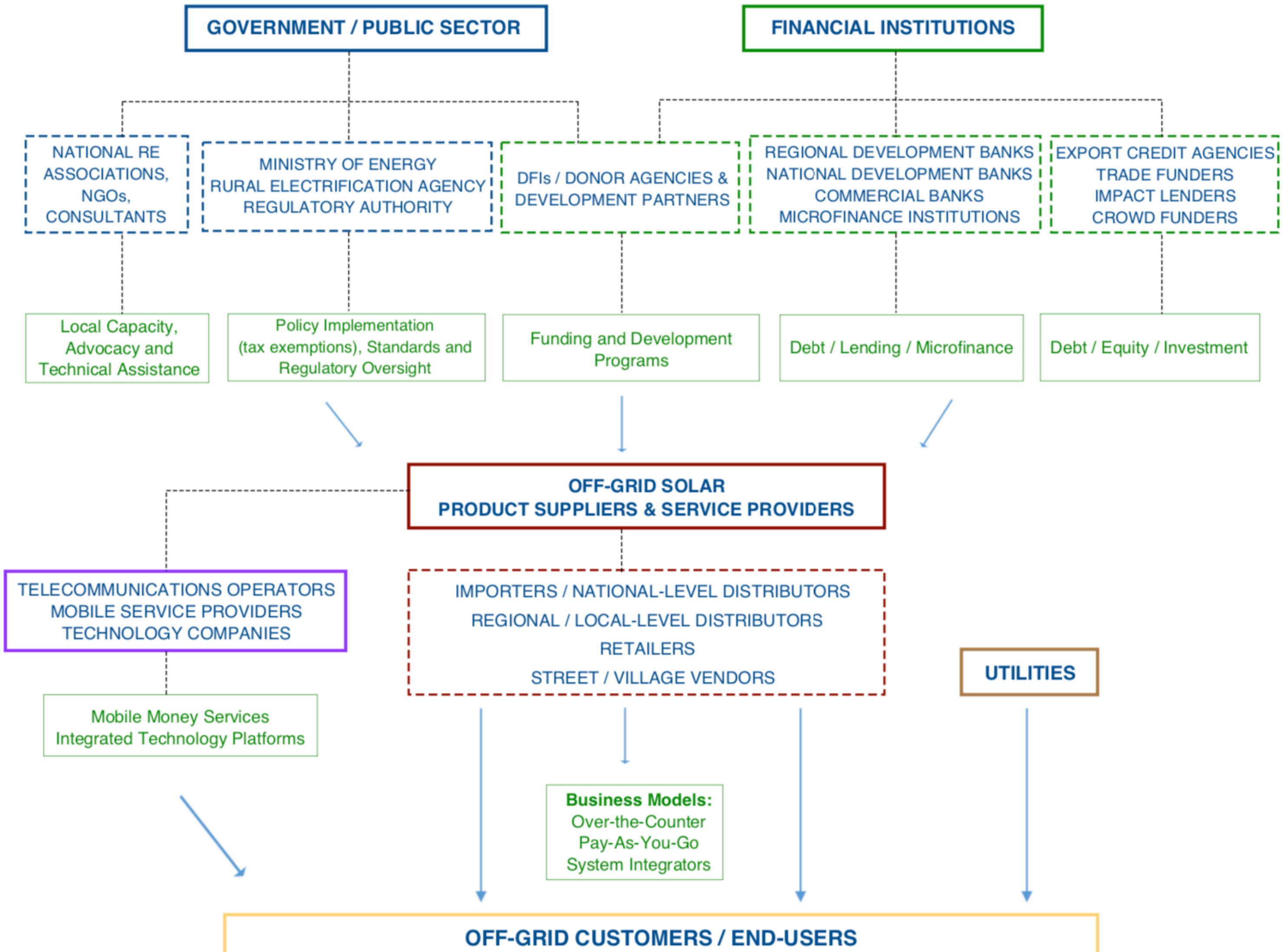
Classification		Description
Tier 1	Startup companies	• Less than 3 full time employees • Less than 300 SHS or Less than 1,500 lanterns sold • Less than USD 100,000 annual revenues • Does not have access to outside finance except personal loans and may have a business account
Tier 2	Early stage companies	• 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	• 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

- **Regional Off-Grid Solar Market and Supply Chain Overview**

A number of actors participate in the off-grid solar supply chain, including importers, distributors, wholesalers, retailers, financial and technical partners and end-users (**Figure ES-12**). The 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 region, 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. This is especially true in countries where the reliability of grid electricity is poor.

Figure ES-12: Off-Grid Solar Market and Supply Chain Overview



Source: GreenMax Capital Advisors

Figure ES-13: OGS Product Sales Volume and Cash Revenue, 2016-2017

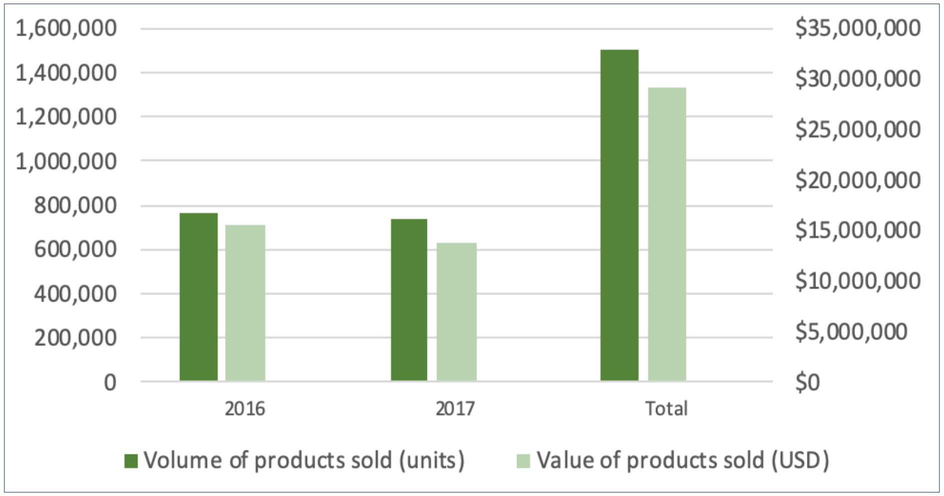
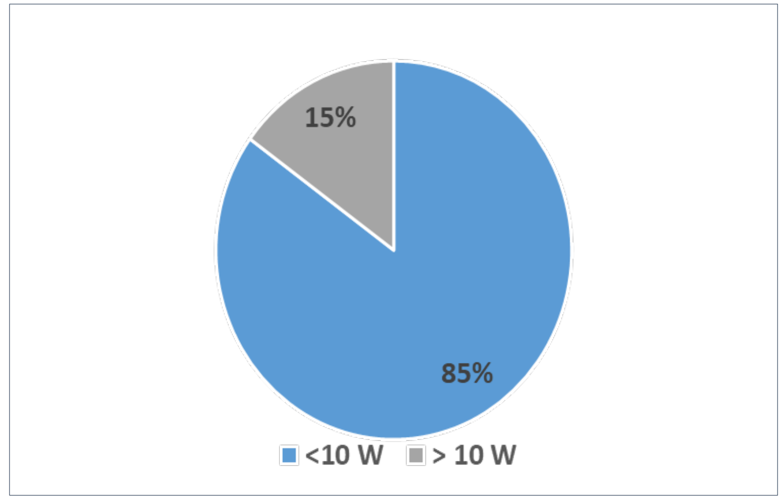


Figure ES-14: OGS Product Sales Volume by System Size, 2017



NOTE: **Figure ES-13** includes sales of both pico solar and SHS products; does not include sales from Cabo Verde, CAR, Chad, Guinea, Guinea-Bissau and Mauritania (no data)

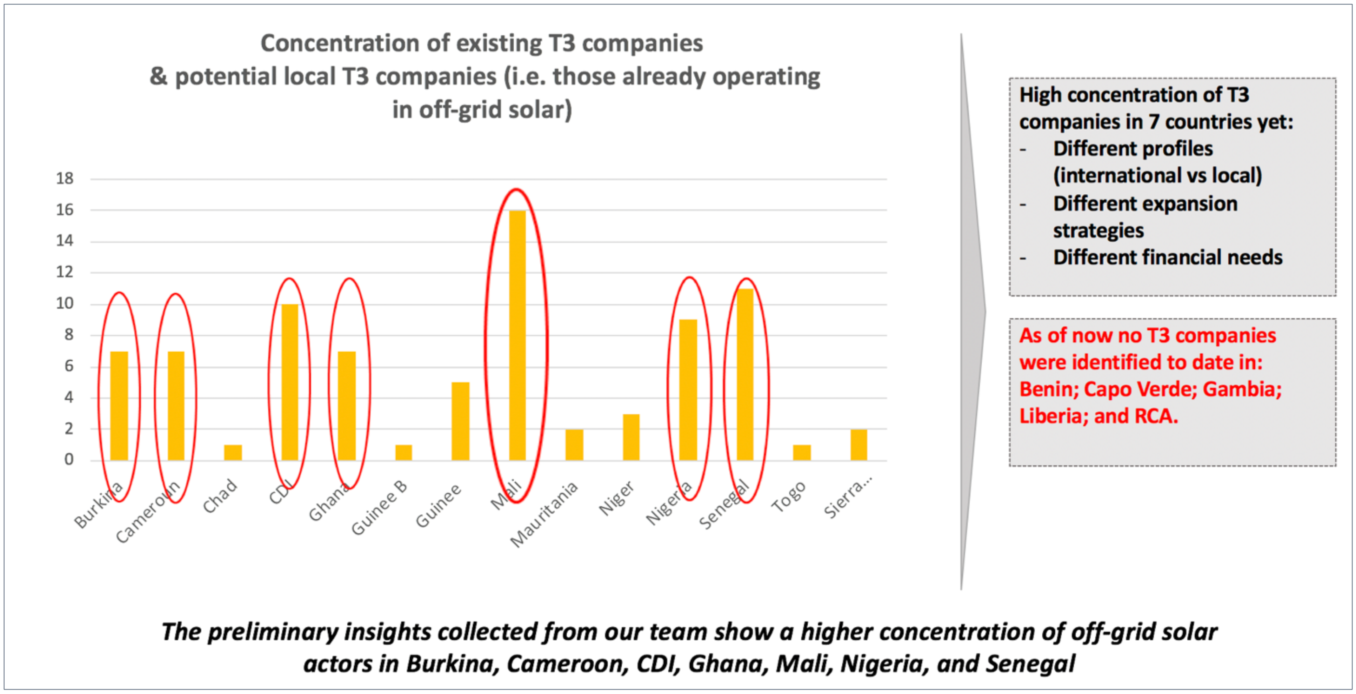
Source: Global Off-Grid Lighting Association

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. The regional market in West Africa and the Sahel, which was almost non-existent only five years ago, now consists of over 500 companies across the 19 countries and represented about 10% of worldwide sales (20% of Sub-Saharan Africa) in 2017.[39]

Recently published data from GOGLA on off-grid solar product sales volume and revenue indicates that in 2016 and 2017, more than 1.5 million off-grid solar systems were sold for an estimated cash sales revenue of USD 28.7 million in West Africa and the Sahel, with Nigeria (USD 10.7 million), Burkina Faso (USD 5 million), Mali (USD 4.1 million) and Ghana (USD 3 million) representing the markets in the region with the largest OGS product sales revenue during this period. Pico-solar products and systems continue to make up the majority of sales volume (**Figure ES-14**).

[39] "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

Figure ES-15: ROGEP Supplier Market Insights



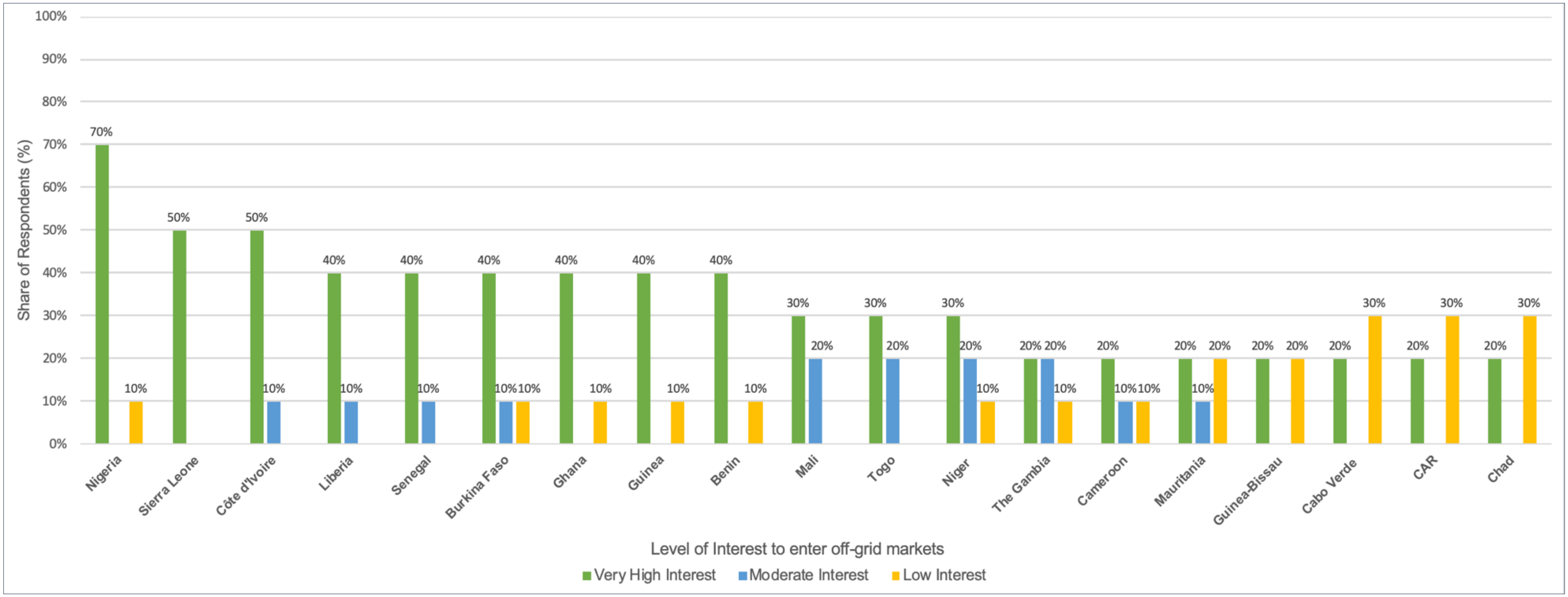
Source: ECOWAS Center for Renewable Energy and Energy Efficiency

Most of the 500 identified solar companies in the region are small local players, who 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 (**Figure ES-15**).

- **Level of Interest in the Region**

A survey of large international solar companies that assessed *inter alia* their level of interest in entering the off-grid markets of West Africa and the Sahel. The results of this survey are presented in **Figure ES-16**. 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.

Figure ES-16: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[40]



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

[40] NOTE: This is not a representative sample of respondents (sample size = 10 respondents). The survey was meant to solicit general 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.

- **Key Challenges for the Off-Grid Solar Supply Chain**

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.

The region's nascent 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 face a number of technical competency requirements, including the selection of approaches and solar PV technologies, the design of their associated marketing instruments and the implementation of related initiatives.

➢ KEY BARRIES TO AND DRIVERS OF OFF-GRID SOLAR MARKET GROWTH

Local industry and supply-chain stakeholders who participated in the Task 2 focus group discussions and surveys identified a number of barriers to and drivers of OGS market growth. A summary of the most common market barriers and drivers from across the region are presented in **Table ES-3**.

Table ES-3: Key Barriers to and Drivers of Off-Grid Solar Market Growth in West Africa and the Sahel

Key Barriers to Off-Grid Solar Market Growth
• Low consumer purchasing power and lack of consumer financing options
• Low levels of consumer awareness and/or misperceptions about the value of solar solutions, particularly in rural areas
• Lack of financing for solar companies
• Lack of enforceable standards and regulation leads to informal sector competition and market spoilage
• Lack of local capacity/qualified technicians to maintain systems
• Insufficient or fragmented market data on consumer electricity needs, usage or experience
• High transaction costs associated with equipment inventory, distribution, importation, taxation etc. (and lack of policy support)
• Policy/regulatory barriers – many governments have not done enough to disincentivize alternatives/substitutes for solar (e.g. diesel subsidies), which makes solar a less attractive option to consumers
Key Drivers of Off-Grid Solar Market Growth
• Strong off-grid electricity demand – electricity needs much higher than what national utilities can offer in the short and medium-term
• Rapidly increasing demand for consumer appliances that require electricity (e.g. cellphone, radio, TV, refrigerator etc.)
• Government policy/action is generally 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 region's 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, SUNREF (described below)

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

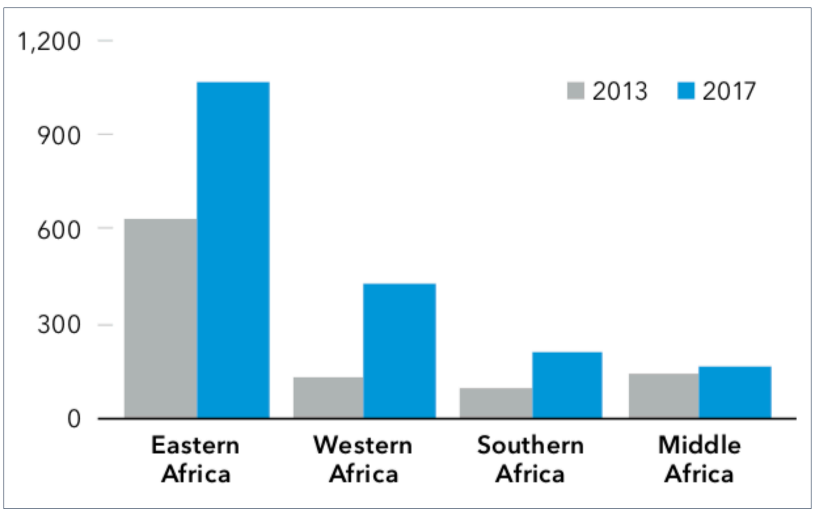
E. THE ROLE OF FINANCIAL INSTITUTIONS

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 study analyzed the willingness and capacity of national and regional financial institutions to provide financing to businesses and consumers throughout the region to support development of the OGS sector. In addition to commercial banks and microfinance institutions, various other sources of financing for the off-grid sector were analyzed, including from DFIs, private equity investors, specialized debt facilities, impact investors and crowdfunders.

➢ THE DIGITAL REVOLUTION AND ELECTRICITY ACCESS

The expansion of digital financial services, especially mobile money, has created new opportunities to better serve women, the lower-income population and other groups that are traditionally excluded from the formal financial system. Digital payments increase transparency across the private, public, and development sectors, and support economic growth by driving major cost savings, efficiencies, and higher productivity.[41] 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. In fact, most of the growth in the off-grid solar sector to date has been limited to countries with strong mobile money ecosystems, with particular crowding-in in East Africa, although the sector is also growing rapidly in West Africa (**Figure ES-17**).

Figure ES-17: Registered Mobile Money Accounts in Africa by Region

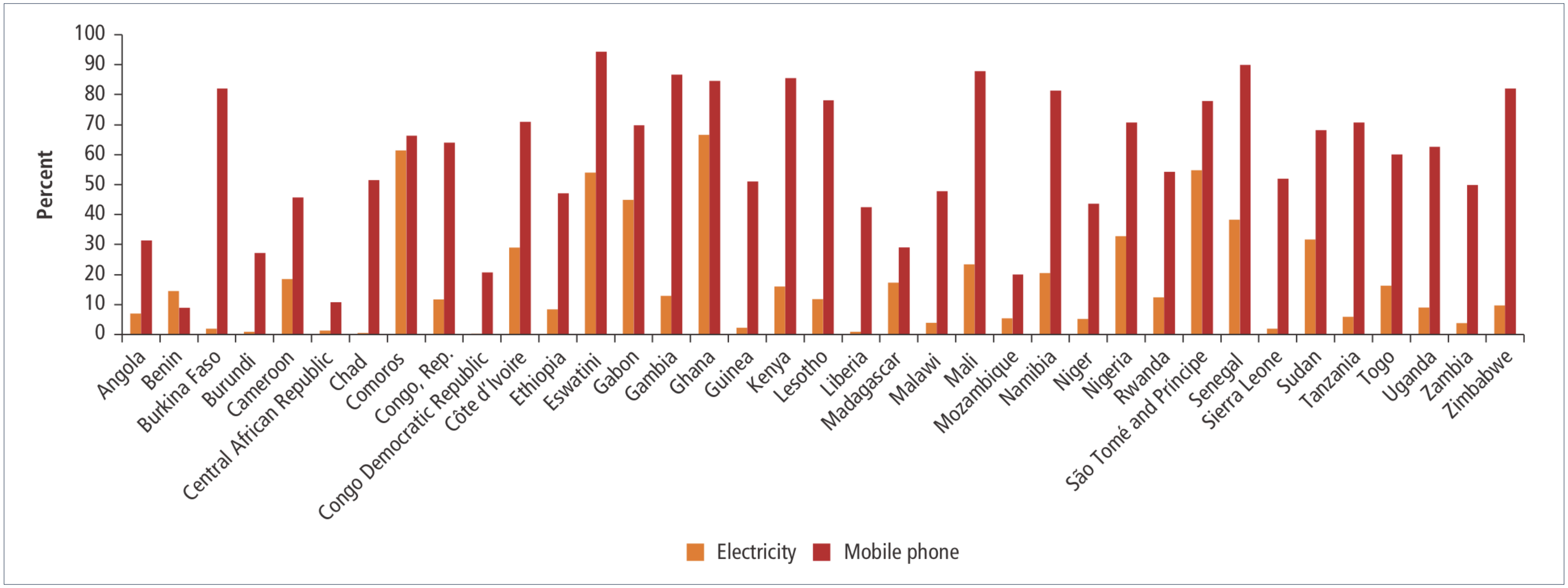


Source: International Monetary Fund

Widespread mobile phone ownership (**Figure ES-18**), growing network coverage (**Figure ES-19**) and mobile internet penetration rates (**Figure ES-20**) have led to the proliferation of mobile money services and rapid growth of the sector across the region (**Figures ES-21-22**). These dynamics are collectively increasing overall access to financial services and driving financial inclusion.

[41] "The Fight for Light: Improving Energy Access through Digital Payments," United Nations Capital Development Fund, (July 2017): https://btca-prod.s3.amazonaws.com/documents/291/english_attachments/Full-Energy-Case-Study.pdf?1499786348

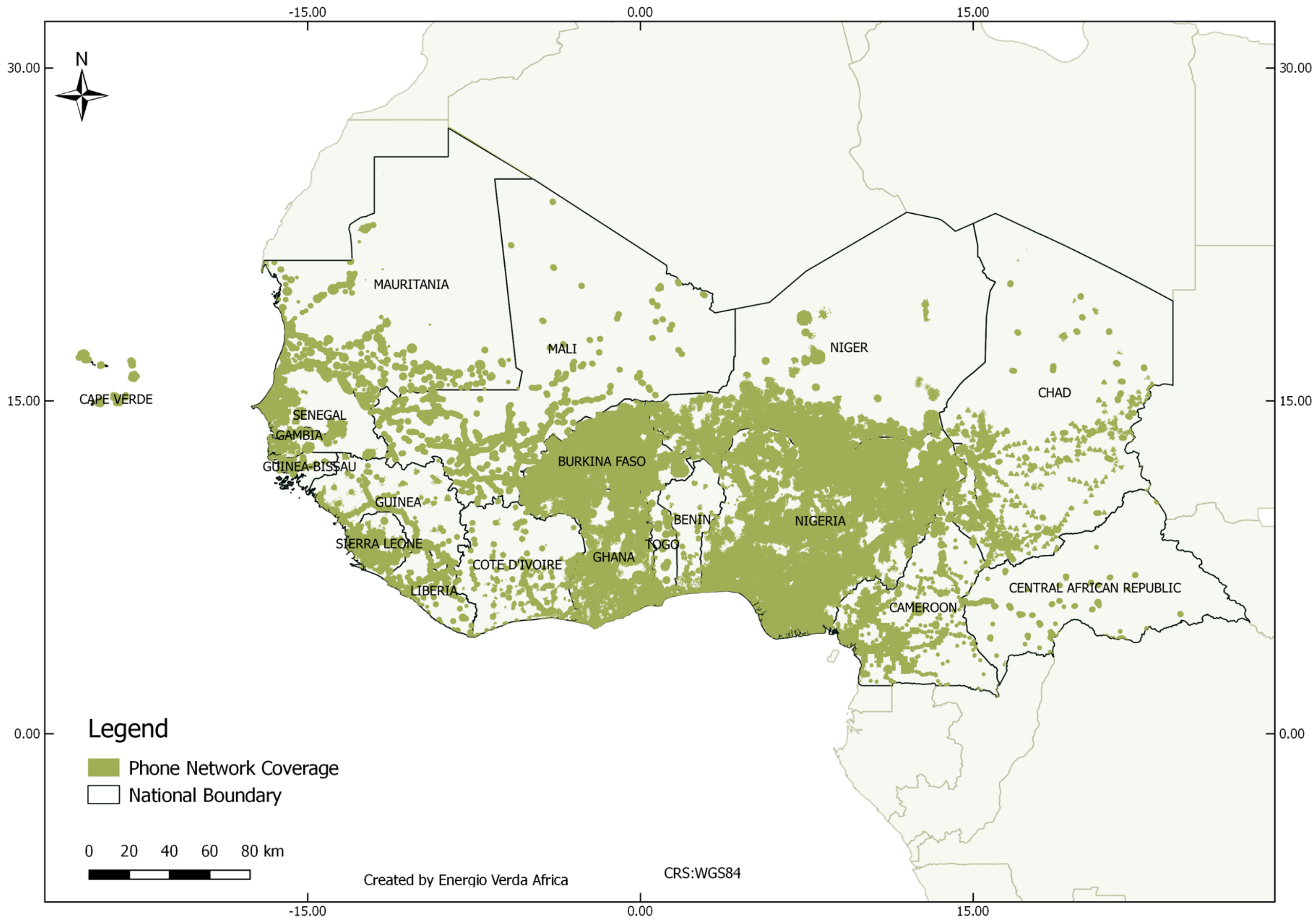
Figure ES-18: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)[42]



Source: World Bank

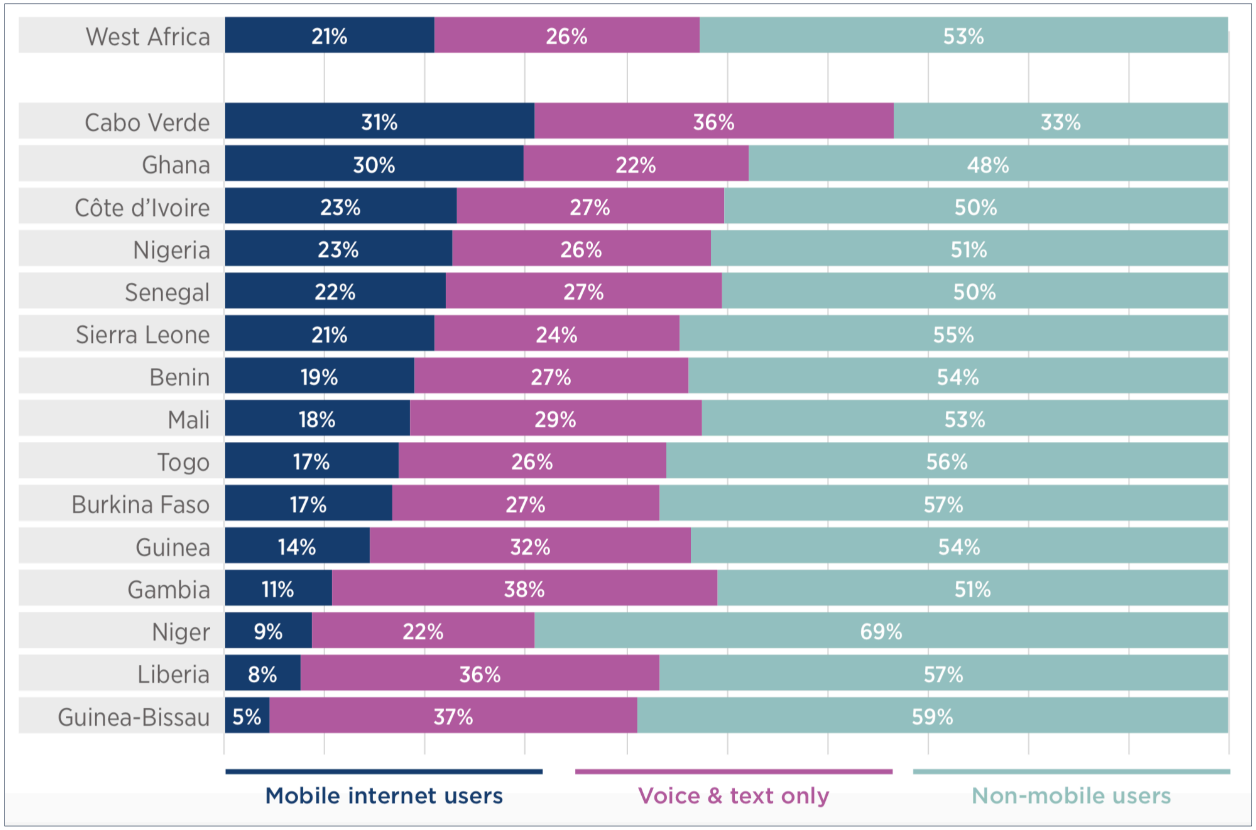
[42] Blimpo and Cosgrove-Davies, 2019.

Figure ES-19: Mobile Phone Network Geographic Coverage in West Africa and the Sahel



Source: GSMA

Figure ES-20: West Africa Mobile Internet Penetration, 2017[43]

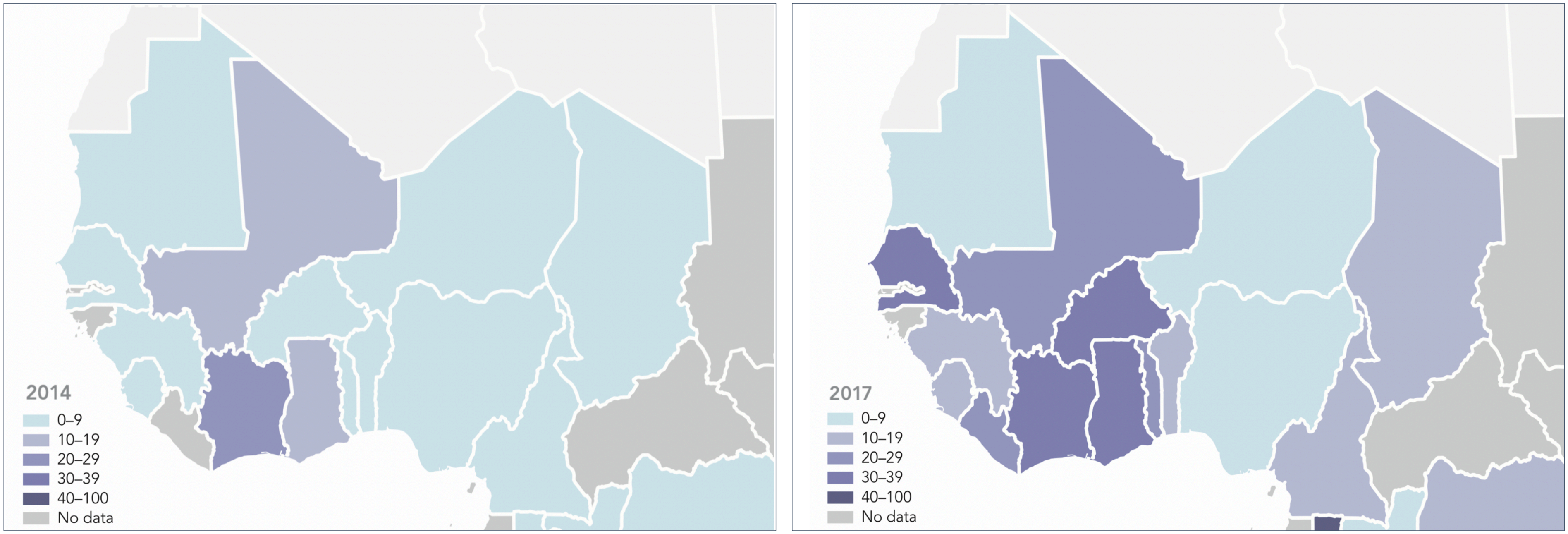


Source: GSMA Intelligence

By the end of 2017, there were 176 million unique subscribers across the ECOWAS region, while the overall subscriber penetration reached 47% (**Figure ES-20**). It is estimated that by 2025, around 72 million new mobile subscribers will be added in West Africa, taking subscriber penetration to 54%. Nigeria will account for the largest share of new subscribers, while Niger will record the fastest growth over this period.

[43] "The Mobile Economy: West Africa 2018," GSMA Intelligence, (2018): https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download

Figure ES-21: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[44]

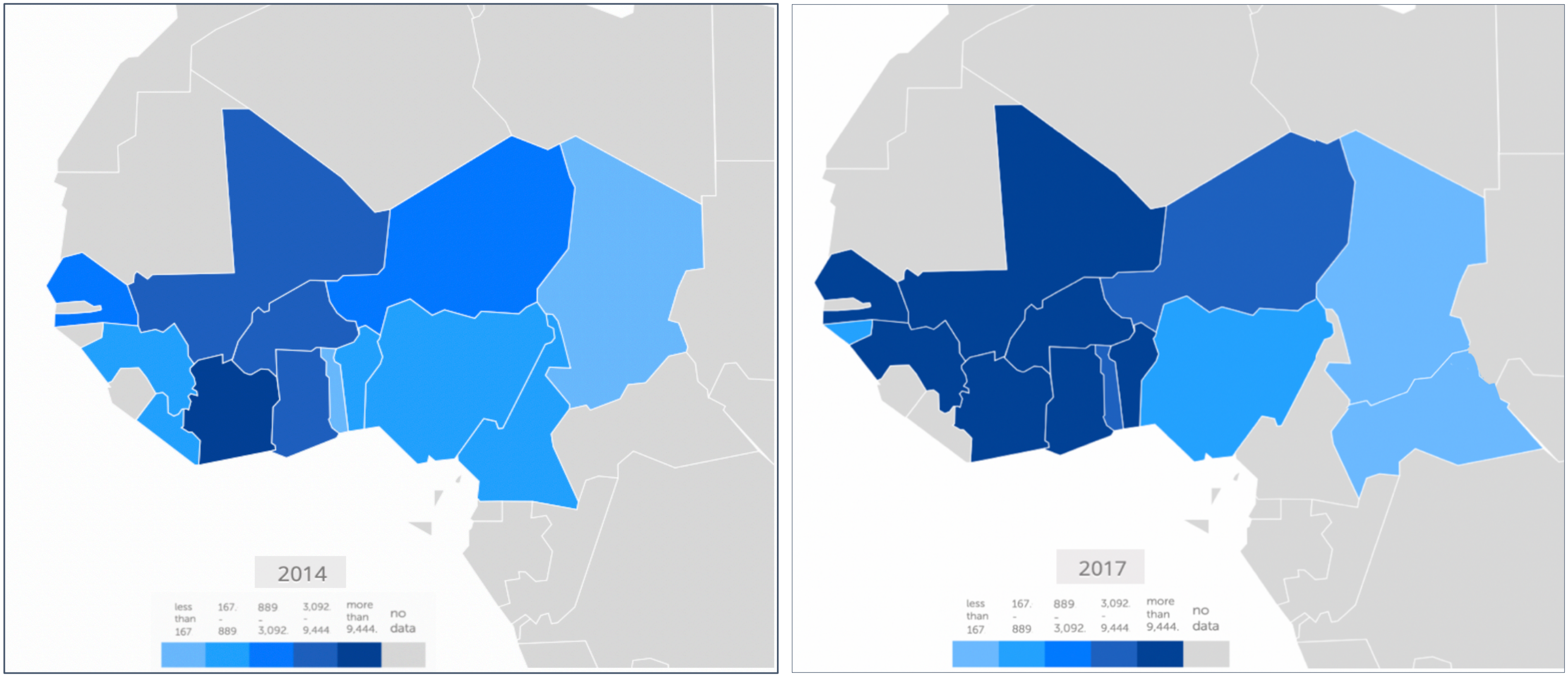


Source: World Bank Global Findex Database

Figure ES-21 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.

[44] Demirguc-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 ES-22: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[45]



Source: International Monetary Fund

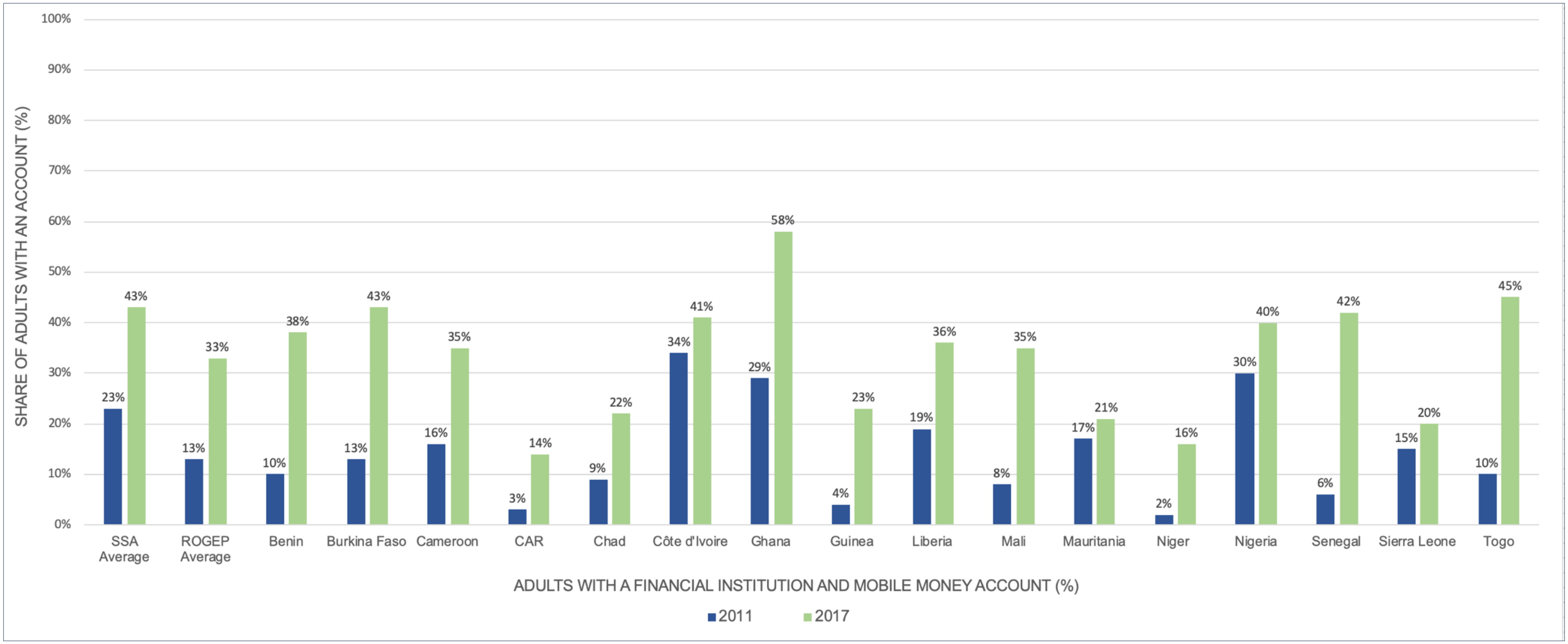
Figure ES-22 shows the increase in the number of mobile money transactions across West Africa and the Sahel between 2014 and 2017. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. Between 2014 and 2017, mobile money transaction volume 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.

[45] International Monetary Fund – Financial Access Survey: http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460054136937

- **FINANCIAL INCLUSION**

In 2017, 33% of the adult population in West Africa and the Sahel had an account at a financial institution or with a mobile money service provider, up from 13% in 2011. Despite this improvement, the region was still 10% below the average for Sub-Saharan Africa in 2017 (**Figure ES-23**).

Figure ES-23: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017[46]



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

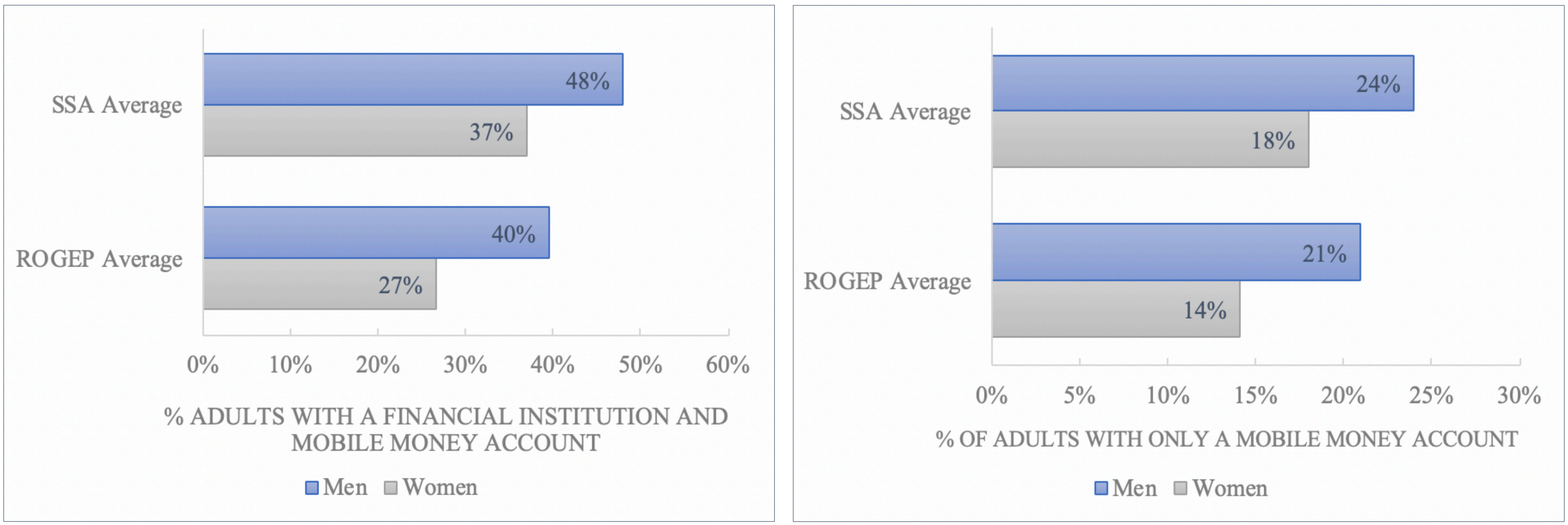
Source: World Bank Global Findex Database

[46] Demirguc-Kunt et al., 2017.

- **Gender and Women's Financial Inclusion**

According to data from the World Bank's 2017 Global Findex survey – which examines, among many things, the extent of financial inclusion in Sub-Saharan Africa (SSA) – women in the region are about 10% less likely to have an account at a financial institution or with a mobile money service provider than men. As of 2017, the financial inclusion gender gap in West Africa and the Sahel was slightly higher than the SSA average at 13% (**Figure ES-24, left**). The gender gap in access to mobile money is smaller; as of 2017, 21% of adult men compared to 14% of women in West Africa and the Sahel only had a mobile money account (**Figure ES-24, right**), which is similar to the mobile money gender gap in SSA (6%). While the financial inclusion gender gap increased in many countries, in absolute terms, rates of financial inclusion improved for women across the region. Only Mauritania and Nigeria witnessed a decline in access to financial services for women in absolute terms between 2014 and 2017.

Figure ES-24: Gender Gap in Financial Inclusion (Left) and Mobile Money (Right) in Sub-Saharan Africa and West Africa and the Sahel, 2017[47]



NOTE: Cabo Verde, Guinea-Bissau and The Gambia excluded (no data)

Source: World Bank Global Findex Database

[47] Demirguc-Kunt et al., 2017.

➢ FINANCIAL INSTITUTIONS AND PROGRAMS SUPPORTING OFF-GRID SOLAR LENDING

• Donor and DFI-Funded Programs

AFD – Sustainable Use of Natural Resources and Energy Finance (SUNREF): The SUNREF program is an AFD-sponsored initiative that provides concessional financing and technical assistance to financial institutions to fund clean energy projects. The TA component aims to validate projects and their eligibility for the program, which are then presented to partner banks for financing. In 2014, Orabank, Société Générale and AFD signed a partnership agreement to launch SUNREF's West Africa program, which makes a EUR 30 million credit line available to banks in the West African Economic and Monetary Union. To date, the program has deployed financing to partner banks in Benin, Côte d'Ivoire, and Senegal, with projects in Togo and Nigeria scheduled for implementation in 2019.[48] Prior to its expansion into West Africa, the SUNREF initiative achieved success in East Africa's off-grid sector, where it increased lending particularly to the commercial and industrial (C&I) market segment.

USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR): The CEADIR program in West Africa was a multi-year initiative that took place from 2016 to 2018 in eight West African countries – Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone. The program's objective was to strengthen the clean energy lending capacity of participating local FIs in each country. CEADIR engaged with local banks by delivering national workshops that provided training to bank staff covering the stand-alone solar sector, mini-grids and the pay-as-you-go business model. The workshops were complemented with one-on-one technical assistance to help banks develop clean energy lending strategies based on the specific capacity building needs of each bank in the context of each country.[49]

African Development Bank – Sustainable Energy Fund for Africa (SEFA) and **Facility for Energy Inclusion (FEI)**: The SEFA is a USD 60 million multi-donor trust fund administered by the AfDB with the objective of supporting sustainable private sector led economic growth in African countries through the efficient utilization of clean energy resources and support small- and medium-scale renewable energy project development.[50] 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 launch of the FEI in 2016 led to a significant increase in AfDB financing for distributed renewable energy throughout Sub-Saharan Africa, with Cameroon, Côte d'Ivoire, Niger, Burkina Faso, Mali and Ghana having received among the largest shares of energy access financing from AfDB between 2014 and 2017.[51] The FEI Off-Grid Energy Access Fund (OGEF), structured by Lion's Head in partnership with the Nordic Development Fund, supports transaction structuring, provides local currency options to reduce risk for borrowers and their customers, and also offers technical assistance to companies to support off-grid market development.[52] The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[53]

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[48] Sunref West Africa: https://www.sunref.org/afriquedelouest/
[49] USAID Climate Economic Analysis for Development, Investment and Resilience: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
[50] African Development Bank – Sustainable Energy Fund for Africa: https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/
[51] Lee, A. Doukas, A. and DeAngelis, K., "The African Development Bank and Energy Access Finance in Sub-Saharan Africa: Trends and Insights from Recent Data," Oil Change International and Friends of the Earth U.S., (November 2018): http://priceofoil.org/content/uploads/2018/11/AfDB-Energy-Access-Finance-report-high-quality.pdf
[52] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com
[53] "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/

International Finance Corporation (IFC): In June 2018, the IFC announced it had invested USD 60 million in a regional risk-sharing facility to support Bank of Africa Group's lending to SMEs in eight African countries – including six ROGEP countries: Burkina Faso, Ghana, Mali, Niger, Senegal and Togo. Half of the facility is earmarked for women-run businesses, and for climate-related improvements, such as energy efficient equipment upgrades, small solar systems, and climate-smart agricultural supply chains. IFC's investment will cover up to 50% of the risk on these SME loans.[54]

- **Private Equity Investors**

One of the key findings of GreenMax's survey of both off-grid equity and debt financiers as well as of stand-alone solar entrepreneurs, is that there is a dearth of available equity, particularly for seed and Series A investment rounds in the off-grid space. As a result, many off-grid entrepreneurs are left with no source for early stage development aside from grant funding, which has become ever more competitive. Moreover, even many established off-grid enterprises find themselves overleveraged with debt. A recent study by Wood Mackenzie and Energy4Impact indicates that of more than USD 1.1 billion raised by Solar Home System companies to date, more than 50% has been through debt facilities.[55]

With some notable exceptions, most of the early stage equity invested in Africa focused off-grid enterprises to date has come either from a handful of specialized Energy Access Investors, from general Impact Investors or from DFIs making direct investments. An early trend of investment by global tech venture funds seems to have ended due to slow results. A few investments, generally at Series B stage, have been made by Africa focused Private Equity or Infrastructure Funds. Most recently, several specialized energy funds, originally designed to focus on larger scale IPPs have ventured into the off-grid space. Strategic players are becoming increasingly active in the sector.

- **Specialized Off-Grid Debt Facilities**

In recent years, responding to a lack of debt financing overall for all off-grid energy sub-segments, there have emerged a plethora of specialized debt funds dedicated solely to lending for African off-grid projects and enterprises. GreenMax has identified 18 specialized lenders either already in operation or nearing their first close. If all of these lenders accumulate the funds they have indicated, there will be a total of close to USD 2 billion in funds under management available to lend to the African off-grid space by sometime in 2019. Unfortunately, at time of writing only a handful of these are actively seeking mini-grid lending opportunities, as most are focused on asset-based lending for SHS portfolios. Of special note of course is Crossboundary Energy Access (CBEA), which is the only specialized mini-grid lender and which has already provided a term sheet to SMZ. As more of these funds become available and the market becomes more competitive, most of these lenders have indicated that they may consider lending to mini-grid developers in the future.

- **Loan Guarantee Programs and other Risk Mitigation Instruments**

Governments, DFIs and donors can offer guarantees to private lenders that loans will be repaid in the event of default by an off-grid project owner or developer. A loan guarantee is a promise by a guarantor to an identified lender to assume the debt obligations of an identified borrower (i.e. the mini-grid developer or project owner). Such guarantees usually cover 50% of the outstanding principal of the loan but can be more – even 75% – to encourage banks to offer more-attractive terms. Common sources of these guarantees

[54] "IFC Invests in Bank of Africa to Expand SME Lending in Eight Countries," International Finance Corporation, (4 June 2018): https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/947B76E4C106A246852582A200440E1C?OpenDocument

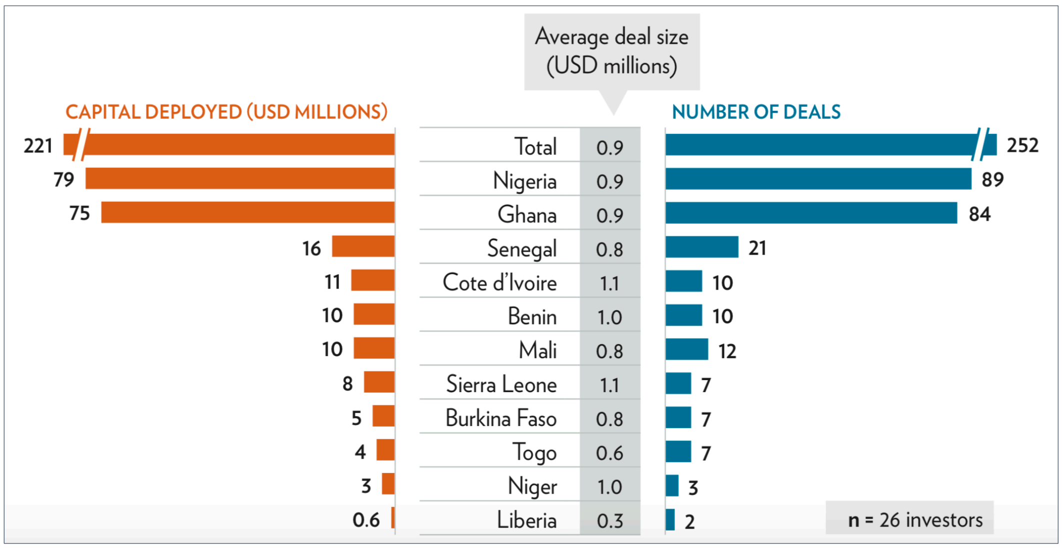
[55] "Strategic investments in off-grid energy access: Scaling the utility of the future for the last mile," Energy4Impact, (February 2019): https://www.energy4impact.org/file/2086/download?token=9-hw5RF1

include the IFC Small Loans Guarantee Program (SLGP), the USAID Development Credit Authority (DCA), the African Guaranty Fund (AGF), the Swedish International Development Cooperation Agency (SIDA), GuarantCo, the African Export-Import Bank (Afrexim Bank) and African Trade Insurers.

- **Impact Investors and Crowdfunders**

An assessment carried out by the Global Impact Investing Network found that while impact investing steadily increased across Africa between 2005-2015, most of the investment in West Africa was highly concentrated, with Nigeria and Ghana together accounting for about 70% of the total capital deployed in the region (**Figure ES-25**).[56]

Figure ES-25: Non-DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Crowdfunding is a relatively novel approach for the financing off-grid solar projects and companies in Africa, though the sector has quickly grown in importance. Crowdfunding for energy access projects and off-grid energy companies reached USD 8.7 million in 2016, and this figure is expected to grow rapidly.[57] By 2018, the total transaction value of international crowdlending in Africa has reached USD 3.7 billion, with a 12% combined annual growth rate.[58] Although most of the international financing for off-grid energy has focused on East Africa to date, this dynamic is gradually shifting, as a growing number of crowdfunding platforms are expanding their operations into West Africa. As an example, Bettervest, a German-based crowdfunding portal, has supported at least 20 off-grid energy projects in West Africa, raising over USD 3 million in just the last three years.[59] In addition to Bettervest, additional identified crowdfunders that are active in ROGEP countries include Trine, Lendahand, Ecoligo, Crowdcredit, Sun Exchange and Kiva.

[56] "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

[57] Cogan, D. & Collings, S., 'Crowd Power; Can the Crowd Close the Financing Gap?'" Energy 4 Impact (2017): https://www.energy4impact.org/file/1883/download?token=aft0NCOX

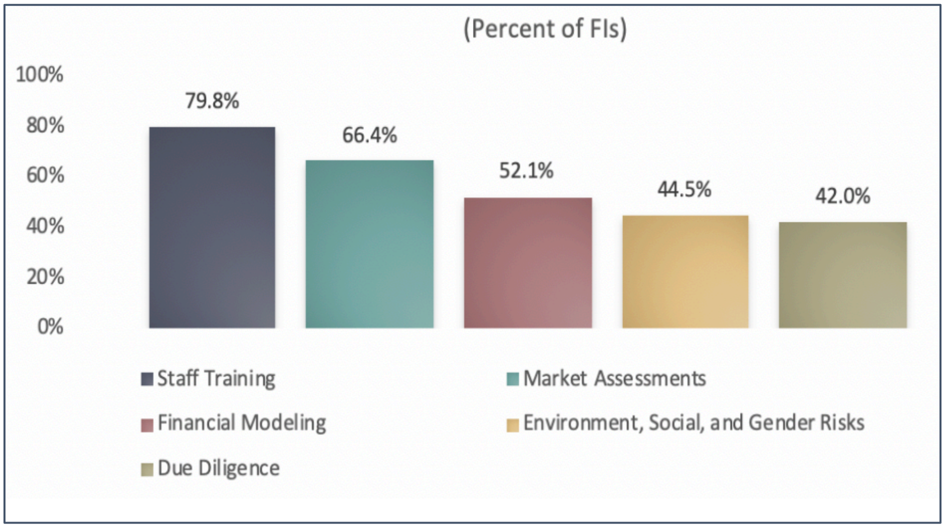
[58] Statistica: https://www.statista.com/outlook/334/100/crowdlending--business-/worldwide

[59] Bettervest: https://www.bettervest.com/en/funded-projects/

➢ FINANCIAL INSTITUTION ASSESSMENT

According to the Task 3 survey of financial institutions across the region,[60] 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-26**). 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-26: Financial Institution Needs to Increase Off-Grid Solar Lending



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

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 the region, 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-27**). 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.[61] 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-28**).

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[60] 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.

[61] "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

Figure ES-27: Key Barriers to Women's Participation in Energy Access

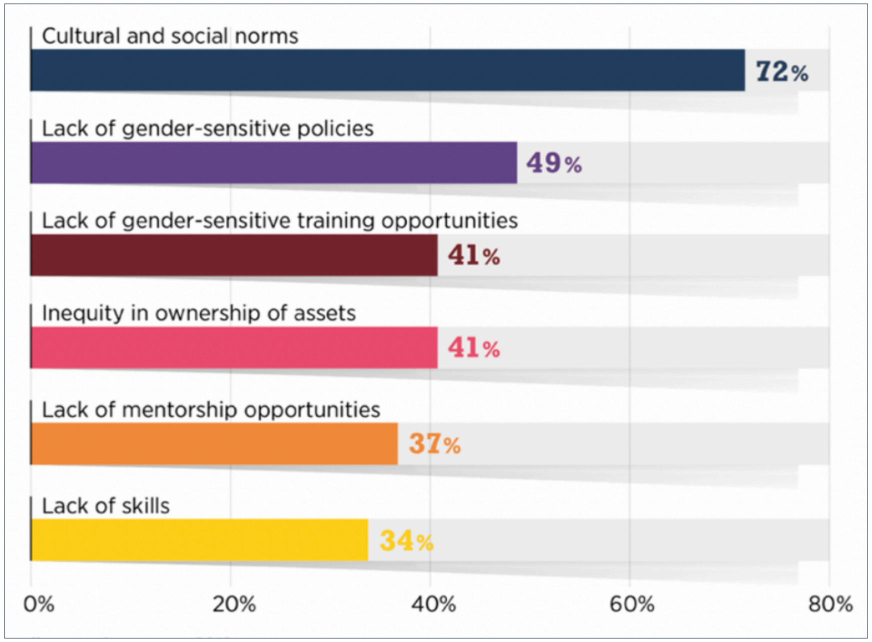
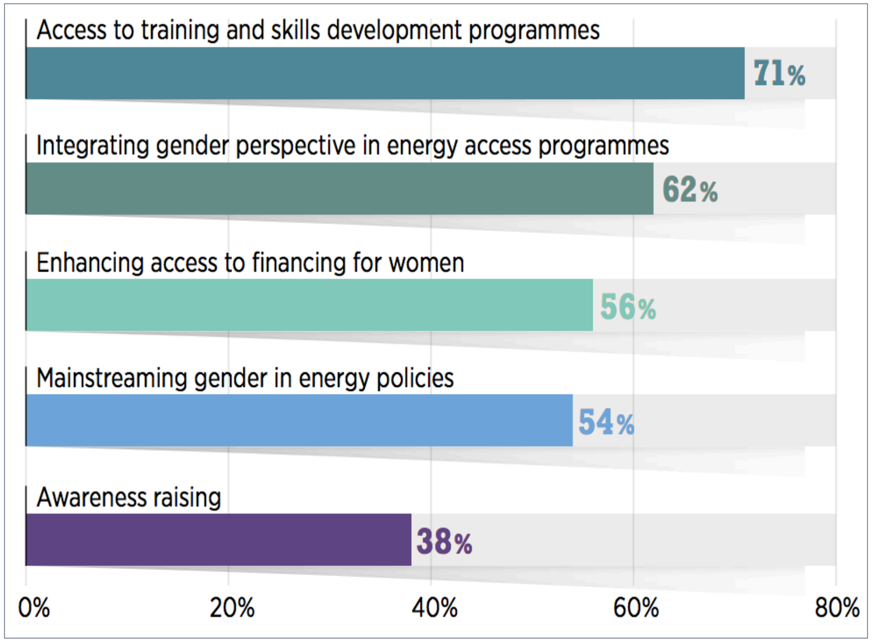


Figure ES-28: Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in each country 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.[62]

[62] "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. REGIONAL OVERVIEW

This section summarizes the main regional institutions, organizations and agencies in West Africa and the Sahel and briefly examines the region's macroeconomic environment.

1.1 Regional Institutions, Organizations and Agencies

The 19 ROGEP countries are divided into two main groups: (i) the 15 member states of ECOWAS, and (ii) the three countries that are members of the Economic Community of Central African States (ECCAS) – Cameroon, CAR and Chad. Mauritania remains outside of ECOWAS, although the country signed a partnership agreement with the community in 2017 aimed at improving its economic and security situation. The ROGEP countries are further sub-divided into the West African Economic and Monetary Union (WAEMU or Union Economique et Monétaire Ouest Africaine, UEMOA) and the Central African Economic and Monetary Community (Communauté Économique et Monétaire de l'Afrique Centrale, CEMAC). UEMOA consists of eight countries[63] that share a common currency, the West African CFA franc, while CEMAC is made up of six countries[64] that also share a common currency, the Central African CFA franc. Both CFA zone currencies are pegged to the euro. Despite some progress towards regional integration, economic and monetary policies across CFA countries still need to be further harmonized for member states to reap the macroeconomic and structural benefits of the currency unions.[65]

- **Economic Community of West African States**

The Economic Community of West African States (ECOWAS) is a regional political and economic union that was established over 40 years ago to increase the self-sufficiency of its member states[66] and to promote economic integration across the region. ECOWAS includes both the West African Economic and Monetary Union as well as the West African Monetary Zone. The economic union was founded to foster the idea of collective self-sufficiency by creating a single large trade bloc. ECOWAS has created an integrated region where the population enjoys free movement and engages in economic and commercial activities.

- **ECOWAS Center for Renewable Energy and Energy Efficiency**

In 2010, the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) was launched with the objective of promoting sustainable development across the region, focusing on infrastructure development and the provision of efficient, reliable and competitive energy sources to member states, with a specific emphasis on rural electrification/energy access. More specifically, ECREEE seeks to realize:

- A region that fosters sustainable development in agricultural, industrial and mineral resource development strategies;
- A region that develops infrastructure and makes services accessible to its citizens and enterprises; and
- A region that conserves its environment and resources, promotes modes of equitable and sustainable development in economic, social and environmental fields.

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[63] Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo.
[64] Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon and the Republic of Congo.
[65] "African Economic Outlook 2018," African Development Bank (2018): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf
[66] Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal and Togo.

➢ **ECOWAS Bank for Investment and Development (EBID)**

The ECOWAS Bank for Investment and Development (EBID) is the financial arm of ECOWAS. After many structural changes, EBID is now a single entity with two windows; one for promoting the private sector and the other for developing the public sector. The vision of EBID is to be the leading regional investment and development financial institution in West Africa and an effective instrument for poverty reduction, wealth creation and job promotion in the region. It's mission is to assist in creating favorable conditions for the emergence of an economically strong, industrialized and prosperous West Africa that is fully integrated into the global economic system with a view to taking advantage of opportunities and prospects offered by globalization. EBID aims to achieve these objectives by:

- Contributing to attaining the objectives of the Community by supporting infrastructure projects relating to regional integration or any other development projects in the public and private sectors; and
- Assisting in the development of the Community by funding special programs[67]

➢ **West African Economic and Monetary Union**

The West African Economic and Monetary Union (WAEMU, or Union Économique et Monétaire Ouest Africaine, UEMOA) is an economic coalition between eight West African countries (Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo) that share the same currency (CFA franc) and are mostly francophone. The founding treaty was signed in 1994 by the heads of state and government of seven countries and would later be signed in 1997 by Guinea-Bissau. The treaty was ratified to:

- Strengthen the economic and financial competitiveness of Member States in an open and competitive market environment and within a streamlined and harmonized legal context
- Secure convergence in the economic performance and policies of Member States by instituting multilateral monitoring procedures
- Create a common market among the Member States, based on the free movement of persons, goods, services, and capital, the right of establishment of self-employed or salaried persons, as well as a common external tariff and common market policy
- Institute the coordination of national sector-based policies by implementing joint actions and eventually administering joint policies, particularly on human resources, territorial administration, agriculture, energy, industry, mines, transport, infrastructure and telecommunications
- Harmonize, to the extent necessary, all actions taken to ensure the smooth running of the common market, the legislative systems of member states, and particularly the taxation system[68]

In 2001, UEMOA, in cooperation with ECOWAS, adopted the **Common Energy Policy** for its member states with the aim of (i) securing energy access; (ii) optimizing the management of energy resources through grid interconnection and common investment; and (iii) promoting renewable energy, energy efficiency and sustainable development.

In 2005, the **ECOWAS-UEMOA Energy Partnership Agreement** was signed by the two organizations with the aim of supporting development of energy access services in rural and peri-urban zones, promotion of renewable energy sources, regional energy information systems, human and institutional capacity building, and awareness raising among development partners and other key stakeholders as needed.

[67] Banque d'Investissement et de Developpement de la CEDEA: http://www.bidc-ebid.com/english/who-we-are/
[68] "The Amended Treaty," West African Economic and Monetary Union: http://www.uemoa.int/en/amended-treaty

- **West African Development Bank**

The West African Development Bank (Banque Ouest Africaine de Développement, BOAD) is a specialized and autonomous institution that promotes the balanced development of its member countries and fosters economic integration within West Africa by financing priority development projects. The bank provides direct support through subsidiaries, special funds established by the bank itself, or through national financial institutions. Its support can take on several forms, including equity investments, medium and long-term loans, guarantees and interest rate subsidies to BOAD member governments and public institutions, as well as to private businesses involved in development projects. BOAD supports (1) the construction or improvement of infrastructure needed for development, mainly in the areas of communications, transportation and electricity; (2) the improvement, creation or transfer of ownership of production and distribution machinery in the rural and industrial sectors; and (3) project preparation studies.[69] In 2017, BOAD gave out approximately USD 967.6 million in loan approvals.[70]

- **Economic Community of Central African States**

The Economic Community of Central African States (ECCAS) is an regional organization that promotes economic integration and cooperation of Central African states with the same currency (the Central African CFA Franc). Its member countries include Angola, Burundi, Cameroon, Central African Republic, Chad, Republic of the Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe, and Rwanda. ECCAS aims to promote and strengthen harmonized regional cooperation and sustainable development in areas of economic and social activity. These specifically include the fields of industry, transport and communication, energy, agriculture, natural resources, trade, customs, monetary and financial issues, human resources, tourism, education, skills development, culture, science and technology.

The ECCAS aims to achieve collective self-sufficiency, to raise the standard of living of the region's population, to increase and maintain economic stability, to strengthen peaceful relations between Member States, and to contribute to the progress and development of the entire region. The community seeks to create a Central African common market by developing capacities to maintain peace, economic and human integration, as well as to establish an autonomous financing mechanism through its monetary union (CEMAC). ECCAS is also a signatory of the International Energy Charter, a declaration of political intention aimed at strengthening energy cooperation between the signatory states.

- **Economic and Monetary Community of Central Africa**

The Economic and Monetary Community of Central Africa (Communauté Economique et Monétaire de l'Afrique Centrale, CEMAC) is made up of six countries (Cameroon, Chad, CAR, Equatorial Guinea, Gabon and the Republic of Congo). CEMAC's mission is to harmonize the regulations of member states to boost trade and facilitate the convergence of economic policies within the region. The Central Bank (Banque des Etats de l'Afrique Centrale, BEAC) oversees regional monetary policy for members states that share the same currency. CEMAC's vision is centered around the Regional Economic Program (Programme Économique Régional, PER), which has an objective of developing an integrated economic region where security, solidarity and good governance prevail. It aims to achieve this through the following measures:

- Ensuring stable management of the common currency (CFA Franc)
- Securing the environment of economic activities
- Establishing an even closer union among the Member States to strengthen their geographic and political solidarity

[69] West African Development Bank: https://www.boad.org/en/mission-objectives/
[70] "La BOAD en Chiffres," West African Development Bank: https://www.boad.org/en/la-boad-en-chiffres/

- Promoting national markets by removing barriers to community trading
- Coordinating development programs and industrial projects
- Creating a common market

➢ **West African Monetary Zone**

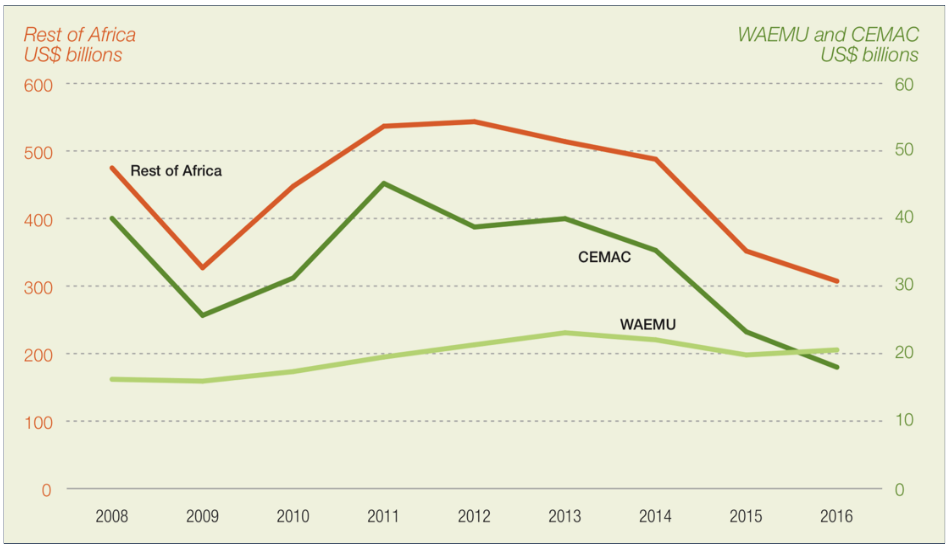
The West African Monetary Zone (WAMZ) is a group of six member states that includes The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone. The WAMZ was founded in 2000, with provisions for the West African Monetary Institute (WAMI) based in Ghana. WAMI was tasked with undertaking technical preparation for the establishment of a common West African Central Bank and the launch of a single currency for the WAMZ. WAMI's main function is the monitoring of macroeconomic convergence among member states and was later expanded to include facilitation of trade integration, financial sector integration, payment systems development, and statistical harmonization.[71] While the WAMZ has proposed plans to develop its own currency (the 'Eco'), the goal is to eventually join UEMOA and the CFA Franc zone, thus establishing a single monetary zone for much of West Africa.

[71] "West African Monetary Zone (2018) End-Year Statutory Meetings," Government of Ghana Ministry of Finance, (2019): https://www.mofep.gov.gh/press-release/2019-29-01/west-african-monetary-zone-2018-end-year-statutory-meetings

1.2 Macroeconomic Environment

The West Africa and the Sahel region faces a range of macroeconomic challenges but has made progress relative to its fragmented past. Real GDP growth in West Africa is projected to increase modestly from 3.6% in 2018 to 3.8% in 2019, driven by increased economic output from the region's larger economies – Nigeria, Ghana, Côte d'Ivoire, and Senegal – as well as impressive growth from several smaller economies – Benin, Burkina Faso, Sierra Leone and Togo. Central Africa has generally not fared as well in recent years, largely due to the region's dependence on oil exports. During the decrease in oil prices from 2014-2016, the CEMAC countries (especially Chad) experienced a sharp decline in exports (**Figure 1**) as well as greater exchange rate volatility (**Figure 2**).[72]

Figure 1: Exports from CFA Countries and the Rest of Africa



Source: African Development Bank

Figure 2: Exchange Rate Misalignment in CFA Countries

Source: African Development Bank

[72] African Economic Outlook, 2018.

While significant variation exists across the region, countries across West Africa and the Sahel have struggled to diversify and re-structure their economies to shift away from less productive sectors (e.g. agricultural) to more productive sectors (e.g. services). This transition has been slow due to the overdependence that many states still have on the agricultural sector as a source of livelihood for rural populations as well as export revenue for governments. With such a high percentage of the labor force reliant upon on the agricultural sector, economic growth and development in many countries is slow-moving, as the sector tends to employ low-skilled workers who lack the education and skills necessary to join the fast-growing services sector. Job creation in the formal economy of most countries also remains relatively limited, as the majority of people are employed by the informal sector. Meanwhile, despite improvements in recent years, poverty rates remain high, particularly in rural areas.

With its vast endowment of natural resources and agriculture potential, West Africa and the Sahel has huge potential for trade both in global and intra-regional terms.[73] However, most of the documented trade figures show that the region relies heavily on revenues from the export of a limited number of specific raw materials (e.g. petroleum, natural gas, rubber, cocoa, cotton, etc.). Poorly diversified economies have created planning problems for many governments, whose export revenues remain susceptible to volatility in global commodity prices and rainfall or climatic conditions. When agricultural output is slowed, corresponding increases in food imports have resulted in an increasingly negative trade balance. Lower global oil prices have severely constrained economies that rely on the extractives sector and/or fossil fuel export revenues. Nigeria, the region's largest economy, experienced a decrease in output of 1.5% in 2016 due to lower oil prices; a subsequent rebound in prices in 2017 helped the Nigerian economy recover slightly.[74] Chad, another oil-exporting ROGEP country, experienced a similar downturn during this period.

WAEMU and CEMAC countries benefit from relatively low rates of inflation and low interest rates, especially compared to other countries in the region outside of the CFA zone. For example, between 2009 and 2014, the average inflation rate for WAMEU countries was approximately 1%, while the average inter-bank interest rate during the same period was about 4%.[75] CFA zone countries survived the recent collapse of oil prices and commodities without suffering from currency collapse, inflation and fiscal distress like other West African countries (e.g. Nigeria).[76] However, the zone's pegged exchange rate system limits the ability of member states to quickly respond to shocks.

Both ECOWAS and ECCAS, as well as their respective monetary unions, WAEMU and CEMAC, continue to progress towards further regional integration and economic cooperation. However, there is still significant potential to improve cross-border movement of people as well as economic and monetary integration. While intra-regional trade takes place, it remains largely informal. Enhancing intra-regional trade offers opportunities for economies of scale and allows goods and resources to flow from areas of abundance to areas where a deficit exists. Tariffs are also critical barriers to regional trade, as well as import and export restrictions through quotas. Many West African countries regularly impose such restrictions either to protect local producers and industries (import restrictions) or to account for short-term food security concerns (export restrictions). In general, there is a dearth of reliable information stemming from the high volume of informal trade that goes on between countries across the region.

[73] "Overview of trade and barriers to trade in West Africa: Insights in political economy dynamics, with particular focus on agricultural and food trade," European Centre for Development Policy Management, (2016): www.subsahara-afrika-ihk.de/wp-content/uploads/2016/10/DP195-Overview-Trade-Barriers-West-Africa-Torres-Seters-July-2016.pdf

[74] African Economic Outlook, 2018.

[75] "The Landscape for Impact Investing in West Africa: Understanding the current trends, opportunities and challenges," Dalberg and Global Impact Investing Initiative, (December 2015): https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

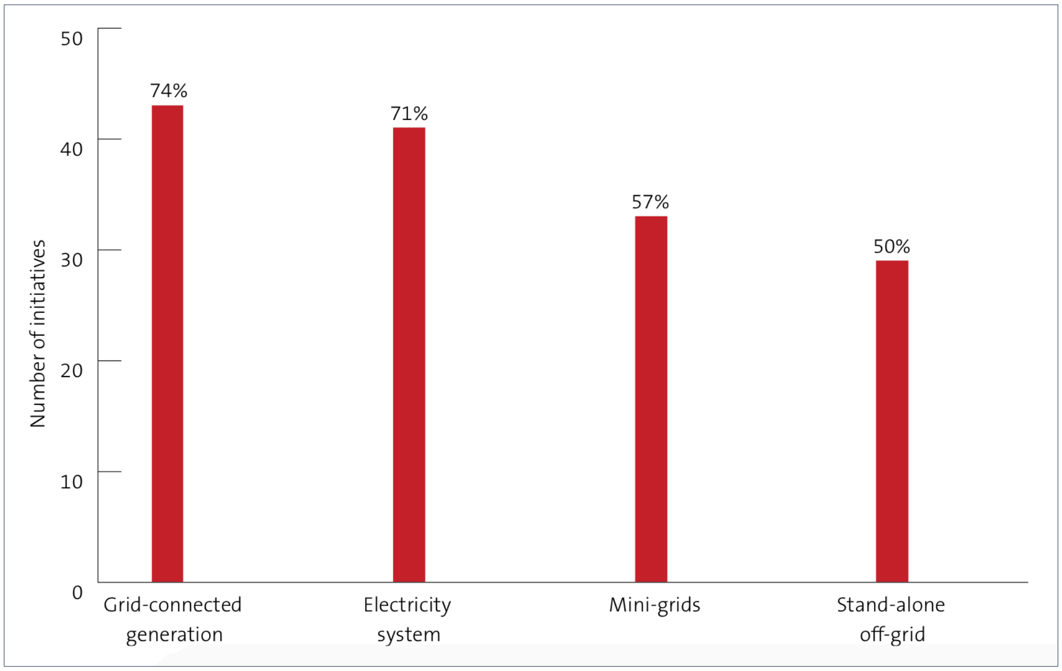
[76] Cappola, F., "In Africa: Understanding the CFA Franc and its Foreign Exchange Rate Impact," https://www.americanexpress.com/us/foreign-exchange/articles/cfa-franc-and-its-foreign-exchange-rate-impact/

II. REGIONAL OFF-GRID DEVELOPMENT PROGRAMS AND INITIATIVES

This section provides a comprehensive overview of the numerous regional and national off-grid sector programs and initiatives in West Africa and the Sahel, as well as specific program activities in ROGEP countries (where applicable).

An assessment undertaken by the Africa-EU Energy Partnership (AEEP) between 2009 and 2013 of development programs and initiatives offering a range of energy sector financing and technical assistance (TA) across Africa found that the stand-alone off-grid sector received less support compared to grid-connected initiatives in the electricity sector (**Figure 3**).[77]

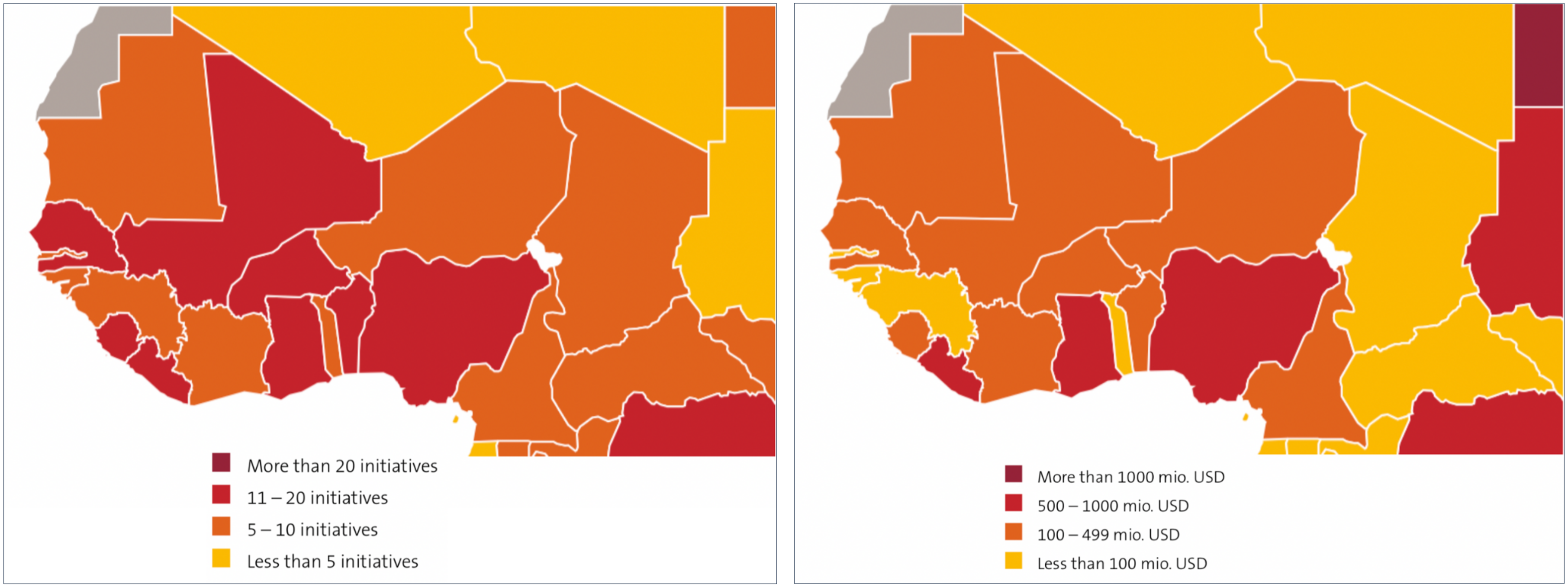
Figure 3: Energy Sector Development Programs and Initiatives in Africa, 2009-2013



Source: Africa-EU Energy Partnership

[77] "Mapping of Energy Initiatives and Programs in Africa," Africa-EU Energy Partnership, (2016): http://www.euei-pdf.org/sites/default/files/field_publication_file/mapping_of_initiatives_final_report_may_2016.pdf; and http://www.euei-pdf.org/sites/default/files/field_publication_file/annex_5_aeep_mapping_of_energy_initiatives_overview_of_initiatives_0.pdf

Figure 4: Geographic Distribution of Energy Development Programs and ODA in West Africa and the Sahel, 2009-2013[78]



Source: Africa-EU Energy Partnership

The maps in **Figure 4** show the geographic distribution of selected energy sector development programs and initiatives (left) and energy sector official development assistance (right) in West Africa and the Sahel between 2009 and 2013. The countries targeted by the largest number of selected programs and initiatives in the region during this period were Benin, Burkina Faso, Ghana, Liberia, Mali, Nigeria, Senegal and Sierra Leone. Liberia, Ghana and Nigeria were the top three countries in the region in terms of the energy sector ODA they received between 2009 and 2013.

[78] Africa-EU Energy Partnership, 2016.

Table 1 summarizes the programs that are actively providing funding/support to ROGEP countries and/or where ROGEP countries are eligible for the program's funding. These programs are described in further detail below.

Table 1: Summary of Regional Development Initiatives Active in West Africa and the Sahel[79]

Country	Regional Off-Grid Energy Development Programs / Initiatives																		
	SEforALL (Africa Hub)			AFD		ACP-EU Facility	AfDB FEI	AECF	AFREA	AGF	CDC Group	USAID CEADIR	Ci-Dev	ElectriFi	UK Energy Africa	EnDev	EREF	FMO AEF	Lighting Africa
	Gap Analysis	AA	IP	ARE	Sunref														
Benin		√+	√	√	√+		√		√+	√	√			√		√+	√	√	√
Burkina Faso	√+	√+	√	√		√+	√	√+	√	√	√			√		√	√	√	√+
Cabo Verde	√+	√+	√	√			√			√	√						√	√	√
Cameroon	√+	√	√	√			√		√	√	√			√				√+	√
CAR	√+	√	√	√			√			√	√			√				√	√
Chad	√+	√	√	√			√			√	√			√				√	√
Côte d'Ivoire		√+	√+	√	√+	√+	√+		√	√	√	√+		√			√	√+	√
The Gambia	√+	√+	√+	√			√		√	√	√			√			√	√	√
Ghana	√+	√+	√	√			√	√		√	√+	√+		√	√	√+	√	√+	√+
Guinea	√+	√	√	√			√			√	√	√+		√			√	√	√
Guinea-Bissau	√+	√+	√	√		√+	√			√	√			√			√	√	√
Liberia	√+	√+	√+	√		√+	√	√	√	√	√	√+		√		√+	√	√	√+
Mali		√+	√	√		√+	√	√	√+	√	√		√+	√+		√+	√	√+	√+
Mauritania				√		√+	√			√	√			√				√	√
Niger	√	√+	√	√			√		√	√	√	√+		√			√	√	√
Nigeria	√+	√+	√	√	√		√+		√	√	√	√+		√	√+		√	√	√+
Senegal		√+	√	√	√+	√+	√		√+	√	√	√+	√+	√	√+	√+	√	√	√+
Sierra Leone	√+	√+	√+	√			√			√	√	√+		√	√+	√+	√	√+	√
Togo	√+	√+	√	√	√		√			√	√			√+			√	√	√

√+ = eligible and support provided
√ = eligible (no support provided to date)
AA = Action Agenda
IP = Investment Prospectus

Source: Africa-EU Energy Partnership; Program websites

[79] NOTE: This table is limited to active development initiatives that are (i) ongoing in at least two ROGEP countries and/or (ii) where at least two ROGEP countries are eligible.

Regional Off-Grid Energy Development Programs / Initiatives (continued)											
Country	Power Africa	RECP	responsAbility EAF	SEFA	SIDA	SIMA fund one	SOGE	SREP	SPRD	UKAID ACEP	USADF
Benin	√		√	√+			√+	√	√		
Burkina Faso	√		√	√	√+	√	√	√	√		
Cabo Verde	√		√	√			√	√	√		
Cameroon	√		√	√+			√	√	√		
CAR	√		√	√			√	√	√		
Chad	√+		√	√+			√	√	√		
Côte d'Ivoire	√+	√+	√	√		√	√	√	√		
The Gambia	√		√	√			√	√	√		
Ghana	√+		√	√		√	√+	√	√	√+	√+
Guinea	√		√	√			√	√	√		
Guinea-Bissau	√		√	√			√	√	√		
Liberia	√+		√	√	√+		√	√	√		√+
Mali	√+		√	√+			√	√+	√		
Mauritania	√+		√	√			√	√	√		
Niger	√+	√+	√	√			√	√	√		
Nigeria	√+	√+	√	√+		√	√+	√	√	√+	√+
Senegal	√+	√	√	√		√	√	√	√	√+	
Sierra Leone	√		√	√			√+	√	√	√+	
Togo	√		√	√			√	√	√		

√+ = eligible and support provided
√ = eligible (no support provided to date)

Source: Africa-EU Energy Partnership; Program websites

- **Sustainable Energy for All (SEforALL) Africa Hub**: The SEforALL Africa Hub is a partnership of African institutions – namely the African Development Bank (AfDB), the African Union Commission (AUC), the NEPAD Planning and Coordination Agency and the UN Development Programme (UNDP) – that provides TA to African countries to facilitate the implementation of the SEforALL initiative in Africa and the achievement of its 2030 objectives.[80]

  In 2011, ECREEE partnered with the SEforALL Africa Hub and adopted a coordinated approach to work closely with member states to implement SEforALL Country Action Agendas. ECREEE provides ongoing TA to ECOWAS member states to help each country prepare the following set of interconnected reports and policy documents:

  - National Renewable Energy Action Plans (NREAP)
  - National Energy Efficiency Action Plans (NEEAP)
  - SEforALL Action Agenda
  - SEforALL Investment Prospectus

  The African Energy Leaders Group (AELG) is a community of energy sector leaders from the public and private sector dedicated to promoting a sustainable energy transition in Africa in support of the objectives of the SEforALL Initiative.[81] Among the group's key political leaders are the President of Côte d'Ivoire, Vice President of Nigeria, several West African Prime Ministers, and regional organizations such as the AUC, ECREEE and others.

- **AfDB Facility for Energy Inclusion (FEI):** The AfDB sponsored FEI is a USD 500 million debt platform used to catalyze capital markets support for innovative energy access strategies.[82] The initiative aims to connect 75 million households through off-grid energy access solutions through 2025. The dual goals are to scale up access to clean electricity for off-grid households as well as crowding in local financial institutions as co-lenders. FEI was first presented in 2018 in five African countries – including Côte d'Ivoire and Nigeria (see **Section 7.3.3: Specialized Off-Grid Debt Funds** for more details).

- **AfDB New Deal on Energy for Africa (2016-2025):** The New Deal on Energy for Africa is an AfDB strategic initiative focusing on improving electricity access in Sub-Saharan Africa. The program's main activities include: (i) setting up the right enabling policy environment, (ii) enabling utility companies for success, and (iii) dramatically increasing the number of bankable energy projects. For the off-grid sector, the objective is to increase off-grid generation and add 75 million connections (through isolated mini-grids and stand-alone systems) continent wide by 2025. In terms of outputs, the AfDB approved projects that contributed to the installation of 500,000 connections in 2017. Given that all AfDB off-grid energy programs fall under the purview of the New Deal on Energy for Africa, all of the ROGEP countries would be eligible to benefit either directly or indirectly from the initiative. Some of the strategy's flagship initiatives related to the promotion of off-grid include the "Bottom of the Pyramid Access Program" that includes the launch of a large-scale energy financing facility and the "Mobile Payment Program" that focuses on the fast track development and roll out of the PAYG business model.[83]

[80] "Sustainable Energy for All: The African Hub," https://www.se4all-africa.org/the-africa-hub/

[81] "The African Energy Leaders Group," SEforALL Africa Hub: https://www.se4all-africa.org/seforall-in-africa/regional-initiatives/the-african-energy-leaders-group/

[82] "African Development Bank, Nordic Development Fund and Partners launch Off-Grid Energy Access Fund with US$58 million," (August 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/

[83] African Development Bank: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Bank_s_strategy_for_New_Energy_on_Energy_for_Africa_EN.pdf

- **AFD African Renewable Energy (ARE) Scale-Up Facility:** In 2017, AFD, PROPARCO, and the European Commission launched the ARE Scale-Up Facility (EUR 24 million), a component of the Africa Renewable Energy Initiative (AREI), to boost private sector investment in off-grid renewable energy production in Africa. The Facility includes (i) a TA component (EUR 12 million) managed by AFD to strengthen regulatory and institutional frameworks and to prepare financing of private or public sector renewable energy initiatives in Africa; and (ii) a Guarantee Facility (EUR 12 million) managed by PROPARCO to support investment in off-grid, mini-grid and decentralized power industry companies. The ARE Scale-Up Facility initiative is an extension of the ElectriFI initiative of the EU, which pursues the same objective but with a more specific focus on rural and remote areas.[84]

- **AFD Sustainable Use of Natural Resources and Energy Finance (SUNREF):** The SUNREF initiative provides concessional financing to encourage FIs to fund clean energy projects. The funding includes a TA component to validate projects and their eligibility for the program, which are then presented to partner banks for financing. To date, EUR 30 million has been deployed to partner banks in Benin, Côte d'Ivoire, and Senegal, while Togo and Nigeria are also eligible under the newly established SUNREF West Africa initiative.[85] The SUNREF initiative has achieved some success in East Africa's off-grid sector, where it has increased lending particularly to the commercial and industrial (C&I) market segment. In the C&I segment, solar systems are larger and offtakers are often companies with large enough balance sheets to borrow; as a result, this has been one of the stand-alone market segments where there has been some lending to date.

- **AfDB Sustainable Energy Fund for Africa (SEFA):** SEFA was initially established in 2011 by the AfDB with a commitment from the government of Denmark until it expanded into a multi-donor facility in 2013, with additional financial commitments from the governments of the United States, the United Kingdom and Italy. The USD 95 million facility is a key source of funding for the SEforALL Initiative and cooperates closely with the Africa Hub. SEFA operates through three financing components all focused on unlocking private investments in small to medium scale sustainable energy projects: (i) grants to facilitate the preparation of bankable projects, (ii) equity investments to bridge the financing gap and infuse managerial capacity, and (iii) support to public sector institutions in improving the enabling environment for private sector investments. SEFA is active in the following ROGEP countries: Burkina Faso, Cameroon, Chad, Mali and Nigeria. SEFA and the SEforALL Africa Hub are jointly developing a regional Green Mini-Grids Market Development Program.[86]

- **Africa Renewable Energy Access program (AFREA):** The AFREA program was established in 2009 to help meet energy needs and widen access to energy services in Sub-Saharan Africa.[87] AFREA is managed by the World Bank's Africa Energy Unit and is a funding window of the World Bank's Energy Sector Management Assistance Program (ESMAP). AFREA was set up through a USD 28 million contribution from the Kingdom of the Netherlands to the Clean Energy Investment Framework Multi-Donor Trust Fund (CEIF-MDTF) of ESMAP. AFREA II is funded through the World Bank's ESMAP. The program aims to expand access to reliable and affordable modern energy services by supporting improved service delivery and the scale-up of innovations in electricity, lighting and cooking.[88]

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84 "Renewable energy in Africa: €24 million to develop innovative projects and boost electrification on the African Continent," AFD PROPARCO, (March 2017): https://www.proparco.fr/en/renewable-energy-africa-eu24-million-develop-innovative-projects-and-boost-electrification-african

85 Sunref West Africa: https://www.sunref.org/afriquedelouest/

86 Sustainable Energy Fund for Africa: https://www.se4all-africa.org/seforall-in-africa/financing-opportunities/sustainable-energy-fund-for-africa/

87 "AFREA," World Bank ESMAP: https://esmap.org/node/1403

88 "Energizing Africa," ESMAP: https://www.esmap.org/sites/default/files/esmap-files/AFREA%20Energizing%20Africa_Web_0424_0.pdf

- In Liberia, AFREA has provided support for the development of the Catalyzing New Renewable Energy in Rural Liberia Project, notably by assisting the Government of Liberia to establish the Rural and Renewable Energy Agency.
- In Mali, AFREA has financed programs for the integration of renewable energy technologies into the country's off-grid electrification program under the Household Energy & Universal Access project (HEURA)

- **<u>AFREA Gender and Energy Program</u>:** The AFREA Gender and Energy Program aims to provide TA to develop gender and energy expertise by working with governments and their partners to integrate gender equity into energy institutions, programs, and projects. The primary objective is to establish a core body of evidence to demonstrate that promoting gender equity in energy projects improves development outcomes. Other objectives include building capacities of government officials and energy professionals to mainstream gender into their energy operations. This USD 1.5 million program is implemented by the World Bank Africa Energy Unit and the ESMAP.[89]

    - Under AFREA I, the Gender and Energy Program has helped integrate gender-sensitive approaches in Benin, Mali and Senegal to improve access to energy services into World Bank-financed projects. In Benin, the Program was implemented in Benin's National Energy Policy. In Mali, gender activities were integrated under World Bank's HEURA project and into SREP programs/projects. In Senegal, the gender assessment was integrated into the World Bank PROGEDE I project and has led to the design of PROGEDE II.
    - Under AFREA II, the Gender and Energy Program was extended to a number of additional ROGEP countries: Cameroon, Côte d'Ivoire, The Gambia, Liberia, Niger, and Nigeria.

- **<u>ACP-EU Energy Facility</u>:** The ACP-EU Energy Facility was established in 2005 by the EU Commission to co-finance projects on increasing access to modern and sustainable energy services for the impoverished in African, Caribbean and Pacific (ACP) countries, especially in rural and peri-urban areas. It is expected to provide off-grid electricity access to 4.7 million people worldwide.[90]

    - In Burkina Faso, the ACP-EU Energy Facility is currently implementing the Decentralized Rural Electrification of Ziro and Gourma Provinces Project, which intends to increase electrification through hybrid PV/diesel and PV/biomass/diesel systems.
    - In Côte d'Ivoire, the facility supported the electrification of rural communities through solar PV micro-grids in the region of Zanzan, between 2012 and 2017. As a result, seven micro-grid plants have been built, operated, and managed by the communities themselves.
    - In Guinea-Bissau, the Community Program for Access to Renewable Energy (2011-2015) has installed a 312 kW PV hybrid power generation system, providing electricity to 250 clients (190 households and 60 business and 10 institutions).
    - In Liberia, the ongoing Light Up Project (2016-2019) supports the development of off-grid solar PV solutions for lighting and cooking, targeting 10,000 villages. As of December 2017, over 2,000 products (solar and cook stove) have been sold through the 10 retailers that have been identified.
    - In Mali, the facility is supporting the Access to Modern and Sustainable Services Project (2014-2018), which targets the distribution of clean lighting solutions, including solar lanterns.
    - In Mauritania, off-grid solar was expanded to isolated rural communities under the IED IPES-RURAL Project (2011-2015) and also under the Électrification rurale décentralisée interrégionale en Mauritanie (ERUDI) Project (2011-2016), which resulted in the establishment of rural community solar platforms.

[89] AFREA: http://siteresources.worldbank.org/INTGENDER/Resources/336003-1289616249857/awa_seck.pdf
[90] ACP-EU Project Database: http://database.energyfacilitymonitoring.eu/acpeu/PublicProjectOverview.xhtml

- In Senegal, the Projet d'acces aux services electriques de la Region de Sedhiou (PASES) launched in 2011 and now closed, provided small solar PV mini-grid plants and individual off-grid PV solutions to the country's rural population.
- In Burkina Faso and Mali, the "Flexi-Energy" pilot project developed a concept of hybrid solar-PV diesel plants in each country (2011-2016).

- **Africa Enterprise Challenge Fund (AECF):** The AECF is a development institution which supports businesses to innovate, create jobs, leverage investments and markets in an effort to create resilient and sustainable incomes in rural and marginalized communities in Africa. Launched in 2008, AECF is a fund managed by KPMG International Development Advisory Services. Its main activities involve the provision of grants and interest-free loans to private sector companies to support innovative business ideas in agriculture, agribusiness, renewable energy, adaptation to climate change and access to information and financial services. While the AECF portfolio of RE activities focused on Southern and Eastern Africa, it now intends to expand its activities into West Africa. Two RE financing windows are available: REACT EEP (Efficient Electrification Project) and REACT SSA (Supporting the Private Sector). Burkina Faso, Liberia and Mali are the three countries eligible in West Africa.[91]

  - In Burkina Faso, AECF REACT EEP has partnered with the Burkina Faso Ministry of Energy for a two-year pilot project (USD 5 million), launched in July 2018. The project seeks to support the installation of solar PV systems for households and SMEs in the urban and peri-urban areas of the capital, Ouagadougou. Under AECF REACT, a subsidy will be provided to households and SMEs (70% and 30% respectively) for the acquisition of the equipment.
  - In Liberia, AECF hopes to invest in the renewable energy industry through existing private sector companies. It plans to invest US 6 million over the next five years.

- **Carbon Initiative for Development (Ci-Dev):** The Ci-DEV was launched in 2011 by the World Bank Carbon Finance Unit. Ci-Dev's main objective is to increase the flow of international carbon finance to Least Developed Countries (LDCs) – with a focus on Africa – to support climate change mitigation, access to clean energy and other poverty reducing technologies. In the off-grid solar energy sector, Ci-Dev is active in two ROGEP countries: Mali and Senegal.[92]

  - In Mali, Ci-Dev has signed an emissions reduction purchase agreement (ERPA) with the rural electrification agency (AMADER) in 2016. Under the ERPA, Ci-Dev supports the PV hybridization of 250 diesel-based mini-grids and the distribution of 750,000 solar lanterns to rural households, with funds being used to improve regulatory and program management capacity within AMADER for the PV/diesel mini-grid hybridization component and to provide a subsidy to help households afford the solar lanterns.
  - In Senegal, Ci-Dev has signed an ERPA with the rural electrification agency in Senegal (Agence Sénégalaise d'Electrification Rurale, ASER) in 2016. Under the ERPA, Ci-Dev supports the government's off-grid rural electrification initiative by providing funding directly to households in the form of a cash voucher. Households can present these vouchers to the private concessionaires in order to pay for part of the initial costs to switch to cleaner electricity supplied by the new connection. The concessionaire then takes the voucher to ASER for reimbursement, with funding coming from the Ci-Dev.

- **CDC Group:** The CDC group is a development financial institution owned by the UK government. It supports the building of businesses in Sub-Saharan Africa and South Asia to push the growth of certain sectors. Growth that leads to jobs such as manufacturing, agribusiness, infrastructure, financial

[91] AECF Africa: http://aecfafrica.org
[92] Ci-Dev: https://www.ci-dev.org/Projects

institutions, construction, health, and education. CDC has developed an off-grid investment and lending program over the past three years (see **Section 7.3.3: Specialized Off-Grid Debt Funds** for more details).

- **Climate Economic Analysis for Development, Investment and Resilience (CEADIR):** CEADIR is a USAID-funded program that supports national and subnational governments, the private sector, and civil society make the business and economic case for climate change mitigation and adaptation by planning strategies, investments, and policies. This global project conducts assessments, develops and disseminates tools, and increases capacity for analysis, design, and implementation of clean energy.[93] Under the USAID West Africa Regional Mission, CEADIR carried out the Scaling Up Clean Energy Lending in West Africa initiative, a multi-year engagement that seeks to fund technical assistance and training to help local commercial banks scale up RE lending in Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal, and Sierra Leone. CEADIR carried out market analyses in all eight countries to identify critical challenges impeding clean energy lending in the region and identified three high-potential market segments for local FIs to begin or expand lending – PAYG, mini-grids, and rooftop solar. This initiative is also being supported by Power Africa.[94]

- **DEG:** the German Development Finance Institution, a subsidiary of KfW, aims to promote business initiatives in developing countries as a contribution to sustainable growth and improved living conditions. DEG invests about 60% of its annual financing in direct senior loans to companies, 40% in equity capital, broadly divided into mezzanine financing (20%), direct equity in companies (10%) and direct equity in funds (10%). In West Africa the priority DEG countries are Ghana, Cameroon, Côte d'Ivoire and Nigeria, although financing in all Sub Saharan countries may be considered. In the Africa off-grid energy space:

  - During 2015, DEG has provided risk capital in the form of both debt facilities and an equity investment in Germany based PAYG Solar Home System provider Mobisol to expand its activities in East Africa.
  - Through its Upscaling Program, DEG provides funding of 500,000 EUR, which constitutes a maximum of 50% of the total investment volume. Private sponsors must contribute a substantial share of equity (at least 25%). DEG's funds must be repaid in the event of success of the investment (depending on pre-defined financial criteria such as cash flow, revenue or profit). Through the Upscaling Program in 2018 DEG provided funding from its Up-scaling program for Daystar Power to finance, install and operate hybrid solar power systems for commercial customers in West Africa. The co-financing is part of Daystar Power's ongoing fundraising activities, targeting both equity and debt financing for the roll-out of its systems to leading African corporate customers.
  - Scaling innovative business models: With the Up-scaling program, DEG finances investments of small and medium enterprises (SMEs) that intend to scale up innovative business models with high developmental impact. The program addresses companies whose financing needs lie somewhere between microfinancing and the traditional financing by commercial banks.
  - Target group: Eligible are early-stage SMEs which are registered in a developing country or emerging market. These may also be local subsidiaries of German or European companies. Preference is given to investments in Africa or India.
  - Conditions for funding: The program addresses companies that fulfill the following requirements:
    - The company employs an innovative and scalable business approach with a high developmental impact.

[93] USAID CEADIR: https://www.climatelinks.org/project/ceadir
[94] "Scaling Up Clean Energy Lending in West Africa", USAID CEDAIR, (2018): https://www.climatelinks.org/project/scaling-clean-energy-lending-west-africa

- The company is operational, and a pilot phase has already been completed including proof of concept with regards to technology and business model at local level.
- The planned investment generates positive returns (as outlined by a comprehensive business plan and financial projections).
- The company shows high growth potential owing to the size of the market and the target group.
- The company has the management capacity, human resources and know-how to substantially scale their activities.

• Interested companies may submit their proposals for funding through Up-scaling to DEG at any time. For this purpose, please use the documents provided here.

• **ECOWAS Renewable Energy Facility (EREF):** The EREF is a grant facility managed by ECREEE that provides grant co-funding for small-to-medium sized renewable energy and energy efficiency projects and businesses in rural and peri-urban areas of ECOWAS member countries. The EREF, which undertakes regular demand-driven call for proposals, concluded its first phase (2011-2016) and intends to support 41 eligible projects with an overall funding amount of EUR 1 million. The EREF is currently in its second phase (2016-2020), during which the facility intends to broaden its portfolio of financial instruments and support schemes.[95]

• **ElectriFi:** ElectriFi is a financing facility funded by the European Commission and Power Africa with an initial amount of EUR 115 million. ElectriFi aims to support investment through risk capital to increase and/or improve access to modern, affordable and sustainable energy service worldwide. The focus is on providing decentralized energy solutions for populations living in rural areas or living in zones with unreliable power supply. The facility supplies senior debt, subordinated debt, quasi-equity and equity instruments. The maximum amount of any financing solution is EUR 10 million (or local currency equivalent).[96]

  • In **Mali**, ElectriFi is supporting the development of a demand-driven innovative Flex-Grid technology, based on a demand-driven rural electrification approach, including the development of metering and payment solutions. ElectriFi provided EUR 100,000 for the construction of the pilot project in Mali.
  • In **Togo**, ElectriFi co-finances the implementation of the Asrama Microgrid Pilot Project in a Togolese village of 5,000 residents with Benoo Energies as the project's operator. The objective of the project is to develop a 24-kW electricity capacity grid, providing electricity access to 370 households and 85 businesses.
  • With the exception of Cabo Verde, all ROGEP countries are eligible for funding. ElectriFI has shifted during 2017-18 from issuing periodic calls for proposals to a rolling application approach and is in process of launching country specific funding windows to complement its Africa region-wide approach, which may build in more concessional finance as dictated by country conditions. The first country facility for West Africa is planned for Nigeria in 2019-2020.[97]

• **The Energy Africa Campaign** is a UK government initiative that aims to achieve universal energy access in Africa by 2030. The campaign was launched in 2015 and is focused on delivery of off-grid energy to households through private investment. Key objectives of the campaign include removing financial barriers that have inhibited off-grid energy firms from raising commercial capital, analyzing the policy and regulatory environments, offering recommendations, raising awareness about clean energy, and facilitating increased partnerships within the sector.[98]

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[95] ECOWAS Renewable Energy Facility: http://www.ecreee.org/page/renewable-energy-facility-peri-urban-and-rural-areas-eref
[96] ElectriFi: http://electrifi.eu/insights/case-studies/
[97] Stakeholder interview with ElectriFi Fund Manager, June 2018.
[98] Energy Africa Campaign: https://www.gov.uk/government/news/energy-africa-campaign

- In Nigeria, the Energy Africa Campaign is bringing solar power to millions of homes using the PAYG business model. The 2015 Nigeria-UK Energy Africa Compact has promoted the improvement of the policy environment, provided various technical support and financing to catalyze commercial capital within the off-grid sector.
- In Senegal, the Energy Africa Campaign is providing financial and technical support, as well as policy reform assistance to the government.
- Sierra Leone was the first country to participate in the Energy Africa Campaign and has since received policy support and technical assistance from the UK government. As part of the compact between the Government of Sierra Leone and the UK Government, Sierra Leone announced the removal of import taxes on solar equipment.

- **Energizing Development (EnDev):** Launched in 2005, the EnDev program is a multi-donor and multi-country partnership that aims to support modern energy access for households, social institutions and SMEs and scale-up successful interventions in Africa, Asia and Latin America, based on a bottom-up approach.[99]

  - In Benin, EnDev supports the marketing of solar PV products by financially supporting importers and distributors in the field through a result-based finance mechanism whereby up to 50% of the product FOB cost is paid or given to partner companies which import quality PV products on every sale they make. In partnership with Benin's rural electrification agency, ABERME, EnDev also provides financial support (up to 50% reduction in cost) to households, productive units and social institutions for the installation of stand-alone solar systems.
  - In Ghana, EnDev's intervention focuses on supporting 30 small-scale farmers using solar water pumps for irrigation. Sales-based grants are the main incentive provided to the private sector selling and installing PV pumps.
  - In Liberia, EnDev is involved in the installation of solar systems for health facilities and schools, for offices and petrol stations as well as for mini-grids. EnDev also works alongside the Rural and Renewable Energy Agency (RREA), the Renewable Energy Association of Sierra Leone (REASL), and NGOs to promote solar products and is involved in outreach, marketing and awareness campaigns.
  - In Mali, EnDev's work is focused on developing solar PV-driven communal battery charging stations and stand-alone PV systems to provide electricity to households and social infrastructure (schools, health centers, solar street lights). Operation and maintenance is provided by service providers through a revolving fund financed by fees charged for communal services.
  - In Senegal, EnDev is supporting rural electrification by individual solar home systems in smaller villages: 70% of the hardware cost is subsidized by EnDev (the remainder by the operator and the municipality) and the households pay on a fee-for-service basis.
  - In Sierra Leone, EnDev is supporting distribution of SHS to public facilities (schools and health centers) and is also working to develop a shared platform to coordinate activities in the country's solar industry.[100]

[99] EnDev: https://endev.info/content/Main_Page
[100] http://www.renewables-salone.info/

- **EU – European Development Finance Institutions (EDFIs) Private Sector Development Facility (EEDF):** The EEDF is a facility whose goal is to promote access to clean energy in Africa, the Caribbean, and the Pacific countries. The facility, which was launched in 2013 by the EDFIs, the European Investment Bank (EIB) and the European Commission (EC), is a component of the SEforALL initiative. The facility utilizes a partnership approach and combines EU financing with funds from private sector in clean energy projects.[101] In ROGEP countries, the EEDF has provided energy projects with financing that they otherwise would not have received under existing market conditions and has also supported feasibility studies and other TA services. The EEDF's initial budget of EUR 50 million (EUR 45 million allocated for guarantees and EUR 5 million for TA) has been committed through the end of 2019. The EDFI have launched a Management Company that is currently administering implementation of ElectriFi, an EU-funded facility to support energy access.

- **EU Energy Initiative Partnership Dialogue Facility (EUEI PDF):** The EUEI PDF, initially established in 2004 as an energy program coordination facility, has developed into a platform hosting several related multi-donor programs, including the Africa-EU Energy Partnership (AEEP) as well as the Africa-EU Renewable Energy Cooperation Programme (RECP), which has recently been rebranded under the GET.Invest program. RECP has supported development of markets for small-scale RE across Africa through policy and regulatory framework development, Africa-EU private sector exchange and business development, project bankability and financing, and building technical and doing-business capacity. As GET.Invest, the mandate has been enlarged to include a significant focus on the off-grid sector. Since 2015, GIZ has been the implementing agency of the RECP and now GET.Invest through the EUEI PDF.[102] In 2018, the EUEI PDF closed and was replaced by the newly established Global Energy Transformation Programme (GET.Pro), under which GET.Invest is now implemented.

    - In the ECOWAS region, the EUEI PDF has provided TA for the elaboration of the Regional Renewable Energy Policy and its related guiding principles, including the provision of an extensive support to ECREEE to support policy implementation.
    - In The Gambia, the EUEI PDF conducted a policy advisory project in 2013, which contributed to the development of a Renewable Energy Strategy/Investment Plan and a Renewable Energy Law. The December 2013 Gambia Renewable Energy Bill was based on the outputs of this project.
    - In Nigeria, 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.
    - In Senegal, the RECP provided TA to support implementation of the Senegalese Renewable Energy Law adopted in 2010 (from 2012-2014), to develop renewable energy tariffs for IPPs.
    - First RECP and now GET.Invest operated the Financial Catalyst program which acts as a limited engagement financial advisor to support small scale renewable and off-grid energy projects and enterprises to secure implementation capital at advanced stage of development

- **EU Technical Assistance Facility (TAF):** The TAF was launched in 2015 to help partner countries improve their energy policies and regulatory frameworks as a means of facilitating increased energy sector investment. The main activities of the TAF include policy reform assistance, capacity building, planning support for investment projects, mobilization of funds and partnerships, and technical information exchange. The EUR 37.5 million facility is dedicated to helping African countries achieve their SEforALL targets through a range of energy sector reforms. The facility has the following objectives: (i) accelerate energy sector reforms and facilitate increased energy access and use of RE, (ii) increase partnerships amongst countries as a means to enhance technical capacities, and (iii) facilitate increased RE and off-grid sector investment.[103]

[101] EDFI: https://www.edfi.eu/facility/eedf/
[102] Africa-EU Renewables RECP: https://www.africa-eu-renewables.org/
[103] European Commission Technical Assistance Facility: https://ec.europa.eu/europeaid/tags/technical-assistance-facility-taf_en

- **Finnfund:** Finnfund is a development financier which builds a sustainable world by investing in responsible and profitable businesses in developing countries. Finnfund gets its funding from the State of Finland and the private capital markets, as well as retained earnings from its investments. All profits get recycled into new projects that drive sustainable development. Finnfund provides businesses operating in developing countries with risk capital, long-term investment loans, mezzanine financing and expertise on how to invest in the developing markets. Special emphasis is placed on sectors that are critical to sustainable development, such as clean energy, sustainable forestry, sustainable agriculture and financial services. In the off-grid energy space, Finnfund has provided long term debt facilities totaling USD 15 million during 2016 -17 to PAYG SHS provider Mobisol and joined Norfund in a USD 10 million long term debt facility for Nigerian Solar C&I developer Starsight in 2019.

- **FMO Access to Energy Fund (AEF):** The Access to Energy Fund was jointly initiated by the Dutch government and FMO in 2007 to support private sector projects aimed at providing long-term access to energy services in Sub-Saharan Africa. As of December 2018, the fund has committed EUR 96 million to the African Region. The fund supports energy generation, transmission, and distribution project in developing countries. It has already provided energy access to 2.4 million people. The fund can either directly invest in or lend to a project or motivate a wider range of investor interest. The funding possibilities include:

  - Minority shares in equity investments
  - Loans of up to EUR 7 million (or local currency equivalent)
  - Early stage equity to contribute to the high-risk, early stage project development phase

  Among the investments of the AEF have been:

  - ZOLA Electric, one of the leading distributed renewable energy providers in Tanzania with operations across East and West Africa in Rwanda, Ghana, Côte d'Ivoire and Nigeria. ZOLA provides more than one million customers with access to energy each day and employs more than 1,000 people across Africa. FMO invested USD 17.5 million in ZOLA Electric (USD 5 million from AEF, USD 12.5 million from FMO) and mobilized an additional USD 15 million from Symbiotics. FMO's share in this investment is expected to create 1,089 new jobs, connect 78,360 new households to electricity and yield a GHG emission reduction of 36,476 tons of CO_2 equivalent.
  - d.light, one of the leading PAYG solar home system companies globally. FMO is part of a Consortium supporting d.light with USD 41 million in equity funding, energy expertise and networks. This support will enable the leading distributed solar provider to expand and accelerate its growth rate as well as provide energy access to millions of people in Africa. The Consortium is led by Inspired Evolution, an Africa-focused investment advisory firm that specializes in the energy sector. Other Consortium partners include Swedfund and Norfund. The deal is a co-investment with Inspired Evolution's second fund, in which FMO invested in 2017. Now, FMO invests USD 10.6 million in d.light, funded by the Access to Energy Fund (AEF) and the Infrastructure Development Fund (IDF).

- **Global Innovation Fund:** Through grants, loans, and equity investments ranging from USD 50,000 to USD 15 million, GIF backs innovations with the potential for social impact at a large scale, whether they are new technologies, business models, policy practices, technologies, or behavioral insights. GIF gave a USD 240,000 convertible loan for a pilot in Kenya of a new business model that provides off-grid communities with affordable clean energy using a 'pay-as-you-go' model.[104]

[104] Global Innovation Fund: https://globalinnovation.fund/investments/poapower/

- **IFC Lighting Africa:** Lighting Africa is an IFC-World Bank sponsored program that aims to provide electricity access to 250 million people across Sub-Saharan Africa currently living without electricity by 2030. The initiative aims to achieve this through a number of different activities across the supply chain including market intelligence, access to finance, consumer education, and business development support.[105] Lighting Africa is a lead sponsor of the ROGEP initiative.[106]

- **InfraCo:** The equity investment and project development arm of the multi-donor facility Private Infrastructure Development Group (PIDG), InfraCo Africa provides funding and expertise to projects at their earliest stage, enabling them to grow from an initial concept to a bankable investment opportunity. InfraCo can work with projects directly where they already have an experienced lead developer, or they can provide on-the-ground project development expertise through InfraCo's own developer teams. InfraCo can also provide equity to fund the construction of pioneering projects or for innovative infrastructure businesses that need to scale-up and demonstrate commercial viability to attract further investment. InfraCo involvement reduces the risks and costs associated with early stage project development, ensures international standards are met, and facilitates private sector investment. In the off-grid energy space, InfraCo Africa has made three investments:

  - Kalaganga Infrastructure Services (KIS): KIS is a pioneering mixed utility company that has responded to the complexity of the needs of Uganda's Bugala Island, on Lake Victoria. KIS has delivered and now operates two modern roll-on roll-off ferries; has upgraded the island's 66km Luuku – Mulabana main road; is distributing clean water to 19 villages on the island; and has developed 1.6MW of hybrid solar-diesel power and recently taken over operation of the Kalangala Town Council (KTC) grid.
  - Standard Microgrid (SMG): SMG is a mini-grid developer that has developed an innovative approach to providing distributed renewable energy services in Zambia: a 12kW micro power utility that integrates proprietary grid management tools with solar photovoltaic (PV) technology and batteries, to provide clean, reliable energy to approximately 150 customers (including households, small businesses, rural schools and clinics).
  - Redavia Tanzania: Germany's REDAVIA developed an innovative, modular, solar PV solution: with the PV panels, fittings, electrical components and control systems required to provide up to 90KWp of installed solar power generation, all delivered in a standardized shipping container. REDAVIA's solar units are offered on a rental basis and, being modular, can be sized to meet customers' needs: units can be rapidly deployed or redeployed if these needs change or lease terms aren't met. Using an initial USD 350,000 of capital from InfraCo Africa, REDAVIA deployed two solar farms to two rural communities in the Mbeya region of Tanzania: Isenzanya and Shitunguru. Once these were operational, InfraCo Africa committed to release further funding up to a total of USD 5million to finance the deployment of up to 30 solar systems. This investment will enable REDAVIA to prove its business model and grow to a commercially viable scale in Tanzania.

- **Norfund:** The Norwegian Investment Fund for Developing Countries invests in the establishment and development of profitable and sustainable enterprises in developing countries. The aim is to contribute to economic growth and poverty reduction. Norfund always invests with partners, Norwegian or foreign, focusing on renewable energy, agribusiness and financial institutions. Norfund also has a grant facility that is designed to strengthen the development effects of its investments. The facility provides professional and technical assistance for projects through operational improvements (such as training,

[105] "Lighting Africa to Support New Regional Program Targeting 19 West African Countries," World Bank, (2017): https://www.lightingafrica.org/lighting-africa-support-new-regional-program-targeting-19-west-african-countries/
[106] https://www.lightingafrica.org/wp-content/uploads/2017/12/ROGEP-overview_-Dec-17.pdf

improving the internal control systems or HSE procedures, local community development and project development. In the off-grid space, during 2017 Norfund has been part of an FMO led consortium which invested USD 30 million in PAYG SHS provider d.light and in 2019 joined with FinnFund in providing a USD 10 million long term debt facility to Nigerian based solar C&I developer Starsight.

- **U.S. Overseas Private Investment Corporation (OPIC) – Global Energy Program:** Established in 2007, the US OPIC Global Energy Program supports projects that expand global access to electricity. From 2007 to 2017, the program financed and insured 144 traditional and renewable energy projects globally. OPIC's clean energy portfolio has grown to over USD 8 billion in commitments. In the off-grid space OPIC has been a lead investor in the specialized debt fund SunFunder, which extends loans to creditworthy businesses in developing countries that distribute off-grid energy solutions and led a USD 90 million debt facility provided to PAYG solar home system provider, Lumos (see **Section 7.3.3: Specialized Off-Grid Debt Funds** for more details).

- **Power Africa:** The Power Africa initiative, launched in 2013, is a USAID-funded partnership bringing together technical and legal experts, the private sector and governments,[107] which aims to increase access to power in Sub-Saharan Africa. The overall objective is to add more than 30,000 MW of cleaner, more efficient electricity generation capacity and 60 million new home and business connections. This notably includes a "beyond the grid" component, as the quickest way to increase access for the most vulnerable and remote communities.[108] The Power Africa initiative is heavily engaged in West Africa and the Sahel, providing a range of services, including transaction support to developers and off-grid companies seeking to scale up operations across the region:

    - Power Africa is assisting Ghana in partnership with private US company Weldy-Lamont to connect more than 67,000 rural households, as part of the government of Ghana's Self-Help Electrification Program.
    - In Nigeria, Power Africa is supporting off-grid options as well. With a USD 15 million loan from the Overseas Private Investment Corporation (OPIC), Lumos, Inc. is deploying rooftop solar panel kits to approximately 70,000 residential and small commercial customers, using a lease-to-own business model. The USADF has awarded nine USD 100,000 grants to entrepreneurs for innovative, off-grid energy projects.
    - In Chad, Power Africa has facilitated 60 connections through solar lanterns.
    - In Côte d'Ivoire, Power Africa off-grid interventions are focused on: (i) supporting the Government's Electricity for All Program, (ii) providing transaction advisory assistance for off-grid companies (notably PEG Africa), (iii) assisting in the creation of a national off-grid policy, and (iv) helping the regulator conduct the country's first ever willingness-to-pay survey, which will help support national tariff reform.
    - In Liberia, Power Africa is supporting the development of the nascent off-grid sector. USAID Liberia has notably conducted three renewable energy pilot projects under community-based ownership models, which concluded that solar is the most feasible renewable energy technology to scale up in rural Liberia.
    - In Mali, Power Africa has supported 150,000 off-grid connections since its inception, through private sector partners operating in the off-grid sector. The majority of these connections are solar lanterns, while the rest are more advanced solar home systems.
    - In Mauritania, Power Africa has facilitated 8,436 connections in solar lanterns through partnerships with private off-grid companies.

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[107] Partners include the AfDB, the AUC, and among ROGEP countries, the Governments of Côte d'Ivoire, Ghana, Guinea, Liberia, Nigeria, Senegal, and Sierra Leone.

[108] "Power Africa: A 2017 Update," USAID, (2017): https://www.usaid.gov/news-information/press-releases/dec-4-2017-fact-sheet-power-africa-2017-update

- In Niger, Power Africa is providing technical assistance in multiple areas including mini-grid development, increased off-grid rural electrification, and off-grid policy and strategy development. Through a USAID regional transaction advisor, Power Africa supports private sector expansion into the Nigerien off-grid market and has facilitated 28,053 solar connections since 2013.
- In Senegal, Power Africa provided TA to prepare an updated generation and transmission Master Plan in collaboration with the Ministry of Energy, SENELEC, and other key stakeholders. More specifically, it provides transaction advisory assistance to private sector off-grid companies and rural concession holders, helping to strengthen business models and expand services.

- **Proparco:** Proparco is the private sector financing arm of Agence Française de Développement (AFD). Proparco has been working to support international development for 40 years. It plays a key role in AFD Group and the French cooperation mechanism by providing financing and support for projects led by companies and financial institutions in emerging markets – from SMEs to regional banking groups, including microfinance institutions.

- **Renewable Energy Performance Platform (REPP):** REPP works to mobilize private sector development activity – and investment – in small to medium-sized projects (typically up to 25MW) and is supported with £148m funding from the UK's Department for Business, Energy and Industrial Strategy (BEIS) and the International Climate Finance initiative. REPP is managed by Camco Clean Energy, a leader in renewable energy finance, which provides developers with access to various financing products, services and experience. REPP provides loans for selected third party development expenses, such as feasibility studies, grid studies, environmental and social impact assessments, legal advice etc. The program also offers developers general project guidance and support. REPP also can help bring projects to financial close using a range of financing structures, including bridge financing, construction loans, equity and equity conversion options, results-based financing, results-based loans for mini-grid rollout, subordinated debt, trade finance for SHS, and working capital loans. To date, REPP has committed USD 13.1 million in co-financing for the development of 20 contracted projects covering a wide range of technologies, from solar homes systems to grid-connected solar farms and run-of-river hydropower plants. Six of the funded projects are off-grid enterprises:

  - ARC Power, a mini-grid developer in Rwanda
  - GVE, a mini-grid developer in Nigeria
  - PEG Africa, a PAYG Solar Home System provider in West Africa
  - Powerhive, a Kenya based mini-grid developer
  - PAS Solar, a BBOXX affiliated PAYG SHS provider in Nigeria

- **Scaling Up Renewable Energy Program (SREP):** SREP aims to scale up the deployment of renewable energy solutions in the world's poorest countries. It pilots and demonstrates the economic, social, and environmental viability of development pathways that do not exacerbate global warming.[109] It is funded by the Strategic Climate Fund to an approximate amount of USD 318 million.

  - Mali is tapping USD 40 million in grant and near-zero interest credit financing from the SREP to support policy and institutional strategies, financial and regulatory frameworks, and sustainable investments in renewable energy solutions.[110]

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[109] "Scaling Up Renewable Energy Source in Low Income Countries (SREP),": https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/climate-investment-funds-cif/strategic-climate-fund/scaling-up-renewable-energy-program-in-low-income-countries-srep/
[110] CIF: https://www.climateinvestmentfunds.org/country/mali

- **Seed Capital Assistance Facility (SCAF):** SCAF's vision is to increase the availability of investment for early stage development of low-carbon projects in developing countries, contributing to low-carbon sustainable development, economic growth, poverty reduction and climate change mitigation.[111] Phase II of SCAF started in 2014 and will run for 8 years. The facility is funded by the UK Department for International Development and the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. SCAF provides grants and contingent loans as seed capital co-financing for private equity and venture capital fund managers, and project development companies operating in the sustainable energy space. SCAF has supported fund managers such as Inspired Evolution and Frontier as well as the integrated C&I Solar project development/financing platform Empower.

- **SIDA:** is the Swedish government agency that works to reduce poverty in the world by following Sweden's Policy for Global Development. SIDA's mission has three parts; (i) to enable people living in poverty to improve their lives, (ii) to reform cooperation with Eastern Europe, and (iii) to distribute humanitarian aid to people in need of assistance.[112] SIDA administers half of Sweden's development aid budget. SIDA has two major endeavors in the off-grid financing space.

    - AECF: SIDA is a leading supporter of the Africa Enterprise Challenge Fund's REACT program to provide seek level grant support to renewable and off-grid entrepreneurs. Burkina Faso, and Liberia are part of SIDA's latest investment of USD 15 million in REACT that will give 5 to 15 million people in rural and slum areas access to electricity.[113]
    - Loan Guarantee Fund: 50% pari passu guarantee. Currently being deployed in Rwanda on a portfolio basis to support Rwanda Development Bank loans to SACCOs for solar consumer lending

- **Smart Power for Rural Development (SPRD):** Smart Power for Rural Development is a USD 75 million initiative launched in 2015 by the Rockefeller foundation. The initiative brings together energy service companies (ESCOs), technology experts, local businesses, national and local governments, as well as the private sector to build viable partnerships around decentralized renewable energy solutions. It promotes sustainable business models that deliver renewable electricity and spur economic development among poor, underserved rural populations.[114] In sub-Saharan Africa, The Rockefeller Foundation is partnering with the Virgin Unite Foundation and Rocky Mountain Institute to help governments create a self-sustaining program to accelerate on- and off-grid development through Sustainable Energy for Economic Development (SEED).[115] SEED provides technical, policy, and financial advice on energy sector development to governments and other partners to ensure that decentralized renewable energy solutions are successfully implemented.

- **Swedfund:** is the development finance institution of the Swedish state. Its objective is to eliminate poverty by creating sustainable business in some of the world's toughest and most promising growth markets. Equity investments range between SEK 20M and 100M. In the off-grid energy space Swedfund has made equity investments in Husk Power in 2017 and in d.light during 2018.

- **UKAID Africa Clean Energy Programme:** The Africa Clean Energy Programme will catalyze a market based approach for private sector delivery of solar home system (SHS) products and services.

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[111] Seed Capital Assistance Facility: https://www.scaf-energy.org/about
[112] Sida, (2019): https://www.sida.se/English/About-us/Our-mission/
[113] "Sida support to off-grid energy access for millions of people across Africa," Sida (2019): https://www.sida.se/English/press/current-topics-archive/2019/sida-invests-usd-50-million-to-increase-off-grid-energy-access-in-africa/
[114] "Smart Power for Rural Development: Overview," Rockefeller Foundation (2016) : https://www.rockefellerfoundation.org/report/smart-power-for-rural-development-overview/
[115] Smart Power for Rural Development: https://www.rockefellerfoundation.org/our-work/initiatives/smart-power-for-rural-development/

The program will support: (i) technical assistance to improve the enabling environment for a market based approach for private sector delivery of SHS products and services, (ii) finance for businesses wanting to enter new and emerging SHS markets in sub-Saharan Africa for their start up and early commercialization of ideas, and (iii) test innovative approaches to stimulating private sector investment and market development.[116] To date, the project has spent GBP 15.1 million out of a total budget of GBP 65.3 million. The program will work in 14 countries, including Ghana, Nigeria, Senegal, and Sierra Leone.

- **U.S. African Development Foundation (USADF):** The USADF was established under Power Africa in partnership with General Electric to provide financing and related TA to support off-grid market development in Africa, including the following ROGEP countries: Ghana, Liberia, and Nigeria.

- **USAID / UK DFID / Shell Foundation Scaling Off-Grid Energy (SOGE):** The Scaling Off-Grid Energy platform leads donors and investors to develop Africa's off-grid energy sector and coordinate investments to provide households and businesses with access to modern, clean and affordable electricity. The SOGE initiative has set a target of providing 20 million households in Sub-Saharan Africa with electricity by 2030, with a focus on supporting lower-income groups. The program aims to achieve its mission – the SOGE Grand Challenge for Development – by helping overcome supply, demand, and market challenges in the African off-grid energy sector in order to accelerate technological innovation and catalyze financing for early-stage companies. SOGE is structured to complement the U.S. and U.K. flagship energy access initiatives in Sub-Saharan Africa, Power Africa and Energy Africa.[117] The Scaling Off-Grid Energy platform is currently providing marketplace strengthening services in Nigeria as well as investment support to off-grid solar companies in Nigeria (Greenlight Planet and Wandel), Benin (Shinbone), Ghana (PEG Africa), and Sierra Leone (d.light).[118]

[116] Africa Clean Energy Programme, 2019: https://devtracker.dfid.gov.uk/projects/GB-1-204637
[117] Scaling Off-Grid Energy: http://www.scalingoffgrid.org/scaling-grid-energy
[118] "Scaling Off-Grid Energy: A Year in Review," (2017): https://static.globalinnovationexchange.org/s3fs-public/asset/document/SOGE%20infographic_11032017.pdf?TPOFskxW19J3UGWffnVVOUeFmt_820NA

III. REGIONAL ENERGY MARKET

3.1 Regional Energy Sector Overview

West Africa and the Sahel has long suffered from large deficits in the supply of and access to electricity. As of 2016, over 200 million people across the 19 countries – more than half of the region's population – lacked access to electricity. This figure represents nearly one-third of Africa's total unelectrified population and the region as a whole has among the lowest rates of access in the world.

Rates of urban and rural electrification vary widely across states, with the average rate of access more than three times higher in urban areas (60%) when compared to rural areas (18%) in 2016. Even where grid connections exist, power supply is often unreliable. On average, less than one-third of firms and households in West Africa and the Sahel reported reliable electricity supply when surveyed.[119]

Expensive and unreliable electricity impedes private sector development, depriving the region of critical investment capital and economic development. At the same time, West Africa and the Sahel is among the most energy resource-rich regions in Africa, with potential from oil, gas, hydropower, solar, and wind energy. Solar potential is particularly high, as many of the countries in the region have above average levels of solar irradiation.

ECOWAS has pursued an ambitious regional energy agenda since its founding in 1975. Early objectives were to promote cooperation and development in all fields of economic activity and to increase the collective energy autonomy of the sub-region.[120] It was not until 1999 that implementation of this regional agenda started to materialize with the establishment of the West African Power Pool (WAPP), a regional transmission network and the foundation for all interstate electricity trading in the region. Outside of ECOWAS, Chad, Cameroon, and CAR are all members of the Central African Power Pool (CAPP), while Mauritania is a member of COMELEC, the Maghreb Electricity Committee, a North African regional network.

The 2003 ECOWAS Energy Protocol sought to promote long-term cooperation, increase complementarity, and attract investment to promote regional energy trading. To further the implementation of the Energy Protocol, three regional bodies were established in addition to the WAPP – the West African Gas Pipeline Authority (WAGPA) in 2005, the ECOWAS Regional Electricity Regulatory Authority (ERERA) in 2008, and the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) in 2010.[121]

The creation of a regional electricity market has proven to be challenging, as the level of development of electricity markets at the national level varies widely by country. The 14 countries that are member of the WAPP (Cabo Verde, an island nation, is not part of the interconnected system), as well as the four other ROGEP countries in CAPP and COMELEC, range from vertically integrated, state-owned electricity sectors, to partially and fully unbundled and/or privatized power markets. Another constraint for regional integration is the huge difference in size (and corresponding electricity demand) between countries, which contributes to competing priorities for governments and utilities.

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[119] 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

[120] "ECOWAS Energy Policy," ECOWAS: http://allafrica.com/stories/201311191358.html.

[121] Ikeonu, I., "Perspectives in Regulating a Regional Electricity Market: The ECOWAS Experience," International Confederation of Energy Regulators (ICER), (March 2018): http://icer-regulators.net/wp-content/uploads/download-manager-files/Perspectives_in_Regulating_a_Regional_Electricity_Market.pdf

In ECOWAS, ERERA's mandate allows it to set rules for both the technical and economic regulation of all cross-border electricity trading within the region. It is also responsible for ensuring the development and monitoring of the regional electricity market and is equally vested with quasi-judicial powers to resolve disputes among market participants. In addition to its role in the regional market, ERERA is authorized to assist member states and national regulators that request assistance on technical issues with respect to domestic regulation. In 2012, ERERA undertook an initial assessment of the status of the power sector in each member country to establish a regional strategy going forward for ECOWAS. The results of the study helped categorize member states into different groups based on the level of market reform and private sector participation in the electricity sector.

While significant investments have been made to boost energy production across the region, nearly every country continues to struggle to meet rapidly increasing electricity demand. With few exceptions, the energy markets in West Africa and the Sahel remain highly dependent on expensive thermal power. Nigeria, Ghana and to some extent Côte d'Ivoire are net exporters, largely through historical bilateral arrangements, while the majority of countries depend on fossil fuel based imports for electricity supply. Regional infrastructure has the potential to drive down electricity prices and power development costs in the long run; however, the poor state of national grids and markets both in net-producing and net-consuming countries remains an obstacle to further integration and prevents convergence among countries in the short-term.

In addition to electricity supply deficits, many countries in the region are also facing extremely low rates of access to electricity, particularly in rural areas. The majority of the electrified population lives in urban areas, where access rates tend to be higher. In many instances, the disparities between urban and rural areas and low levels of consumption in rural markets make grid extension projects uneconomic.[122] Traditional biomass remains the primary source of energy for the poor and accounts for about 80% of total energy consumed for domestic purposes.

To address some of the regional challenges, under its Community Development Program (CDP), ECOWAS announced plans in 2017 for sub-regional development projects worth nearly USD 30 billion between 2018-2022 to cover infrastructure, energy, agriculture and health sectors.[123] There are three priority projects in the energy sector under the CDP, including (i) ROGEP, (ii) a USD 1.34 billion transmission project linking seven countries across the region, and (iii) the constriction of three solar power plants and two wind power plants totaling over 800 MW of renewable energy capacity at an estimated cost of USD 1.25 billion.[124]

[122] Karaki, K., "Understanding ECOWAS Energy Policy: From National Interests to Regional Markets and Wider Energy Access? European Center for Development Policy Management (ECDPM), (March 2017): https://ecdpm.org/wp-content/uploads/ECOWAS-Energy-Background-Paper-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

[123] "ECOWAS to Spend US$ 29 Billion on Development Projects in West Africa," AllAfrica, (28 December 2017): https://allafrica.com/stories/201712290145.html

[124] "ECOWAS Community Development Programme (CDP) Priority Projects," ECOWAS: http://ecowas-events.ecowas.int/cdp-conference/wp-content/uploads/2016/06/Projects-English.pdf

3.2 Regional Electricity Access: *Grid and Off-Grid*

3.2.1 Demand and Supply/Generation Mix

The current installed capacity in the 19 ROGEP countries is approximately 25 GW (**Table 2**), although not all of this is operational capacity. About three-quarters of total installed capacity is thermal power, with large hydropower comprising nearly all of the remaining balance (**Figure 5**). On a regional level, the EREP intends to increase the share of renewable energy (excluding large hydro) in the energy mix from 1% in 2017 to 5% by 2020 and 12% by 2030.[125]

Table 2: Installed Capacity by Technology in West Africa and the Sahel, 2017

Country	Total (MW)	Thermal (MW)	Hydropower (MW)	Non-hydro renewable energy (MW)
Benin	220.5	220	0.5	-
Burkina Faso	355	288	32.5	36.1
Cabo Verde	172.5	135.5	-	31.5
Cameroon	2,327	1,592	732	3
Central African Republic	37	18.7	18.3	-
Chad	125	125	-	-
Côte d'Ivoire	2,199	1,320	879	-
The Gambia	99	93	-	6
Ghana	4,419	2796	1580	42.6
Guinea	617	249	368	-
Guinea-Bissau	12.5	12.5	-	-
Liberia	126	38	88	-
Mali	672	357	312	3
Mauritania	434	362	18	54
Niger	146	103	36	7
Nigeria	12,522	10,142	2,362	18
Senegal	928	826	81	102
Sierra Leone	155	77	63	15
Togo	230	163	67	-
Total	**25,796.5 MW**	**18,917.7MW**	**6,637.3MW**	**318.20 MW**
Share (%) of Total		**73.3%**	**25.7%**	**1.2%**

NOTE: Figures from 2017 or most recent data available

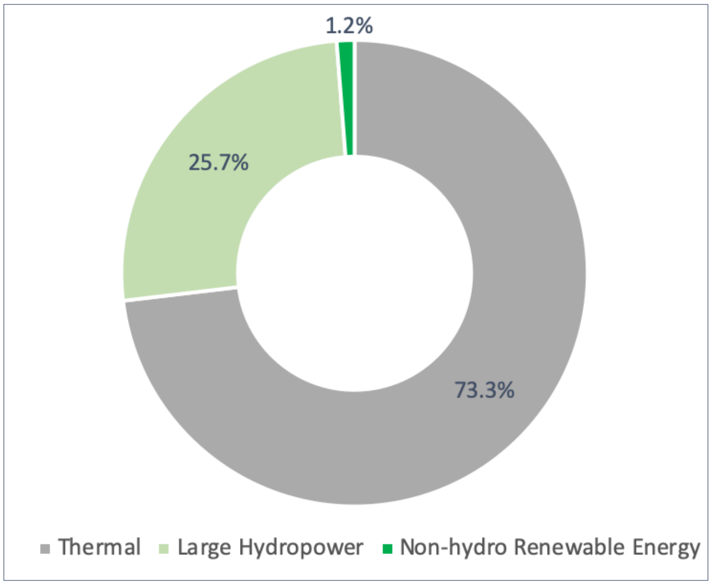
Source: ECREEE; GreenMax Capital Advisors analysis

Although total installed capacity in the ROGEP countries amounts to 25 GW, the total operational capacity is approximately half of this figure. Many production facilities are functioning at much lower than nominal capacity, while others are fully dysfunctional or are operational, but grid transmission issues render them unusable for actually meeting demand. The most apparent case of this gap between installed capacity and operational capacity in the region is in Nigeria, which has 12.5 GW of installed capacity, of which an estimated 3.8 GW are actually operational and meeting demand. To a lesser extent, the same also applies to Ghana, Mali and Benin.[126]

[125] "Regional Progress Report on Renewable Energy, Energy Efficiency and Energy Access in the ECOWAS Region," ECREEE, (2016): http://www.ecreee.org/system/files/ecreee_report_-_regional_monitoring_framework_2016_0.pdf

[126] "From Vision to Coordinated Action: Consolidation of SEforALL Action Agendas, National Renewable Energy Action Plans, and National Energy Efficiency Action Plans," ECREEE, (2017): http://SEforALL.ecreee.org/sites/default/files/final_report_on_SEforALL_consolidation.pdf

Figure 5: Installed Capacity by Technology in West Africa and the Sahel, 2017



Source: ECREEE; GreenMax Capital Advisors analysis

Electricity demand forecasts estimate that demand across the region will exceed 40 GW by 2030 (**Table 3**). Of this 2030 figure, more than half (about 23 GW) is expected to come from Nigeria alone. In the WAPP, 85% of total demand presently comes from just four countries – Nigeria, Côte d'Ivoire, Senegal, and Ghana. Relative to 2010 demand levels, expected demand in 2050 is projected to increase by a factor of more than six. To meet this massive growth in demand, the WAPP's current generation scenario is based largely on additions of large hydropower and natural gas capacity, with a small but gradually increasing share of non-hydro renewable energy.

By 2025, Nigeria will continue to be the major focal point of the region's electricity demand, accounting for about 60% of overall power demand, followed by Ghana, which will account for slightly above 10% and Cameroon and Côte d'Ivoire at about 7% and 6.5%, respectively. The remaining countries will together contribute the remaining 15% balance of the projected demand in 2025.[127] It is important to note that these demand forecasts do not consider the off-grid demand that can be met with off-grid sector growth.

[127] "Baseline Report for the ECOWAS Renewable Energy Policy (EREP)," ECREEE, (2012): http://www.euei-pdf.org/sites/default/files/field_publication_file/ecowas_baseline_report_en.pdf

Table 3: Estimated Electricity Demand in West Africa and the Sahel, 2011, 2020, 2030[128]

Country	Estimated Electricity Demand (MW)		
	2011*	**2020 (estimated)**	**2030 (estimated)**
Benin	219	420	697
Burkina Faso	178	345	579
Cabo Verde	112	169	231
Cameroon	1,036	1,730	3,319
Central African Republic	No data	300	385
Chad	No data	No data	No data
Côte d'Ivoire	968	1,652	2,512
The Gambia	50	135	212
Ghana	1,629	2,775	4,198
Guinea	139	340	519
Guinea-Bissau	29	83	152
Liberia	9	68	121
Mali	199	550	900
Mauritania	100	205	316
Niger	149	287	449
Nigeria	6,376	14,983	23,778
Senegal	456	891	1,412
Sierra Leone	38	170	292
Togo	170	426	731
Total	**11,857 MW**	**25,529 MW**	**40,418 MW**

* 2011 or most recent data available

Source: ECREEE; West African Power Pool; GreenMax Capital Advisors analysis

3.2.2 Transmission and Distribution Network

With the exception of Cabo Verde, all of the ECOWAS countries are members of the WAPP. The WAPP is comprised of 15,000 km of high-voltage transmission in approximately 800 major transmission lines as well as approximately 200 grid-connected power plants (hydro and thermal) with 600 subsidiary power substations (**Figure 6**).[129] Of the remaining ROGEP countries, Cameroon, CAR and Chad are all members of the CAPP, a specialized institution of the ECCAS comprised of 10 counties and powered almost entirely by hydropower (**Figure 7**),[130] while Mauritania is a member of COMELEC, a North African regional grid institution, but is not yet connected to the regional network.[131] Preliminary institutional arrangements are in place for the WAPP, the CAPP and COMELEC, but the regional entities have yet to fully develop and implement regulatory frameworks to support electricity trading. The WAPP and CAPP intend to develop a free market exchange of electricity between member states by 2030.

Within these power pools, member countries collaborate on electricity transmission and distribution (T&D) infrastructure projects as well as regional network interconnections and related electrification initiatives.

[128] "Baseline Report for the ECOWAS Renewable Energy Policy (EREP)," ECREEE, (2012): http://www.euei-pdf.org/sites/default/files/field_publication_file/ecowas_baseline_report_en.pdf
[129] Ikeonu, 2018.
[130] "Africa's Power Infrastructure: Investment, Integration, Efficiency," World Bank, (2011): https://openknowledge.worldbank.org/bitstream/handle/10986/2290/613090PUB0Afri158344B09780821384558.pdf?sequence=1&isAllowed=y
[131] "Mauritania Renewables Readiness Assessment," International Renewable Energy Agency, (2015): https://www.irena.org/-/media/Files/IRENA/RRA/Country-Report/IRENA_RRA_Mauritania_EN_2015.pdf

Continued cooperation between countries will be critical for meeting electrification objectives; the AfDB Program for Infrastructure Development in Africa (PIDA) estimates that enhanced regional network integration would save USD 33 billion per annum on average by 2040 in power generation costs.[132]

If ECOWAS meets its T&D improvement objectives, the resulting efficiency gains would go a long way towards helping countries meet their energy access goals. Under the CDP, ECOWAS announced a USD 1.34 billion transmission infrastructure priority project linking the following seven countries across the region: Nigeria, Niger, Benin, Burkina Faso, Ghana, Mali and Guinea. The project, which includes 300 kV and 225 kV interconnections, will increase electricity access, facilitate the exchange of electricity between these countries and improve the overall reliability of interconnection networks in the WAPP system.[133]

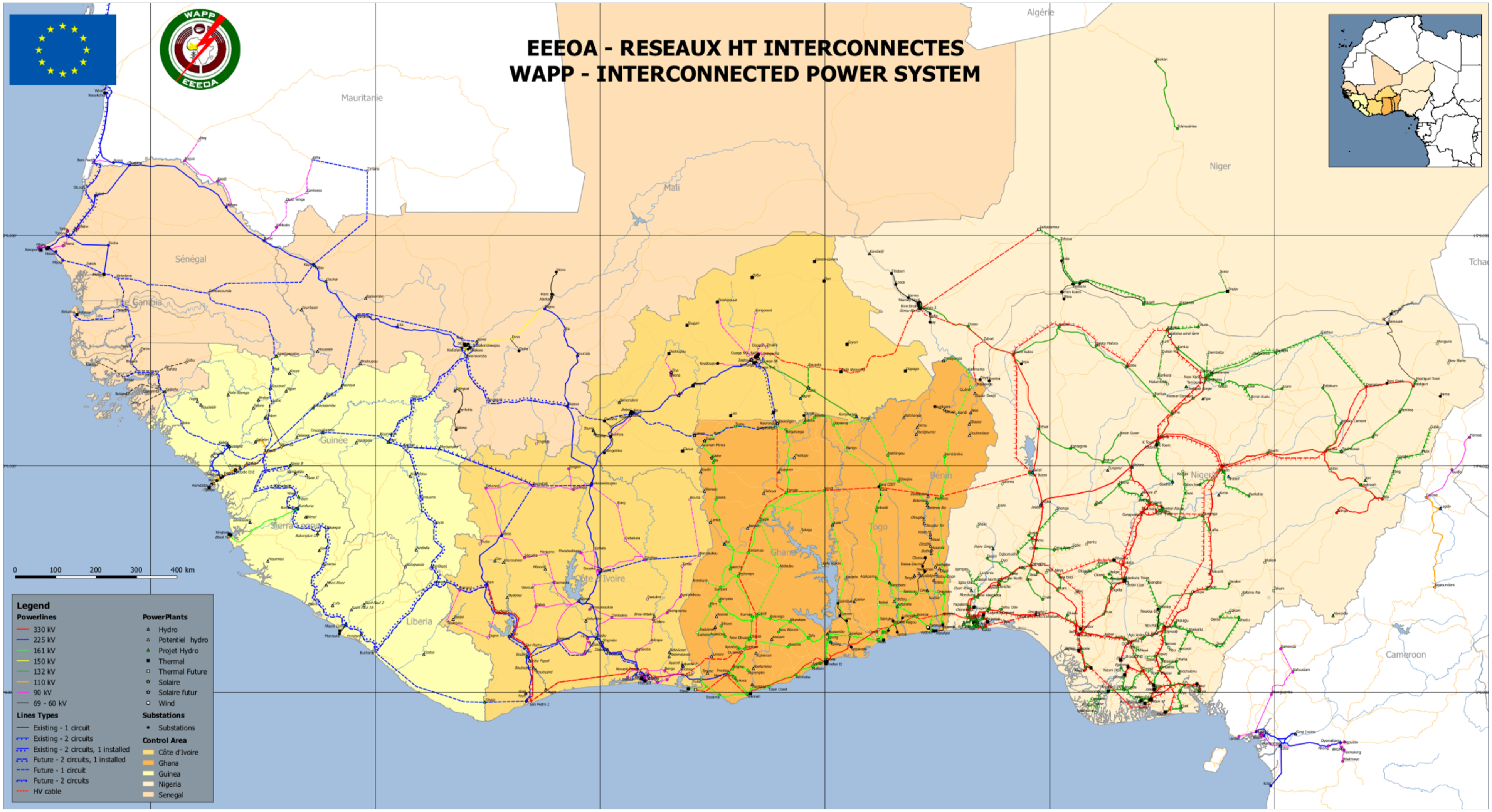
Several other regional transmission development projects are already underway. While power-sharing and international electricity imports are already commonplace between Benin and Togo, which share regulatory authority over some of their infrastructure, and between Nigeria and its neighbors, the forthcoming Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) regional transmission project will further expand the region's transmission infrastructure. With funding from the World Bank and other DFIs, the WAPP-CLSG System Redevelopment Sub-program will develop new transmission lines to connect the four countries and also includes plans to connect rural communities along high-voltage lines with step-down low-voltage lines.[134] Another World Bank-funded project, The Gambia River Basin Development Organization (Organisation pour la Mise en Valeur du fleuve Gambie OMVG), is bringing crucial international interconnections to four WAPP countries: Gambia, Guinea, Guinea-Bissau, and Senegal. The OMVG Interconnection Project for Africa will enable electricity trading between the four countries of up to 800 MW on new high-voltage lines.[135] These initiatives will help countries become net electricity exporters within the region and will also help address some of their capacity-demand gap challenges.

Losses in the transmission and distribution of electricity remain an ongoing challenge across the region. These losses can be (i) technical, resulting from underinvestment in infrastructure and outdated and/or unmaintained transmission lines, transformers, and substations, as well as (ii) commercial, resulting from theft and/or unpaid consumption. Commercial and technical losses in power distribution vary widely in countries throughout West Africa and the Sahel (**Figure 8**). Electricity networks in countries across the region are in need of significant investment to address these losses; however, electricity tariffs in most countries are not cost-reflective and thus do not generate sufficient revenue for utilities to make necessary improvements to grid infrastructure. As a result, where grid connections exist, electricity supply is often unreliable (**Figures 9-11**).

This is a huge challenge that policymakers, regulators and utilities are working to address both at the national and regional level, especially given how important it is for the long-term sustainability of the electricity sector and for countries to meet their electrification objectives. To reduce losses, countries are implementing or planning to implement in the near future action plans to rehabilitate existing physical infrastructure, while simultaneously pushing for electricity market reform to reduce commercial losses and improve the reliability of supply.

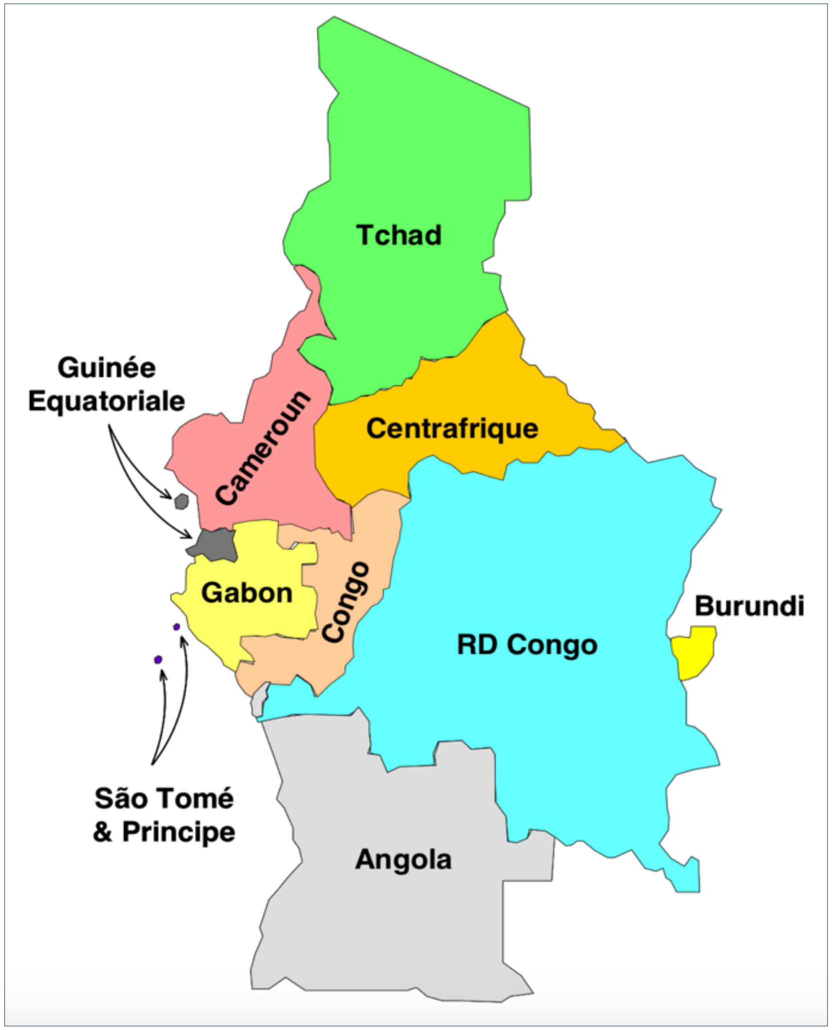
[132] "Energy Access for structural transformation and sustainable development in Africa," African Development Bank, (February 2018): http://unohrlls.org/custom-content/uploads/2018/02/African-Development-Bank-Presentation-Access-to-electricity-in-Africa-FINAL.pdf
[133] "ECOWAS Community Development Programme (CDP) Priority Projects," ECOWAS: http://ecowas-events.ecowas.int/cdp-conference/wp-content/uploads/2016/06/Projects-English.pdf
[134] "West African Power Pool: CLSG Power System Redevelopment Sub-Program," World Bank: http://siteresources.worldbank.org/INTENERGY2/Resources/exercise.pdf
[135] OMVG Interconnection Project: http://projects.worldbank.org/P146830?lang=en

Figure 6: West African Power Pool



Source: West African Power Pool

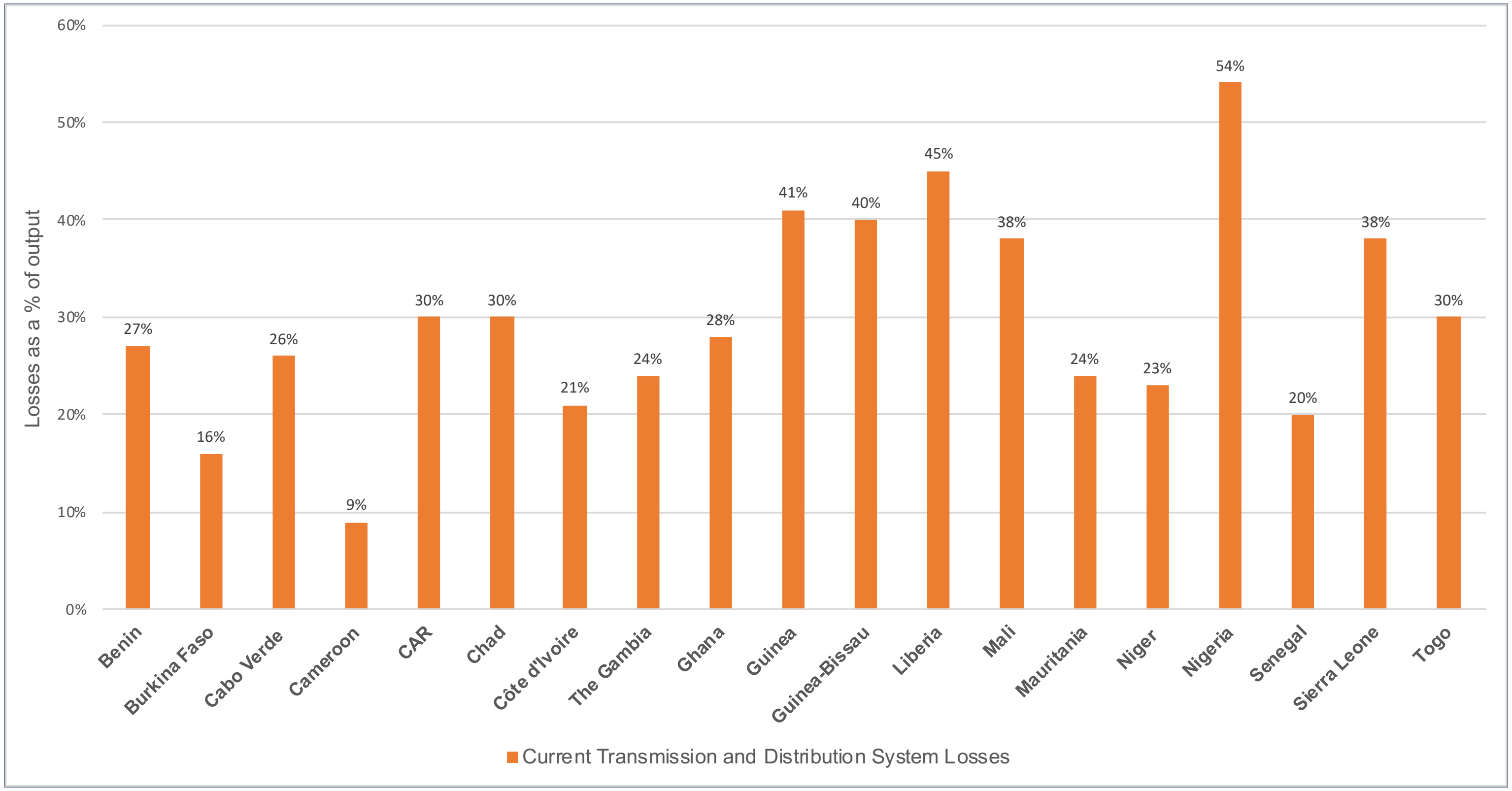
Figure 7: Central African Power Pool[136]



Source: Central African Power Pool

[136] CAPP: http://www.euei-pdf.org/sites/default/files/field_publication_file/EUEI_PDF_CAPP_Regional_Power_Policy_ToR.pdf

Figure 8: Transmission and Distribution System Losses in West Africa and the Sahel, 2016[137]

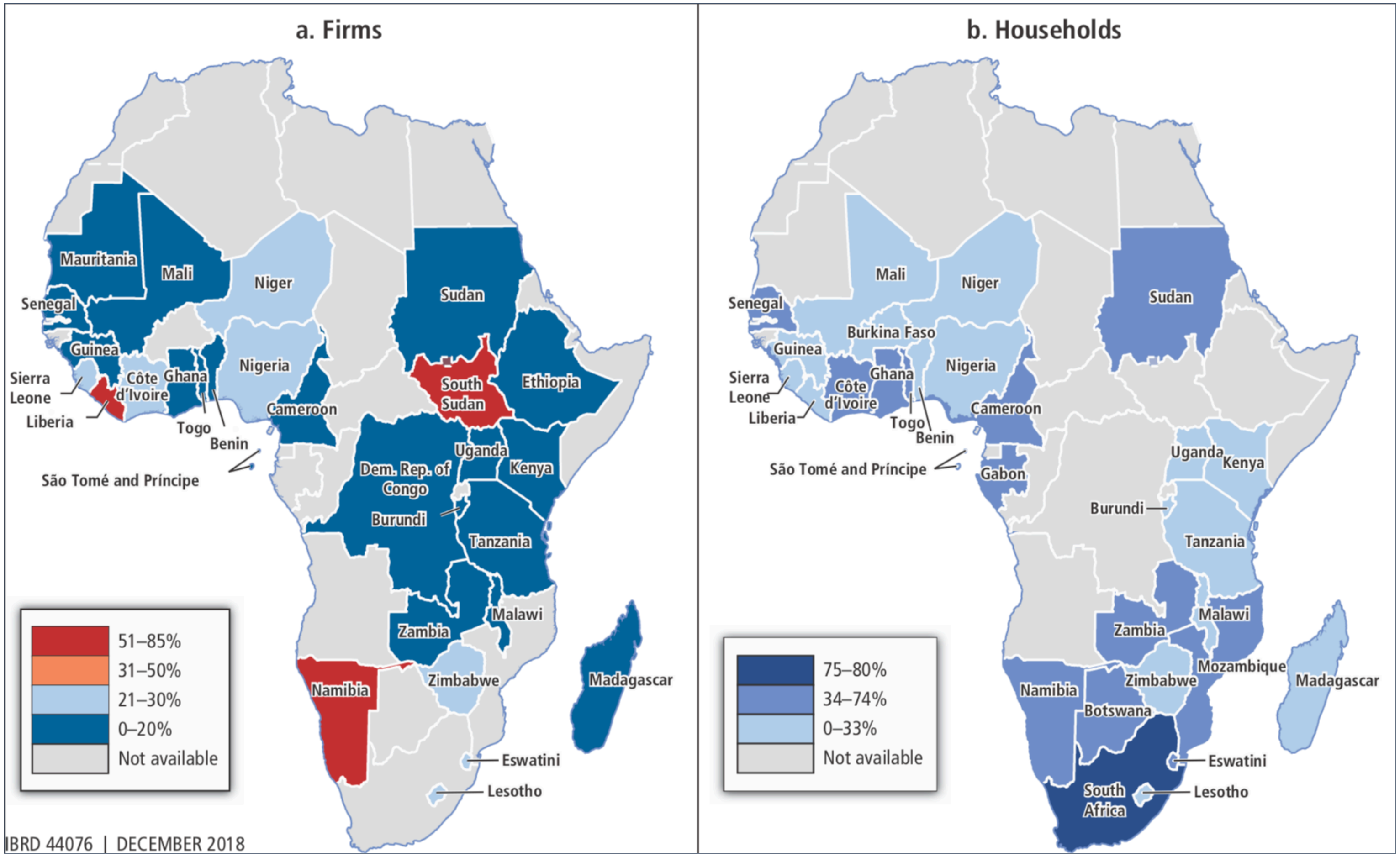


NOTE: Data from 2016 or year in which most recent data is available

Source: ECREEE; GreenMax Capital Advisors analysis

[137] "Regional Progress Report on Renewable Energy, Energy Efficiency and Energy Access in ECOWAS Region, 2016," ECREEE, (August 2018): http://www.ecreee.org/system/files/ecreee_report_-_regional_monitoring_framework_2016_0.pdf

Figure 9: Access to Reliable Electricity by Firms and Households in Africa[138]

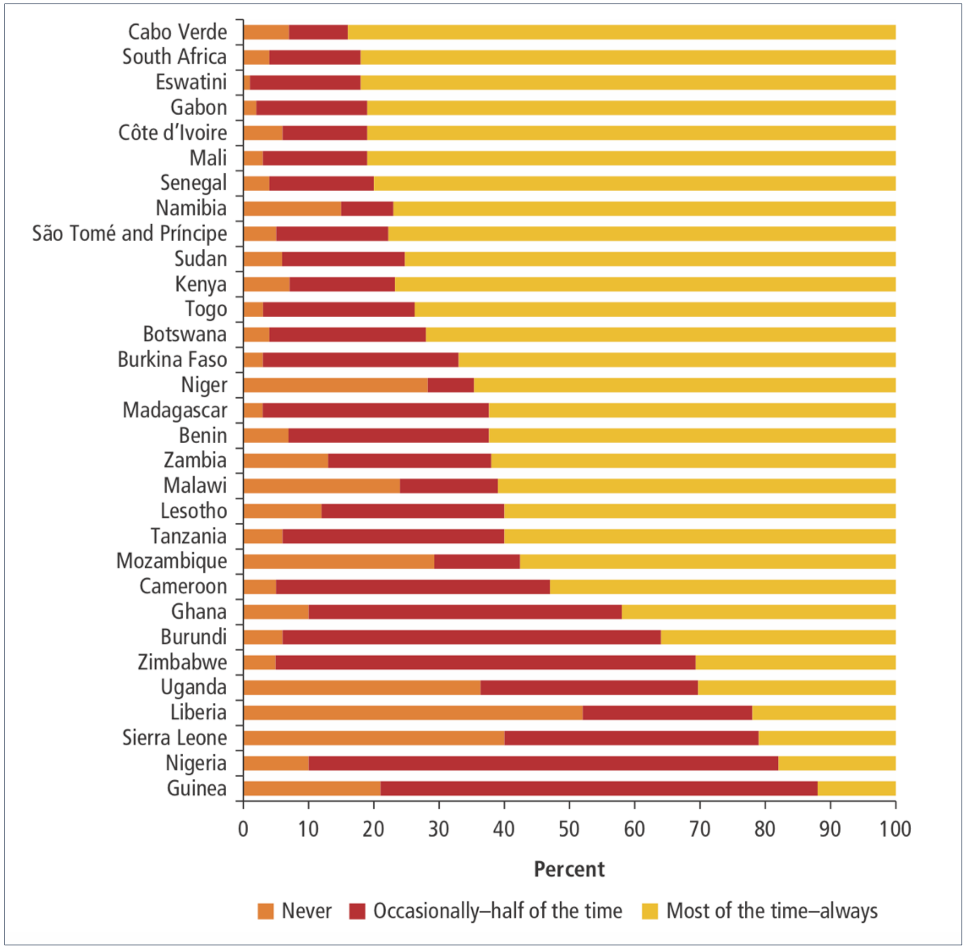


Source: World Bank Enterprise Surveys, 2013-2017 and Afrobarometer Household Surveys, 2014-2015

The maps in **Figure 9** illustrate the share of firms (Panel a) and households (Panel b) reporting access to a reliable supply of electricity across Africa. In West Africa and the Sahel, on average, less than one-third of firms and households reported reliable electricity supply when surveyed.

[138] 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 10: Reliability of Grid Electricity in Connected Households in Africa[139]

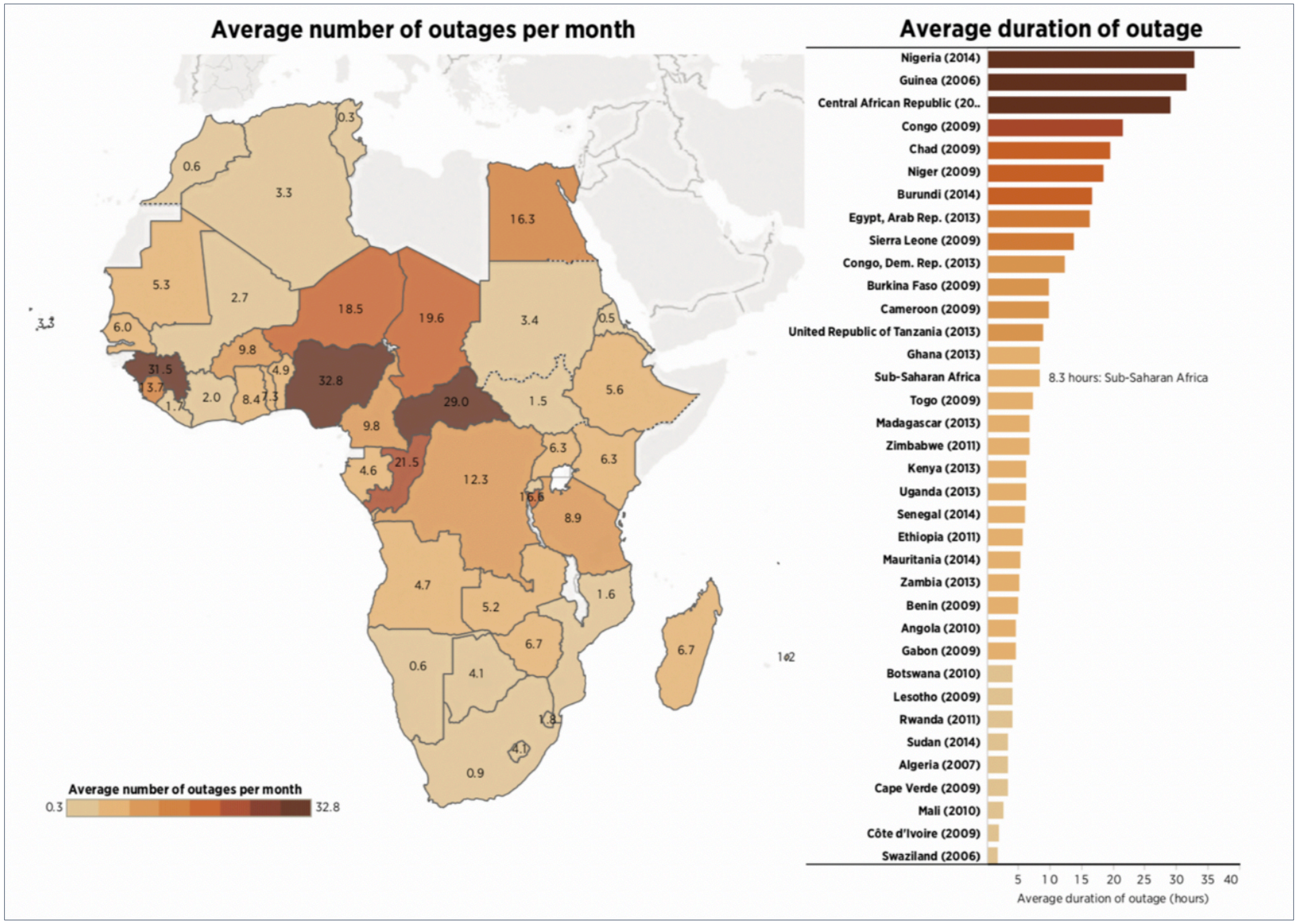


Source: Afrobarometer Household Surveys, 2014-2015

Figure 10 shows the variation in the reliability of grid electricity for connected households across Africa. The reliability of grid electricity varies widely across West Africa and the Sahel. Households in some of the countries reported reliable electricity service (e.g. Cabo Verde, Côte d'Ivoire, Mali, Senegal), while households in other countries reported extremely unreliable service (e.g. Liberia, Sierra Leone, Nigeria and Guinea).

[139] Blimpo and Cosgrove-Davies, 2019.

Figure 11: Average Number and Duration of Power Outages in Africa[140]



Source: World Bank Enterprise Surveys, 2013-2017

Figure 11 shows how the number of power outages in firms in a given month varies by country in Africa. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. The country with the highest value in the region is Nigeria, where firms reported an average of more than 30 power outages per month. The West Africa and Sahel region's average is 12 outages per month. Nigeria, Guinea and Central African Republic recorded the longest average duration of power outages.

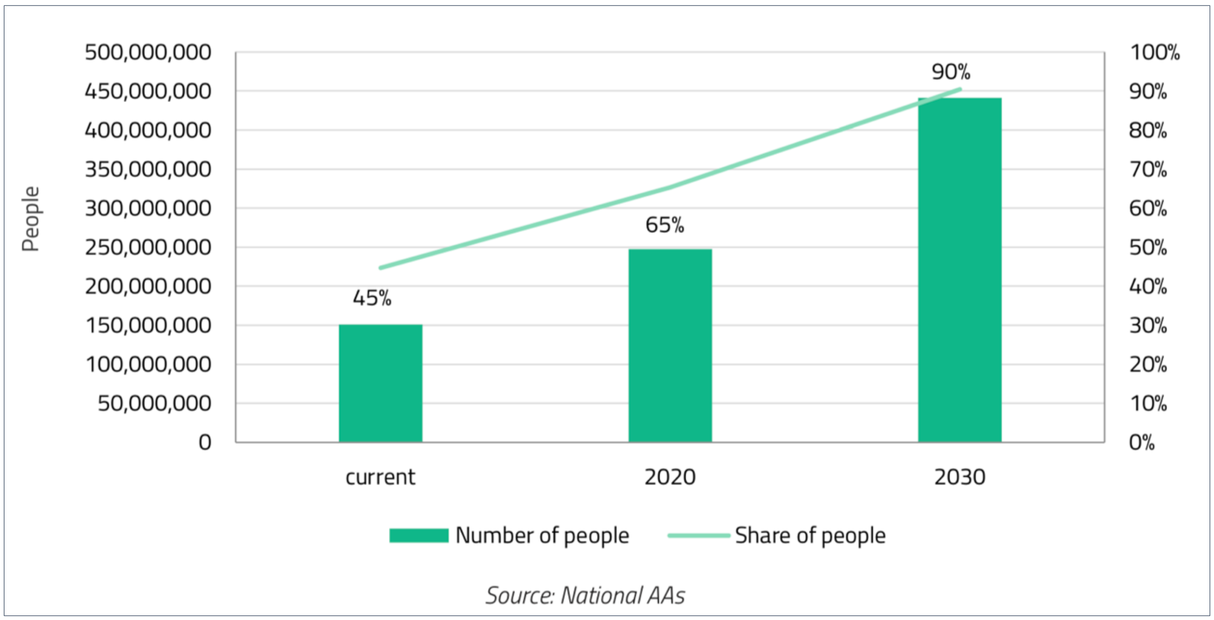
[140] "Power outages in firms in a typical month (number) – Africa," IndexMundi / World Bank, https://www.indexmundi.com/facts/indicators/ic.elc.outg/map/africa

3.2.3 Off-Grid Market Overview

3.2.3.1 Regional Overview

At a regional level, electricity access rates across West Africa are estimated to reach 90% by 2030 given current population trajectories and the country targets set in SEforALL Action Agendas (**Figure 12**). If successful, this would impact millions of people across the region. Currently, less than 3% of the region is served by off-grid and decentralized electricity services, equivalent to approximately five million people.[141] The share of the rural population served by decentralized renewable energy (mini-grids and stand-alone systems) is expected to reach 22% by 2020 and 25% by 2030, when the number of people served by off-grid systems is estimated to increase to approximately 60 million people. Despite relatively low current national, urban and rural electrification rates across the region (**Figure 13**), many governments in West Africa and the Sahel have announced ambitious electrification targets, with most committing to a goal of achieving universal access by 2030 (**Figure 14** and **Table 4**).

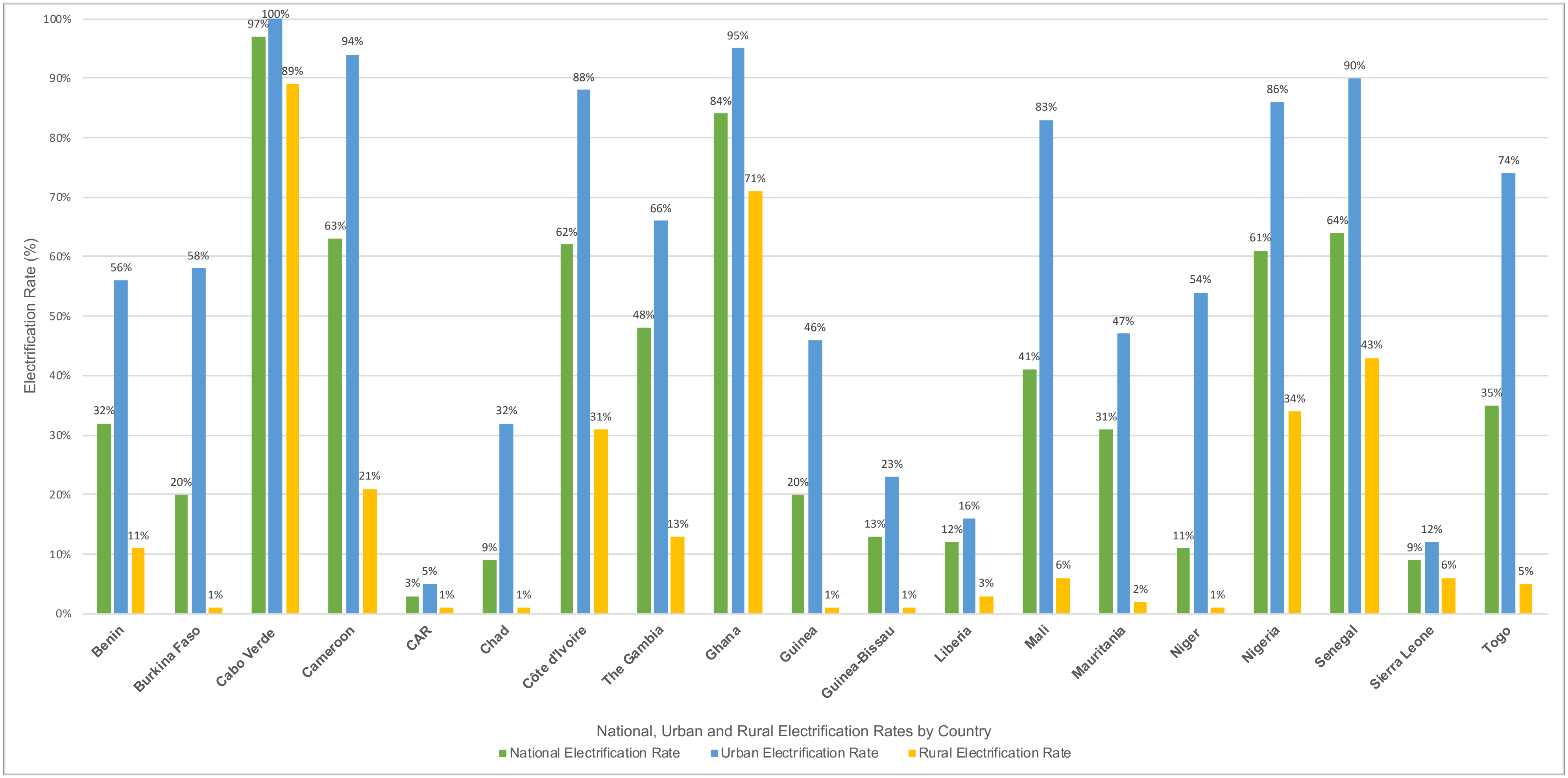
Figure 12: ECOWAS Electricity Access Trajectory through 2030[142]



Source: ECOWAS Center for Renewable Energy and Energy Efficiency

[141] NOTE: Estimate does not include Cabo Verde, The Gambia, Ghana, Guinea, and Togo as data was not available for these countries.
[142] "From Vision to Coordinated Action: Consolidation of SEforALL Action Agendas, National Renewable Energy Action Plans, and National Energy Efficiency Action Plans," ECREEE, (2017): http://SEforALL.ecreee.org/sites/default/files/final_report_on_SEforALL_consolidation.pdf

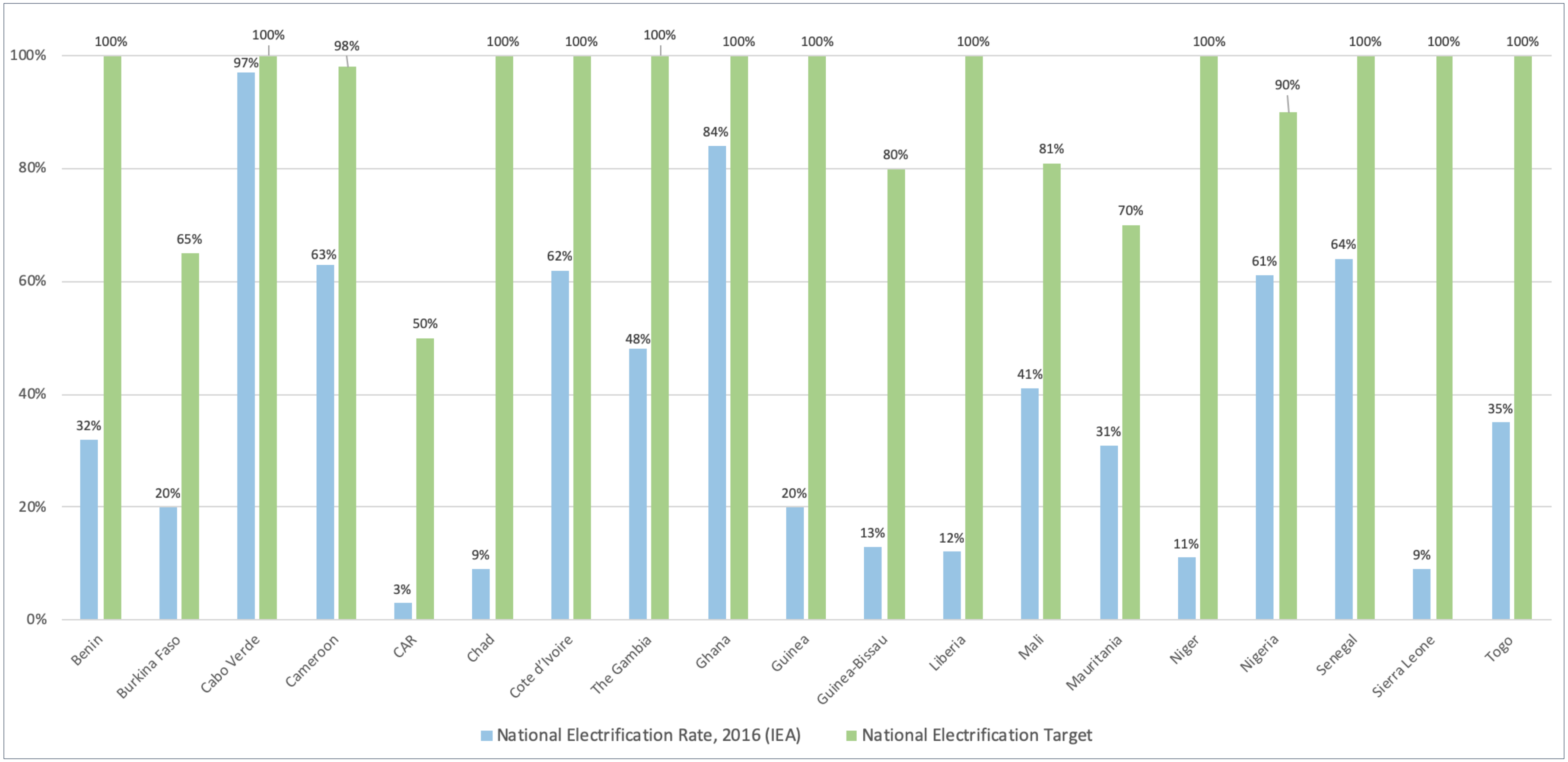
Figure 13: National, Urban and Rural Electrification Rates in West Africa and the Sahel, 2016[143]



Source: International Energy Agency

143 IEA Energy Access Outlook, 2017.

Figure 14: National Electrification Rates and Targets in West Africa and the Sahel[144]



NOTE: All electrification targets for 2030 with the exception of Cameroon (2035), Côte d'Ivoire (2025), Niger (2035), Senegal (2025) and Sierra Leone (2025).

Source: International Energy Agency; SEforALL Action Agendas; GreenMax Capital Advisors analysis

[144] See **Table 4** for a complete list of targets by country.

Table 4: National Electrification Rates and Targets in West Africa and the Sahel

National Electrification Targets (% of overall population with electricity access by year)						
Country	**2016 (IEA)[145]**	**2020 (planned)**	**2025 (planned)**	**2030 (planned)**	**2035 (planned)**	**2040 (planned)**
Benin	32%	-	-	100%	-	-
Burkina Faso	20%	45%	-	65%	-	-
Cabo Verde	97%	-	-	100%	-	-
Cameroon	63%	-	-	-	98%	-
Central African Republic	3%	-	-	50%	-	-
Chad	9%	-	-	100%	-	-
Côte d'Ivoire	62%	-	100%	-	-	-
The Gambia	48%	-	-	100%	-	-
Ghana	84%	-	-	100%	-	-
Guinea	20%	-	-	100%	-	-
Guinea-Bissau	13%	-	-	80%	-	-
Liberia	12%	-	-	100%	-	-
Mali	41%	52%	-	81%	-	-
Mauritania	31%	-	-	70%	-	-
Niger	11%	-	-	-	100%	-
Nigeria	61%	-	-	90%	-	100%
Senegal	64%	-	100%	-	-	-
Sierra Leone	9%	-	100%	-	-	-
Togo	35%	50%	75%	100%	-	-
Regional Average	**37.6%**					

Source: International Energy Agency, SEforALL; GreenMax Capital Advisors analysis

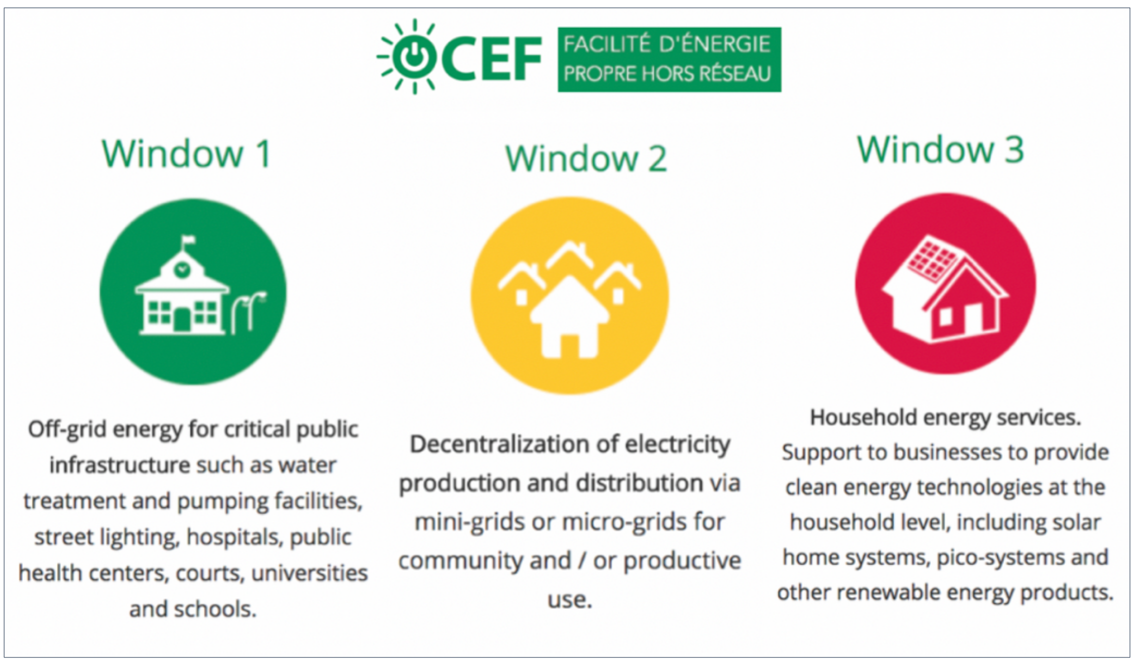
[145] IEA Energy Access Outlook, 2017.

3.2.3.2 Select National Off-Grid Development Programs

This section is a brief overview of five prominent national off-grid development initiatives that have been selected for their nationwide scale, PPP features and diversity of approaches.

- In **Benin**, an off-grid regulatory framework is currently under development – 'Access to Electrification Outside the Grid' (Cadre Réglementaire de L'électrification Hors-Réseau, EHR) – includes a regime for contracts with the private sector for the sale of quality pico solar products receiving a subsidy in an off-grid area. The EHR framework, which is being developed by the Millennium Challenge Corporation (MCC) in partnership with the Government, is intended to serve as the country's roadmap or 'Master Plan' for rural electrification. The EHR calls for legal reforms to the electricity code to prioritize renewable energy consumption over conventional electricity, promotes the integration of the off-grid sector with mobile money services and includes specific measures to incentivize private sector participation and investment in off-grid development.[146] The MCC framework also includes provisions to implement an Off-Grid Clean Energy Facility (OCEF), which provides a platform for organizations and companies in Benin to search for potential partners to finance and develop off-grid clean energy projects.[147] The OCEF includes three distinct grant funding windows and corresponding TA to support proven and sustainable off-grid clean energy businesses and projects, with the first round complete and the second funding window scheduled for 2019.[148] The third window includes funding for the stand-alone solar market segment (**Figure 15**).

Figure 15: Benin Off-Grid Clean Energy Facility



Source: Off-Grid Clean Energy Facility

146 "Regulatory Framework for Off-Network Electrification, Cadre Réglementaire de L'électrification Hors-Réseau (EHR)," Benin Energie: https://www.benin-energie.org/bilan-energetique.html
147 "Launch of the Off-Grid Clean Energy Facility in Benin," Energy Access Practitioner Network, (2018): http://energyaccess.org/news/recent-news/launch-of-the-off-grid-clean-energy-facility-in-benin/
148 https://ocef.bj/

- In **Côte d'Ivoire**, the government launched the National Program for Rural Electrification, (Programme National d'Electrification Rurale, PRONER) in 2014 to align public and private resources and coordinate the development efforts necessary to expand electricity coverage to all localities and double the number of household connections. State-owned CI-ENERGIES also developed a Rural Electrification Master Plan (Plan Directeur d'Electrification Rurale, PDER), which has set a target of universal access by 2025 through a combination of grid extensions and off-grid solar technology.

  In addition to the government's policy initiatives, in 2018, AfDB approved a proposal to help Zola EDF Côte d'Ivoire (ZECI) – an off-grid energy company – to mobilize a CFAF 15.75 billion loan arranged by Société Générale de Banque in Côte d'Ivoire (SGBCI) and Crédit Agricole Corporate and Investment Bank (Crédit Agricole CIB). This loan will aid in the implementation of a project that will pilot a local currency receivables-backed financing structure. ZECI will be able to utilize this loan to provide access to approximately 100,000 rural households with PAYG SHS by 2020. This operation would be the first large-scale local currency financing structure using this financing model to bolster the off-grid renewable energy sector in Africa. ZECI's business model, which consists of selling solar kits that meet international quality standards under lease-purchase agreements for a three-year period, makes it easier for poor households to renewable electricity. Moreover, this project increases financial inclusion since these customers have the potential to establish credit history, have access to financing, and have ownership of assets.[149]

- In **Ghana**, the off-grid market differs considerably from most of the countries in the region, as the country had a national electrification rate of 84% and a rural electrification rate of 71% in 2016. This is largely due to the success of the country's National Electrification Scheme, which extended electricity access to thousands of communities over a 30-year period from 1990 to 2020. In 2019, with funding from UNDP and DANIDA, Ghana published a Renewable Energy Master Plan (REMP), which includes a series of targets in five-year blocks through 2030. The REMP intends to add a total of 20 MW of stand-alone solar by 2030 and also aims to support integration of existing stand-alone systems into mini-grids under the country's net metering scheme.[150]

- In **Nigeria**, the Nigeria Electrification Project (NEP) is a key development 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.[151] This project aims to develop a pipeline of local investments and financial incentives to catalyze off-grid market growth. The NEP is divided into four components, including one that is dedicated to stand-alone solar systems (**Figure 16**).[152] Under the Rural Electrification Strategy and Implementation Plan (RESIP), which is currently under development, Nigeria's Rural Electrification Agency (REA) will administer a Rural Electrification Fund (REF) to provide developers with financial incentives to expand rural electricity access. 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.[153]

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[149] "Côte d'Ivoire: African Development Bank to help mobilize over CFAF 15 billion to finance pay-as-you-go solar home systems," African Development Bank, (2018): https://www.afdb.org/en/news-and-events/Côte-divoire-african-development-bank-to-help-mobilize-over-cfaf-15-billion-to-finance-pay-as-you-go-solar-home-systems-18244/

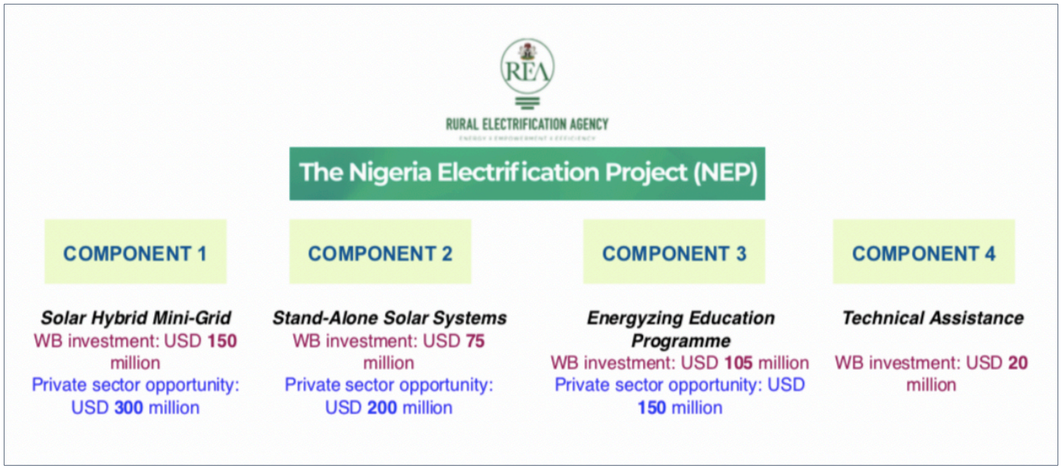
[150] Ghana Renewable Energy Master Plan: https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/UNDP_GH_SUS_DEV_REN_MASTER_PLAN_2019.pdf

[151] "World Bank Approves $350M for REA Off-Grid Projects," Rural Electrification Agency, (2018): http://rea.gov.ng/wbank-approves-350m-for-reas-solar-power-projects-in-schools-others/

[152] "The Nigeria Electrification Project," REA, (2018): http://rea.gov.ng/nigeria-electrification-project-nep/

[153] "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

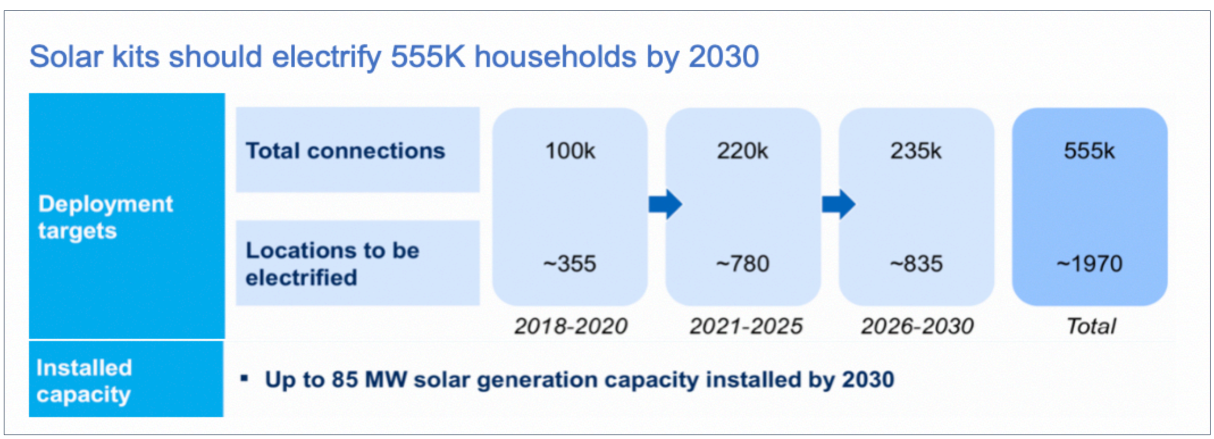
Figure 16: Nigeria Electrification Project Overview



Source: Rural Electrification Agency

- In **Togo**, the government has adopted the Togo Electrification Strategy, which relies heavily on renewable energy to increase electrification in the country. The strategy will be rolled out in three phases over 12 years and will cost an estimated CFA 100 billion (USD 1.8 billion), of which half is expected to come from private investment. The target of this program is for electricity to reach 50% of Togo's 7.5 million-population by 2020, 75% by 2025 and to achieve universal access by 2030. The strategy envisions a combination of grid extensions, mini-grids and stand-alone solar systems to achieve its objectives. The government of Togo analysis found that the stand-alone sector will play a significant role in electrifying rural households – with an estimated 555,000 solar kits to be distributed to 1,970 locations through 2030 (**Figure 17**). The off-grid solar component of the electrification program is estimated cost of CFA 435 billion (USD 737 million), which would cover subsidies and tax incentives to offset the cost of the solar kits, credit lines to finance deployment to specific market segments, guarantees for operators to cover default risk, technical assistance and other indirect support (**Figure 18**). The private sector is expected to cover about two-thirds of this total financing requirement.[154]

Figure 17: Togo Electrification Strategy – Stand-alone Solar Kit Deployment Targets, 2018-2030



Source: Togo National Electrification Strategy

[154] Togo electrification strategy, 2018: https://www.lightingglobal.org/wp-content/uploads/2018/12/Togo-Electrification-Strategy-Short-EN-Final.pdf

The government has adopted a specific platform to lead implementation of the off-grid stand-alone solar component of the strategy – the 'CIZO' program. Under this initiative, the Government provides subsidies to households to offset the purchase of solar home systems sold by participating companies. Two private sector solar companies have been granted licenses to operate in the country's market.[155]

In 2017, UK-based BBOXX won a tender to distribute 300,000 solar home systems (SHS) over a five-year period under the program. BBOXX has partnered with France's EDF Group and is also collaborating with La Poste – Togo's postal company – to take advantage of its extensive network in rural areas of the country to distribute its solar products. BBOXX received USD 4 million in debt financing from Union Togolaise de Banque as well as a 50% pro-rata credit enhancement from the African Guarantee Fund.[156] In 2019, BBOXX launched *Tomorrow's Connected Community* – a conceptual business model that provides solar electricity to an entire village (streetlights, households, schools, businesses etc.) through a micro-grid and solar home systems, fully managed and maintained by the company's digital platform.[157]

The Government also awarded a license to another supplier – Soleva, a consortium of Aphelion Energy and Wawa Energy Solutions – to distribute Greenlight Planet's Sun King solar lighting kits. The Government's subsidy to households is meant to cover the price of the solar equipment, leaving customers to pay only the cost of their energy consumption on a Pay-As-You-Go (PAYG) basis. Around 10,000 solar kits were installed in rural Togo in 2018; another 100,000 households are due to be connected by 2020, and a total of 555,000 by 2030.[158]

[155] "Togo electrification scheme gets boost from solar rollout," Republic of Togo, (2017): http://www.republicofTogo.com/Toutes-les-rubriques/In-English/Togo-electrification-scheme-gets-boost-from-solar-rollout
[156] "BBOXX receives invitation to meet President of Togo to roll out 300,000 solar home systems," BBOXX, (July 2017): http://www.bboxx.co.uk/bboxx-receives-invitation-meet-president-Togo-roll-300000-solar-home-systems/
[157] "BBOXX Launches 'Tomorrow's Connected Community,'" Alternative Energy Africa, (April 25, 2019): https://ae-africa.com/read_article.php?NID=9968
[158] "Togo subsidizes off-grid solar to extend electricity access to all," Reuters, (March 2, 2019): https://af.reuters.com/article/topNews/idAFKCN1QJ09L-OZATP?platform=hootsuite

Figure 18: Togo Electrification Strategy – Government Interventions in Support of Stand-alone Solar Market Growth

Support measures will be deployed along the solar kit value chain. Cizo participants will receive additional support

Project Cizo benefits

Role throughout the value chain

	Kit financing	Distribution and logistics	Sales and marketing	Payment	Repair and battery replacement	Consumer credit
Private operator	▪ **Self and debt** financing from the – parent company – commercial banks – financial backers	▪ Kit **import** ▪ Management, monitoring and payment of **distribution to POSs**	▪ Self **marketing** of products ▪ Agent management with sales incentives	▪ Monitoring of **payment collection** from consumers ▪ Partial acceptance of **risk of payment default**	▪ Provision of **equipment to replace batteries and defective components** ▪ Project Cizo technician **training** in particular products	N/A
Government intervention	2 **Credit line**	1 – **Logistics** – **POSs** ▪ Facilitated **import** methods and **procedures**	▪ Public **awareness** campaign about the kits 1 Training and supply of **sales agents** • Provision of **market data**	1 Mobile payments via different operators included on the same **domestic platform**	▪ **Solar academies** and **technician training** ▪ **Network of local technicians** ▪ **User** training in kit use	2 Support for one or more **microfinance bodies** via a credit line 2 **Credit office** fed with household use data 3 Level 1 subsidies[2]

Source: Togo National Electrification Strategy

3.2.4 Least-Cost Electrification Analysis

➢ **Introduction / Overview**

A least-cost electrification analysis was performed to assess the potential development of electricity access in each country through 2023 and through 2030 ("Scenario 2023" and "Scenario 2030").[159] The analysis identifies the scale of market opportunities for off-grid stand-alone solar electrification. The analysis utilized geospatial techniques to determine the least-cost electrification options for settlements and households across the region. Three options were considered:

- Connection to the national grid (on-grid)
- Electrification by mini-grids
- Electrification by off-grid stand-alone systems

The analysis is based on the proximity of settlements to existing and planned electricity grid networks, power stations and mini-grids, population density and nodes of economic growth. The methodology is outlined in **Annex 1** of this report, while additional geographic information system (GIS) information, including categorizations, key definitions, and datasets specific to the analysis undertaken in each country are included in Annex 1 of each country report.

➢ **Data Limitations**

Data limitations influenced the results of the least-cost electrification analysis for several countries. A detailed summary of data limitations per country is included in **Annex 1** of each country report. Three datasets were limited across nearly every country:

- Low voltage lines (LV lines): Low voltage lines were not available for all countries. The LV grid lines contribute to the identification of households within close proximity to the grid that are not connected to the grid. Instead, the analysis used a combination of population density and high voltage and medium voltage data to establish the ratio of non-connected households.
- Medium voltage lines (MV lines): For most countries, the planned or future MV lines (to be constructed after the year 2018) were unknown. The analysis therefore did not estimate new MV lines to be built.
- Settlements: Settlements were often outdated, or the given locations were approximated. This limitation was addressed by using the Voronoi polygon analysis (see **Annex 1** for more details).

Cabo Verde: As an island state with a very high electrification rate (97% of the population has electricity access), Cabo Verde is an outlier in the West Africa and Sahel region. A different approach was taken for the least-cost electrification analysis for Cabo Verde, as the electrical grid network was not available for the GIS analysis. According to the National Directorate of Industry, Commerce and Energy, (Direcção Nacional da Indústria Comercio e Energia, DNICE), approximately 30 communities across three islands were un-electrified in 2018. Due to the dispersed nature of these villages, it was assumed that these villages will not be connected to the national grid until 2030 and are therefore suitable for either mini-grids or off-grid stand-alone solutions. The same approach/methodology used for the rest of the countries was then applied to Cabo Verde to estimate which electrification option was most appropriate for the country's off-grid communities.

[159] NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to electrification targets for 2030.

- **Results**

The least-cost electrification analysis estimated the share of the population in each country that could be connected to the national electrical grid in 2023 and 2030, as well as the corresponding share of the population suitable for off-grid solutions. The results of the least-cost analysis are presented and analyzed in further detail below, beginning with estimates for grid connections followed by estimates for the off-grid sector. **Figure 19** shows the distribution of settlements according to least-cost electrification options in the region under scenario 2030.

In general, when comparing the results of the analysis with national electrification targets in each country (**Table 5** and **Figure 20**), it is evident that in many countries, off-grid solutions – both mini-grids and stand-alone systems – will play an important role in achieving national electrification objectives.

The results of the analysis were closely aligned with the electrification targets set by the governments of Benin, Cabo Verde, Cameroon, Côte d'Ivoire, The Gambia, Ghana, Nigeria, Senegal and Togo, which suggests that these countries have strong potential to reach their national electrification targets (assuming all grid extensions will be completed as planned). The findings also indicate that a smaller overall share of the population in these countries would need to be electrified by off-grid solutions (mini-grids or stand-alone systems) to reach national electrification targets.

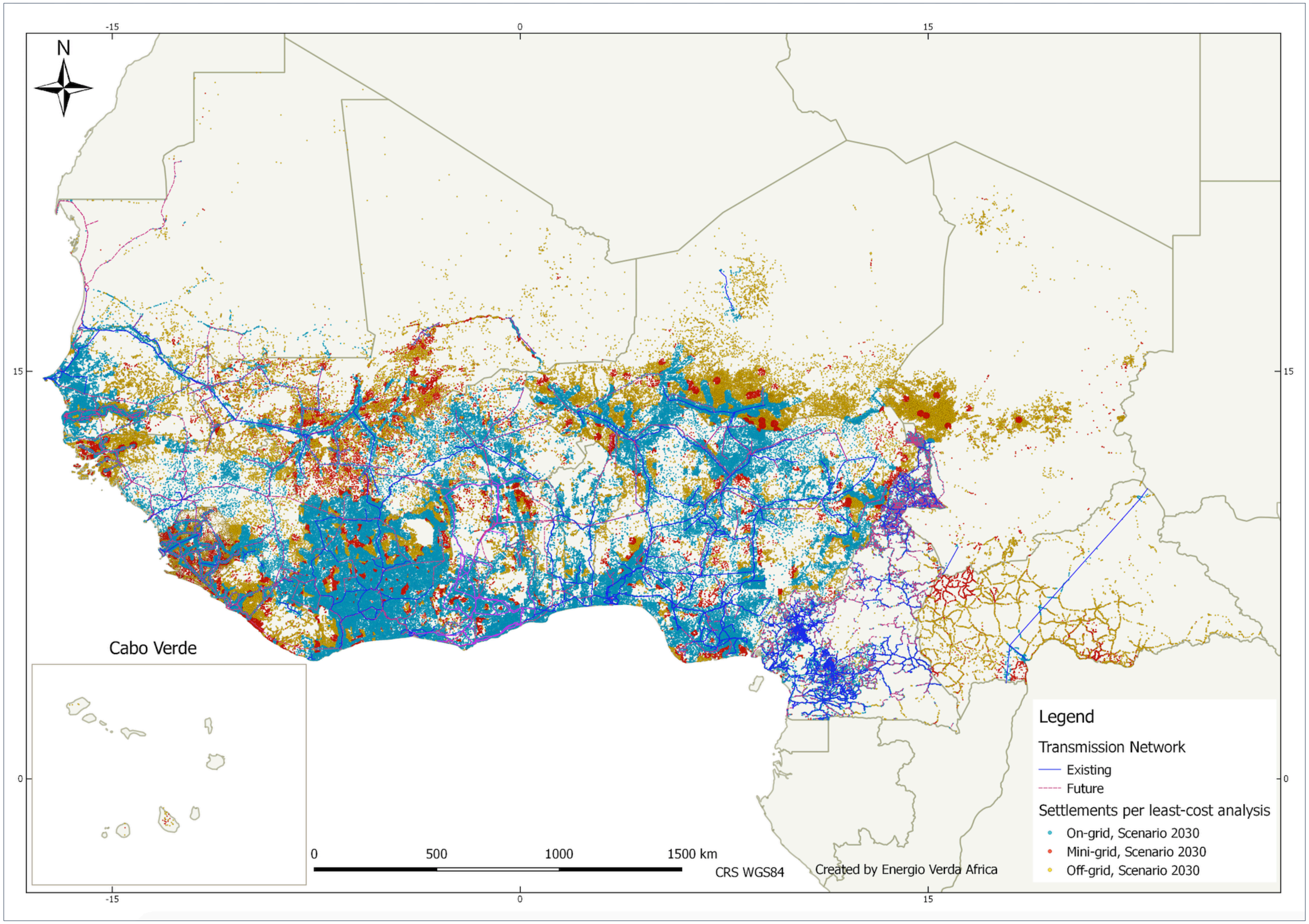
The results of the analysis were not as closely aligned with targets set by the governments of Central African Republic, Chad, Guinea-Bissau, Mali, Mauritania, Niger and Sierra Leone. This suggests that these countries may have set slightly ambitious targets, but also that these countries will need to increase the utilization of off-grid solutions (mini-grids and stand-alone systems) in electrification plans in order to achieve their electricity access objectives, particularly in the near-term until planned grid extensions are realized.

In Burkina Faso, the analysis found that the country could exceed its 2030 national electrification target of 65%[160] by about 15% assuming that all planned grid extensions will be completed by that year. In Liberia, although the government has set a target of achieving universal electricity access by 2030, the recently adopted Rural Energy Strategy and Master Plan (RESMP) envisions electrifying 66% of the population through grid extensions.[161] The results of the least-cost analysis suggest that a slightly higher percentage of the overall population can be connected to the grid by 2030 (about 75% of the population), assuming that all planned grid extensions will be completed by that year.

[160] "Mapping the least cost option for rural electrification in Burkina Faso: Scaling up renewable energy," European Commission, (2017): https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/mapping-least-cost-option-rural-electrification-burkina-faso-scaling-renewable-energies

[161] "Rural Energy Strategy and Master Plan for Liberia, 2030," Rural and Renewable Energy Agency, Developed by Gesto Energy Consulting, (2016): http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf

Figure 19: Distribution of Settlements by Least-Cost Electrification Option, 2030



Source: Energio Verda Africa GIS analysis

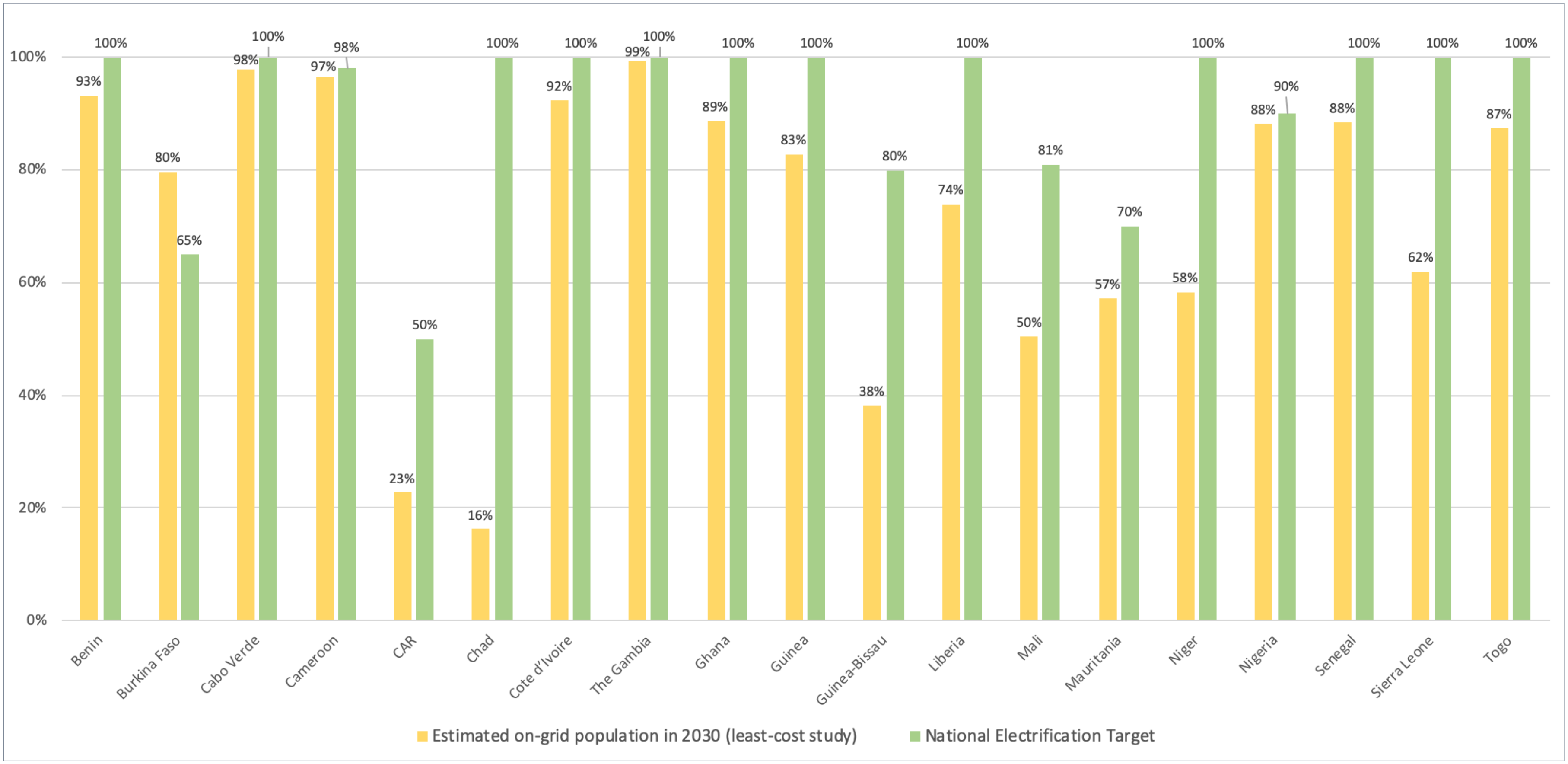
Table 5: Estimated Share of Population with Electricity Access via the National Grid and National Electrification Targets

Least-Cost Electrification Analysis % of population with electricity access via the national grid			National Electrification Targets % of population with electricity access (all electrification options)					
Country	**2023 (estimated)**	**2030 (estimated)**	**2016 (IEA)[162]**	**2020 (planned)**	**2025 (planned)**	**2030 (planned)**	**2035 (planned)**	**2040 (planned)**
Benin	74.7%	93.2%	32%	-	-	100%	-	-
Burkina Faso	43.8%	79.7%	20%	45%	-	65%	-	-
Cabo Verde	97.8%	97.8%	97%	-	-	100%	-	-
Cameroon	66.5%	96.6%	63%	-	-	-	98%	-
Central African Republic	10.9%	22.7%	3%	-	-	50%	-	-
Chad	11.5%	16.2%	9%	-	-	100%	-	-
Côte d'Ivoire	65.5%	92.3%	62%	-	100%	-	-	-
The Gambia	79.6%	99.3%	48%	-	-	100%	-	-
Ghana	63.6%	88.7%	84%	-	-	100%	-	-
Guinea	35.5%	82.8%	20%	-	-	100%	-	-
Guinea-Bissau	15.8%	38.3%	13%	-	-	80%	-	-
Liberia	27.6%	73.9%	12%	-	-	100%	-	-
Mali	25.5%	50.4%	41%	52%	-	81%	-	-
Mauritania	35.5%	57.1%	31%	-	-	70%	-	-
Niger	32.7%	58.3%	11%	-	-	-	100%	-
Nigeria	54.8%	88.1%	61%	-	-	90%	-	100%
Senegal	71.2%	88.4%	64%	-	100%	-	-	-
Sierra Leone	26.9%	61.9%	9%	-	100%	-	-	-
Togo	67.8%	87.4%	35%	50%	75%	100%	-	-
Regional Average	**47.8%**	**72.3%**	**37.6%**					

Source: International Energy Agency, SEforALL, Energio Verda Africa GIS analysis; GreenMax Capital Advisors analysis

[162] IEA Energy Access Outlook, 2017.

Figure 20: Estimated Share of Population with Electricity Access via the National Grid and National Electrification Targets[163]

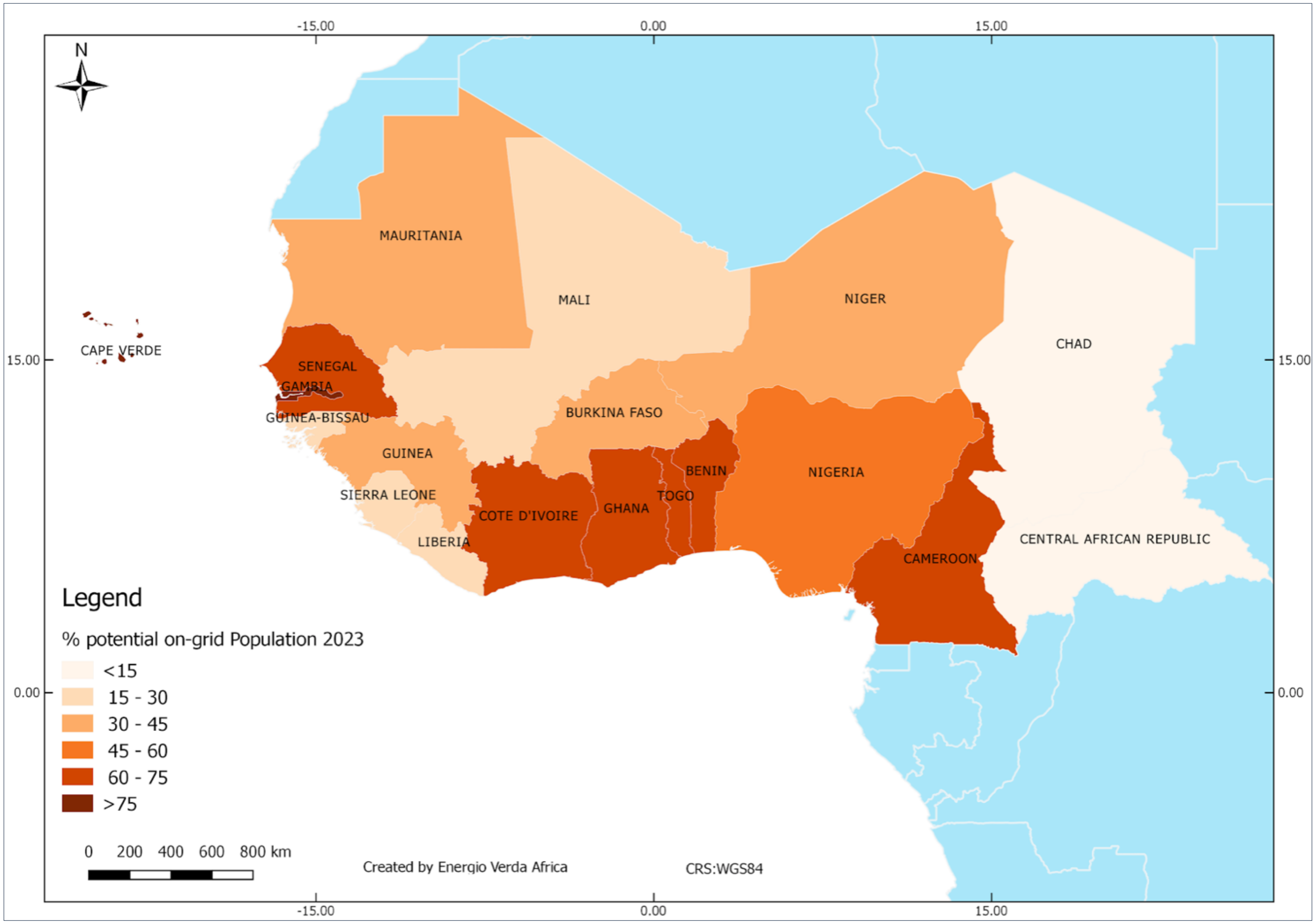


NOTE: All electrification targets for 2030 with the exception of Cameroon (2035), Côte d'Ivoire (2025), Niger (2035), Senegal (2025) and Sierra Leone (2025)

Source: Energio Verda Africa GIS analysis; GreenMax Capital Advisors analysis

[163] See **Table 5** for a complete list of targets by country.

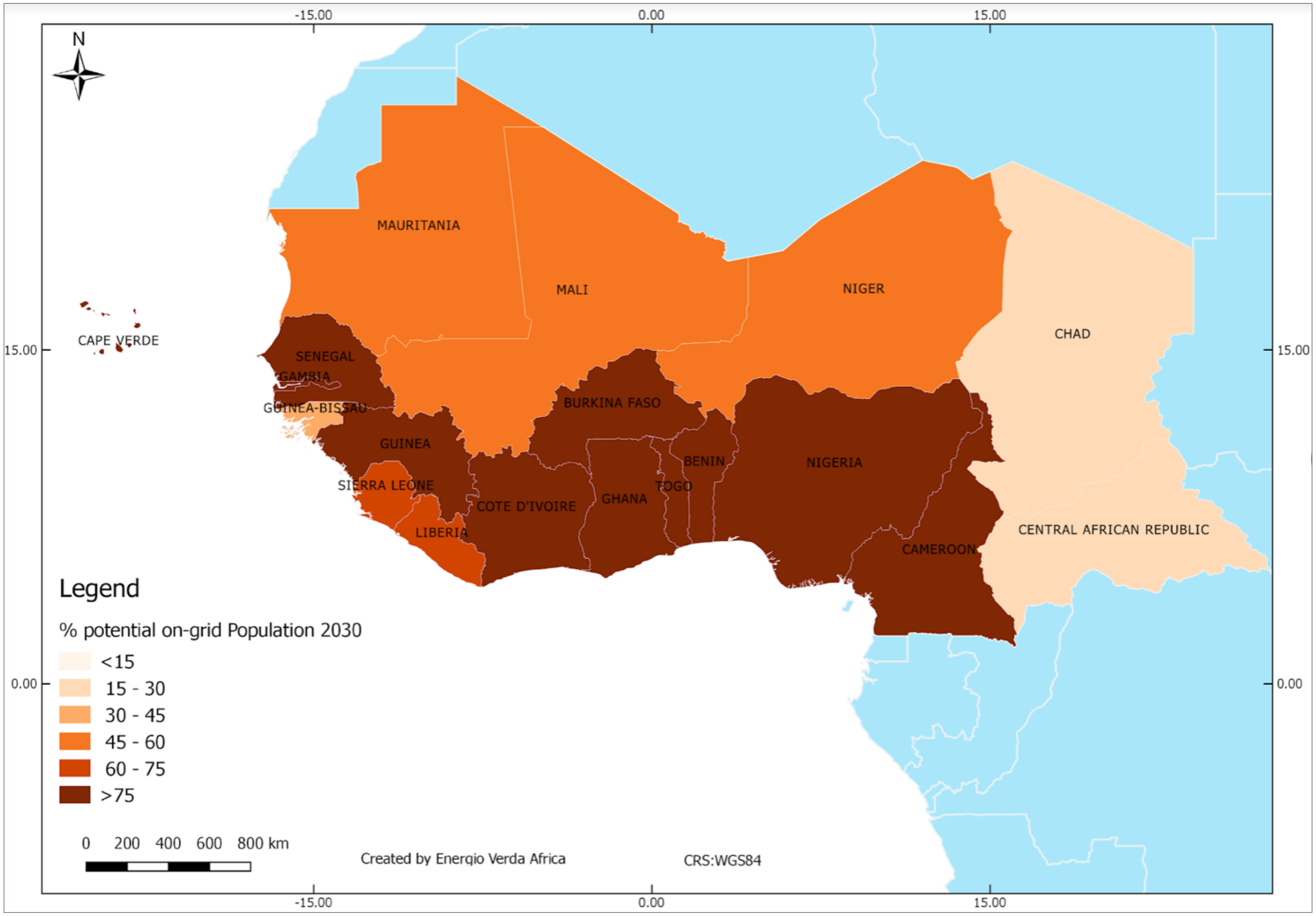
Figure 21: Estimated Share of Population with Electricity Access via the National Grid, 2023



Source: Energio Verda Africa GIS analysis

Figure 21 illustrates the estimated percentage of the population in countries across West Africa and the Sahel that will have electricity access via the national electrical grid in 2023. The countries with the largest percentage are Cabo Verde, The Gambia, Benin, Senegal, Togo, Cameroon, Côte d'Ivoire and Ghana.

Figure 22: Estimated Share of Population with Electricity Access via the National Grid, 2030



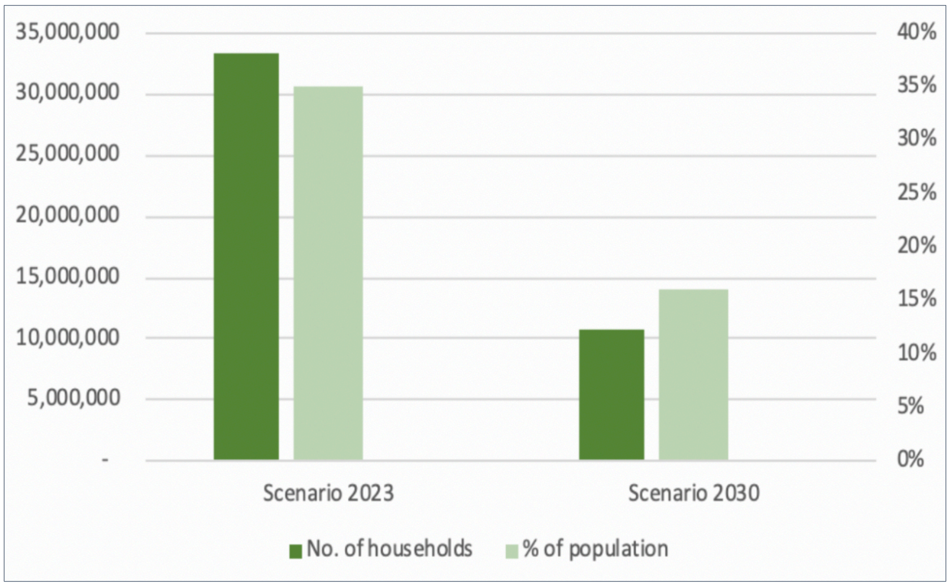
Source: Energio Verda Africa GIS analysis

Figure 22 illustrates the estimated percentage of the population in countries across West Africa and the Sahel that will have electricity access via the national electrical grid in 2030. The countries with the largest percentage are Cabo Verde, The Gambia, Cameroon, Benin, Côte d'Ivoire, Ghana, Senegal, Nigeria and Togo.

The estimated number of people, households and share of population that will be suitable for off-grid stand-alone systems in countries across West Africa and the Sahel in Scenarios 2023 and 2030 is presented in **Figures 23-29** and **Table 6** below.

In total across West Africa and the Sahel, the least-cost analysis estimated that about 166 million people, 33 million households and an average of 35% of the population will be suitable for stand-alone systems in 2023. These figures will decrease to about 60 million people, 11 million households and an average of 16% of the region's population by 2030 (**Figure 23** and **Table 6**).

Figure 23: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

In Scenario 2023, the estimated number of off-grid households suitable for stand-alone systems will vary widely across the region. Nigeria has the largest potential for off-grid electrification, with an estimated 19.3 million households suitable for stand-alone systems in 2023, equivalent to about 40% of the population in that year. The second largest number of potential off-grid households in 2023 will be in Niger, with slightly more than 2 million, followed by Chad and Burkina Faso. By 2030, the absolute number of off-grid households will decline in every country, with the exception of Chad, where the number increases by about 165,000 households.

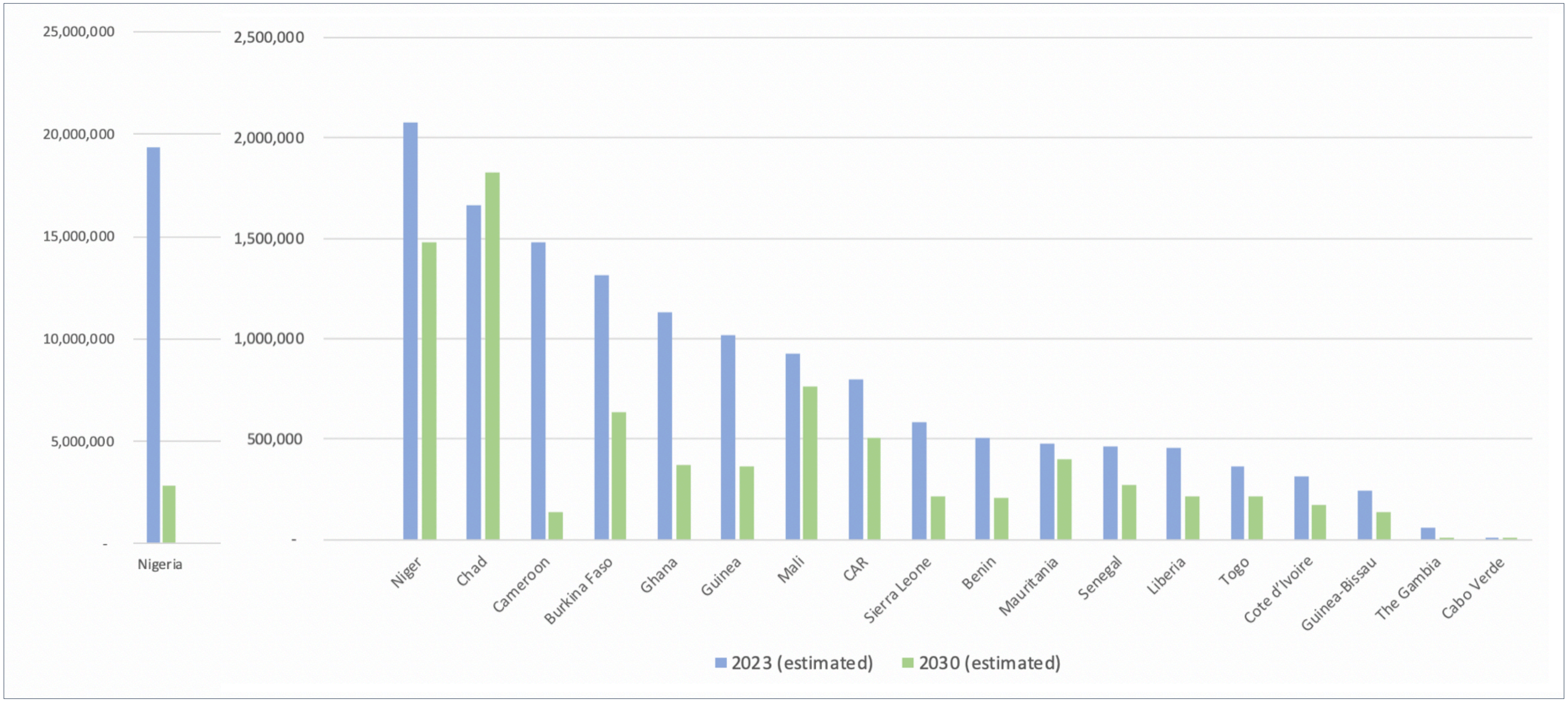
The countries with the lowest number of households in off-grid areas are Cabo Verde, The Gambia and Guinea-Bissau. Whereas Cabo Verde and The Gambia have an extensive grid network in place or detailed plans for grid extension, Guinea-Bissau's network is concentrated in the capital Bissau and other urban areas.

Table 6: Estimated Number of People, Households and Share of Population Suitable for OGS Systems, 2023 and 2030

	Scenario 2023			Scenario 2030		
Country	**Estimated No. of people**	**Estimated No. of households**	**Estimated % of population**	**Estimated No. of people**	**Estimated No. of households**	**Estimated % of population**
Benin	2,527,532	505,506	18.7%	1,037,674	207,535	6.3%
Burkina Faso	7,512,057	1,318,256	33.1%	3,598,169	631,258	13.0%
Cabo Verde	6,088	1,450	1.1%	3,851	917	0.6%
Cameroon	7,686,306	1,478,136	28.8%	711,643	136,854	2.2%
Central African Republic	3,896,714	795,248	72.3%	2,390,957	508,358	41.9%
Chad	9,655,335	1,664,713	60.1%	10,615,500	1,830,259	53.7%
Côte d'Ivoire	1,706,487	316,016	6.2%	922,749	170,879	2.8%
The Gambia	466,179	56,851	18.6%	17,802	2,171	0.6%
Ghana	3,945,562	1,127,303	12.0%	1,305,196	372,913	3.4%
Guinea	7,346,713	1,020,377	48.9%	2,613,990	363,054	14.6%
Guinea-Bissau	1,304,328	241,542	60.2%	731,094	135,388	28.4%
Liberia	2,284,033	456,807	41.8%	1,072,524	214,505	16.5%
Mali	5,258,385	922,524	25.3%	4,342,974	761,925	17.0%
Mauritania	2,920, 628	478,792	59.3%	2,309,754	395,042	40.6%
Niger	14,754,955	2,078,163	59.8%	10,493,616	1,477,974	32.7%
Nigeria	89,070,325	19,363,114	39.9%	13,078,988	2,843,258	4.9%
Senegal	3,864,976	465,660	20.8%	2,259,558	272,236	10.0%
Sierra Leone	3,281,083	585,908	42.1%	1,212,853	216,581	13.0%
Togo	1,685,228	366,354	20.8%	980,196	213,086	10.2%
Total	**166,252,286**	**33,242,720**	**35% (avg.)**	**59,699,088**	**10,754,193**	**16% (avg.)**

Source: Energio Verda Africa GIS analysis

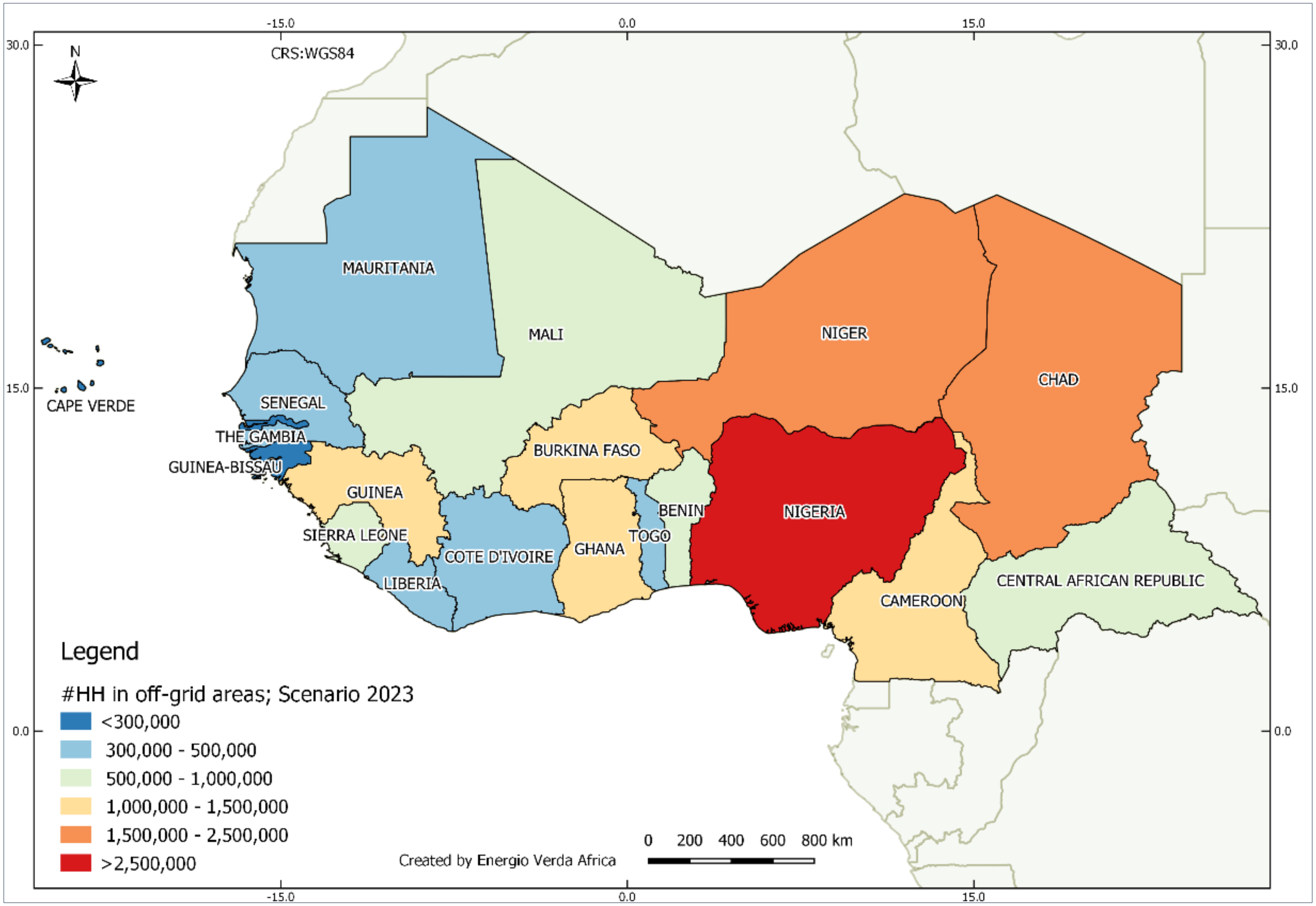
Figure 24: Estimated Number of Households Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

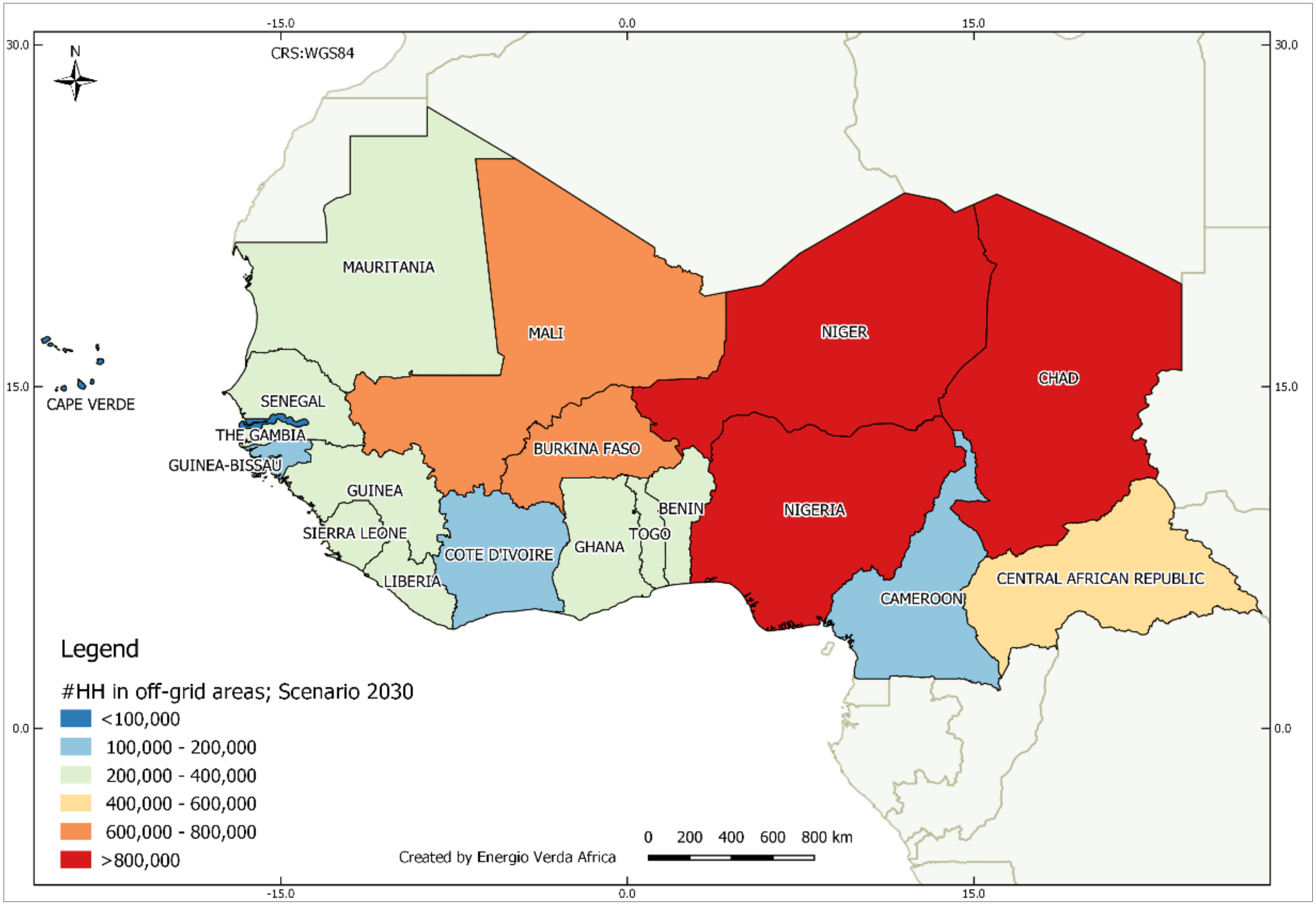
According to the least-cost electrification analysis, in 2023, Nigeria will have the largest number of households suitable for stand-alone systems (19.3 million), followed by Niger (2 million) and Chad (1.6 million). By 2030, Nigeria will still have the largest number of households (2.8 million), followed by Chad (1.8 million) and Niger (1.5 million). Chad is the only country in the region that will witness an increase in the number of off-grid households between 2023 and 2030.

Figure 25: Estimated Number of Households Suitable for OGS Systems, 2023



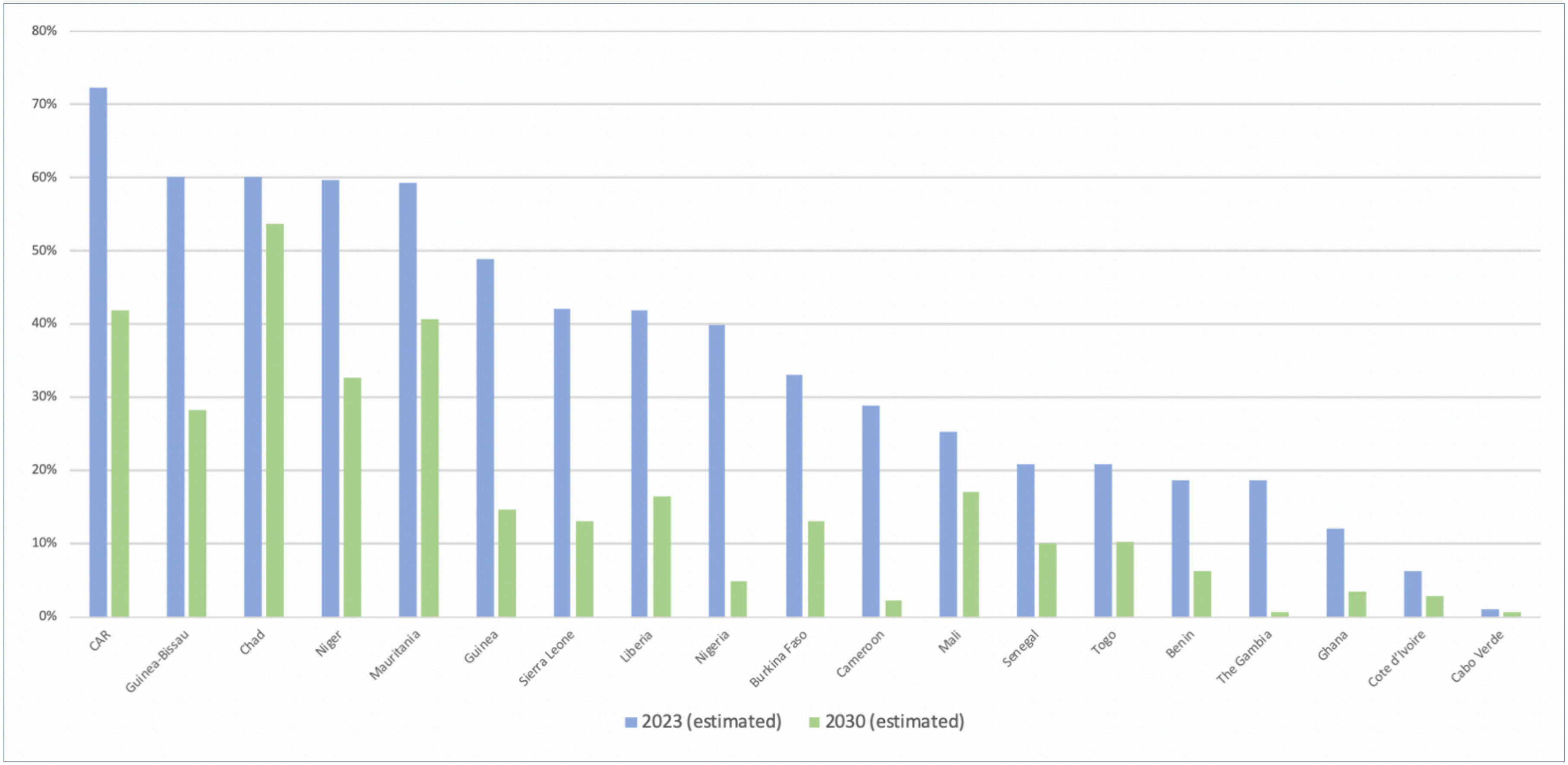
Source: Energio Verda Africa GIS analysis

Figure 26: Estimated Number of Households Suitable for OGS Systems, 2030



Source: Energio Verda Africa GIS analysis

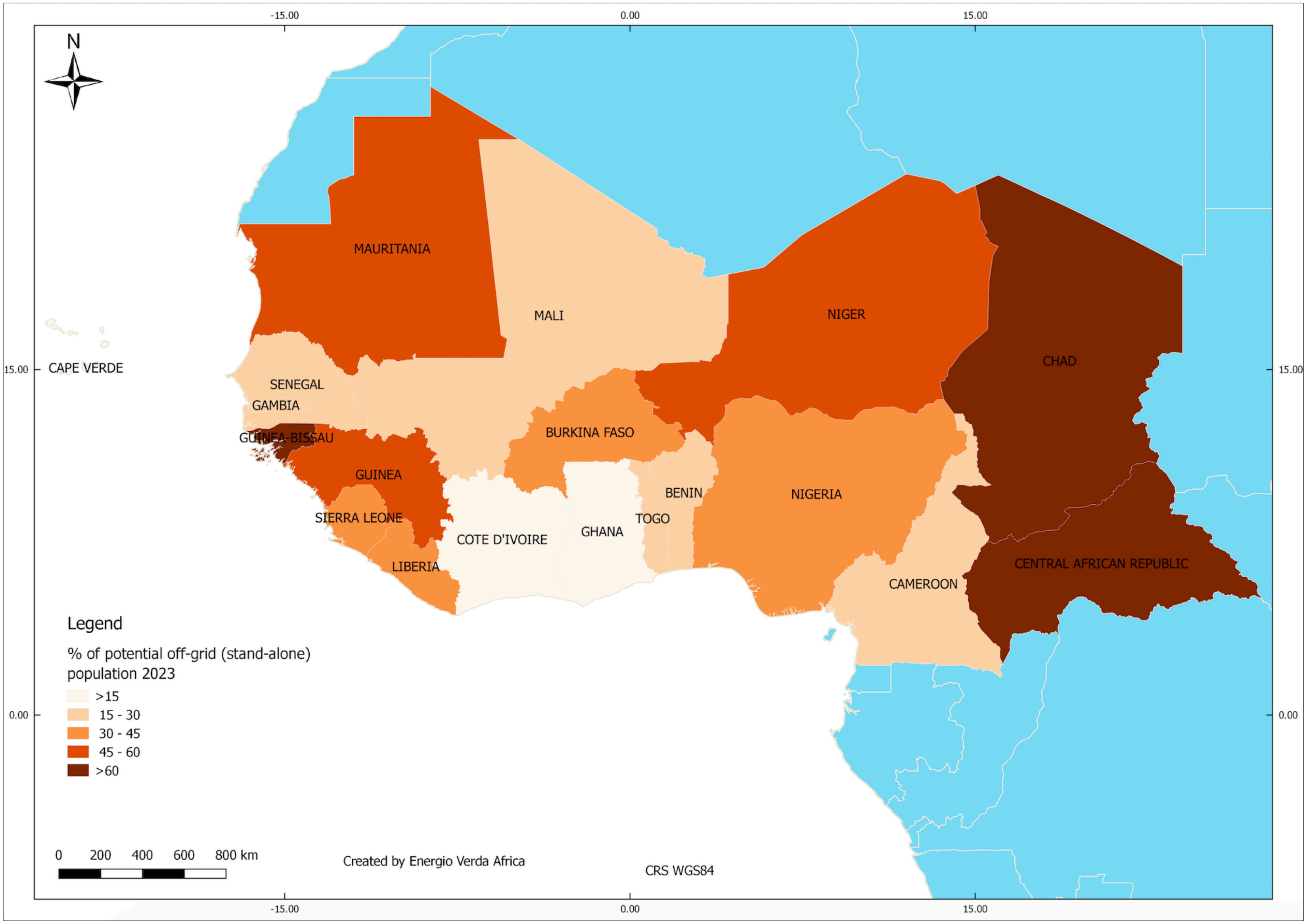
Figure 27: Estimated Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

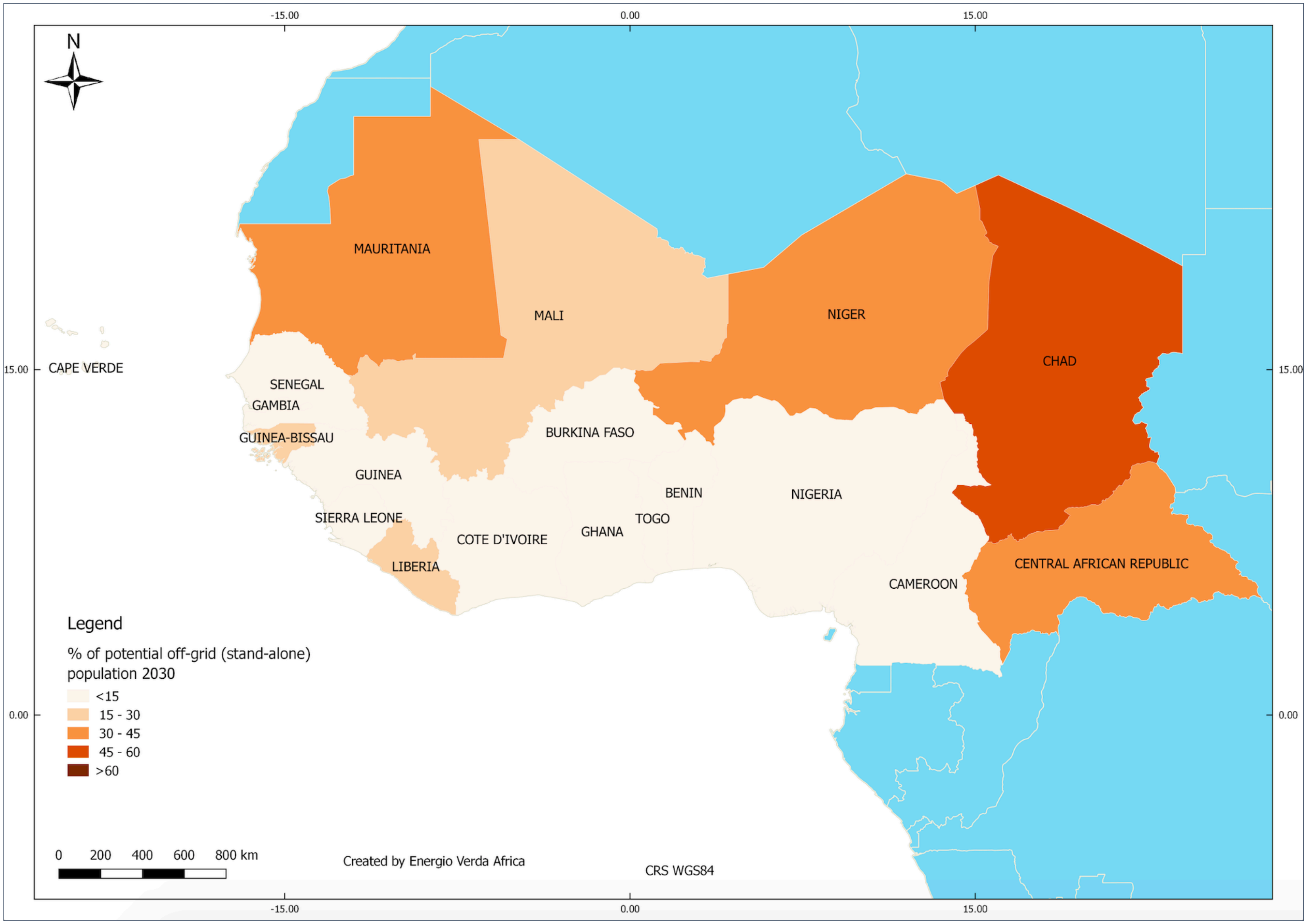
According to the least-cost electrification analysis, in 2023, Central African Republic will have the largest share of its population suitable for stand-alone systems (72.3%), followed by Guinea-Bissau, Chad, Niger and Mauritania (all with about 60% of their populations suitable for OGS). By 2030, Chad will have the largest share of its population suitable for stand-alone systems (53.7%), followed by CAR (41.9%) and Mauritania (40.6%).

Figure 28: Estimated Share of Population Suitable for OGS Systems, 2023



Source: Energio Verda Africa GIS analysis

Figure 29: Estimated Share of Population Suitable for OGS Systems, 2030



Source: Energio Verda Africa GIS analysis

In addition to the analysis of settlements, population and households, the least-cost electrification analysis also estimated the number of social facilities (schools and health facilities) that will be located in off-grid areas under the 2023 and 2030 scenarios. Based on available GIS data, the results of this analysis are presented in each country report. However, a regional assessment is not possible due to a lack of sufficient data across the analyzed countries (see **Annex 1** for more details).

- **Conclusions**

As illustrated above, all of the countries in the region will need to utilize off-grid solutions to achieve national electrification targets. The extent to which electrification options are most suitable vary by country, with the main factors for variation being:

- Difference in land size (and corresponding population distribution)
- Geographic location (size of coastline, landlocked, arid zone/desert)
- Detail of electricity grid construction plans

Chad, Mali and Niger have all adopted ambitious electrification targets (**Table 6**). However, all three countries face the difficulty of having a large land size with vast, arid desert regions; this leads to smaller and more dispersed settlements. Therefore, construction of long grid lines would be needed to connect a relatively small number of settlements to the main grid, which would be expensive and potentially unfeasible. The usage of some combination of decentralized mini-grids and/or stand-alone solutions would be preferable for these settlements. For example, Mali's energy utility, Électricité du Mali (EDM), already operates 28 isolated grid centers and could expand upon this approach to improve rural electrification. Mauritania's grid network in the south is well developed with detailed extension plans in place. Scattered settlements with higher population densities (often mining areas) are electrified by decentralized power stations using short distribution lines connecting most households in the vicinity. Yet, the analysis estimates that by 2030 a significant share of the country's population will still be suitable for OGS systems.

Countries in the region that have a detailed distribution network (MV lines) and extensive grid extension plans are closer to reaching their electrification targets via the national grid. Other countries such as Guinea and Sierra Leone did not have a vast electrification network in place at the time of this study but are developing plans to increase off-grid electrification significantly.

Central African Republic, Chad and Guinea-Bissau, three countries with high percentages of their population suitable for off-grid solutions, currently have their electricity networks concentrated in their capital only. Until new electricity lines are constructed to reach areas of higher population density, off-grid solutions (both mini-grids and stand-alone systems) will need to be utilized to achieve electrification targets.

It is worth noting that although a large number of households across the region will be connected to the national electrical grid by 2030, households 'under the grid' may also benefit from stand-alone solutions, as the reliability of electricity supply remains an ongoing challenge in most countries due to underinvestment in grid maintenance, significant electricity losses and voltage fluctuations. The estimated number of households suitable for off-grid solutions in close proximity to the grid was not determined for 2030 due to uncertainties regarding population density fluctuations over such a long timeframe.

3.2.5 Inclusive Participation

The participation of women will be critical to the success of the energy sector transformation that is underway in the region. There are clear linkages between energy and gender, namely the different access, use and effects of energy sources and appliances in the home, community and wider society. Yet, studies on the energy sector often do not adopt a gendered approach and gender-related issues tend to be marginalized or even absent altogether from national energy policies of most states across West Africa and the Sahel. Clear information is needed for policymakers to understand the needs and priorities of women in the context of sustainable development.

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.[164] This disparity is most evident in the areas of education, land ownership, inheritance systems, political power and decision-making, creating imbalance in social relations and making it difficult for women to advance. The region as a whole performs poorly in the UNDP Gender Inequality Index, which measures gender inequality in the areas of health, access to education and economic status.[165]

While gender disparities in primary, secondary and tertiary education are gradually improving in some countries, inequality persists in most countries throughout the region. Some progress has been made in Guinea and Benin, where women have nearly reached parity in primary education, while educational opportunities for women in Togo and Senegal are also improving.[166] Despite this progress, gender inequalities in access to secondary and higher education remains a significant challenge in the region, as there has been little improvement in the enrollment rates of women, which are still among the lowest in the world. The highest enrollment rate was recorded by Cabo Verde, followed by Ghana. At just 2%, Niger has the lowest rate of enrollment for women in the region. In addition to fewer educational opportunities available for women, in many of these societies there also tends to be a discrepancy between existing curricula and the needs of the economy, which has resulted in a lower labor participation rate and higher rates of unemployment among women.

These gender dynamics are magnified in rural areas and among poorer segments of the population. Illiteracy remains higher among women, who are more curtailed in their access to information. While multiple deprivation characterizes life for a sizable share of African women, rates are significantly higher in West Africa and the Sahel region, which includes four of the six lowest ranked nations in Africa (**Figure 30**).[167]

It is also necessary to consider how energy poverty effects women specifically. As a result of societal gender roles, energy poverty can disproportionately intensify the effort and energy needed to perform activities women are typically burdened with. In parts of West Africa and the Sahel, and particularly rural areas, women are responsible for cooking, collecting fuel and water, childcare, and small-scale agriculture. All of these tasks would be made easier and more productive with improved access to energy resources (e.g. solar powered water pumps, milling equipment etc.), which would in turn save women several hours a day.[168]

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[164] "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," ECREEE and SEforALL, (2015): https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf

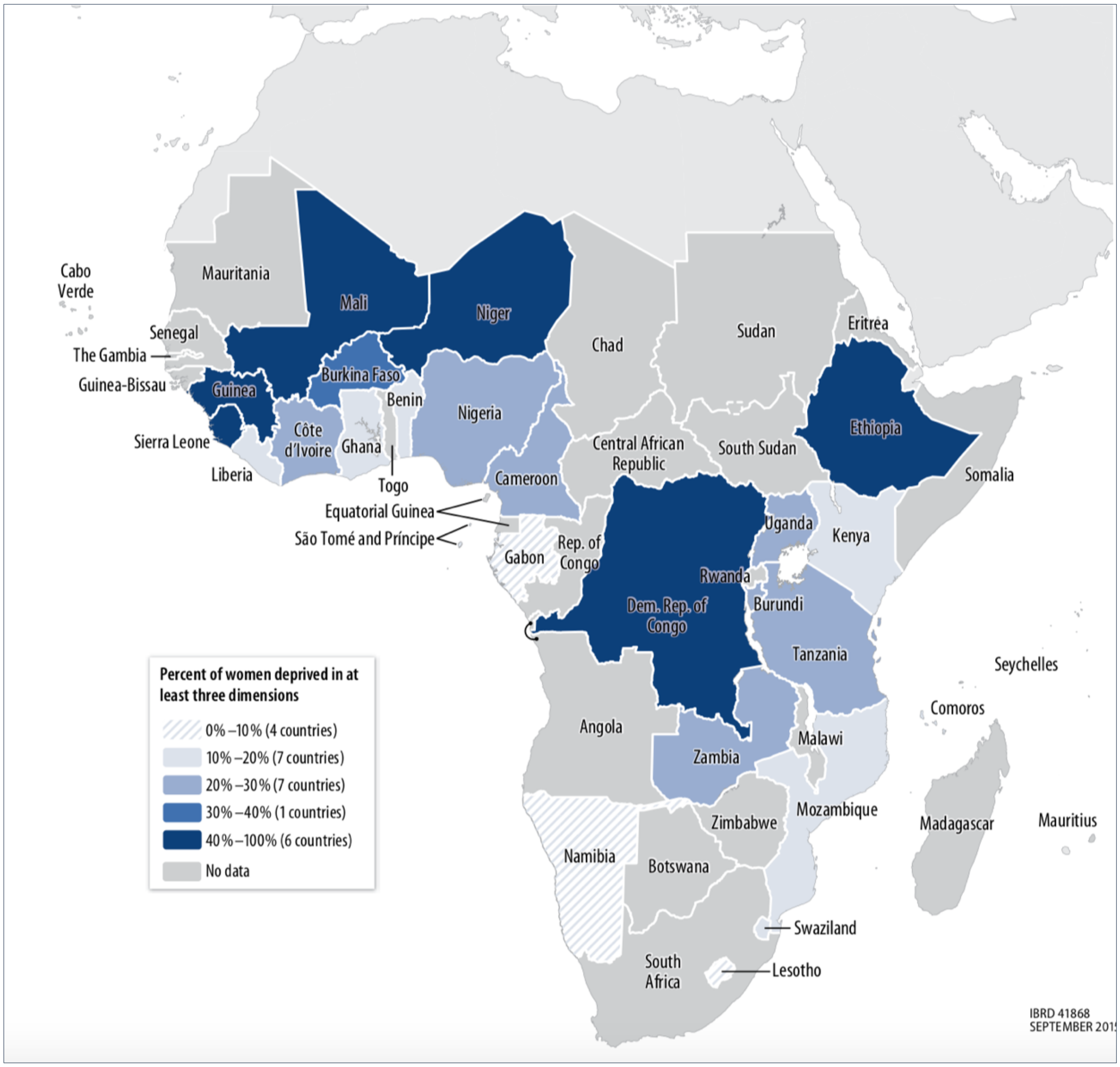
[165] "Gender Inequality Index," UNDP, (2015): http://hdr.undp.org/en/composite/GII

[166] "An assessment of progress towards regional integration in the economic community of West African states since its inception," United Nations Economic Commission for Africa, (May 2015): http://repository.uneca.org/bitstream/handle/10855/23038/b11560721.pdf?sequence=1

[167] "Poverty in a Rising Africa: Africa Poverty Report," World Bank, (2016): https://www.un.org/africarenewal/sites/www.un.org.africarenewal/files/Poverty%20in%20a%20Rising%20Africa%20Overview.pdf

[168] Rewald, R., "Energy and Women and Girls: Analyzing the Needs, Uses, and Impacts of Energy on Women and Girls in the Developing World," Oxfam Research Backgrounder series, (2017): https://www.oxfamamerica.org/explore/ research-publications/energy-women-girls

Figure 30: Socioeconomic Deprivation of Women in Africa

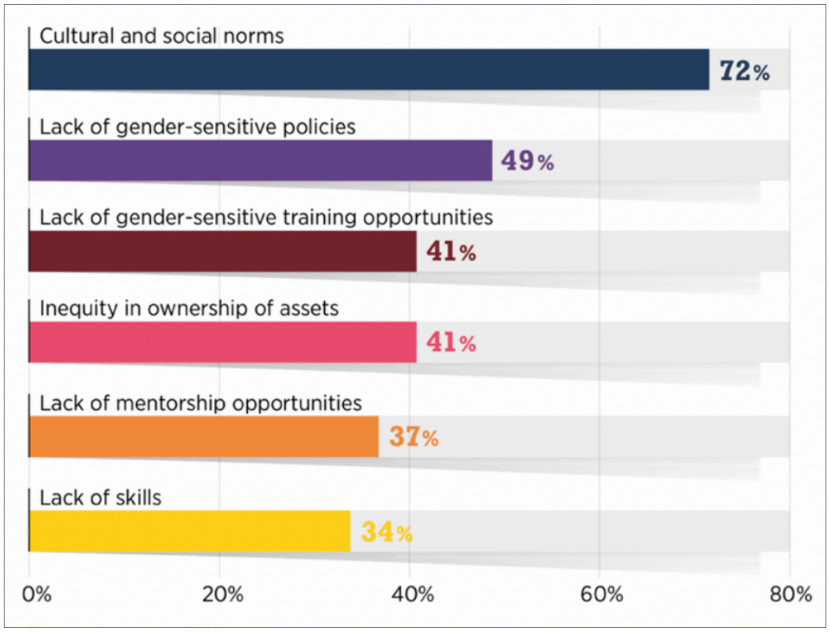


Source: World Bank

Given that the off-grid market is only beginning to emerge in the region, women are not yet highly engaged in the off-grid 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 31**). 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.[169]

[169] "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

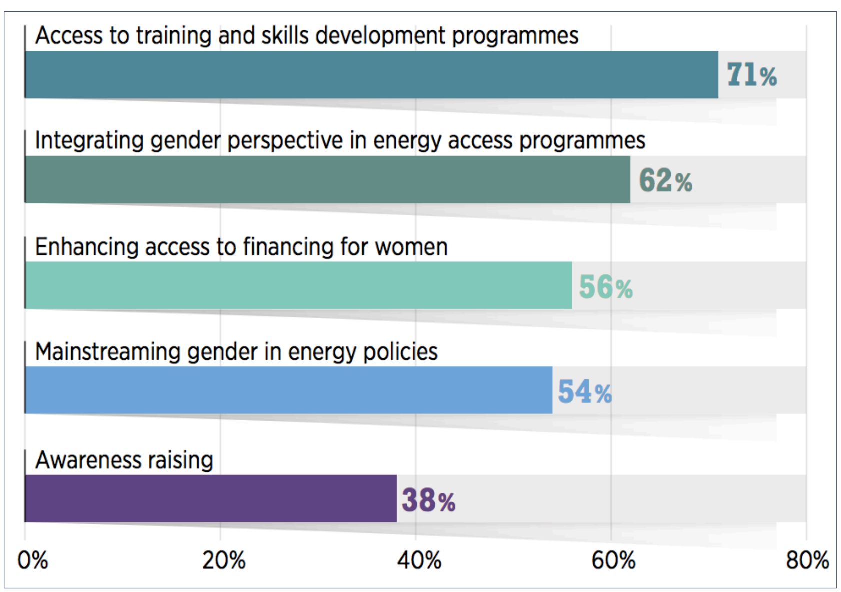
Figure 31: Key Barriers to Women's Participation in Expanding Energy Access



Source: International Renewable Energy Agency

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 32**).

Figure 32: Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in each country corroborated many of these findings and revealed several interrelated challenges that women face in the off-grid sector:

- 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)
- Extensive household responsibilities reduce their ability to generate income and service credit
- Financial literacy among women remains low and there is generally a lack of education and information available to women on access to financial resources

To address these challenges, governments across the region have adopted policies to improve gender equality. In addition to pursuing international and regional laws and standards covering women's rights, most countries in the region have also adopted strategic guidelines for development which seek, among other things, to promote gender equality, women's empowerment and improved social protection. Many of the countries are signatories to the major international conventions on women's rights, including the International Convention on Civil and Political Rights, the Child Rights Convention, International Covenant on Civil and Political Rights, the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, the Solemn Declaration on Gender Equality in Africa and the Beijing Platform for Action, among others. All 19 ROGEP countries have signed and ratified the Convention on the Elimination of All forms of Discrimination Against Women (CEDAW) and seven countries have signed its optional protocol (CEDAW Protocol); 15 of the 19 countries have ratified the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa, while CAR, Chad, Niger and Sierra Leone have signed the Protocol but have yet to ratify it (**Table 7**).

In this context, ECOWAS is making efforts to improve the living conditions of women and girls in order to reduce gender inequality across the region. The ECOWAS Policy for Gender Mainstreaming in Energy Access is 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.[170] ECREEE, the agency that is administering the initiative throughout the region, is working with ECOWAS member states to implement policy, regulatory and institutional measures that aim to improve inclusive energy access by 2030.

While the gender mainstreaming process is gaining momentum, it is slow-moving, as governments work to develop strategies and objectives to remove gender-related barriers, enhance economic opportunities for women and create an environment for inclusive growth and sustainable development. To date, gender mainstreaming has not been a key component of most energy policies; likewise, energy/off-grid issues have not typically been reflected in gender policies. A total of 14 of the 19 ROGEP countries have started integrating gender dimensions into their energy policies and in three of the countries – Burkina Faso, Nigeria and Togo – gender policies are already directly linked to energy policy.

A key metric that is an important initial step to addressing gender-related issues is the presence of a gender focal point person in government to champion gender mainstreaming efforts (**Table 7**). To date, 11 out of the 19 ROGEP countries have established gender focal points within their respective Energy Ministries (Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Liberia, Mali, Niger, Senegal, and Sierra Leone), another three countries have established a gender focal point within another public sector agency (Cabo Verde, Cameroon, Sierra Leone), while the remaining five countries have yet to establish a public sector gender focal point (CAR, Chad, Guinea-Bissau, Mauritania and Togo).

[170] "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," ECREEE and SEforALL, (2015): https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf

A number of ROGEP countries have other ministries supporting gender mainstreaming efforts such as Benin, Burkina Faso, Chand, Gambia, Ghana, Guinea, Mali and Senegal. Several countries have either developed or are developing National Gender Plans or Strategies, including Burkina Faso, Cabo Verde, CAR, Côte d'Ivoire, Guinea-Bissau, Mauritania, Sierra Leone, Senegal and Togo. Chad published a draft National Gender Policy in 2011 but has yet to adopt it.

Another key gender mainstreaming initiative includes gender audits of the energy sector. This activity is typically carried out by energy ministries. To date, five ROGEP countries have conducted a gender audit of the energy sector – Benin, Ghana, Nigeria, Senegal and Togo.

In addition to government policy efforts, several development agencies and programs are also working to help improve gender inclusion in the energy and off-grid sectors across the region. 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.[171]

The Africa Renewable Energy Access (AFREA) Gender and Energy Program is also working to integrate gender-sensitive approaches in Benin, Mali, and Senegal, with plans to expand (AFREA II) into Cameroon, Côte d'Ivoire, The Gambia, Liberia, Niger, and Nigeria (see **Regional Off-Grid Development Programs and Initiatives** for more details).[172]

While many gender mainstreaming programs and initiatives are being undertaken in ECOWAS countries, comparatively few programs are in place in the ECCAS/CEMAC region. To date, CAR, Chad and Mauritania have not engaged in specific projects to support gender mainstreaming.

[171] "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/

[172] AFREA: http://siteresources.worldbank.org/INTGENDER/Resources/336003-1289616249857/awa_seck.pdf

Table 7: National Gender Policies and Gender Mainstreaming Initiatives in West Africa and the Sahel

Country	National Gender Policy	National Policy of woman Advancement/Equity/Disabled	National Gender Plan or Strategy	National Ministry in charge of Gender	National Ministries with supporting roles	Other Institutions involved
Benin	National Policy for Gender Promotion (2009)	National Policy for the Advancement of Women and Gender Equality 2009–2016		Ministère de la Famille, des Affaires Sociales, de la Solidarité Nationale, des Handicapés et des Personnes de Troisième Age (MFASSNHPTA)	Micro-finance, youth and women employment Ministry (Ministère de la micro-finance et de l'emploi des jeunes et des femmes)	Conseil national de promotion de l'équité et de l'égalité de genre (CNPEEG), Observatoire de la Famille, de la Femme et de l'Enfant Institut National pour la Promotion de la Femme (INPF)
Burkina Faso	National Gender Policy (2009)		National Plan for Gender Equality and Equity (PNIEG) 2005-2009 National Action Plan to fight gender violence (2009-2011) The Gender Equality Action Plan (2011-2012)	The Ministry for Promotion of Women and Gender (Ministère de la Promotion de la Femme)	Ministry of Finance Ministry of Human Rights and Civic promotion (Ministère des Droits Humains et de la promotion Civique) Gender committee in sectoral ministry (Cellules genre dans les ministères sectoriels)	National Council for Gender Promotion (Conseil National pour la promotion du Genre) Funds for Women's Revenue Generating Activities The Institute for Women
Cabo Verde			Plan for Gender Equality and Equity (2005-2009) 3rd National Gender Plan (PNIG) 2015-2018 National Action Plan to fight gender violence (2015-2018) Second national plan against Gender-Based Violence, 2015-2018 (PNVBG).	ICIEG (Cape Verdean Institute for Gender Equality) Cabo Verde Women Institute (Instituto da Condição Feminina (ICF)	Ministry of Education and Family and Social Inclusion	Gender Observatory (Observatorio de Génnero) 2016
Cameroon	National Gender Policy Document 2011-2020			The Ministry of Women's Empowerment and Family		Appropriate Technology Center (Centre de technologie appropriée)
CAR	The National Gender Policy (NGP) in 2007	National Policy for the Advancement of Older Persons	National Plan for the Promotion of equality and equity (PNPEE), 2005	Ministry of Social Affairs, National Solidarity and Gender Promotion (Ministère des Affaires Sociales, de la Solidarité Nationale et de la Promotion du Genre)		Comité sectoriel « Egalité de Genre et Réduction de la pauvreté »

Chad	A draft of National Gender Policy (2011) published but not adopted			Ministère de l'Action Sociale, de la Solidarité Nationale et de la Famille (Ministry of Social Action, National Solidarity and the Family)	Ministry of Planning, Economy and International Ministry of Social Action, Family and National Solidarity	
Côte d'Ivoire		The National Policy for Equalities for Chances, Equity and Gender (2009) Disabled Persons Protection and Advancement Act (2000)	The Solemn Declaration of Côte d'Ivoire on Equality of Chances, Equity and Gender (2007)	Ministry of Women, Child Protection and Solidarity (Ministère de la Femme, de la Protection de l'enfant et de la Solidarité)		National Women Council Observatory for Equality and Equity Fonds Femme et Développement (Women and Development Fund) Côte d'Ivoire Women Support (Fonds d'Appui aux femmes de Côte d'Ivoire (FACFCI)
The Gambia		The National Gender and Women Empowerment Policy NPAGW (2010-2020)		Ministry of Women's Affairs (MoWA)	Ministry of Education Gender Unit The Gambia Bureau of Statistics (GBOS) Gender Unit	National Women's Council (NWC) Women's Bureau (NWB) National Federation of Women
Ghana	The National Gender and Children's Policy (2004)			Ministry of Gender, children and social protection	Ministry of Agriculture Ministry of Health	
Guinea	National Policy on Gender (2011)			Ministry of Social Action, Women Advancement and Childhood (Ministère de l'Action Sociale, de la Promotion féminine et de l'Enfance)	Groupe Genre – Le Hub Rural – Fonds d'appui à la Population Ministry of Economy and Finance (Ministère de l'Economie et des Finances)	
Guinea-Bissau	The National Gender Policy (PNIEG) 2012-2015		National Gender Action Plan (2015) The poverty strategy DENARP II	Minister for Women, Family, Social Cohesion and Fight against Poverty		Institute for Women and Children, IMC (Instituto da Mulher e Criança) Peace Building Fund "Gender Promotion Initiative"
Liberia	The National Gender Policy (NGP) (2009)			Ministry of Gender and Development	Ministry of Finance Ministry of Planning and Economic affairs Ministry of Internal Affairs	National Gender Forum National Children's Council

Mali	The National Gender Policy			Ministry for the Advancement of Women, Children and the Family (Ministère de la Promotion de la femme, de l'Enfant et de la Famille)	The Ministry of Labour and Public Service. Gender Committee Ministry of Finance ?	National Centre for Documentation and Information on Women and Children (CNDIFE) "Cité des enfants" (Children's Centre).
Mauritania			National Strategy of institutionalization of gender (2015)	Ministry of Social Affairs of Childhood and Family (Ministère des Affaires Sociales de l'Enfance et de la Famille –MASF)		
Niger	National Gender Policy (Politique Nationale de Genre) 2008			Ministry of Social Action, National Solidarity and the Family (Ministère de l'Action Sociale, de la Solidarité Nationale et de la Famille)	Ministry of Health Ministry of National Education, Ministry of Public Affairs and Labour	National Observatory for Gender Promotion 2015
Nigeria	The National Gender Policy (2006)			Federal Ministry of Women Affairs		National Gender Resource Centre (through the National Centre for Women's)
Senegal			A National Strategy for Gender Equality and Equity (SNEEG) National Plan of Action for Women (PANAF)	Ministry of Women, Family and children Ministère de la femme de la famille et des enfants	Ministry of Education	
Sierra Leone		National Policy on the Advancement of Women National Policy on Gender Mainstreaming	Advancement of Women and Gender Mainstreaming National Action Plan	Ministry of Social Welfare Gender and Children's Affairs (MSWGCA)		Gender and Social Welfare Committees Local Councils Sierra Leone Gender and Education Network
Togo		National Equity and Gender Equality Policy (PNEEG) 2011 National Equity	Gender Equality Action Plan	Ministry of Social Action, advancement of women and literacy (Ministère de l'Action Sociale, de la Promotion de la Femme et de l'Alphabétisation)		

Source: Stakeholder interviews; GreenMax Capital Advisors analysis

3.3 Key Regional Energy Sector Challenges

Across West Africa and the Sahel, national and rural electrification rates remain particularly low due to a large gap between the infrastructure needs of the power sector and the availability of resources to expand electrification. In many countries, significant transmission distances and low population densities often make grid extension to rural areas costly. Electricity tariffs across the region are not cost-reflective and do not generate enough revenue for utilities to invest sufficiently in network extensions or in maintenance of grid infrastructure. Governments often intervene to subsidize tariffs to ensure their affordability and the commercial viability of utilities. Yet, grid connection costs remain prohibitively high in many countries, while many utilities end up relying on international development funds to invest in grid extension and improvement projects.

One of the most critical energy access challenges is the lack of a comprehensive plan; while many governments have set electrification targets, some have yet to develop integrated Master Plans with least-cost options for electrification. Many countries still lack the supportive policy and regulatory frameworks and institutional capacity necessary to support off-grid development. In other countries (e.g. Nigeria), governments continue to subsidize diesel fuel, keeping retail prices low compared to clean renewable energy alternatives. In general, a successful rural electrification strategy requires extensive financial and technical assistance for all key stakeholders in order to address (*inter alia*) the following

- Awareness raising, education and training for consumers to maintain their solar systems;
- Solar PV system supply chain and O&M services, including training of local technicians to ensure that the cost of maintenance is affordable and sustainable;
- Standards for equipment and service providers (i.e. installers, technicians) to guide customers to certified suppliers and solar companies;
- Financial incentives to attract private sector participation, including import duty and VAT exemptions for stand-alone systems (solar PV products, components and accessories); and
- The support of local commercial banks and microfinance institutions to lend to the sector

The electricity sectors in the 19 ROGEP countries face a wide variety of challenges, most of which are not country-unique or specific. Challenges to the expansion of the off-grid solar market in particular are similarly consistent and offer the possibility of shared problem-solving and resource and knowledge-sharing across the region as countries look to expand energy access and grow the off-grid market. Some of the key issues identified in many countries across the region include (but are not limited to):

- Government focus on grid extension and maintenance;
- Lack of access to reliable data for governments, stakeholders, and financial institutions;
- Insufficient local capacity, technical expertise, consumer awareness, and standards development;
- Development goals focused on "baseload" energy sources, particularly fossil fuels and large hydropower;
- High electricity costs for consumers and non-cost-reflective tariffs;
- Lack of financing; and
- The need for enhanced institutional capacity

These key energy sector challenges are addressed in further detail below:

- **Focus on investment in grid extension and maintenance**: As ROGEP countries seek to expand electricity access and meet their energy access goals, energy policymakers are primarily utilizing a combination of grid extensions combined with increasing installed grid capacity. Comparatively few policies have focused on developing off-grid solutions to meet electrification targets. In nearly every country across the region, economic growth and corresponding increases in electricity demand are putting pressure on power supply. Transmission infrastructure, which is outdated and in need of maintenance and investment, is being put under increasing strain, which leads to high T&D losses (**Figure 8**) and unreliable power supply (**Figures 9-11**). While it is imperative that countries increase their power supply, prioritizing grid-connected projects and power line extensions over off-grid solutions in rural areas will likely result in slower energy access. Policymakers typically prioritize urban electrification given the higher perceived costs of rural electrification. As illustrated in the results of the least-cost electrification analysis (**Section 3.2.4**), off-grid solutions need to be part of long-term electrification plans for governments to meet their electricity access targets.

- **Lack of reliable data:** Public and private stakeholders across the ROGEP countries generally lack the data and often the resources necessary to make informed decisions related to the off-grid sector. This includes access to data on existing energy resources and resource potential, contemporary energy access maps, grid expansion plans, high-potential locations for future projects, the volume of certified vs. un-certified solar products entering the market, and a range of consumer and supplier needs and preferences. This lack of data impedes informed government decision-making and private-sector development. Both rural electrification agencies and off-grid players in the private sector need access to likely project location data, energy access maps, and grid expansion plans in order to identify geographies where off-grid development will prove useful. The risk of expanding off-grid in an area soon to be grid-connected is a major concern for developers. Additionally, some policymakers have limited access to knowledge about and limited experience with off-grid solar technology, and as such do not support what is perceived as a risky push to expand the sector. Even if policymakers are supportive of the technology, lack of prior experience make it difficult to deliver specific and data-driven policy goals that are tied to a nascent and uncertain market, especially given the lack of data resources that can be used to substantiate a given policy measure.

- **Insufficient local capacity, technical expertise, consumer awareness, and quality standards:** Successful development of the off-grid sector requires more than dedicated agencies, data, and finance – governments across the region need to develop and implement a range of measures to expedite growth of the market, including a robust TA platform to supplement ROGEP's objectives. This platform should address *inter alia* awareness raising, education and training for consumers; (ii) solar PV system supply chain and 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. Off-grid sector development can and should create jobs while also increasing rural electrification rates. 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. Regulations are critical to addressing uncertainty surrounding competition from / the impact of un-certified low-quality solar products, which are a huge concern for suppliers. Low-quality solar lanterns and panels imported mainly from East Asia have surged in the recent years and are estimated to represent at least half of total sales in Sub-Saharan Africa.[173] As consumer awareness grows, fewer systems will be handed over to beneficiaries without prior capacity building and training in place. Consumers will also be educated about quality standards and warranties for their solar appliances. Without these support systems in place, low quality products have engendered mistrust of off-grid solar market players whose equipment is perceived as unreliable. A robust set of standards and quality enforcement mechanisms must be adapted to ameliorate these concerns and further enhance the effectiveness of rural electrification strategies and bolster market development.

[173] "Reaching Scale in Access to Energy: Lessons from Practitioners," Hystra, (May 2017): https://static1.squarespace.com/static/51bef39fe4b010d205f84a92/t/594a8a4f86e6c05c7d651eb1/1498057514242/Energy_Report+%28ADB+excluded+%2B+license%29.pdf

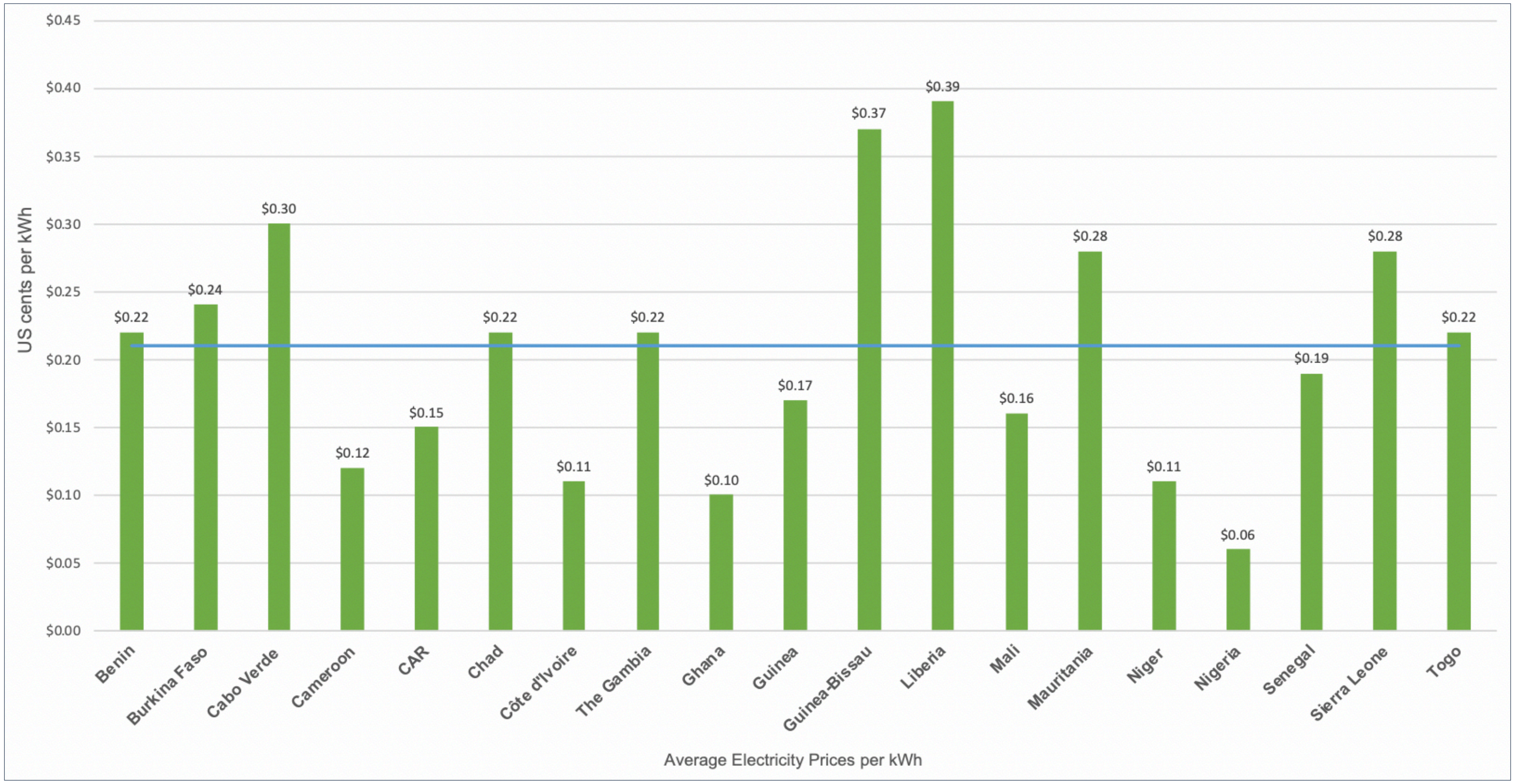
- **Prioritization of baseload growth*:*** While all ROGEP countries recognize the role that off-grid solar can play in increasing electrification rates, particularly in rural areas, the primary energy access policy objectives that nearly every country is pursuing remain to increase grid-connected capacity and extend the grid. While these are important and necessary measures, the focus on expanding baseload installed capacity means policies that typically reward non-renewable fossil fuels and large-scale hydropower. These expensive, centralized infrastructure facilities offer large power output but are also vulnerable to several risks, including fuel price variability (for diesel and gas plants), reliance on an operational transmission and distribution grid, and climate-related risks (for hydropower). While off-grid / decentralized solutions offer smaller outputs of power, they are not susceptible to the risks of associated with the centralized electrification model. Additionally, the policy frameworks in place in many ROGEP countries supporting these baseload energy sources can be detrimental to off-grid solar market development (e.g. subsidies for fossil fuels make solar comparatively expensive, energy policy goals focused on hedging against imported oil price vulnerability or seeking PPPs for large dam developments etc.) When a country's power mix is overly reliant upon imported oil and large hydropower, there is comparatively little investment in and focus on off-grid solar. Without changes to current regulatory, pricing and subsidy frameworks in many ROGEP countries, off-grid solar cannot always compete economically with baseload power under existing regulatory environments.

- **Electricity Tariffs:** Although retail electricity rates vary widely across ROGEP countries (**Figure 33**) the overall price of electricity is extremely high, representing a large portion of income expenditures for the majority of the population and displacing personal spending desperately needed in other areas. Moreover, tariffs are not cost-reflective and do not generate enough revenue for utilities to invest sufficiently in network extensions or in the maintenance of grid infrastructure. As a result, most governments across the region heavily subsidizes tariffs to ensure their affordability and the commercial viability of the utilities, who typically rely on international funds to invest in grid improvement.

- **Lack of financing:** Lack of financing is an issue that impacts both end-users who cannot afford systems as well as suppliers who want to access affordable funding to expand their business. Across West Africa and the Sahel, local FIs and MFIs tend to lack sufficient internal capacity and credit appetite to provide funding for the off-grid sector. This challenge is complicated as it arises 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 misperceptions about the potential size of these markets as well as doubts about the profitability of offering financial products in rural off-grid areas where potential client creditworthiness can be an issue. The off-grid space is particularly complicated given the relatively high transaction costs and risks associated with a sector that generally lacks the policy and regulatory support that is necessary to spur market growth.

- **Insufficient institutional capacity:** While in recent years some ROGEP country governments have created rural electrification agencies, endowed rural electrification funds, and instituted rural electrification strategies and master plans, not all of the countries in the region have adopted these institutional measures. Dedicated agencies with independent funding and staffing and coherent and detailed plans with strong provisions for off-grid solar in place are critical to achieving ROGEP's goals. Creating rural electrification agencies where they do not already exist and strengthening existing institutions is a vital step to supporting the off-grid sector. Detailed rural electrification strategies, Master Plans and supportive policy and financing frameworks will encourage much-needed private sector participation.

Figure 33: Average Electricity Prices in West Africa and the Sahel, 2016[174]



= Regional Average ($0.21/kWh)

Source: ECREEE; World Bank RISE

[174] "From Vision to Coordinated Action: Consolidation of SEforALL Action Agendas, National Renewable Energy Action Plans, and National Energy Efficiency Action Plans," ECREEE, (2017): http://SEforALL.ecreee.org/sites/default/files/final_report_on_SEforALL_consolidation.pdf

IV. REGIONAL POLICY AND REGULATORY FRAMEWORK

4.1 Regional Energy Policies and Regulations

Countries across West Africa and the Sahel operate in a complex framework of regional, sub-regional, and national electrification and energy access policies. There is a great need for coordination of the various regional efforts led by ECOWAS, UEMOA, ECCAS, CEMAC, COMELEC and others such as the Permanent Interstate Committee for Drought Control in the Sahel (Comité permanent inter-État de lutte contre la sécheresse au Sahel, CILSS).[175] These organizations have launched and/or participated in a range of initiatives to promote regional energy sector integration. Below is a brief summary of relevant energy policies, agreements, and regulations covering the West Africa and Sahel region.[176]

- **Common Energy Policy (CEP)**

UEMOA, in cooperation with ECOWAS, adopted a Common Energy Policy in 2001 for its member states with objectives to (i) secure energy access; (ii) optimize the management of energy resources through grid interconnection and common investment; and (iii) promote renewable energy, energy efficiency and sustainable development. UEMOA augmented the CEP in 2009 by launching the Regional Initiative for Sustainable Energy, which included a concessional Energy Development Fund as well as policies targeting private investment to support clean energy project development in member countries.

- **ECOWAS Energy Protocol (EEP)**

ECOWAS member states adopted the EEP in 2003, which intended to establish a legal framework to promote long-term cooperation in the region's energy sector and to create a regulatory environment conducive to investment and increased energy trade in West Africa. The EEP requires ECOWAS member states to undergo a ratifying process to ensure that appropriate national legal and regulatory frameworks are in place to support all regional energy integration initiatives, including WAPP projects.

- **ECOWAS - UEMOA Energy Partnership Agreement**

The objective of this collaboration agreement, which was signed in 2005 between ECOWAS and UEMOA, was to support development of energy access services in rural and peri-urban zones, promotion of renewable energy sources, regional energy information systems, human and institutional capacity building, and awareness raising among development partners and other key stakeholders as needed.

- **ECOWAS - UEMOA White Paper**

Signed in 2006, this established a policy for increasing access to energy services for populations in rural and peri-urban areas across the region. The policy included corresponding action plans and investment programs to achieve its energy access objectives by 2015. Within its specific objectives, the White Paper focused on capacity building of private and public actors, the enhanced availability of loans, grants and private sector funds for energy services in rural or peri-urban areas, the improved exchange, promotion and dissemination of sub-regional experiences in view of energy services and the promotion of local energy production and delivery of energy access services. Although the plan ultimately failed to achieve its

[175] CILSS member countries include Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Chad, The Gambia, Guinea, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Togo.

[176] "ECOWAS at 40: An Assessment of Progress Towards Regional Integration in West Africa," UN Economic Commission for Africa, (2015): https://www.uneca.org/sites/default/files/PublicationFiles/uneca_ecowas_report_en_web_v2.pdf; and "Renewable Energies in West Africa: Regional Report on Potentials and Markets," GIZ, (2009): http://www.ecreee.org/sites/default/files/event-att/gtz_re_in_developing_countries.pdf

ambitious electrification targets, it served to reinforce regional integration, promote institutional reform, and develop a range of energy programs that succeeded in increasing access and reducing poverty.

- **ECOWAS Renewable Energy Policy (EREP)**

In 2013, ECOWAS adopted the EREP, which aims to assist member states with the design and implementation of appropriate legal and regulatory frameworks to promote development of RE technologies, including decentralized services (mini-grids and stand-alone systems), with the long-term objective of achieving universal energy access in the region by 2030.[177] At a regional level, the EREP aims to mobilize development of additional grid-connected renewable energy for nations to diversify their energy mix, and to support the proliferation of off-grid and stand-alone applications at the household level. The plan is to increase the share of RE in the region's overall electricity mix to 35% by 2020 and 48% by 2030.

- **West African Power Pool Master Plan**

The WAPP Master Plan, which was adopted by ECOWAS in 2012, aims to create a fully integrated regional electricity market by 2025. The WAPP intends to achieve this through (i) development of power generation and transmission infrastructure,[178] (ii) enhancing the interconnection capacities of states, (iii) increasing cross-border trade in energy, (iv) promoting investment in the sector, (v) improving the institutional and regulatory capacity of key public and private sector stakeholders across the region, and (vi) harmonizing the framework conditions of national energy markets within the region.[179] The Master Plan Scenario aims to double the regional generation capacity by 2025 (an estimated additional 10 GW) primarily through large hydropower and gas. To date, the Plan's objectives have been hindered by the volatility of global oil and gas prices. The Master Plan is presently being revised by WAPP.

- **ECOWAS Policy for Gender Mainstreaming in Energy Access**

The ECOWAS Policy for Gender Mainstreaming in Energy Access is 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.[180] 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 (see **Section 3.2.5: Inclusive Participation** for more details).

- **COPIL (ECCAS / CEMAC Steering Committee)**

While regional strategies have been developed by both ECCAS (Strategic Vision 2025) and CEMAC (Regional Economic Programme), with technical assistance from the UN Economic Commission for Africa and financial support from the AfDB, the two entities joined in 2007 to establish a Steering Committee (COPIL) to harmonize the Central African sub-region's policies, programs, and initiatives. Much like ECOWAS and UEMOA, ECCAS and CEMAC have yet to harmonize policies to establish intra-regional trade. The Central African Power Pool (CAPP) remains the ECCAS area's dedicated energy policy authority, is not expected to have an operational electricity market until 2025.

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[177] "ECOWAS Renewable Energy Policy," (2013): http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf

[178] The World Bank has developed a strong partnership with WAPP to support regional projects focusing mostly on high voltage interconnection transmission lines and capacity building, including for the OMVG (Guinea, Guinea-Bissau, The Gambia, Côte d'Ivoire), CLSG (Côte d'Ivoire, Liberia, Sierra Leone, Guinea), OMVS (Kayes-Tambacounda), North-Core Transmission (Nigeria, Niger, Benin, Burkina Faso) and the Guinea-Mali Interconnector projects, with WAPP acting as the Implementing Agency.

[179] It is estimated that to achieve its long-term objectives, the WAPP will require USD 16 billion in investment over a 20-year period.

[180] "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," ECREEE, (2015).

➢ **International Energy Charter Treaty**

In 2015, the International Energy Charter was formally adopted to strengthen global energy cooperation in an effort to promote energy security and sustainability and to address some of the key energy sector challenges of the 21st century. While all of the ROGEP countries are signatories to the International Energy Charter (either independently or through their respective affiliated regional organizations – ECOWAS and ECCAS), none have signed or ratified the Energy Charter Treaty.[181] The Treaty provides a legal framework that aims to enhance the enabling environment and rule of law in the energy sector of signatory states and offers countries a multilateral platform on which to address challenges like access to modern energy and energy poverty reduction. The Treaty was designed to promote energy security through more open and competitive energy markets by providing a long-term, competitive, stable and reliable interface between investors and host countries with binding rules that streamline the investment environment. The Treaty's provisions focus on four broad areas:

- The protection of foreign investments, based on the extension of national treatment, or most-favored nation treatment and protection against key non-commercial risks;
- Non-discriminatory conditions for trade in energy materials, products and energy-related equipment based on WTO rules, and provisions to ensure reliable cross-border energy transit flows through pipelines, grids and other means of transportation;
- The resolution of disputes between participating states, and - in the case of investments - between investors and host states; and
- The promotion of energy efficiency and attempts to minimize the environmental impact of energy production and use.

4.1.1 Standards and Quality

The development and adoption of regional standards and a quality assurance framework will be critical to support development of the region's stand-alone solar market. Consumers will need to be educated about quality standards, certified brands and warranties for solar appliances in order to avoid purchasing low-quality products. In addition to supporting consumers, a standardized market would also benefit private sector solar product manufacturers and suppliers as they would have access to a large contiguous market.

➢ **ECOWAS Standards Harmonization Model (ECOSHAM)**

A robust set of quality standards are currently under development to address this issue and further enhance the effectiveness of regional strategies to support off-grid market development. Development of the ECOSHAM is following the same consultative approach used to develop the African Standards and Harmonization Model procedures by the African Organization for Standardization (ARSO).[182]

➢ **Regional Certification Scheme**

ECREEE, with support from UEMOA, IRENA and the GIZ, launched a qualified solar workforce initiative in West Africa to improve the skills of solar installers in the region. This scheme is intended to accelerate the deployment of solar energy across the region through the creation of a regional certification scheme for installers and the development of regional renewable energy standards. For the pilot phase, ECREEE has

[181] The Energy Charter Treaty: https://energycharter.org/process/energy-charter-treaty-1994/energy-charter-treaty/

[182] "Standard Harmonization in the ECOWAS Region – ECOSHAM," ECREEE, (2017): http://www.ecowas.int/events/public-enquiry-stage-standard-harmonisation-in-the-ecowas-region-ecosham/

already pre-selected 21 training institutions across member countries for the initial training of off-grid system installers.[183]

- **ECOWAS Energy Efficiency Policy (EEEP)**

One of the main targets of the EEEP was to establish and ECOWAS Technical Committee for Energy Efficiency Standards and Labelling and adopt initial region-wide standards and labels for major energy equipment.

4.1.2 Trade

Trade is another key regional issue that impacts off-grid market development. Removing barriers to trade and progressing towards a simplified regional tax regime can enhance the affordability and free movement of solar products and equipment across the ROGEP countries.

The **ECOWAS Trade Liberalization Scheme (ETLS)** is an internal market liberalization initiative that aims to eliminate customs duties and non-tariff barriers. In 2013, ECOWAS also established the **Common External Tariff (CET)** to protect goods produced in member states. While the ETLS has not been fully implemented yet, the CET formally came into effect in 2015 and was modeled after a similar scheme developed by UEMOA previously.[184] While the ETLS has been relatively limited in its impact to date, the CET is under implementation in all of the ECOWAS countries excluding Cabo Verde.[185] The CET is expected to expedite the region's progress towards a common market by removing obstacles to the free movement of goods within countries.[186] Trade integration, however, has been a slow-moving process, as the impacts of these schemes on countries like Nigeria complicate these dynamics.[187]

Harmonizing national policies surrounding VAT will be an important step towards regional integration. This will also be significant for the off-grid solar market, as import duties on equipment often impact the affordability of products for customers, the pace and extent of market growth, and the commercial attractiveness of a given country for suppliers. While favorable regional trade policies will enhance trade between countries and support sustainable market development, the establishment of a free trade area and a customs union in West Africa and the Sahel has experienced lengthy delays. Adequate regional policies, regulatory standards need to be developed to support key stakeholders in the power sector and to generate investor-confidence.[188]

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183 "ECREEE launches scheme to create qualified solar workforce in West Africa," (February, 2018): https://www.pv-magazine.com/2018/02/01/ecreee-launches-scheme-to-create-qualified-solar-workforce-in-west-africa/

184 "Political Economy Dynamics of Regional Organizations in Africa," ECDPM: http://ecdpm.org/wp-content/uploads/ECOWAS-Trade-Policy-Brief-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

185 Ibid.

186 The Common External Tariff: http://www.ecowas.int/wp-content/uploads/2016/06/CET_Factsheet_EN.pdf

187 "Political Economy Dynamics of Regional Organizations in Africa," ECDPM: http://ecdpm.org/wp-content/uploads/ECOWAS-Trade-Policy-Brief-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

188 "ECOWAS Sustainable Energy Week: Towards a Viable and Robust Energy Market in the ECOWAS Region," (2016): http://www.ecreee.org/sites/default/files/draft_concept_note_agenda_ecowas_sustainable_energy_week_2016_v11_final.pdf

4.2 Capacity Building and Technical Assistance at Regional Level

Table 8: Gaps in the Regional Off-Grid Policy and Regulatory Framework

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Regional Policies, Laws and Programs	Insufficient progress on regional policy measures, laws, programs and plans	a. Support ongoing development of SEforALL Action Agendas and the National Renewable Action Energy Plan and progress with the SEforALL investment prospectus in member countries and extend to non-ECOWAS member states of ROGEP (Chad, CAR, Cameroon, and Mauritania) b. Review, update and consolidate outdated regional policy frameworks and initiatives (ECOWAS, UEMOA, ECCAS, CEMAC etc.) and harmonize regional and national energy sector legislation / frameworks, especially vis-à-vis free trade areas, customs unions etc. c. Harmonize existing regional policies (EREP, COPIL Vision 2025 etc.) to align with objectives of the Energy Charter Treaty to establish clear, long-term energy access plan, with ongoing capacity building, TA and resulting monitoring
2. Regional Financial Incentives	Insufficiently supportive regional financial incentives / tariff policies	a. Help ECOWAS implement ETLS and CET with specific provisions for solar equipment; Set up a Task Force to mitigate potential difficulties in customs clearance and import logistics, and to eliminate trade barriers b. Harmonize ECOWAS regional tariff policies with those of UEMOA c. Help ECOWAS analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede market uptake of clean energy solutions d. Work with COPIL to implement similar incentives and policies under ECCAS-CEMAC Vision 2025
3. Standards and Quality	A. Insufficient market data	a. Help ECOWAS / ECREEE build upon and expand the ECOWREX database by establishing a Task Force to collaborate with the private sector to compile and regularly update a database of critical off-grid market data from across the region (solar product imports, costs, sales volumes, resource potential etc., GIS data and other key indicators) that can be (i) utilized by policymakers to make informed electrification planning decisions based on accurate market information, and (ii) made easily accessible to interested off-grid developers, investors and other key industry stakeholders
	B. Unclear / lack of quality standards	a. Help ECOWAS finalize implementation of ECOSHAM standards to include 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. b. Help ECOWAS integrate standards with appropriate political establishments (ECOSHAM) to ensure quality-assurance and verification procedures are in place c. Use standardization model (ARSO, ECOSHAM) to develop and implement similar framework for non-ECOWAS ROGEP countries

	C. Lack of capacity of local technical sector (solar PV technicians, installers, services providers etc.)	a. Support ECOWAS and UEMOA with roll-out of a certification scheme for solar equipment installers and seek to expand and/or replicate training and certification schemes in non-ECOWAS ROGEP countries[189] b. Develop standardized training materials and provide capacity building for entrepreneurship and business training for the benefit of entrepreneurs in the region (to enhance entrepreneurs' understanding of permits and licenses, taxes, small business administration, financing, environmental requirements, etc. as they pertain to stand-alone solar equipment) c. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives
	D. Insufficient attention of private companies to environmental/social standards and community engagement	a. Assist private sector and/or civil society organizations to ensure regional environmental/social standards are in place b. Assist in development of regional strategies and frameworks encouraging inclusive gender participation (e.g. that build on the ECOWAS Policy for Gender Mainstreaming in Energy Access)
	E. Insufficient public awareness	a. Help ECOWAS / COPIL implement regional level initiatives on consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related sub-regional and national programs b. Support development and implementation of regional programs (through public/private sector or academia) to educate consumers, retailers and distributors on the benefits of quality certified solar products (vs. poor-quality products)
4. Business Model Regulation	**Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers**	a. Help ECOWAS develop and implement pilot programs to understand the scope of potential business models that would benefit all countries on a regional level b. Help regional level organizations implement partnership platforms between off-grid solar companies and telecommunications and mobile money service providers to foster PAYG business models and accelerate growth on a regional level

Source: GreenMax Capital Advisors analysis

[189] Regional-level training initiatives can take advantage of regional networks that already provide these services throughout Africa, such as the African Network of Centers of Excellence in Electricity (ANCEE).

V. NATIONAL POLICY AND REGULATORY FRAMEWORKS

5.1 State of Energy Access and the Enabling Environment

The off-grid policy and regulatory framework varies widely across countries in West Africa and the Sahel, with some countries having established comprehensive policies, plans, incentives, schemes and regulations, while other countries have lagged behind.

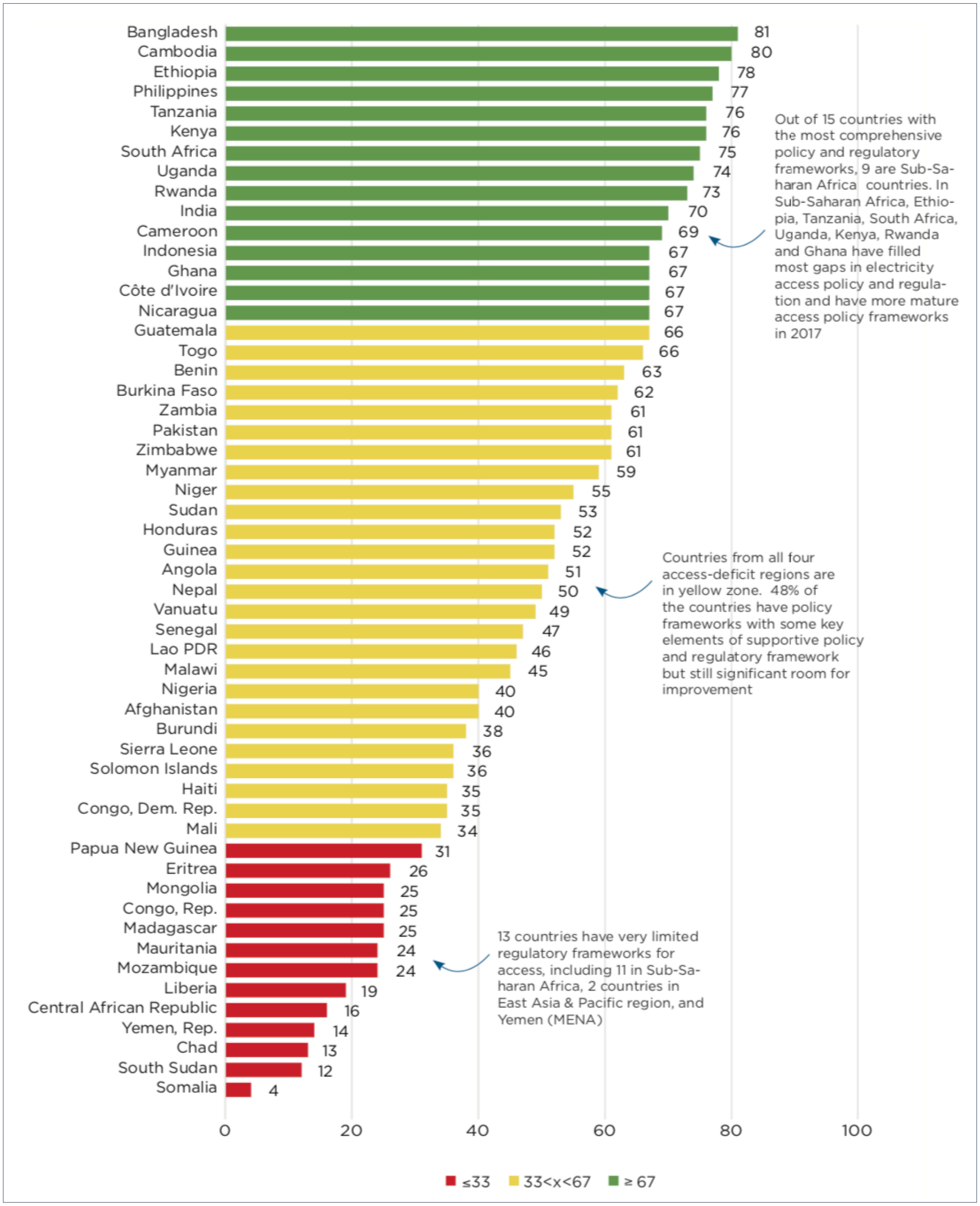
A useful barometer to measure whether countries have made improvements to the enabling policy environment for the off-grid sector is to assess levels of improvement (or regression) in a country's World Bank's Regulatory Indicators for Sustainable Energy (RISE) energy access score (**Figure 34**). Between 2015 and 2017, several ROGEP countries improved their score, with the most notable improvements in Togo, Niger, Burkina Faso, Sierra Leone, Nigeria and Benin. Togo's score improved the most among all countries in the region, as it more than doubled between 2015 and 2017. On the other end of the spectrum, several countries in the region rank poorly, with extremely limited energy access regulatory frameworks, including Chad, CAR, Liberia and Mauritania.

Senegal was the only country to significantly regress between 2015 and 2017 in its energy access score. This can largely be attributed to the country's slowed progress in rural electrification due to the underperforming results of the country's Rural Electrification Action Plan (Plan d'Action Sénégalais d'Électrification Rurale, PASER), which experienced a series of challenges and obstacles in its implementation and was consequently replaced by the recently adopted National Rural Electrification Program (Programme National d'Électrification Rurale, PNER) in 2018.[190]

For the off-grid market segment to grow, it requires a comprehensive enabling environment to be in place, with clear plans, supportive laws, regulations and financial incentives, and the implementation of a robust set of quality assurance standards and long-term technical capacity building support measures. With support from ECREEE, countries in the region have started to develop national energy policies with increased emphasis on off-grid solutions (**Table 9**). However, to date, with the exception of a few countries (see **Section 3.2.3.2: Select National Off-Grid Development Programs**), policies and targets have yet to translate into concrete action plans with clear mandates to address all of the policy and regulatory barriers that hinder off-grid market growth. In other cases, where policies and incentives are adopted, the allocation of financial or technical resources to support program implementation has often been insufficient. For national electrification programs to succeed, funding and support is needed from government and development partners, while extensive engagement with and participation of the private sector is critical to the long-term sustainability.

[190] "Senegal's SE4ALL Rural Electrification: Action Agenda and Investment Prospectus," Gesto Energia, SA, (June 2018): http://gestoenergy.com/wp-content/uploads/2019/04/Gesto_Senegal_EN.pdf

Figure 34: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017[191]



Source: World Bank Regulatory Indicators for Sustainable Energy

[191] "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

Table 9: State of Energy Access and Enabling Environment in ROGEP Countries

Country	National Electrification Plan/Policy	Integrated National Electrification Plan	Energy and Electricity Law	Framework for Stand-alone Systems				
				Existence of Specific National Programs	Financial Incentives	Standards and Quality	Concession Contracts and Schemes	Business Model Regulation
Benin	X	EHR Framework	X	Off-Grid Clean Energy (OCEF)	VAT reduction on solar equipment	ISO & IEC equipment standards	EHR framework for rural concessions	Off-Grid Clean Energy Facility
Burkina Faso	Sectoral Energy Policy Letter 2014-2025 (POSER)	X	General Energy Regulation Law, 2017	Access to Energy Services Program (PASE), Policy for Sustainable Economic and Social Development (PNDES), Electricity Services Access Project (PASEL, Lighting Africa)	Tax exemptions for solar equipment	General Energy Regulation Law, 2017	General Energy Regulation Law, 2017	X
Cabo Verde	X	X	2011 Decree	DNICE	Tax exemptions for solar equipment	X	X	X
Cameroon	Cameroon Electricity Master Plan (PDSE)	Rural Electrification Master Plan (PDER)	X	X	VAT Exemption for solar equipment	X	Rural Electrification Master Plan (PDER)	X
CAR	X	X	2005 Electricity Code	PNUD 2017	Customs duty exemptions for solar products	X	X	X
Chad	X	X	2017 Decree	Stratégie Nationale pour la Promotion des Energies Nouvelles et Renouvelables au Tchad	Customs duty exemptions for solar products	X	X	X
Côte d'Ivoire	National Program for Rural Electrification (PRONER)	Rural Electrification Master Plan (PDER)	2016 Electricity Decree	"Electricity for All" Program (PEPT)	50% VAT reduction on solar equipment	X	Decree N°787 of October 12th 2016	X
The Gambia	X	X	X	Low Emission Climate Resilient Development (LECRDS)	Import duty and sales tax exemptions for solar equipment	The Gambia Standards Bureau	X	X
Ghana	National Electrification Scheme (NES)	Renewable Energy Master Plan (REMP)	Renewable Energy Act 2011	Self-Help Electrification Program (SHEP), National Decentralized Electricity Program (SREP), Solar Lanterns Promotion Program (SLAP)	Import duty / VAT Exemption	Ghana Standards Authority; Ghana Association of Solar Industries	X	X

Country	National Electrification Plan/Policy	Integrated National Electrification Plan	Energy and Electricity Law	Framework for Stand-alone Systems				
				Existence of Specific National Programs	Financial Incentives	Standards and Quality	Concession Contracts and Schemes	Business Model Regulation
Guinea	Policy Letter on the Development of the Energy Sector (LPDSE)	Plan National d'Électrification Rurale (PNER)	2017 Rural Electrification Law	X	X	X	National Rural Electrification Program (PNER)	X
Guinea-Bissau	X	X	X	X	Solar equipment exempts from import duties	X	X	X
Liberia	Rural Energy Strategy and Master Plan (RESMP)		X	WB Liberia Renewable Energy Access Project (LREAP), Lighting Africa	X	X	X	X
Mali	National Energy Policy (PEN)	X	X	Rural Electrification Hybrid System Project (SHER), Rural Electrification Hybrid System Project (REHSP)	Tax exemptions for solar equipment	Rural Electrification Hybrid System Project (SHER)	SHER; private off-grid concessions	X
Mauritania	X	X	X	Agency of Development of Rural Electrification (ADER), Agency for Universal Public Access to Regulated Services (APAUS)	Fund for Universal Access to Services (FAUS)	X	X	X
Niger	National Renewable Energy Strategy (SNER)	X	2016 Electricity Act	Niger Solar Electricity Access Project (NESAP), Electricity Access Expansion Project (NELACEP)	30% import tax exemption for solar	X	X	X
Nigeria	National Energy Policy (NEP)	Rural Electrification Strategy and Implementation (RESIP)	Independent Electricity Distribution Networks (IEDN)	National Electrification Project (NEP)	Rural Electrification Fund (REF)	Standards Organization of Nigeria (SON)	Rural Electrification Strategy and Implementation (RESIP)	X
Senegal	Programme National d'Électrification Rurale (PNER)		X	Programmes Prioritaires d'Electrification Rurale (PPER); Programme National d'Urgence d'Électrification Rurale, (PNUER); Programme Énergétique Multisectoriel (PREM)	Subsidy covering 80% of investment cost for stand-alone systems	Senegalese Association of Standards (ASN)	Off-grid concessions ; Local Initiatives for Rural Electrification (ERIL)	X

Country	National Electrification Plan/Policy	Integrated National Electrification Plan	Energy and Electricity Law	Framework for Stand-alone Systems				
				Existence of Specific National Programs	Financial Incentives	Standards and Quality	Concession Contracts and Schemes	Business Model Regulation
Sierra Leone	National Renewable Energy Policy	Electricity Sector Reform Roadmap	X	Power for All - Energy Access Task Force; DfID Rural Renewable Energy Programme (RREP); EU Promoting Renewable Energy Services for Social Development (PRESSD)	Tax exemptions for IEC-compliant solar products	Electricity Sector Reform Roadmap	Electricity Sector Reform Roadmap	X
Togo	Togo Electrification Strategy		X	Togo Electrification Strategy / CIZO	30% import tax exemption for SHS	ISO & IEC equipment standards	X	CIZO initiative

NOTE:

1) As part of this analysis, national electrification policies, plans, laws and regulations were only considered if they included detailed provisions and corresponding action plan(s) to support development of the off-grid sector (i.e. through the utilization of mini-grids/stand-alone systems)
2) (   ) indicates that the plan/policy is currently under development
3) X = no existing provisions

Source: ECREEE; SEforALL, GreenMax Capital Advisors analysis

5.2 Capacity Building and Technical Assistance at National Level

- **Policy and Regulatory Environment**

The off-grid sector in nearly all ROGEP countries is in its nascent stages; however, it is expected to gain rapid momentum in the coming years as demand for electricity continues to grow and more solar companies enter the regional market. The increase in government engagement and pioneering efforts in increasing energy access are mobilizing companies interested in the off-grid stand-alone solar market in several countries across the region. In **Section 3.2.3.2: Select National Off-Grid Development Programs**, five prominent initiatives are highlighted in Benin, Côte d'Ivoire, Ghana, Nigeria, and Togo for their nationwide scale, PPP features and diversity of approaches.

While supportive policy frameworks are missing from many countries, more than half of the governments have adopted national electrification policies, while several countries have either developed or are currently developing integrated national electrification plans with off-grid provisions. The steady increase in government engagement has encouraged the inclusion of off-grid provisions in energy/electricity laws and other supportive financial and regulatory measures. Momentum in this sector is also driven by DFI and donor funded programs, with dozens of off-grid programs already in place across the region.

While there are promising indicators, there are also areas where improvement can be made to off-grid policy frameworks, particularly in CAR, Chad, Liberia and Mauritania, which still have extremely limited energy access regulatory frameworks according to their RISE energy access scores (**Figure 34**).

- **Financial Incentives**

The path forward for countries in the region must include the integration of financial incentives to attract private sector participation in off-grid market development. Significantly, policymakers in 15 of the 19 countries have adopted financial incentive frameworks to support off-grid sector growth. While most of the countries have financial incentives for off-grid /stand-alone systems, additional reforms to the power sector may be required to catalyze rapid growth in the industry as occurred in the success stories described in **Section 3.2.3.2**. Support mechanisms such as subsidies, tax exemptions and other financing schemes are needed and can help unlock market growth. Eliminating taxation facilitates easy movement of solar products across countries and ultimately enhances their affordability for consumers. Local FIs and cooperatives will also need incentives and support to develop and implement new financial products and administrative procedures to lend to the off-grid sector (this topic is examined in further detail in **Section 7**).

- **Standards and Quality**

Successful development of the off-grid sector requires more than just a financial support mechanism – governments and their supporting agencies across the region also need to develop and implement a range of measures to expedite growth of the market, including the implementation of standards and quality assurance frameworks to support the solar PV system supply chain and make O&M services available and affordable for consumers. Standards for equipment and service providers (i.e. installers, technicians) help guide customers to companies providing the best value for their money. Thus far, about half of the countries in the region have adopted quality standards for the off-grid solar sector. The challenge governments, regulators and companies face will be to successfully enforce these standards on a national scale.

- **Concessional Contracts and Schemes**

Establishing concessional schemes could have a variety of benefits in creating a successful market for commercially sustainable businesses by granting exclusive rights to off-grid developers in a geographic area. Governments need to understand all of the options and models available for possibilities of granting such concessions to private operators of stand-alone systems. Different models used to grant concessions to SHS providers can yield wide-ranging results. Some observers have lauded the approaches being used in Rwanda, Nigeria, Togo and DRC as highly successful while, there has been criticism of the approach deployed in Senegal. Outside of the household market segment, public financing schemes can be developed to facilitate stand-alone solar system investments in public facilities (schools, health care centers etc.)

- **Business Model Regulation**

To date, the increasing penetration rates of mobile money and mobile internet services, and the proliferation of the PAYG business model have been key drivers of off-grid market expansion in Africa. Policies at the regional and national level should aim to foster linkages between off-grid solar companies, telecommunications companies, and mobile money service providers to help expand PAYG consumer financing business models. See **Section 7.2.3: Digital Financial Services and Energy Access** for more details.

VI. REGIONAL OFF-GRID SOLAR MARKET ASSESSMENT

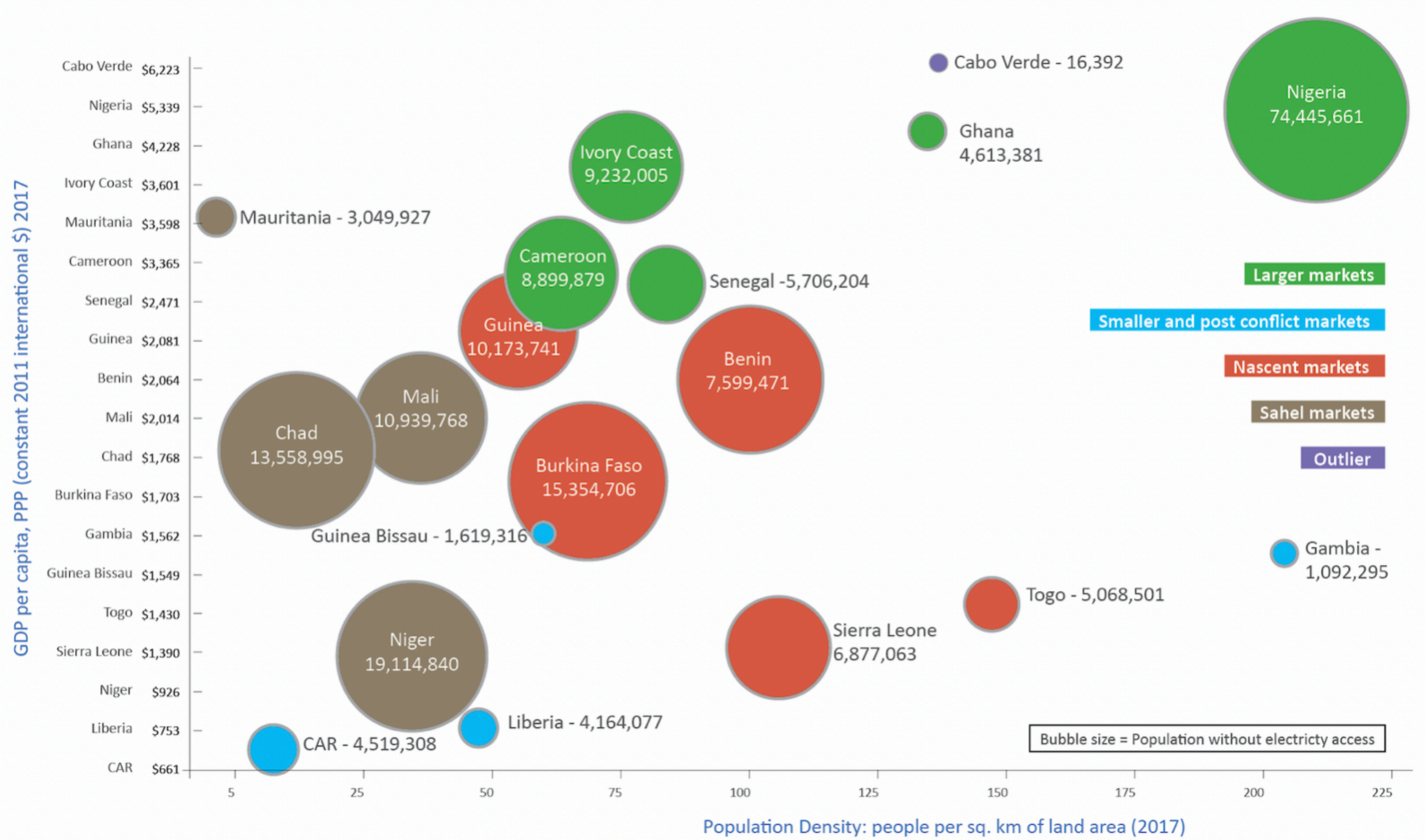
6.1 Overview of Market Segments

The countries in West Africa and the Sahel have a diverse range of market characteristics. Several indicators are important to off-grid solar product market development. To estimate the potential size of the market for OGS products and systems, this assessment examined factors such as population without access to electricity and GDP per capita. Population density was also analyzed, as this is an important indicator for market attractiveness to suppliers, based on distribution and maintenance costs. Using these demographic indicators, countries were grouped into market segments as shown in **Figure 35**.

Larger markets are those with relatively high GDP per capita, large populations without access to electricity, and higher population density. These are generally more diverse economies with stronger infrastructure. Most of these markets are already reporting growing sales of quality-verified OGS products. **Nascent markets** are poised for growth, with large off-grid populations, slightly lower GDP per capita rates and some reported OGS sales. **Smaller markets** present more challenging characteristics, including small population, low GDP per capita and low population density. Countries categorized as **Sahel markets** fall into a distinct category, with low population density but large off-grid populations with a range of GDP per capita levels. Cabo Verde is in a category of its own as an **outlier market** given how unique it is from the rest of the countries in the region as an island nation, with a very high electrification rate and higher income level. The analysis presented in this section will refer to this country categorization to support regional segmentation of the off-grid solar market.

Other market characteristics important to OGS product sales include mobile connectivity and agricultural production. While mobile money platforms are less pervasive in many West African markets than in East Africa, mobile internet penetration rates set a baseline for entry of PAYG business models (see **Section 7.2.3: Digital Financial Services and Energy Access** for more details). Connectivity also supports economic development, value addition, wealth creation and thereby household purchasing power. Mobile phone ownership indicates a baseline of connectivity and a nascent market for internet penetration. Agricultural production indicates rural wealth as well as the potential market size for rural off-grid productive use applications such as water pumping for irrigation, grain milling and cold chain equipment.

Figure 35: Country Categorization by Electricity Access, Income and Population Density



Market definitions	GDP per capita	Population Density	Population without electricity access
Larger markets	>$2,500	>75	>5 million
Nascent markets	$1500 - 2500	>50	>5 million
Smaller and post conflict markets	$0-1500	Varies	<5 million
Sahel markets	Varies	<20	>10 million
Outlier	>$5000		<50,000

Source: African Solar Designs analysis

6.2 Regional Market Assessment – Summary of Findings

The results of the overall market assessment for off-grid solar products and systems across the West Africa and Sahel region are presented in **Table 10**, which includes a summary of potential demand for OGS equipment in each of the analyzed market segments in 2018 – **household** (modeled for both cash and financed purchase potential), **institutional** for public institutions such as schools and health facilities, and **productive use** of electricity to generate economic activity and increase productivity. The results of the analysis suggest that there is significant off-grid solar market potential, with the largest cash demand coming from the productive use sector (USD 1.8B), followed by households (USD 907M) and Institutional users (USD 213M). The estimated annualized cash market potential for the entire region is nearly USD 3 billion, with more than 16 million units sold (686 MW equivalent).

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 realties, 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 10: Indicative Total Off-Grid Solar Cash Market Potential in West Africa and the Sahel, 2018

Off-Grid Market Segment	Units	kW Equivalent	Cash Value (USD)
HOUSEHOLD			
Pico solar	9,978,800	29,937	$449,046,106
Plug and play	3,310,212	33,103	$413,776,330
Small SHS	137,451	6,874	$34,362,608
Medium and Large SHS	16,559	4,150	$10,374,256
Estimated Regional Household Cash Market Potential	**13,443,062**	**74,064**	**$907,559,300**
Pico solar	359,236	1,078	$16,165,641
Plug and play	1,334,607	13,347	$166,825,867
Small SHS	4,261,681	213,084	$1,065,420,256
Medium and Large SHS	2,597,536	649,384	$1,623,459,999
Estimated Regional Household Financed Market Potential	**8,553,060**	**876,893**	**$2,871,871,764**
INSTITUTIONAL			
Water supply	18,919	71,375	$178,424,250
Healthcare facilities	8,500	4,666	$11,659,375
Primary and secondary schools	8,246	6,413	$17,681,235
Public lighting	3,449	1,726	$5,173,875
Estimated Regional Institutional Cash Market Subtotal	**39,114**	**84,180**	**$212,938,735**
PRODUCTIVE USE			
SME applications for micro-enterprises (barbers and tailors)	691,466	172,867	$432,166,625
Connectivity / ICT (phone charging)	206,036	82,414	$177,602,737
Value-added applications (irrigation, milling and refrigeration)	1,642,952	272,532	$1,252,030,852
Estimated Regional Productive Use Cash Market Subtotal	**2,540,454**	**527,813**	**$1,861,800,214**
ESTIMATED ANNUALIZED REGIONAL CASH MARKET POTENTIAL	**16,022,630**	**686,057**	**$2,982,298,249**

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

Source: African Solar Designs analysis

- **Household Cash Market**

The cash purchase model estimated the number of off-grid solar products and systems households can afford to purchase based on income levels. From this output, the estimated cash value and kW equivalent of these units was calculated. According to the analysis, the total regional off-grid solar cash market potential for households in 2018 is USD 907.5 million, decreasing to USD 842.5 million and USD 84.9 million in 2023 and 2030, respectively. The majority of the estimated cash market is dominated by potential sales of pico solar lighting and plug-and-play solar home systems. See **Section 6.3** and **Annex 2** for more details.

- **Household Financed Market**

Consumer financing allows a significant share of the region's lower income population to afford OGS products. Without financing, an estimated 30 million households across the region can afford an OGS system in 2018 (representing 78% of all households without electricity access). However, with the addition of financing, an estimated 39 million households across the region are able to purchase at least one OGS system (accounting for nearly 100% of all households without electricity access). According to the analysis, the total regional off-grid solar financed market potential for households in 2018 is $2.8 billion – more than triple the estimated cash market value in that year. Innovative financing models (i.e. PAYG, lease-to-own, energy-as-a-service) would need to be widely deployed for this market potential to be realized, recognizing that challenges exist in many of the ROGEP countries surrounding the availability of consumer financing. See **Section 6.3** and **Annex 2** for more details.

- **Institutional Cash Market**

The institutional sector analysis evaluated potential demand from four public/institutional market segments in each country – water supply for off-grid communities, healthcare facilities, education centers (primary and secondary schools) and public lighting. According to the analysis, the annualized regional off-grid solar cash market potential for the institutional sector is USD 212.9 million. The market segment with the largest potential is village water supply (USD 178.4 million), followed by education (USD 17.6 million), healthcare (USD 11.6 million) and public lighting (USD 5.1 million). See **Section 6.4** and **Annex 2** for more details.

- **Productive Use Cash Market**

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 (see **Annex 2** for more details on the PUE methodology and calculations). The assessment found that there is a sizeable market for productive use applications across the region (see **Section 6.5**). According to the analysis, the annualized regional off-grid solar cash market potential for the productive use sector is USD 1.8 billion, with the largest market potential coming from value-added applications (USD 1.25 billion), followed by applications for microenterprises (USD 432 million) and connectivity/mobile phone charging (USD 177 million).

6.3 Regional Household Sector Demand

6.3.1 Overview of Household Market Segment

Countries in West Africa and the Sahel have a relatively small total household solar PV market that is still largely undeveloped. Rapid uptake of household lighting and communication technology are driving demand for new electricity sources and appliances. However, despite the recent entrance of PAYG solar companies into the household market segment, the region's household solar market remains in its nascent stages and dominated by the informal sector.[192]

➢ **Demographic and Socio-Economic Segmentation of Household Market**

As of 2016, over 200 million people in the 19 ROGEP countries (over half of the total population) did not have access to electricity. Altogether, this represents a significant potential market for off-grid solar products. While the industry remains in its early stages across much of the region, diverse national markets including Nigeria, Ghana, Mali and Burkina Faso are reporting growing sales of household solar products.

Agriculture is the largest sector of employment across the region, ranging from 37% of total employment in Nigeria to 87% in Chad.[193] The large number of smallholder and subsistence farmers in many countries presents a relatively large market for OGS water pumping and milling. Off-grid household income is highly seasonal and depends on crop cycles. Potential financing mechanisms for financing solar equipment must take this into account (many solar industry players already consider seasonality aspects when planning sales cycles).

Pastoralist communities also represent a significant economic segment. Households throughout the Sahel region have distinct characteristics requiring unique service models tailored to low population density, livestock-based wealth, mobile/small-scale lighting, and cooling/refrigeration.

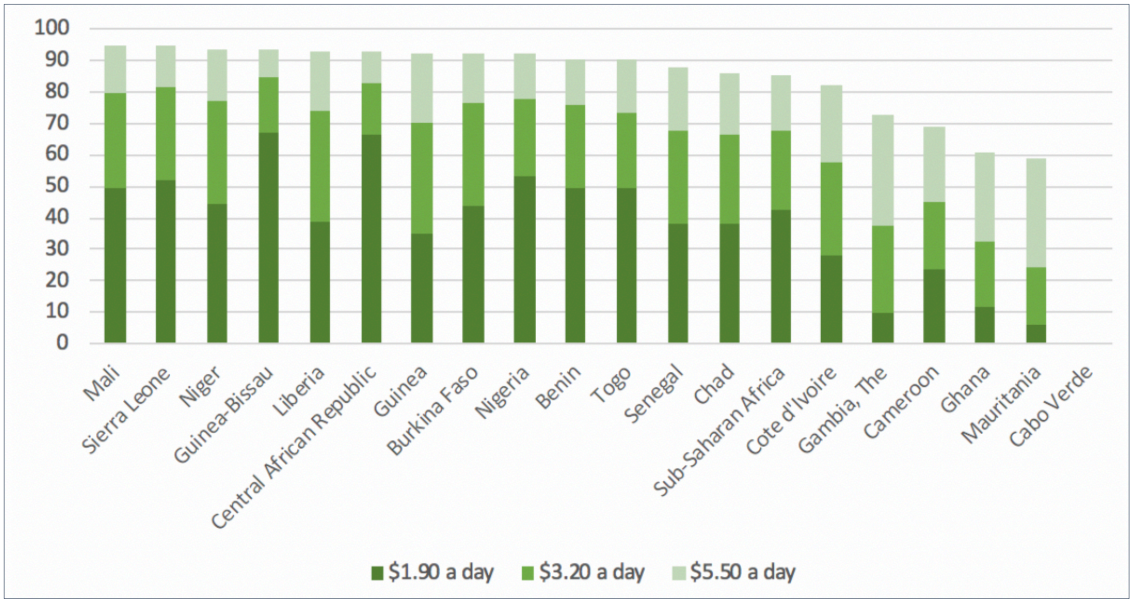
➢ **Consumer Purchasing Power**

While GDP per capita is relatively high on average across the region, this is for many countries driven by natural resource wealth. Income data from countries across the region shows a high incidence of poverty that constrains the majority of households' ability to pay for electricity, despite high demand for electricity. As shown in **Figure 36**, the majority of ROGEP countries have poverty rates higher than the Sub-Saharan Africa regional average. There are several notable exceptions to this trend, such as Ghana, Cameroon, and Mauritania, where the incidence of poverty is significantly lower.

[192] In this context, the informal market or "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.

[193] World Bank World Development Indicators, employment in agriculture, percentage of total employment: https://data.worldbank.org/indicator/sl.agr.empl.zs

Figure 36: Poverty Headcount Ratio as a Share (%) of Population, 2011 PPP[194]



Source: World Bank

National data suggests that rural households prioritize electricity services and have an ability to pay for electricity albeit in small amounts. Focus group data indicates that average households in representative countries spend between USD 3-8 per month on Tier 1 equivalent energy needs.[195] This range increases to USD 11-33 for Tier 1.5 and USD 25-40 for Tier 2. 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.[196] Other research has shown household energy spending between 6-12% for low-income segments in Sub-Saharan Africa.[197] For the purpose of this research, it was assumed that households can allocate 10% of their income on average to energy expenditures.

This does not mean that the equivalent of 6-15% of household income is spent on energy with each household every month. Instead, when households lack income, they do without both electricity and communication services. These two points provide strong evidence of the major transition in household energy expenditure that small-scale solar systems can trigger.

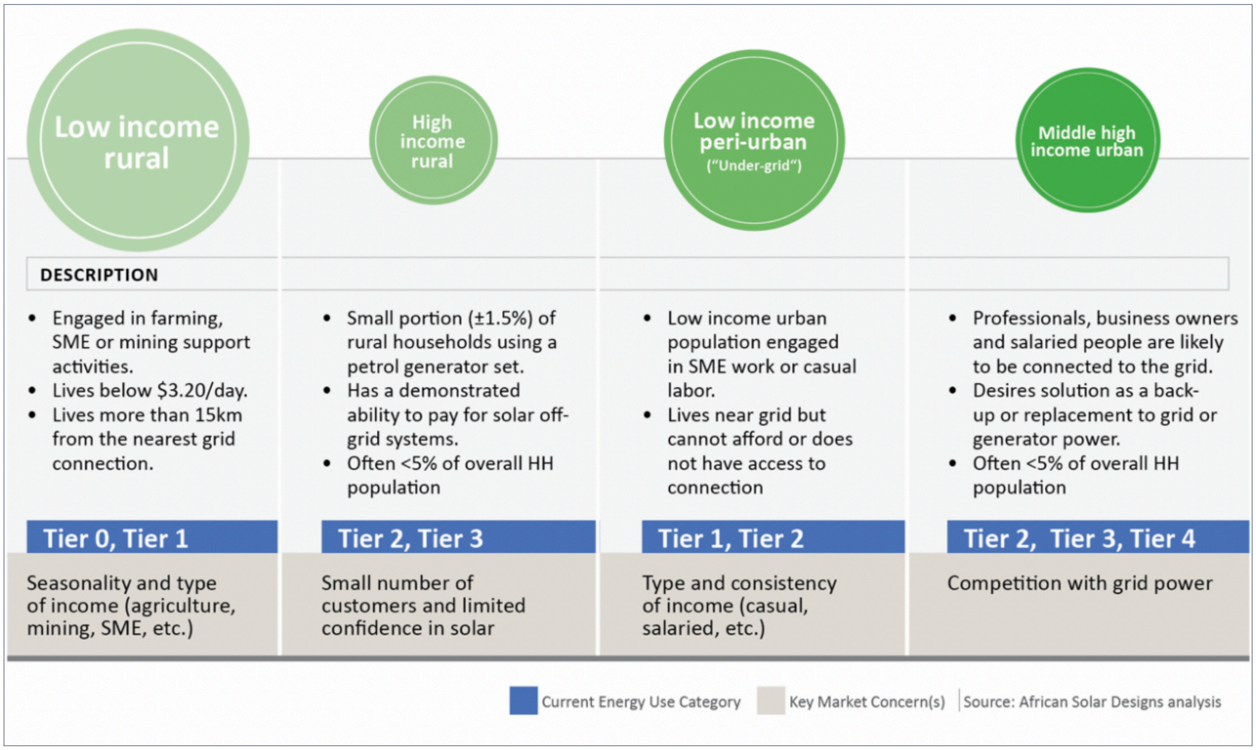
➢ Geographic Components of the Solar Market

Based on demographic and income data, the household solar market can be divided into four distinct segments, as shown below in **Figure 37**, which each require a different business and financing approach. Each segment fits into a distinct tier group as indicated by the Multi-Tier Framework.[198] Tier 5 is not included in this analysis, as off-grid solar systems that can provide a Tier 5 level of service are beyond the

[194] NOTE: No poverty data was available for Cabo Verde so it was removed from this chart to avoid confusion.
[195] Based on focus group data for Ghana, Sierra Leone, Liberia and Mali.
[196] Lai, K., Munro, P., Kebbay, 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): https://pressd-sl.org
[197] Average rural household expenditure on energy varies considerably. 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/
[198] World Bank ESMAP Multi-Tier Energy Access Framework: https://www.esmap.org/node/55526

reach of the vast majority of the population in the region. As will be elaborated upon in **Section 6.6**, suppliers have already developed innovative business models to approach different market segments.

Figure 37: Solar Household Consumer Market Segments



Source: African Solar Designs analysis

Household poverty holds back geographical expansion of solar products and "pure" rural markets are largely untapped due to lack of ability to pay and lack of ability of companies to reach consumers. Four market segments – high and low income rural, peri-urban and urban – were listed as the most important for those selling household equipment. Note also that small-scale productive use equipment is closely associated with household OGS systems (and dealers typically do not distinguish between the two markets).

A geographical breakdown of potential market areas is provided at the national level by the GIS analysis in each country report. At the regional level, it is also possible to make some overarching assessments based on the following information provided during the focus group discussions:

- **Low income rural:** Farmers and business women are key target groups. Traders focus on areas where cash crops such as rice, coffee, cocoa, livestock and fishing are concentrated. Some solar traders provide solar equipment during periods when harvests are underway and when consumers are cash-rich and can afford to make purchases.

- **High income rural:** This represents a small yet distinct market segment in countries with limited grid extension, high density and high agricultural activity. This includes high income households more than 20 km from the grid that will not likely be connected to the grid in the near future and use a generator – perhaps 2-3% of rural people in nascent to large markets. Many of these will be second homes for urban households, who would purchase an OGS product from a provider in an urban center. This would reduce distribution costs for suppliers serving this segment, although rural installation and maintenance costs would remain.

- **Urban and peri-urban / under-grid market:** For some solar traders, urban areas are not considered very good market locations, due to the availability of grid-power. However, other traders consider that the urban and peri-urban demand is viable because of the lack of low-cost quality electricity. In particular, they are interested in demand from consumers of high-end solar systems and from peri-urban poor without access to grid connections. Both of these groups are said to be more "cash rich" than rural areas that are focused on subsistence agriculture. This is an important market in countries such as Nigeria or in post-conflict countries and countries affected by Ebola where the grid is not sufficiently developed. Many of these households want Tier 2, 3 or 4 solar solutions. Suppliers serving this market would enjoy lower distribution costs but face higher competition.

- **Middle to high income urban:** The market sizing model used in this report does not include potential demand from middle to high income urban on-grid households that would purchase OGS systems as a back-up or replacement 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.

- **Extractive industry enclaves:** A number of off-grid "mining enclaves" have potential for sales of OGS products. These areas include locations where natural resources are extracted. Workers in mines have cash for their own homes or for their remote families.

- **Pastoralist markets:** This represents a broad swath of middle-income rural households in the Sahel region, stretching from Mauritania and Senegal in the west, across Mali, Niger, and Chad to the east, as well as the northern parts of Burkina Faso and Nigeria. Wealth held in livestock as well as sharia finance requirements will affect potential payment methods and limit the application of pay-as-you-go models. Very low population density presents extreme distribution challenges, as does insecurity in some areas. Despite these challenges, distinct demand for solar solutions paired with relative wealth presents a viable market to be tapped by innovative business models. Mali is registering growing solar sales and research in pastoralist communities in northern Kenya[199] suggests potential for suppliers that would choose to tap this less competitive market space.

In rural areas, demand for household systems is concentrated in areas where there are high populations and high productivity. However, in many countries demand is spread over a large area given the large areas that are un-electrified and distant from the grid. Low population density is a significant challenge in Sahel countries, which have relatively large populations without access to electricity but also large land mass.

[199] Kenya Off-Grid Solar Access Project: http://projects.worldbank.org/P160009/?lang=en&tab=documents&subTab=projectDocuments See also: Mercy Corps – d.light pilot project in Wajir, Northern Kenya: https://www.mercycorps.org/sites/default/files/Mercy_Corps_Wajir_Solar_Pilot_Fact_Sheet.pdf

6.3.2 Analysis of Regional Household Market Demand

This section analyzes existing demand and costs of household electricity (and lighting energy) for typical user groups.

- **Consumption and expenditures on existing non-solar household fuels and devices**

Recent data from across sub-Saharan Africa indicates that households in many countries are shifting away from predominant use of kerosene to informal use of dry-cell battery powered lighting products, as shown in **Table 11** below. This is a quickly developing and positive trend, indicating household investment in electronic devices that could act as a gateway to use of various OGS products. Households are exercising choice amongst an array of electric products more versatile than traditional kerosene. Many lighting sources double as USB chargers for mobile phones and other devices. However, this market is largely informal and driven largely by inexpensive product imports of unknown quality. Widespread use of non-rechargeable dry cell batteries also presents challenges for disposal of electronic waste. These are important considerations for policymakers and OGS industry advocates.

Table 11: Baseline Household Lighting Products[200]

Lighting usage rates among non-electrified households (%)			
Country	**Candles**	**Kerosene**	**Dry cell batteries**
Burkina Faso (2012)	0%	10%	99%
Senegal (2014)	0%	1%	97%
Sierra Leone (2015)	0%	1.6%	96.8%

Source: Lai et. al., 2015; Grimm and Peters, 2016

The use of solar PV systems is also growing rapidly in many markets, as solar gradually replaces battery powered lights. Feedback from focus group discussions and surveys of industry stakeholders across the region estimated common energy sources and their associated costs as shown in **Figure 38** below.

[200] Lai et. al., 2015; and
Grimm, M., and Peters, J., "Solar off-grid markets in Africa. Recent dynamics and the role of branded products," Field Actions Science Reports, Issue 15, (October 2016): http://factsreports.revues.org/4222

Figure 38: Off-Grid Household Energy Technologies and Estimated Costs in Representative Markets

Current Households Energy Costs				Typical Monthly Costs			
TECHNOLOGY/USES	DETAILS	TYPICAL USAGE	OP COST/UNIT	GHANA	LIBERIA	MALI	SIERRA LEONE
LED FLASHLIGHTS (DRY CELLS)	• D-type batteries • AA-type batteries • AAA-type	• 1-2 torches, with 2-4 batteries, replaced between 2 to 3 times a month	$0.13-$0.38 Dry cell unit cost	$2.55	$2.28	$3.24	$1.95
CELL PHONE CHARGING	• Done at a charging station	• 16 to 30 times a month	$0.13-$0.18 per session	$11.4	$6.08	$5.30	$2.56
RADIO	• D-type batteries • AA-type batteries • AAA-type	• A radio uses 2-4 cells replaced twice a month	$0.13-$0.38 Dry cell unit cost	$7.44	$4.31	$9.04	$6.40
SMALL GENERATOR	• For basic uses (for charger, light, TV, fan and music system)	• Consumes 15 to 20 litres per month (Not provided from FGDs	$0.80-$1.13 per litre petrol cost	$13.95	$16.17	$22.60	$16.0
LEAD ACID BATTERY	• Lead acid batteries charged at stations	• Charged 2 to 4 times a month	$0.55-$1.77 per session	$2.50	$3.05	$7.08	$2.20
OTHER (KEROSENE)	• Purchased in litres	• Not applicable in all countries	$0.84 per litre (Liberia)	N/A	$5.04	N/A	N/A

Data from FGDs, field surveys and published data sources.

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

Based on the data in **Figure 38**, it is possible to estimate “typical” monthly costs that households would incur in order to receive a standard level of electricity service according to the Multi-Tier Energy Access Framework (MTF). The costs to provide the equivalent level of service for each tier level are calculated in **Figure 39** below. In order to establish the cumulative monthly expenditure for each tier, **Figure 39** indicates the monthly cost of sustaining the level of electricity access for each tier within the MTF using the unit monthly costs for each of the electricity sources in **Figure 38**. The cost of each source in each tier is determined using data from **Figure 38** and the cumulative total monthly cost determined. These assumptions guide the calculations to come up with the total monthly expenditures presented in **Figure 39**.

It should be emphasized that few households actually pay these full costs because they do not have the available income. In reality, 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.

Figure 39: Typical Tier-Based Energy Costs in Representative Markets

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Total monthly cost of equivalent service (USD)			
			GHANA	LIBERIA	MALI	SIERRA LEONE
Tier 0 No Electricity	• 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.	• Rely solely on kerosene, wood and other fuel sources for cooking and lighting.	"Subsistence" level of energy; absolute energy poverty	"Subsistence" level of energy; absolute energy poverty	"Subsistence" level of energy; absolute energy poverty	"Subsistence" level of energy; absolute energy poverty
Tier 1 **Range: 1 to 20 Wh/day**	• Access to one torch powered by dry cell batteries. • One cell phone powered by charging service	• One battery-powered light requires dry cell replacement on weekly basis • One cell phone charged 8 times per month	$5.22	$3.60	$6.00	$3.60
Tier 1.5 Range: 20 to 100 Wh/day	• Access to one torch and one lantern each powered by dry cells • One cell phone powered by charging service • Radio powered by dry cells	• 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	$10.5	$7.44	$12.96	$7.44
Tier 2 Range: 55 to 500 Wh/day	• One torch and two lanterns powered by dry cells • One cell phone and one smart phone powered by charge service • Radio • DC TV	• 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	$19.67	$13.40	$22.28	$13.36
Tier 3 Range: 500 to 2500 Wh/day	• Five lighting points • Multiple cell/smart phones • AC radio and music system • AC TV	• Generator powers a set of appliances	$31.50	$21.29	$37.2	$22.23

Source: African Solar Designs analysis

Per **Figure 38**, 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 with the 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.

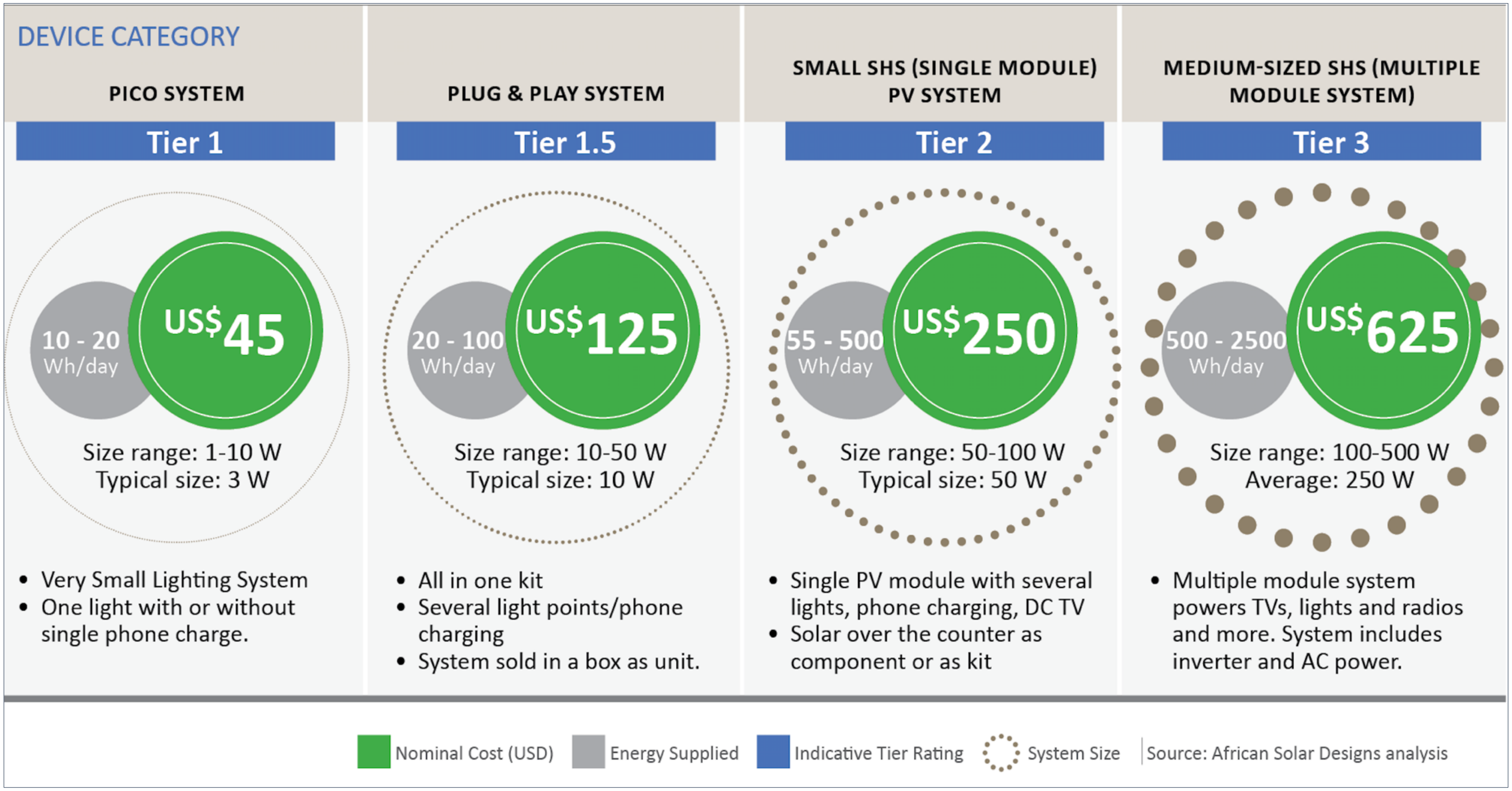
- **Household Solar PV System Types**

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 40** below.[201] Note that the "indicated" prices are less than current prices and are based on the expectation that prices will reduce significantly as the market matures and competition forces down prices.

[201] Prices based on representative data from Sierra Leone. As a nascent market, Sierra Leone provides mid-range data for the region.

Figure 40: Household Solar PV System Descriptions and Market Segments



Source: African Solar Designs analysis

➢ **Potential Household Cost Savings**

Using data from the previous section, it is possible to compare the typical annual household energy expenditure per tier to the equivalent annual cost using an OGS system. This cost savings analysis is shown below for a representative country from each regional market category. Household energy expenditure is based on focus group discussion data from each country. Solar equivalent costs are based on representative data from Sierra Leone. **Tables 12-17** show that for each category, potential household savings are quite high. However, as discussed above, it is important to remember that low-income rural households reduce their energy expenditure as their incomes fluctuate. These cost savings estimates are based on consistent monthly energy expenditures.

Table 12: Household Cost Savings with OGS for Ghana – Category 1 (Larger Markets)

Tier	Current energy Supply Annualized Cost (USD)	Equivalent Solar solution/alternative	Annualized Cost for Solar solution equivalent (USD)	Annualized Cost Savings	% Cost Savings
1	$66.67	Pico	$22.50	$44.17	66%
1.5	$134.03	Plug and Play system	$41.67	$92.36	69%
2	$273.01	Small HH solar system	$50.00	$223.01	82%
3	$428.00	Medium HH system	$125.00	$303.00	71%

Table 13: Household Cost Savings with OGS for Sierra Leone – Category 2 (Nascent Markets)

Tier	Current energy Supply Annualized Cost (USD)	Equivalent Solar solution/alternative	Annualized Cost for Solar solution equivalent (USD)	Annualized Cost Savings	% Cost Savings
1	$47.20	Pico	$22.50	$24.70	52%
1.5	$97.28	Plug and Play system	$41.67	$55.61	57%
2	$172.32	Small HH solar system	$50.00	$122.32	71%
3	$466.76	Medium HH system	$125.00	$341.76	73%

Table 14: Household Cost Savings with Off-Grid Solar for Liberia – Category 3 (Smaller Markets)

Tier	Current energy Supply Annualized Cost (USD)	Equivalent Solar solution/alternative	Annualized Cost for Solar solution equivalent (USD)	Annualized Cost Savings	% Cost Savings
1	$47.20	Pico	$22.50	$24.70	52%
1.5	$97.28	Plug and Play system	$41.67	$55.61	57%
2	$197.80	Small HH solar system	$50.00	$147.80	75%
3	$305.53	Medium HH system	$125.00	$180.53	59%

Table 15: Household Cost Savings with Off-Grid Solar for Mali – Category 4 (Sahel Markets)

Tier	Current energy Supply Annualized Cost (USD)	Equivalent Solar solution/alternative	Annualized Cost for Solar solution equivalent (USD)	Annualized Cost Savings	% Cost Savings
1	$76.00	Pico	$22.50	$53.50	70%
1.5	$163.52	Plug and Play system	$41.67	$121.85	75%
2	$304.36	Small HH solar system	$50.00	$254.36	84%
3	$496.40	Medium HH system	$125.00	$371.40	75%

Table 16: Household Cost Savings with Off-Grid Solar for Cabo Verde – Category 5 (Outlier)

Tier	Current energy Supply Annualized Cost (USD)	Equivalent Solar solution/ alternative	Annualized Cost for Solar solution equivalent (USD)	Annualized Cost Savings	% Cost Savings
1	$48.16	Pico	$22.50	$25.66	53%
1.5	$98.24	Plug and Play system	$41.67	$56.57	58%
2	$175.20	Small HH solar system	$50.00	$125.20	71%
3	$532.40	Medium HH system	$125.00	$407.40	77%

NOTE: In **Tables 12-17**, annualized costs based on indicative prices available for Sierra Leone only.

Source: African Solar Designs analysis

6.3.2.1 Regional Household Cash Market for OGS Systems

This section analyzes the market for various income levels and the corresponding energy services powered by OGS systems they can afford. The potential market for cash purchase is assessed based on household income and affordability, alongside the significantly larger market that could be accessed through consumer financing. In higher income countries, the potential cash purchase market is substantial. However, in many of the countries across West Africa and the Sahel, only off-grid households in the higher income quintiles can afford an OGS system through cash purchase. Even then, many households can largely only afford to purchase pico solar and basic plug-and-play solar home systems. When financing is introduced, all households are able to purchase at least a low cost system, and many are able to purchase larger systems with more functionality, effectively moving them up the energy tier ladder.

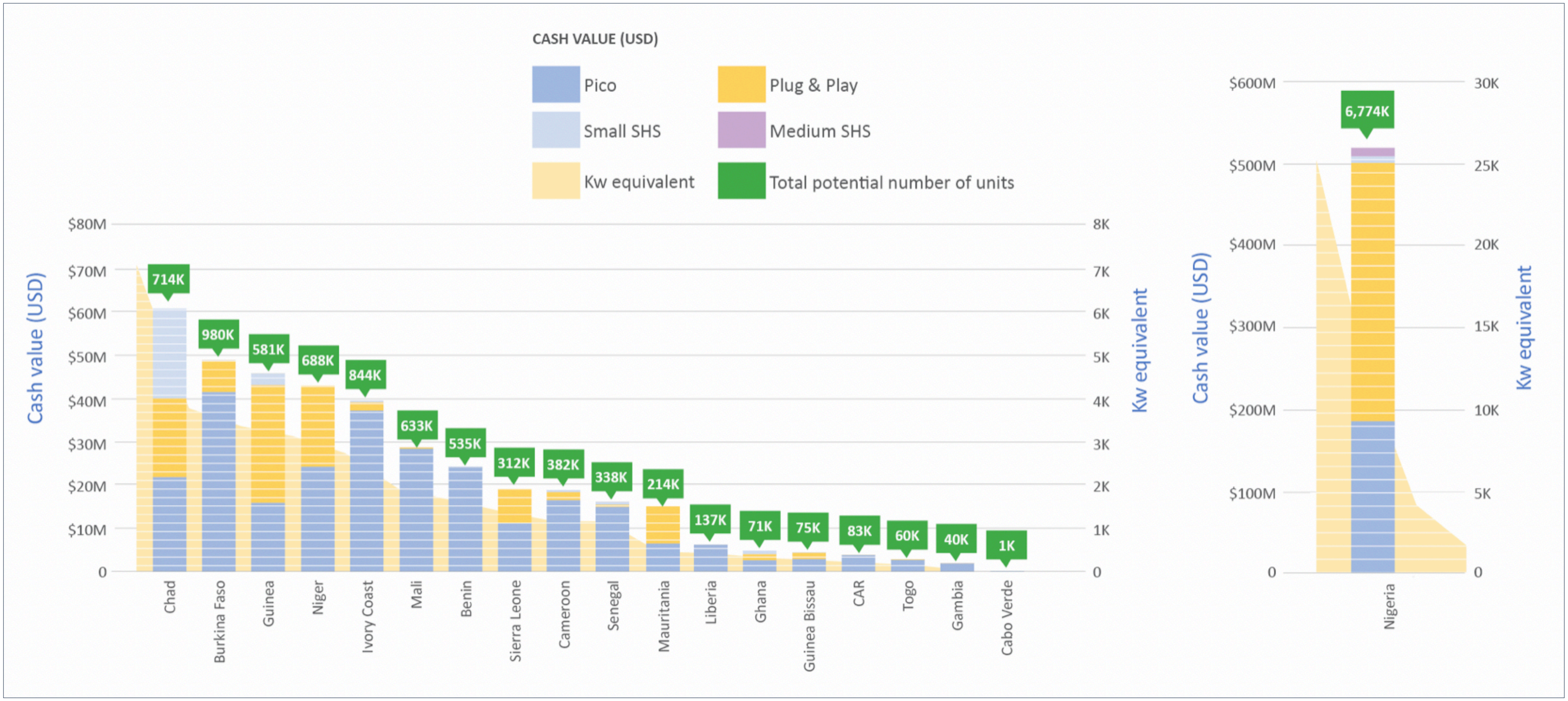
- **Cash Purchase Model**

Modeling of the viable cash purchase market was based on income quintiles associated with data from the World Bank and International Energy Agency (IEA). 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. Monthly energy expenditure is assumed to be 10% of income. 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.

In this way, the cash purchase model assesses how many OGS system units households could potentially afford to purchase based on their income. It also shows the equivalent cash value and installed kilowatts (kW) of those units. The analysis estimates the total regional off-grid solar cash market potential for the household sector to be USD 907.5 million in 2018, decreasing to USD 842.5 million and USD 84.9 million in 2023 and 2030, respectively.

Figures 41-43 and corresponding **Tables 17-19** present the estimated regional off-grid solar cash market potential in 2018, 2023 and 2030, respectively. The total number of off-grid households and their geographic distribution can change significantly over time. A least cost electrification analysis was conducted for this purpose, and GIS maps were prepared from demographic information to present potential market areas for OGS by country. The GIS analysis considered factors such as population density, planned grid extensions, urban and peri-urban centers of economic growth, and off-grid solutions (mini-grids and stand-alone systems) for rural areas. The results of the least-cost electrification analysis are presented in **Section 3.2.4** (see **Annex 1** and **Annex 2** for more details).

Figure 41: Estimated Regional OGS Cash Market Potential for Household Sector, 2018



Source: African Solar Designs analysis

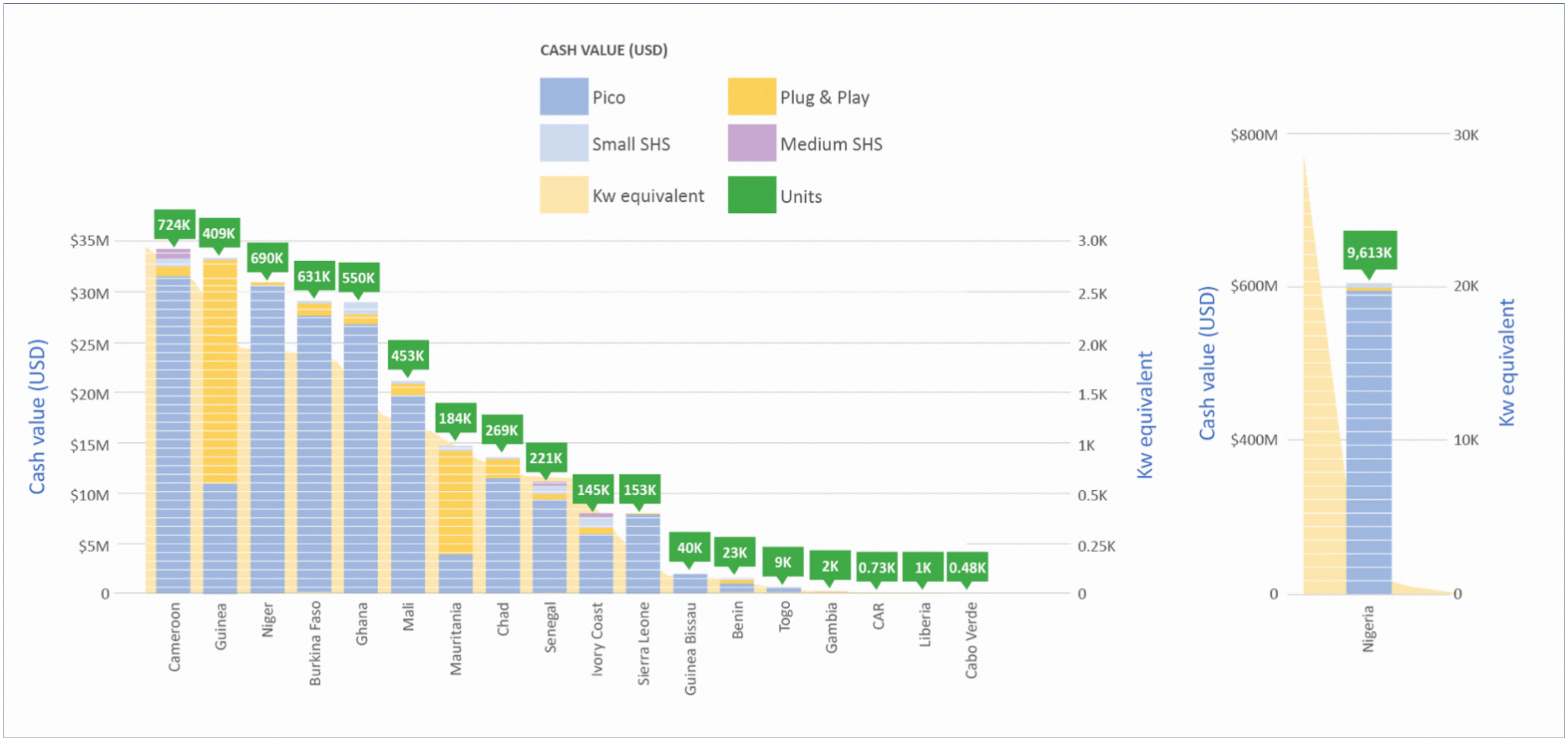
Table 17: Estimated Regional OGS Cash Market Potential for Household Sector, 2018

2018 Potential Cash Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
	Cameroon	365,432	1,096	$16,444,423	15,419	154	$1,927,382	1,850	93	462,572	0	0	$0	382,701	1,343	$18,834,377
	Ghana	57,667	173	$2,595,027	10,984	110	$1,373,030	3,295	165	823,818	0	0	$0	71,947	448	$4,791,875
1	Ivory Coast	827,821	2,483	$37,251,950	14,997	150	$1,874,595	1,800	90	449,903	0	0	$0	844,617	2,723	$39,576,448
	Nigeria	4,149,702	12,449	$186,736,609	2,545,151	25,452	$318,143,852	33,198	1,660	8,299,405	16,599	4,150	$10,374,256	6,744,650	43,710	$523,554,121
	Senegal	332,289	997	$14,953,005	3,819	38	$477,427	2,292	115	572,912	0	0	$0	338,400	1,150	$16,003,344
	Benin	534,198	1,603	$24,038,913	0	0	$0	894	45	223,514	0	0	$0	535,092	1,647	$24,262,427
	Burkina Faso	922,629	2,768	$41,518,316	58,366	584	$7,295,730	0	0	0	0	0	$0	980,995	3,352	$48,814,046
2	Guinea	353,255	1,060	$15,896,470	217,841	2,178	$27,230,064	10,598	530	2,649,412	0	0	$0	581,693	3,768	$45,775,946
	Sierra Leone	249,658	749	$11,234,605	62,977	630	$7,872,096	0	0	0	0	0	$0	312,635	1,379	$19,106,701
	Togo	59,330	178	$2,669,863	1,130	11	$141,263	0	0	0	0	0	$0	60,460	189	$2,811,125
	CAR	83,673	251	$3,765,297	0	0	$0	0	0	0	0	0	$0	83,673	251	$3,765,297
3	Gambia	40,731	122	$1,832,874	171	2	$21,347	0	0	0	0	0	$0	40,901	124	$1,854,221
	Guinea Bissau	63,766	191	$2,869,478	11,489	115	$1,436,175	0	0	0	0	0	$0	75,256	306	$4,305,653
	Liberia	137,225	412	$6,175,137	0	0	$0	0	0	0	0	0	$0	137,225	412	$6,175,137
	Chad	485,534	1,457	$21,849,043	145,575	1,456	$18,196,832	83,234	4,162	20,808,612	0	0	$0	714,343	7,074	$60,854,487
4	Mali	631,078	1,893	$28,398,506	2,169	22	$271,082	0	0	0	0	0	$0	633,247	1,915	$28,669,588
	Mauritania	144,199	433	$6,488,975	70,047	700	$8,755,829	290	14	72,462	0	0	$0	214,536	1,148	$15,317,266
	Niger	538,662	1,616	$24,239,805	150,077	1,501	$18,759,627	0	0	0	0	0	$0	688,739	3,117	$42,999,432
5	Cabo Verde	1,951	6	$87,812	0	0	$0	0	0	0	0	0	$0	1,951	6	$87,812
	Total	**9,978,802**	**29,936**	**$449,046,108**	**3,310,211**	**33,102**	**$413,776,329**	**137,450**	**6,873**	**34,362,609**	**16,599**	**4,150**	**$10,374,256**	**13,443,062**	**74,061**	**$907,559,303**

Source: African Solar Designs analysis

As presented in **Figure 41** and **Table 17**, according to the household market assessment, in 2018, Nigeria represents the largest cash market in the region (USD 523 million) – accounting for more than half of the region's total demand – followed by Chad (USD 60 million), Burkina Faso (USD 49 million), Guinea (USD 45 million) and Niger (USD 43 million).

Figure 42: Estimated Regional OGS Cash Market Potential for Household Sector, 2023



Source: African Solar Designs analysis

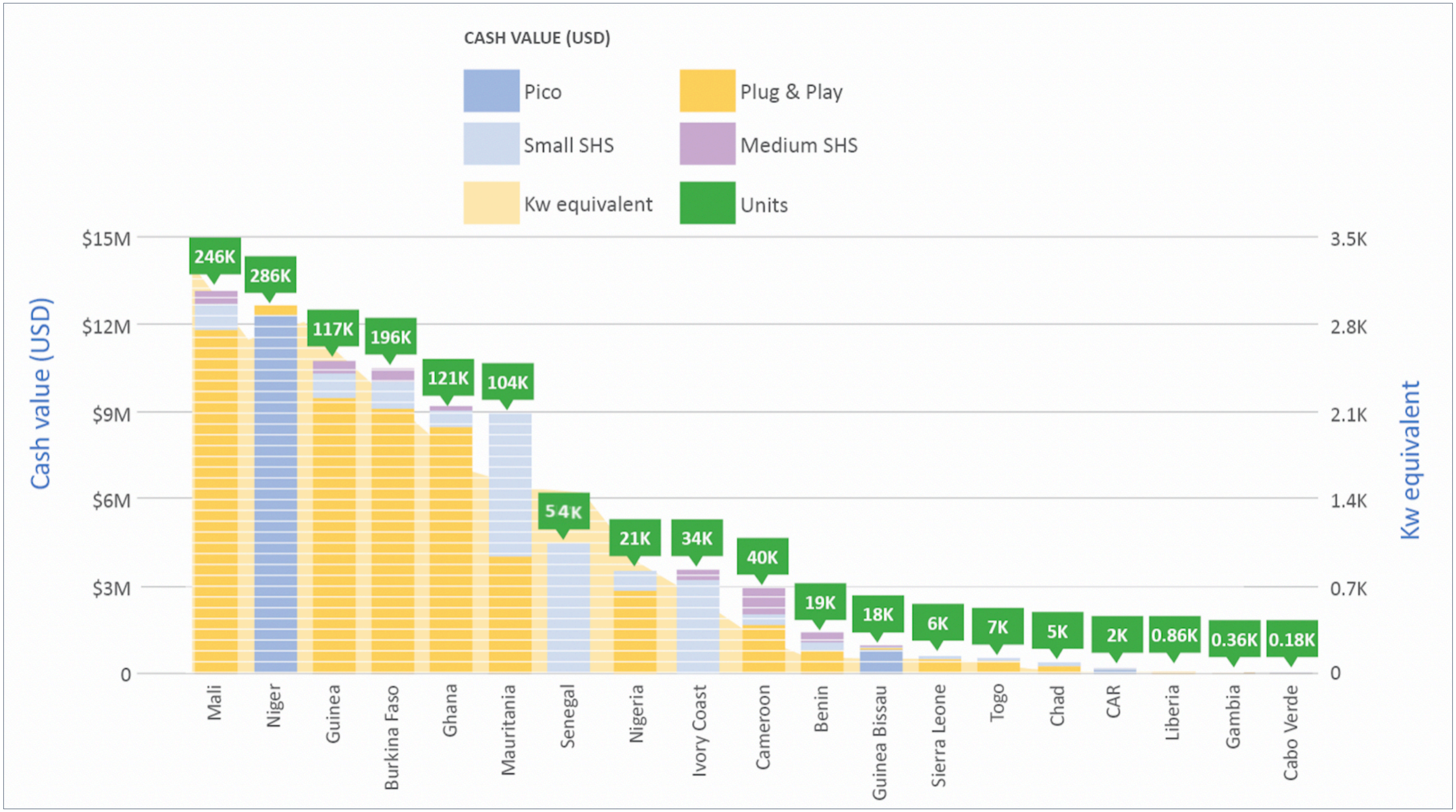
Table 18: Estimated Regional OGS Cash Market Potential for Household Sector, 2023

2023 Potential Cash Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
1	Cameroon	708,277	2,125	$31,484,673	10,264	103	$967,604	4,106	205	$774,083	2,053	513	$967,604	724,699	2,946	$34,193,963
	Ghana	535,583	1,607	$26,720,232	9,356	94	$989,938	5,614	281	$1,187,926	0	0	$0	550,553	1,981	$28,898,096
	Ivory Coast	132,407	397	$5,885,816	6,827	68	$643,605	5,120	256	$965,408	1,024	256	$482,704	145,378	978	$7,977,533
	Nigeria	9,535,801	28,607	$591,789,886	48,585	486	$6,394,549	29,151	1,458	$7,673,459	0	0	$0	9,613,537	30,551	$605,857,894
	Senegal	210,468	631	$9,218,936	5,963	60	$553,933	4,472	224	$830,899	894	224	$415,449	221,798	1,138	$11,019,217
2	Benin	18,922	57	$858,553	3,604	36	$346,817	1,081	54	$208,090	0	0	$0	23,607	147	$1,413,460
	Burkina Faso	617,319	1,852	$27,441,392	12,907	129	$1,216,786	1,549	77	$292,029	0	0	$0	631,775	2,058	$28,950,207
	Guinea	208,472	625	$10,939,545	199,755	1,998	$22,230,127	834	42	$185,602	0	0	$0	409,060	2,665	$33,355,273
	Sierra Leone	152,468	457	$7,867,902	927	9	$101,483	0	0	$0	0	0	$0	153,395	467	$7,969,385
	Togo	8,804	26	$402,999	0	0	$0	704	35	$136,747	0	0	$0	9,509	62	$539,746
3	CAR	0	0	$0	734	7	$71,230	0	0	$0	0	0	$0	734	7	$71,230
	Gambia	2,139	6	$103,150	408	4	$41,668	122	6	$25,001	0	0	$0	2,669	17	$169,819
	Guinea Bissau	40,445	121	$1,851,281	0	0	$0	161	8	$31,190	0	0	$0	40,606	129	$1,882,471
	Liberia	1,092	3	$54,802	0	0	$0	0	0	$0	0	0	$0	1,092	3	$54,802
4	Chad	249,227	748	$11,407,826	19,527	195	$1,895,591	1,108	55	$215,052	0	0	$0	269,862	998	$13,518,469
	Mali	439,407	1,318	$19,647,852	12,142	121	$1,151,395	1,457	73	$276,335	0	0	$0	453,005	1,512	$21,075,581
	Mauritania	80,734	242	$3,848,157	101,725	1,017	$10,282,913	2,430	122	$491,278	0	0	$0	184,888	1,381	$14,622,348
	Niger	687,941	2,064	$30,580,721	2,318	23	$286,195	0	0	$0	0	0	$0	690,259	2,087	$30,866,915
5	Cabo Verde	0	0	$0	483	5	$45,552	0	0	$0	0	0	$0	483	5	$45,552
	Total	**13,629,506**	**40,889**	**$780,103,722**	**435,525**	**4,355**	**$47,219,385**	**57,909**	**2,895**	**$13,293,098**	**3,971**	**993**	**$1,865,757**	**14,126,911**	**49,132**	**$842,481,962**

Source: African Solar Designs analysis

As presented in **Figure 42** and **Table 18**, in 2023, Nigeria will represent the largest household cash market in the region (USD 605 million) – accounting for an even larger share (about 70%) of the region's total demand – followed by Cameroon (USD 34 million), Guinea (USD 33 million), Niger (USD 30 million) and Burkina Faso (USD 28 million).

Figure 43: Estimated Regional OGS Cash Market Potential for Household Sector, 2030



Source: African Solar Designs analysis

Table 19: Estimated Regional OGS Cash Market Potential for Household Sector, 2030

2030 Potential Cash Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
1	Cameroon	0	0	$0	33,334	333	$1,627,034	3,685	184	$359,748	3,685	921	$899,370	40,705	1,439	$2,886,152
	Ghana	0	0	$0	117,041	1,170	$8,392,681	3,922	196	$562,542	436	109	$156,262	121,399	1,475	$9,111,485
	Ivory Coast	0	0	$0	0	0	$0	32,715	1,636	$3,193,643	1,461	365	$356,490	34,176	2,001	$3,550,133
	Nigeria	0	0	$0	19,383	194	$2,877,207	2,326	116	$690,530	0	0	$0	21,709	310	$3,567,736
	Senegal	0	0	$0	0	0	$0	47,936	2,397	$4,455,098	6,511	1,628	$1,512,866	54,447	4,025	$5,967,965
2	Benin	0	0	$0	15,305	153	$799,890	2,624	131	$274,248	1,312	328	$342,810	19,240	612	$1,416,949
	Burkina Faso	0	0	$0	185,569	1,856	$9,057,610	9,460	473	$923,466	1,892	473	$461,733	196,921	2,802	$10,442,810
	Guinea	0	0	$0	111,038	1,110	$9,422,452	4,990	250	$846,900	998	250	$423,450	117,026	1,609	$10,692,801
	Sierra Leone	0	0	$0	5,549	55	$445,323	666	33	$106,877	0	0	$0	6,215	89	$552,200
	Togo	0	0	$0	6,977	70	$375,448	837	42	$90,108	0	0	$0	7,814	112	$465,556
3	CAR	2,426	7	$115,562	0	0	$0	485	24	$52,226	0	0	$0	2,912	32	$167,788
	Gambia	0	0	$0	313	3	$20,044	53	3	$6,735	0	0	$0	366	6	$26,779
	Guinea Bissau	17,088	51	$813,876	955	10	$51,381	382	19	$41,105	191	48	$51,381	18,616	128	$957,742
	Liberia	0	0	$0	866	9	$63,249	0	0	$0	0	0	$0	866	9	$63,249
4	Chad	0	0	$0	4,541	45	$244,360	1,362	68	$146,616	0	0	$0	5,903	114	$390,976
	Mali	0	0	$0	236,056	2,361	$11,749,758	8,960	448	$891,947	1,792	448	$445,974	246,807	3,257	$13,087,679
	Mauritania	0	0	$0	64,857	649	$3,994,550	40,055	2,003	$4,934,000	39	10	$11,984	104,951	2,661	$8,940,534
	Niger	283,095	849	$12,229,944	3,009	30	$361,109	0	0	$0	0	0	$0	286,104	879	$12,591,053
5	Cabo Verde	0	0	$0	0	0	$0	183	9	$17,900	0	0	$0	183	9	$17,900
	Total	**302,610**	**908**	**$13,159,381**	**804,792**	**8,048**	**$49,482,097**	**160,642**	**8,032**	**$17,593,689**	**18,317**	**4,579**	**$4,662,319**	**1,286,360**	**21,567**	**$84,897,487**

Source: African Solar Designs analysis

As presented in **Figure 43** and **Table 19**, by 2030, Mali will represent the largest household cash market in the region (USD 13 million), followed by Niger (USD 12.5 million), Guinea (USD 10.7 million), Burkina Faso (USD 10.4 million) and Ghana (USD 9 million).

The following observations and conclusions can be made based on this analysis:

- In the extremely low income off-grid environment, many consumers will not be able to afford even the smallest systems. As can be seen, the absolute poverty of rural areas means that a large number of the lowest two quintiles by income cannot afford any system.
- 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 majority of the population, especially in lower income countries.
- The model does not adequately address the highest quintile and actual sales in the market. Note that the analysis does not predict purchases of Tier 5 equipment and it does not reflect what is happening at the extreme high end of the market.
- There is reason to be optimistic about solar product market growth. Uptake of cash purchases of electric lamps, mobile phones and other consumer goods signify changes in consumer expenditures – especially among the rural population – that are not captured in income figures and economic analysis. A significant portion of Tier 1 customers may be likely to move to Tier 1.5. There are also indications that purchasers of generator sets will begin to move to Tier 3 solar systems as consumer awareness and willingness to pay change.

6.3.2.2 Regional Household Financed Market for OGS Systems

- **Financial Model**

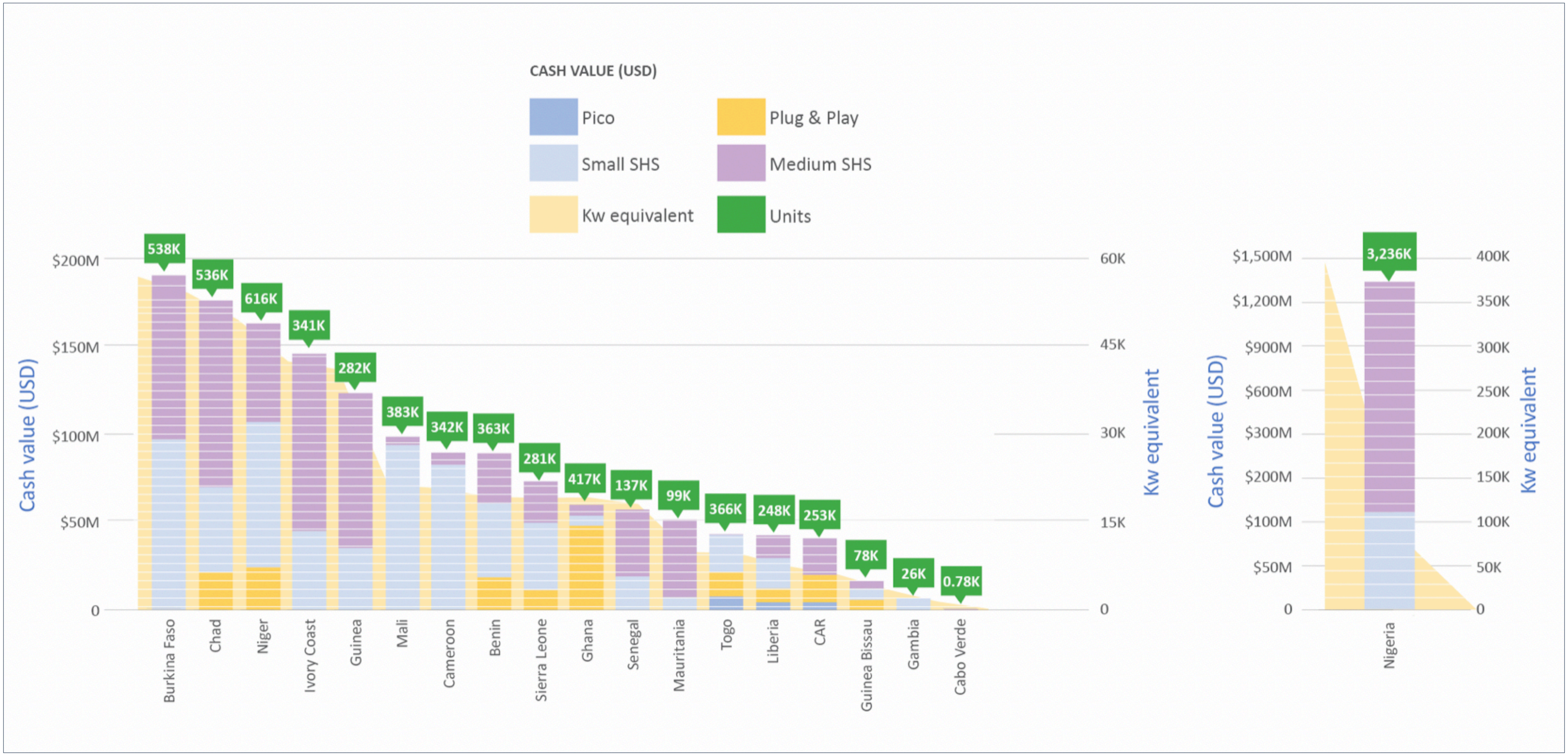
In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with interest rates specific to each country and a 24-month term. Following the PAYG model,[202] the financial model assumes that the households would be willing to save for three months of their current energy expenditure to cover a small 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 over-estimates the potential market for credit as banks, microfinance institutions 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 region, it is difficult to estimate more realistic figures. Nevertheless, this model does give a clear indication that longer loan tenors, combined with a low upfront payment would result in significant market transformation.

The analysis estimates the total regional off-grid solar financed market potential for the household sector to be USD 2.8 billion in 2018 – more than triple the estimated cash market value in that year – decreasing to USD 1.7 billion and USD 523 million in 2023 and 2030, respectively. **Figures 44-46** and corresponding **Tables 20-22** present the estimated regional off-grid solar financed market potential in 2018, 2023 and 2030, respectively. Innovative financing models (i.e. PAYG, lease-to-own, energy-as-a-service) would need to be widely deployed for this market potential to be realized, recognizing that challenges exist in many of the ROGEP countries surrounding the availability of consumer financing. These estimates follow the same least-cost electrification and GIS analysis described above and presented in **Section 3.2.4** (see **Annex 1** and **Annex 2** for more details).

202 For the purpose of this analysis, the pay-as-you-go (PAYG) model is defined as any OGS system sales that are financed over time. Financing could come directly from the system supplier or from a financial service provider such as a commercial bank or MFI, or through some combination/partnership between the two.

Figure 44: Estimated Regional OGS Financed Market Potential for Household Sector, 2018



Source: African Solar Designs analysis

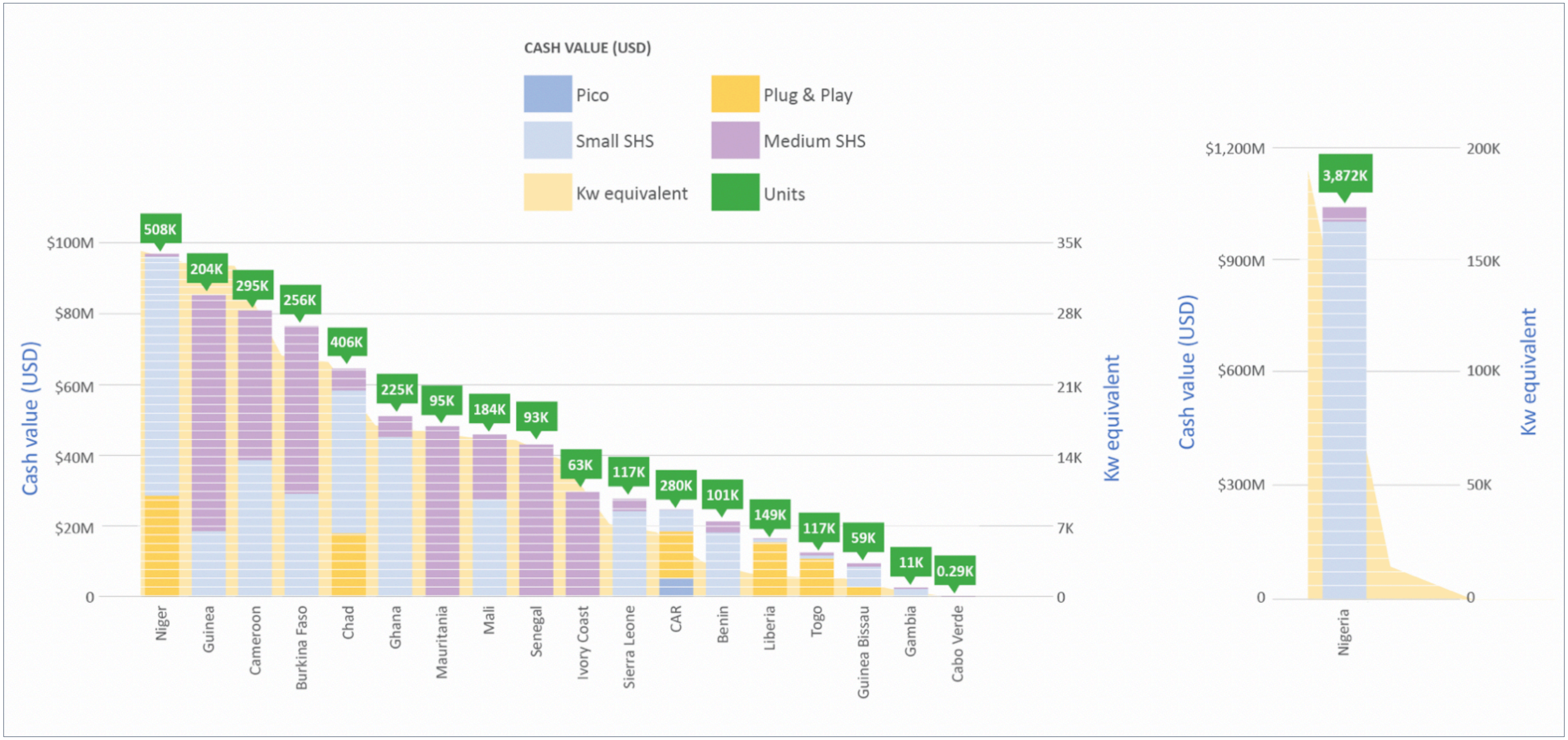
Table 20: Estimated Regional OGS Financed Market Potential for Household Sector, 2018

2018 Potential Financed Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
1	Cameroon	0	0	$0	0	0	$0	331,201	16,560	$82,800,329	11,102	2,775	$6,938,575	342,303	19,335	$89,738,905
	Ghana	0	0	$0	384,448	3,844	$48,056,048	23,067	1,153	$5,766,726	9,886	2,471	$6,178,635	417,401	7,469	$60,001,409
	Ivory Coast	0	0	$0	0	0	$0	179,961	8,998	$44,990,278	161,965	40,491	$101,228,125	341,926	49,489	$146,218,403
	Nigeria	0	0	$0	0	0	$0	1,659,881	82,994	$414,970,241	1,576,887	394,222	$985,554,323	3,236,768	477,216	$1,400,524,564
	Senegal	0	0	$0	0	0	$0	76,388	3,819	$19,097,069	61,111	15,278	$38,194,137	137,499	19,097	$57,291,206
2	Benin	0	0	$0	149,009	1,490	$18,626,153	168,976	8,449	$42,244,116	45,597	11,399	$28,498,015	363,583	21,338	$89,368,284
	Burkina Faso	0	0	$0	0	0	$0	389,255	19,463	$97,313,814	149,506	37,377	$93,441,465	538,762	56,839	$190,755,279
	Guinea	0	0	$0	0	0	$0	141,302	7,065	$35,325,489	141,302	35,325	$88,313,722	282,604	42,391	$123,639,211
	Sierra Leone	0	0	$0	89,967	900	$11,245,851	153,843	7,692	$38,460,811	37,786	9,447	$23,616,288	281,596	18,038	$73,322,950
	Togo	169,515	509	$7,628,179	111,880	1,119	$13,984,995	84,758	4,238	$21,189,386	678	170	$423,788	366,831	6,035	$43,226,347
3	CAR	95,083	285	$4,278,747	124,876	1,249	$15,609,503	0	0	$0	33,469	8,367	$20,918,318	253,429	9,901	$40,806,568
	Gambia	0	0	$0	0	0	$0	26,334	1,317	$6,583,488	307	77	$192,125	26,641	1,394	$6,775,613
	Guinea Bissau	0	0	$0	45,958	460	$5,744,701	25,506	1,275	$6,376,618	6,894	1,723	$4,308,525	78,358	3,458	$16,429,844
	Liberia	94,638	284	$4,258,715	63,092	631	$7,886,510	70,032	3,502	$17,508,052	20,820	5,205	$13,012,742	248,583	9,622	$42,666,019
4	Chad	0	0	$0	171,264	1,713	$21,408,037	194,214	9,711	$48,553,429	170,579	42,645	$106,612,026	536,057	54,068	$176,573,492
	Mali	0	0	$0	0	0	$0	376,044	18,802	$94,011,092	7,807	1,952	$4,879,468	383,852	20,754	$98,890,560
	Mauritania	0	0	$0	0	0	$0	28,985	1,449	$7,246,203	71,013	17,753	$44,382,995	99,998	19,202	$51,629,198
	Niger	0	0	$0	194,113	1,941	$24,264,069	331,932	16,597	$82,983,117	90,046	22,512	$56,278,881	616,091	41,049	$163,526,067
5	Cabo Verde	0	0	$0	0	0	$0	0	0	$0	781	195	$487,846	781	195	$487,846
	Total	**359,236**	**1,078**	**$16,165,641**	**1,334,607**	**13,346**	**$166,825,867**	**4,261,681**	**213,084**	**$1,065,420,256**	**2,597,536**	**649,384**	**$1,623,459,999**	**8,553,060**	**876,892**	**$2,871,871,764**

Source: African Solar Designs analysis

As presented in **Figure 44** and **Table 20**, according to the household market assessment, in 2018, Nigeria represents the largest financed market in the region (USD 1.4 billion) – accounting for half of the region's total demand – followed by Burkina Faso (USD 190 million), Chad (USD 176 million), Niger (USD 163 million) and Côte d'Ivoire (USD 146 million).

Figure 45: Estimated Regional OGS Financed Market Potential for Household Sector, 2023



Source: African Solar Designs analysis

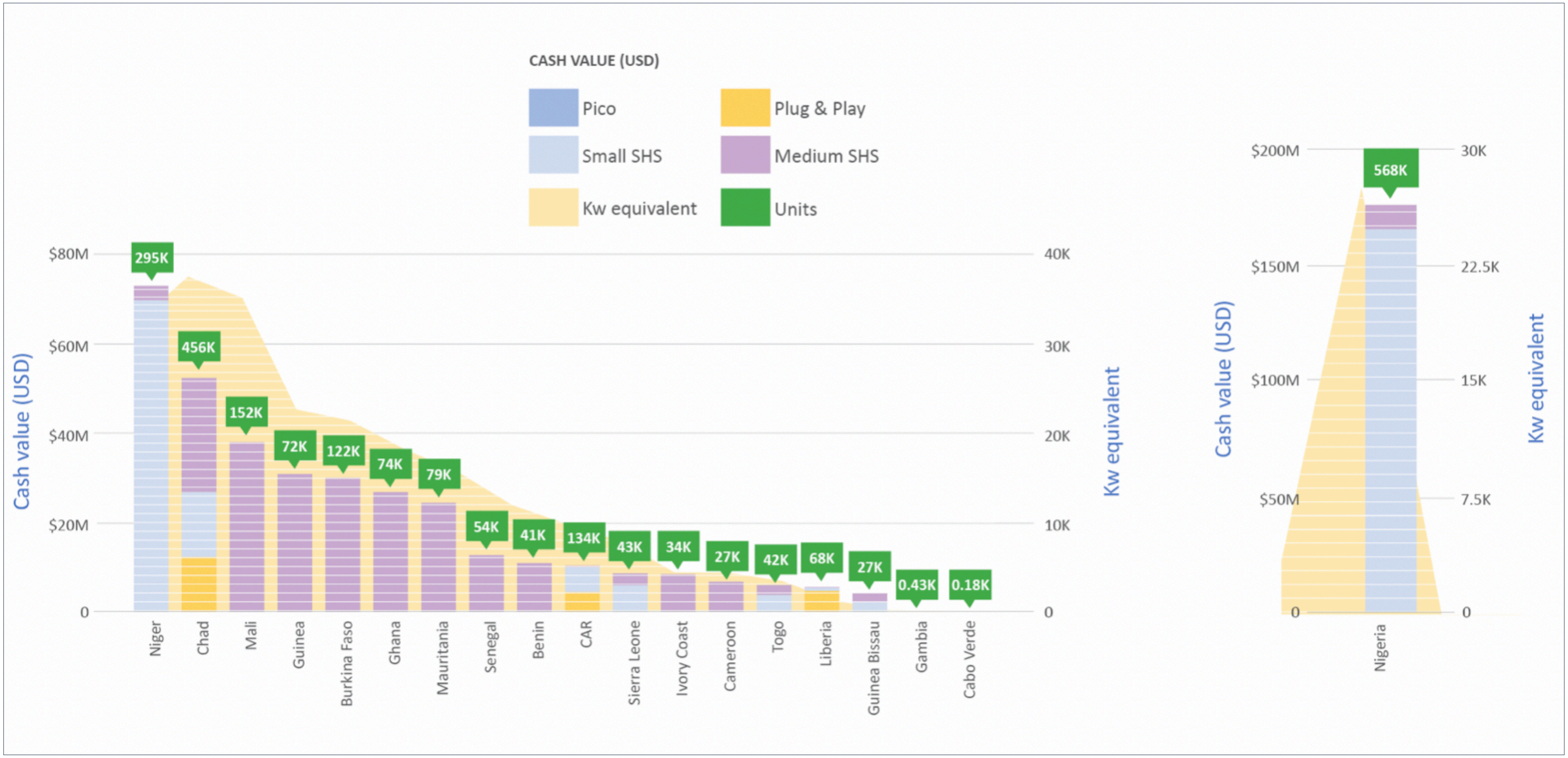
Table 21: Estimated Regional OGS Financed Market Potential for Household Sector, 2023

2023 Potential Financed Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
1	Cameroon	0	0	$0	0	0	$0	205,276	10,264	$38,704,145	90,351	22,588	$42,588,542	295,627	32,852	$81,292,687
	Ghana	0	0	$0	0	0	$0	214,233	10,712	$45,333,900	11,227	2,807	$5,939,629	225,461	13,519	$51,273,529
	Ivory Coast	0	0	$0	0	0	$0	0	0	$0	63,203	15,801	$29,791,923	63,203	15,801	$29,791,923
	Nigeria	0	0	$0	0	0	$0	3,814,320	190,716	$1,004,038,572	58,303	14,576	$38,367,294	3,872,623	205,292	$1,042,405,867
	Senegal	0	0	$0	0	0	$0	0	0	$0	93,132	23,283	$43,256,916	93,132	23,283	$43,256,916
2	Benin	0	0	$0	0	0	$0	94,614	4,731	$18,208,941	6,487	1,622	$3,121,354	101,101	6,353	$21,330,295
	Burkina Faso	0	0	$0	0	0	$0	154,884	7,744	$29,202,858	101,337	25,334	$47,766,859	256,221	33,078	$76,969,718
	Guinea	0	0	$0	0	0	$0	83,389	4,169	$18,560,177	120,687	30,172	$67,154,385	204,075	34,341	$85,714,562
	Sierra Leone	0	0	$0	0	0	$0	110,720	5,536	$24,234,120	6,462	1,616	$3,535,989	117,182	7,151	$27,770,109
	Togo	0	0	$0	110,379	1,104	$10,714,853	4,930	247	$957,227	2,113	528	$1,025,600	117,422	1,879	$12,697,680
3	CAR	110,067	330	$5,038,070	138,684	1,387	$13,462,560	31,372	1,569	$6,090,765	440	110	$213,691	280,563	3,396	$24,805,086
	Gambia	0	0	$0	0	0	$0	10,637	532	$2,175,256	734	183	$375,012	11,370	715	$2,550,268
	Guinea Bissau	0	0	$0	26,775	268	$2,599,177	30,363	1,518	$5,894,934	1,880	470	$912,467	59,019	2,256	$9,406,579
	Liberia	0	0	$0	144,906	1,449	$15,418,717	3,981	199	$847,171	437	109	$232,443	149,324	1,757	$16,498,331
4	Chad	0	0	$0	184,613	1,846	$17,920,990	209,351	10,468	$40,644,806	12,824	3,206	$6,224,403	406,788	15,520	$64,790,198
	Mali	0	0	$0	0	0	$0	145,702	7,285	$27,633,469	38,803	9,701	$18,398,364	184,505	16,986	$46,031,833
	Mauritania	0	0	$0	0	0	$0	0	0	$0	95,758	23,940	$48,399,020	95,758	23,940	$48,399,020
	Niger	0	0	$0	231,776	2,318	$28,619,468	275,177	13,759	$67,957,157	1,391	348	$858,584	508,343	16,424	$97,435,209
5	Cabo Verde	0	0	$0	0	0	$0	0	0	$0	290	72	$136,657	290	72	$136,657
	Total	**110,067**	**330**	**$5,038,070**	**837,133**	**8,371**	**$88,735,765**	**5,388,947**	**269,447**	**$1,330,483,498**	**705,859**	**176,465**	**$358,299,133**	**7,042,006**	**454,614**	**$1,782,556,467**

Source: African Solar Designs analysis

As presented in **Figure 45** and **Table 21**, in 2023, Nigeria will represent the largest financed market in the region (USD 1 billion) – accounting for about 80% of the region's total demand – followed by Niger (USD 97 million) and Guinea (USD 85 million), Cameroon (USD 81 million) and Burkina Faso (USD 76 million).

Figure 46: Estimated Regional OGS Financed Market Potential for Household Sector, 2030



Source: African Solar Designs analysis

Table 22: Estimated Regional OGS Financed Market Potential for Household Sector, 2030

2030 Potential Financed Market by Country																
Category	Country	Pico			Plug & Play			Small SHS			Medium SHS					
		Units	kW	USD	Units	kW	USD	Units	kW	USD	Units	kW	USD	Total Units	Total kW	Total USD
	Cameroon	0	0	$0.00	0	0	$0	0	0	$0	27,371	6,843	$6,679,843	27,371	6,843	$6,679,843
	Ghana	0	0	$0.00	0	0	$0	0	0	$0	74,583	18,646	$26,740,660	74,583	18,646	$26,740,660
1	Ivory Coast	0	0	$0.00	0	0	$0	0	0	$0	34,176	8,544	$8,340,598	34,176	8,544	$8,340,598
	Nigeria	0	0	$0.00	0	0	$0	554,696	27,735	$164,679,367	13,956	3,489	$10,357,945	568,652	31,224	$175,037,312
	Senegal	0	0	$0.00	0	0	$0	0	0	$0	54,447	13,612	$12,650,612	54,447	13,612	$12,650,612
	Benin	0	0	$0.00	0	0	$0	0	0	$0	41,507	10,377	$10,846,787	41,507	10,377	$10,846,787
	Burkina Faso	0	0	$0.00	0	0	$0	0	0	$0	122,693	30,673	$29,943,229	122,693	30,673	$29,943,229
2	Guinea	0	0	$0.00	0	0	$0	0	0	$0	72,611	18,153	$30,808,054	72,611	18,153	$30,808,054
	Sierra Leone	0	0	$0.00	0	0	$0	36,657	1,833	$5,883,610	6,659	1,665	$2,671,937	43,316	3,498	$8,555,546
	Togo	0	0	$0.00	0	0	$0	34,245	1,712	$3,685,544	8,372	2,093	$2,252,690	42,617	3,805	$5,938,235
	CAR	0	0	$0.00	80,878	809	$4,352,202	51,689	2,584	$5,562,965	1,456	364	$391,698	134,023	3,757	$10,306,865
3	Gambia	0	0	$0.00	0	0	$0	0	0	$0	434	109	$138,926	434	109	$138,926
	Guinea Bissau	0	0	$0.00	0	0	$0	19,097	955	$2,055,236	7,981	1,995	$2,147,378	27,078	2,950	$4,202,614
	Liberia	0	0	$0.00	62,846	628	$4,592,277	4,674	234	$683,085	519	130	$189,746	68,039	992	$5,465,107
	Chad	0	0	$0.00	227,050	2,271	$12,217,999	134,868	6,743	$14,514,983	94,954	23,738	$25,548,136	456,872	32,752	$52,281,117
4	Mali	0	0	$0.00	0	0	$0	0	0	$0	152,385	38,096	$37,925,117	152,385	38,096	$37,925,117
	Mauritania	0	0	$0.00	0	0	$0	0	0	$0	79,008	19,752	$24,330,634	79,008	19,752	$24,330,634
	Niger	0	0	$0.00	0	0	$0	290,178	14,509	$69,644,102	5,417	1,354	$3,249,983	295,595	15,863	$72,894,085
5	Cabo Verde	0	0	$0.00	0	0	$0	0	0	$0	183	46	$44,750	183	46	$44,750
	Total	**0**	**0**	**$0.00**	**370,774**	**3,708**	**$21,162,477**	**1,126,104**	**56,305**	**$266,708,892**	**798,712**	**199,678**	**$235,258,722**	**2,295,590**	**259,691**	**$523,130,091**

Source: African Solar Designs analysis

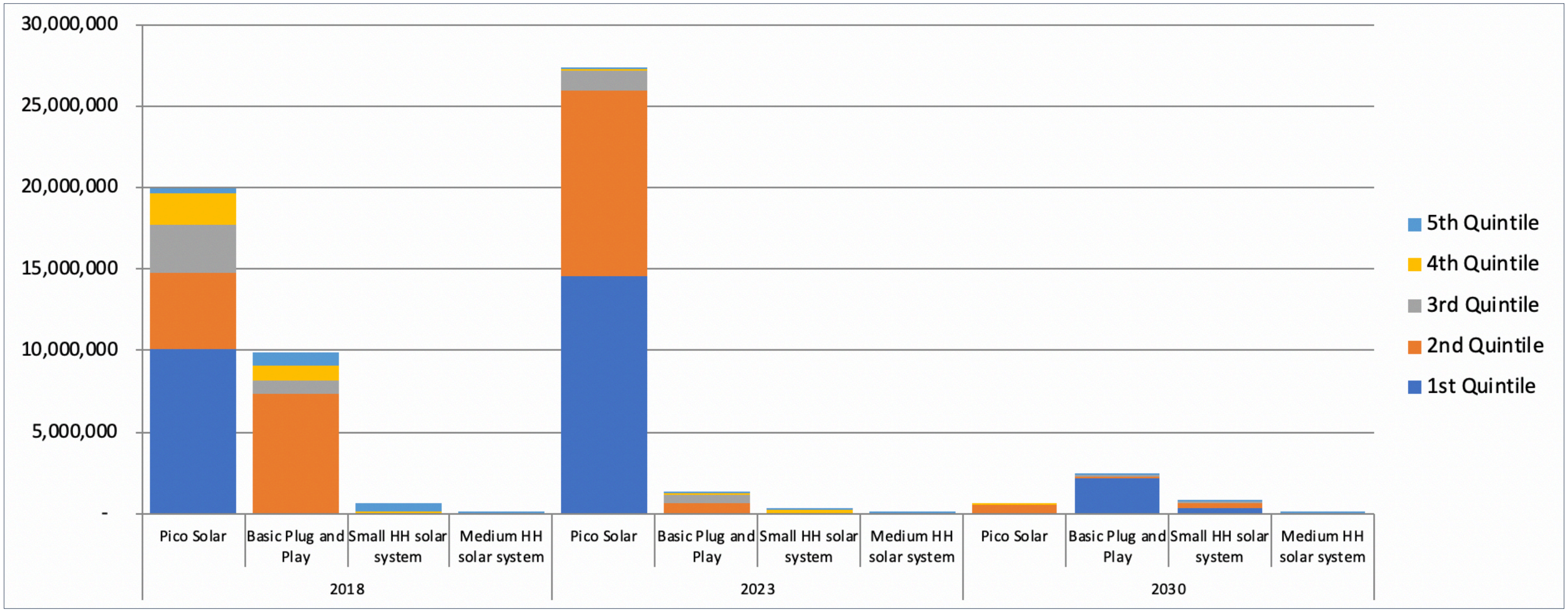
As presented in **Figure 46** and **Table 22**, in 2030, Nigeria will again represent the largest financed market in the region (USD 175 million) – accounting for one-third of total demand – followed by Niger (USD 72 million), Chad (USD 52 million), Mali (USD 37 million) and Guinea (USD 30 million).

6.3.2.3 Household Ability to Pay

This section assesses the total market by number of households able to afford different OGS system types. Comparative analysis is presented between what households can afford through cash purchase and what they could afford with a financing solution. The analysis is grouped according the country categories (Categories 1-5).

All Country Categories: The analysis shows that consumer financing allows a significant share of the region's lower income population to afford OGS products. Without financing, an estimated 30 million households across the region can afford an OGS system in 2018 (representing 78% of all households without electricity access). However, with the addition of financing, an estimated 39 million households across the region are able to purchase at least one OGS system (accounting for nearly 100% of all households without electricity access), as shown in **Figures 47-49**.

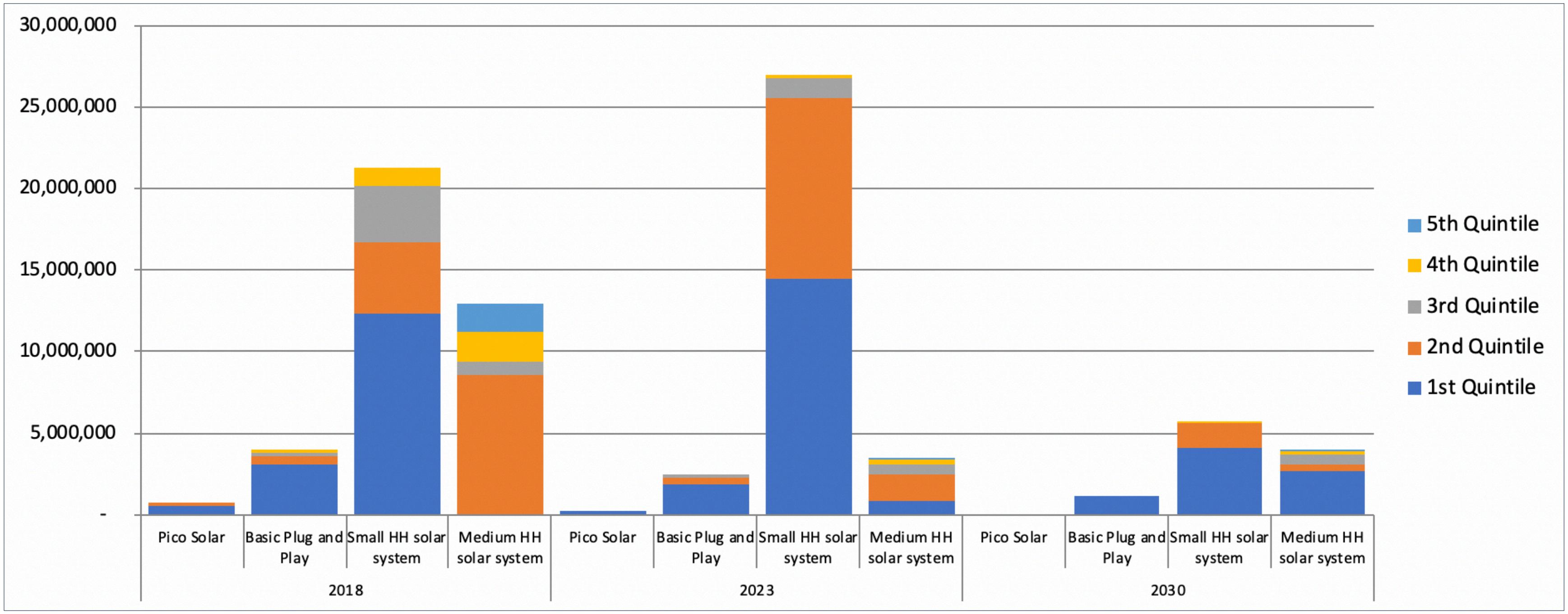
Figure 47: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – All Countries



Source: African Solar Designs analysis

As presented in **Figure 47**, pico solar and basic plug-and-play systems are the most common OGS solutions for the cash market across the region under all three scenarios (2018, 2023 and 2030).

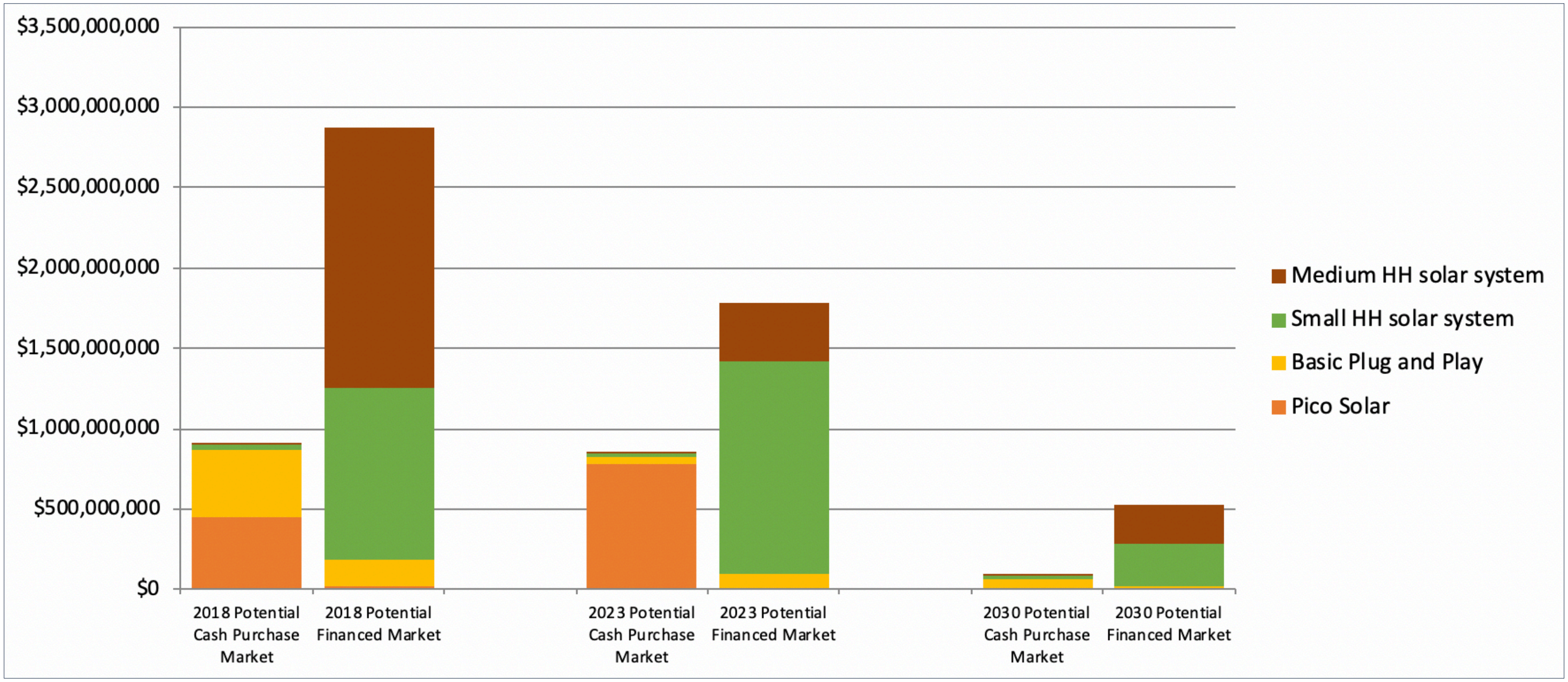
Figure 48: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – All Countries



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure 48**, with financing, small to medium solar home systems are the most common OGS solutions across the region under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

Figure 49: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – All Countries



Source: African Solar Designs analysis

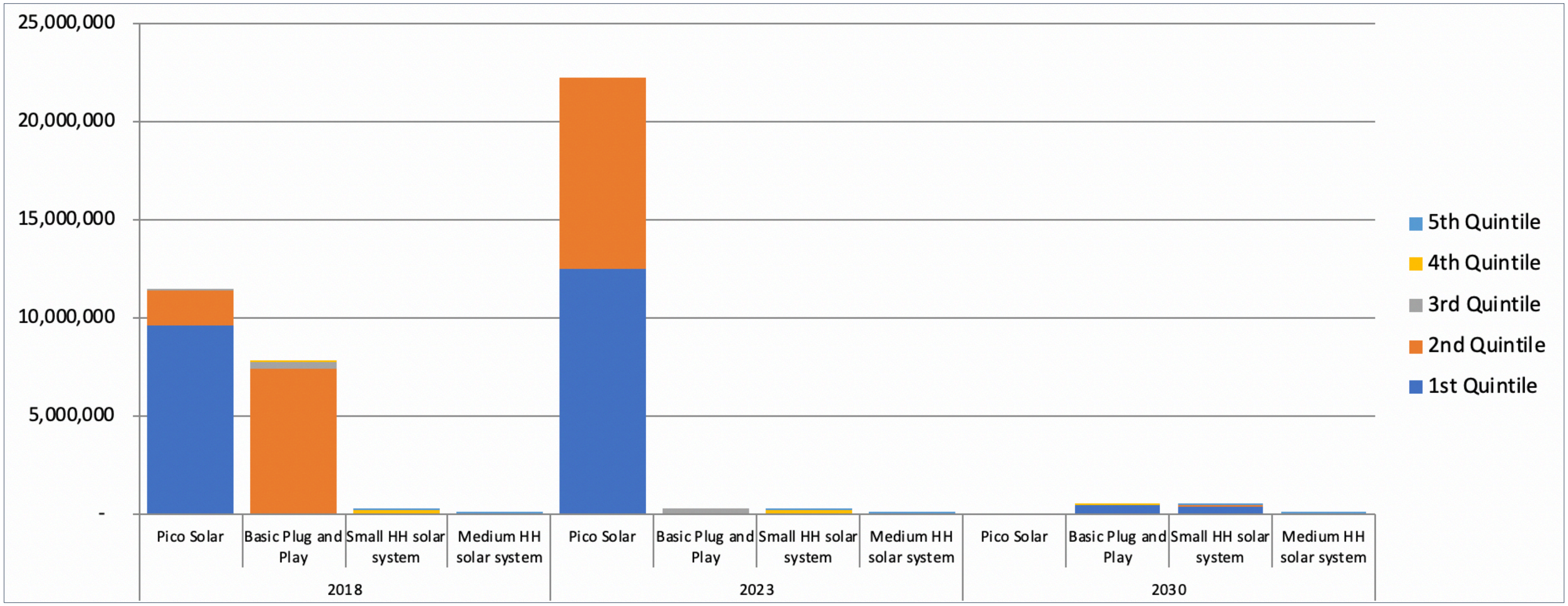
As presented in **Figure 49**, with the addition of consumer financing, the estimated regional OGS market in 2018 triples in size from USD 907.6 million to USD 2.8 billion, mainly due to the larger systems that households are able to purchase.

- **Category 1 – Larger Markets: Cameroon, Ghana, Côte d'Ivoire, Nigeria, Senegal**

In Category 1 countries, financing enables all off-grid households to acquire an OGS system. With financing, the number of households with the ability to acquire at least one OGS system in the 2018 scenario increases from 19.5 million (90% of all households without electricity access in category 1 countries) to 21.6 million (100% of all households without electricity access in category 1 countries) as shown in **Figures 50-52**.

With financing, the potential market size for Category 1 in the 2018 scenario increases from USD 602.8 million to USD 1.8 billion, mainly due to the ability of an additional 9 million more households to purchase the tier 3 system as shown in **Figure 52**, representing 41.7% of all households without electricity access in category 1 countries.

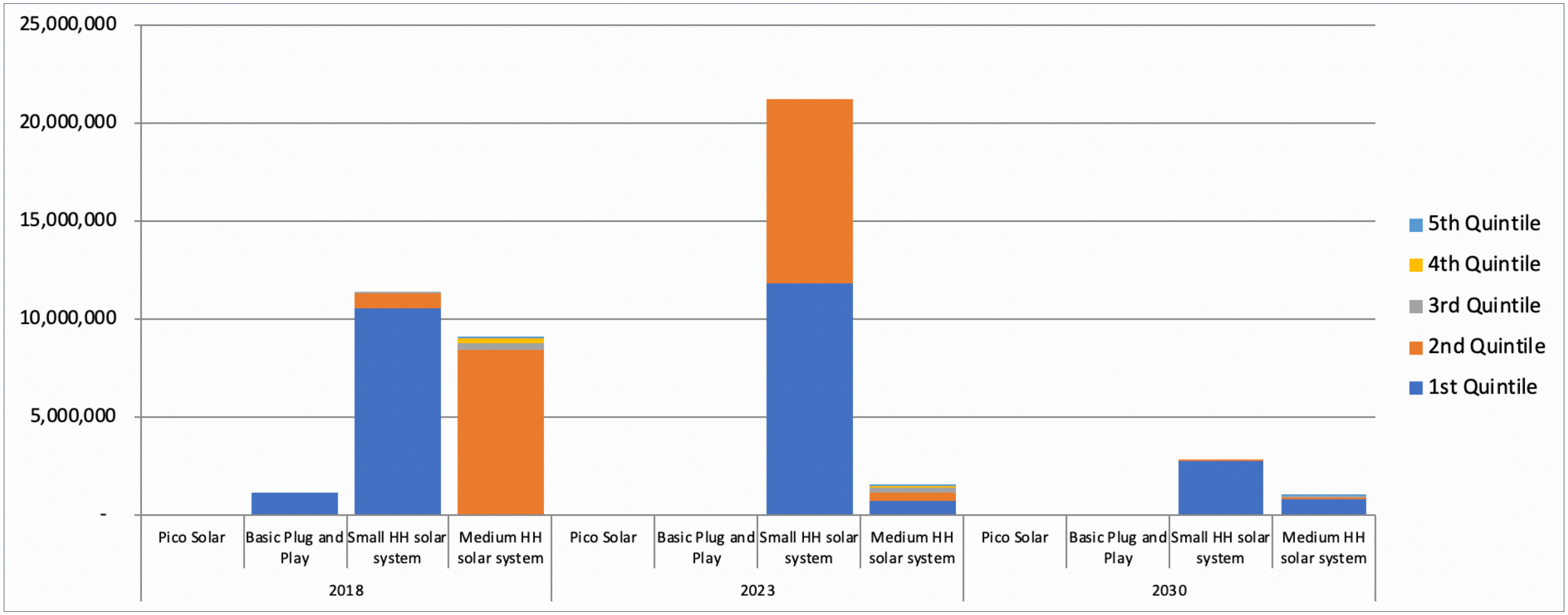
Figure 50: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – Category 1



Source: African Solar Designs analysis

As presented in **Figure 50**, pico solar and basic plug-and-play systems are the most common OGS solutions for the cash market in Category 1 Countries under all three scenarios (2018, 2023 and 2030).

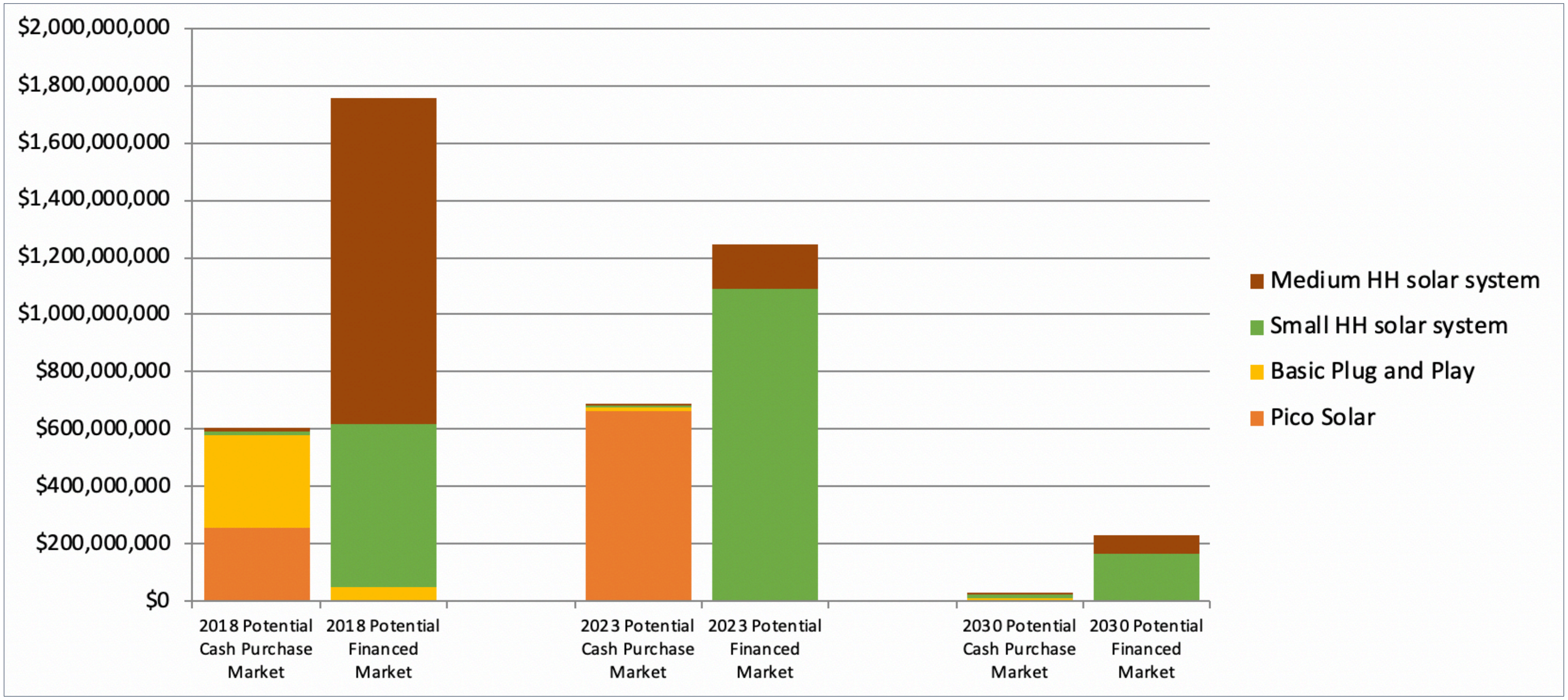
Figure 51: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – Category 1



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure 51**, with financing, small to medium solar home systems are the most common OGS solutions in Category 1 Countries under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

Figure 52: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – Category 1



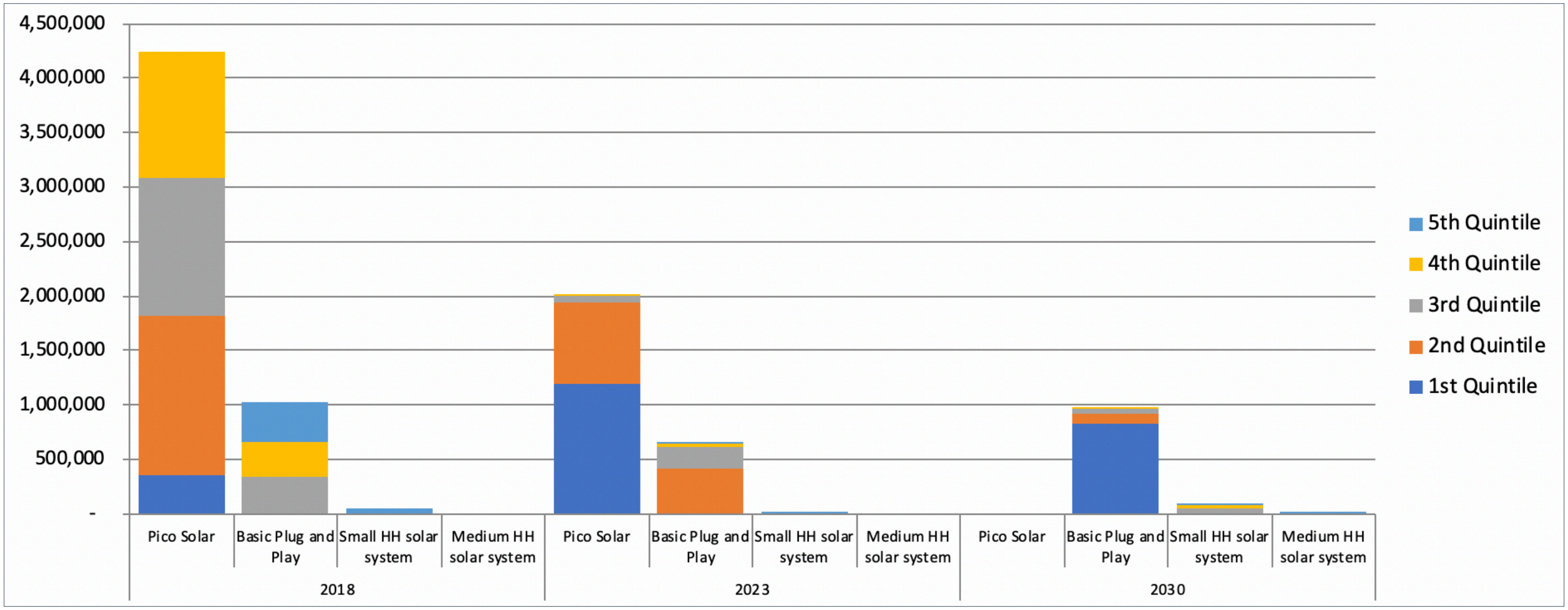
Source: African Solar Designs analysis

As presented in **Figure 52**, with the addition of consumer financing, the estimated OGS market for Category 1 Countries in 2018 nearly triples in size from USD 600 million to USD 1.7 billion, mainly due to the larger systems that households are able to purchase. Similar trends can be observed in 2023 and 2030.

- **Category 2 – Nascent Markets: Benin, Burkina Faso, Guinea, Sierra Leone, Togo**

In Category 2 countries, with financing, the number of households with the ability to acquire an OGS system in the 2018 scenario increases from 5.3 million (67% of all households without electricity access in category 2 countries) to 7.96 million (100% of all households without electricity access in category 2 countries), as 2.7 million households in the three lowest income quintiles are enabled to acquire at least one system as shown in **Figures 53-55**.

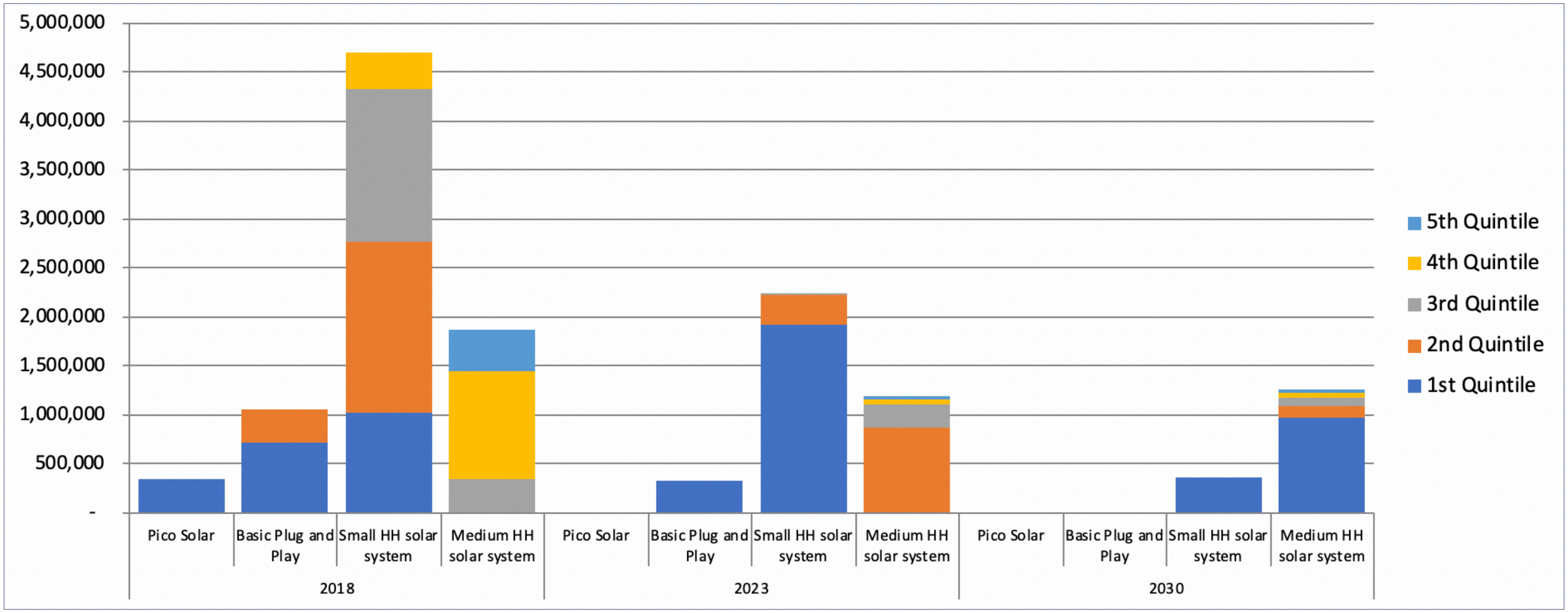
Figure 53: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – Category 2



Source: African Solar Designs analysis

As presented in **Figure 53**, pico solar and basic plug-and-play systems are the most common OGS solutions for the cash market in Category 2 Countries under all three scenarios (2018, 2023 and 2030).

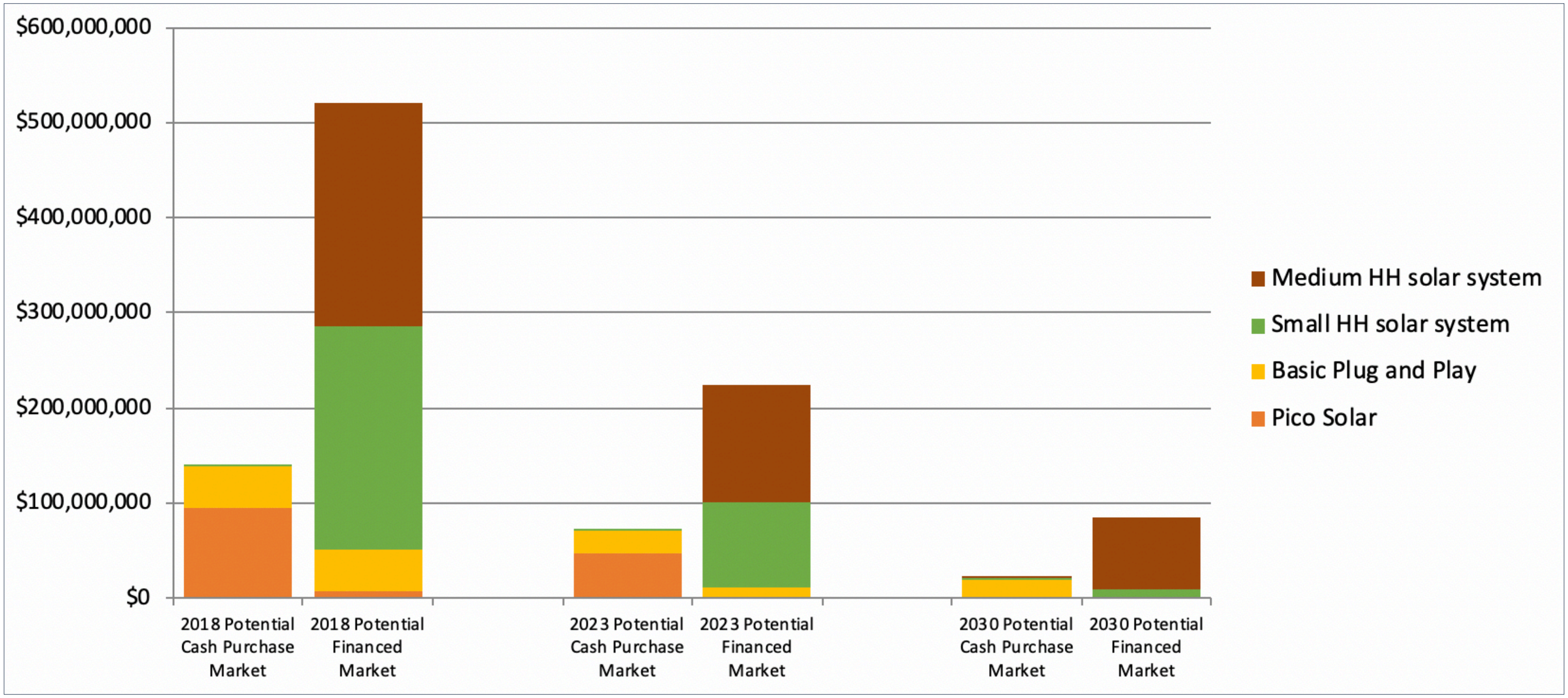
Figure 54: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – Category 2



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure 54**, with financing, small to medium solar home systems are the most common OGS solutions in Category 2 Countries under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

Figure 55: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – Category 2



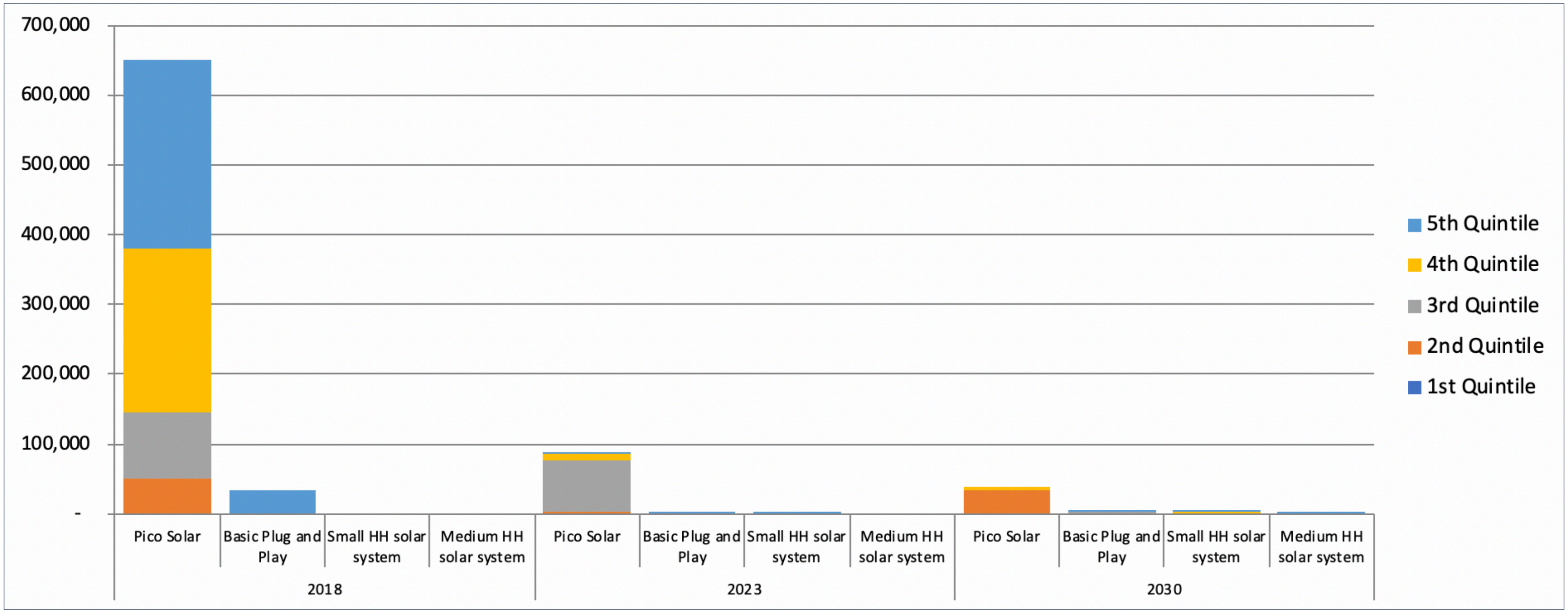
Source: African Solar Designs analysis

As presented in **Figure 55**, with the addition of consumer financing, the estimated OGS market for Category 2 Countries in 2018 more than triples in size from USD 140 million to USD 520 million, mainly due to the larger systems that households are able to purchase.

- **Category 3 – Smaller Markets: Central African Republic, The Gambia, Guinea-Bissau, Liberia**

In Category 3 countries, with financing, the number of households with the ability to acquire an OGS system in the 2018 scenario increases significantly from 685,771 (31% of all households without electricity access in category 3 countries) to 2 million (91.3% of all households without electricity access in category 3 countries) as shown in **Figures 56-58**.

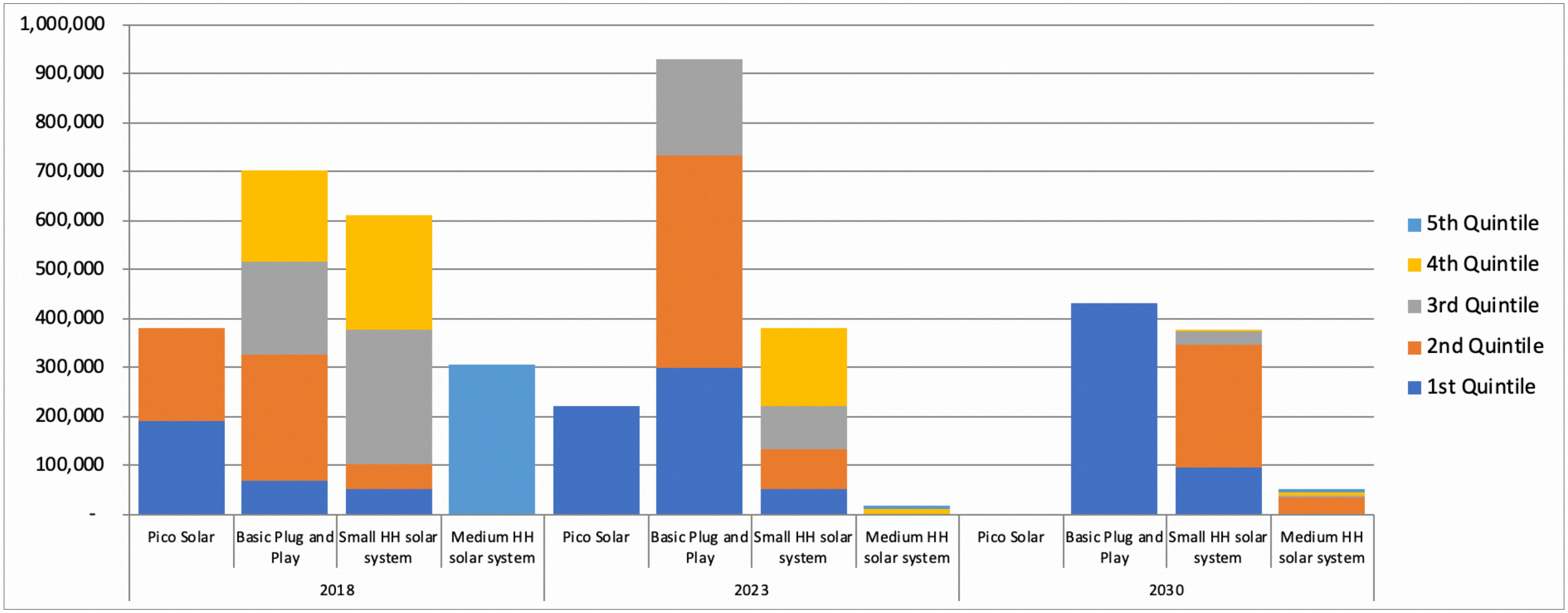
Figure 56: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – Category 3



Source: African Solar Designs analysis

As presented in **Figure 56**, pico solar systems are the most common OGS solutions for the cash market in Category 3 Countries under all three scenarios (2018, 2023 and 2030).

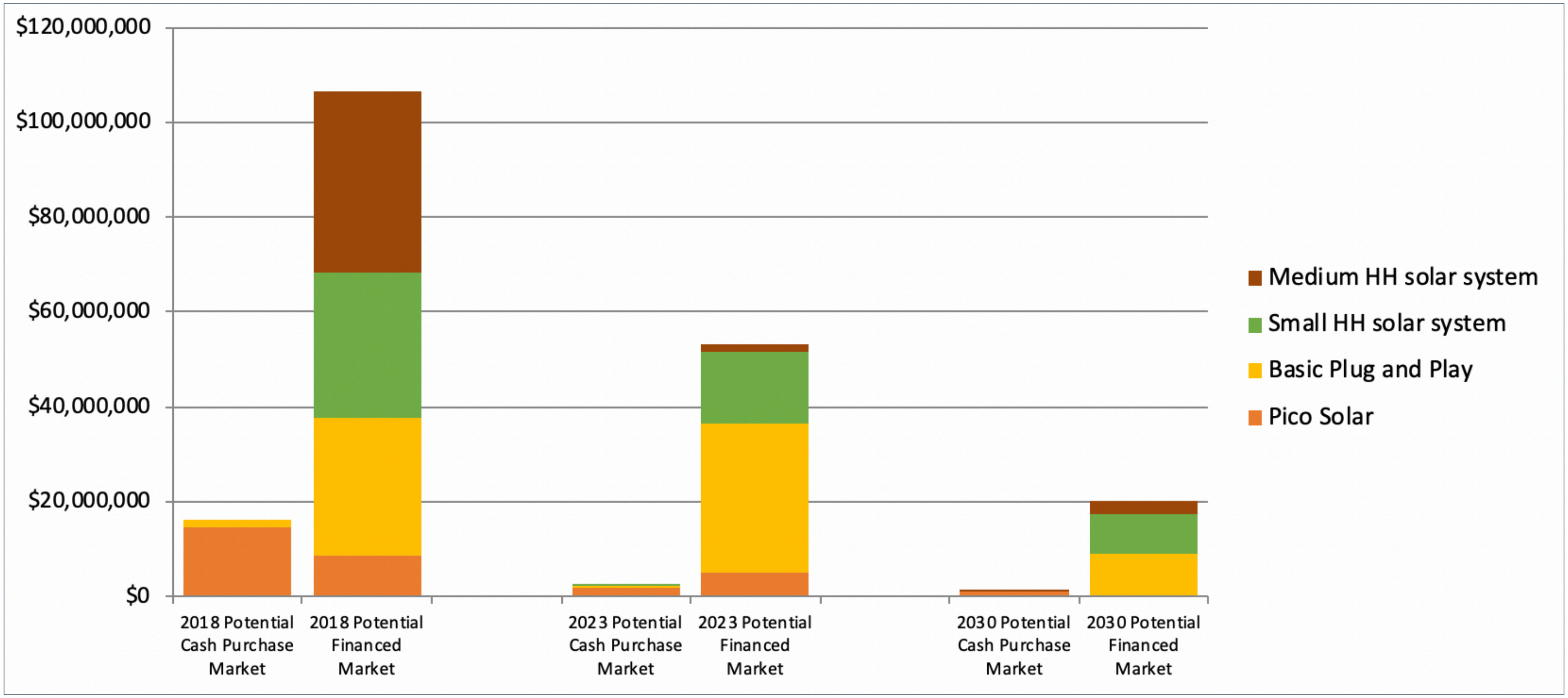
Figure 57: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – Category 3



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure 57**, with financing, basic plug-and-play and small solar home systems are the most common OGS solutions in Category 3 Countries under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

Figure 58: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – Category 3



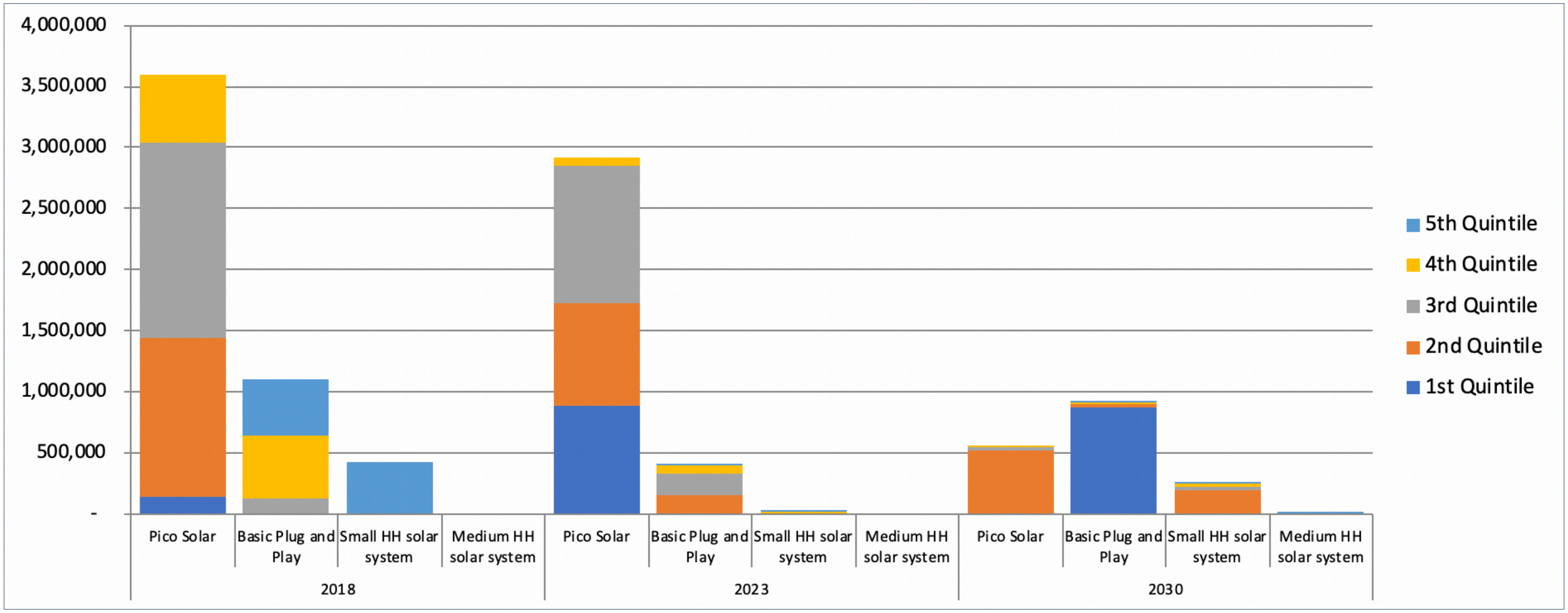
Source: African Solar Designs analysis

As presented in **Figure 58**, with the addition of consumer financing, the estimated OGS market for Category 3 Countries in 2018 increases more than *sixfold* in size from USD 16 million to USD 106 million, mainly due to the larger systems that households are able to purchase.

- **Category 4 – Sahel Markets: Chad, Mali, Mauritania, Niger**

In Category 4 countries, with financing, the number of households with the ability to acquire an OGS system in the 2018 scenario increases significantly from 5.1 million (69% of all households without electricity access in category 4 countries) to 7.4 million (100% of all households without electricity access in category 4 countries), as 2.3 million households in the two lowest income quintiles are enabled to acquire an OGS system as shown in **Figures 59-61**.

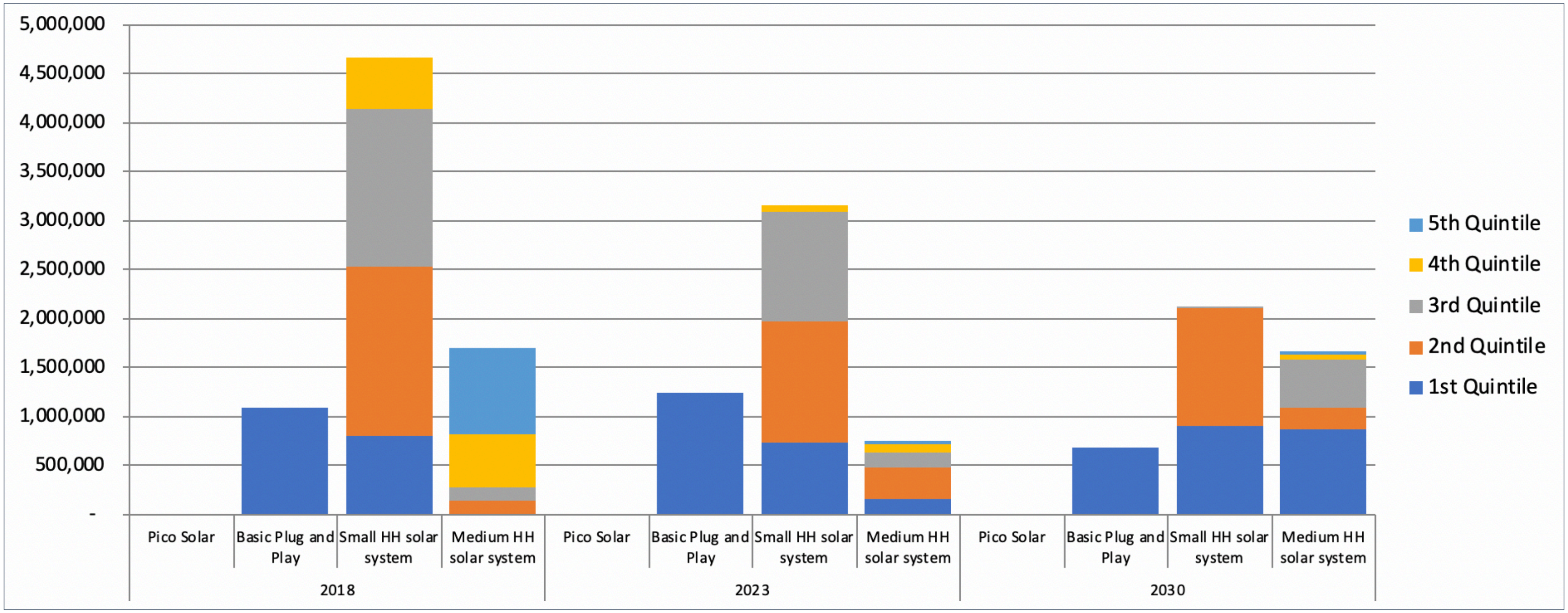
Figure 59: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – Category 4



Source: African Solar Designs analysis

As presented in **Figure 59**, pico solar and basic plug-and-play systems are the most common OGS solutions for the cash market in Category 4 Countries under all three scenarios (2018, 2023 and 2030).

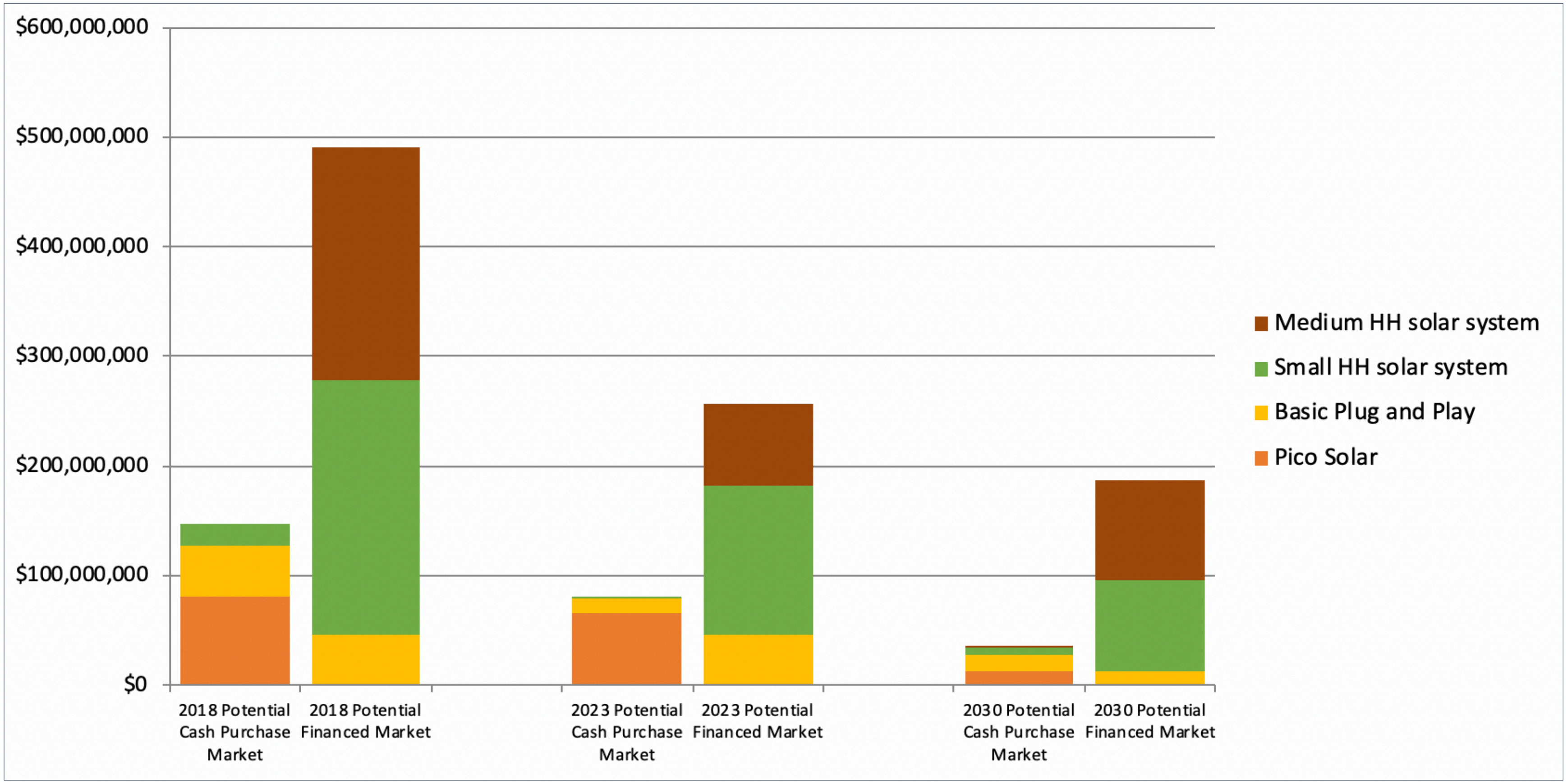
Figure 60: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – Category 4



Source: African Solar Designs analysis

Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems. As presented in **Figure 60**, with financing, small and medium solar home systems are the most common OGS solutions in Category 4 Countries under all three scenarios (2018, 2023 and 2030), even for the lowest (first and second) income quintiles.

Figure 61: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – Category 4



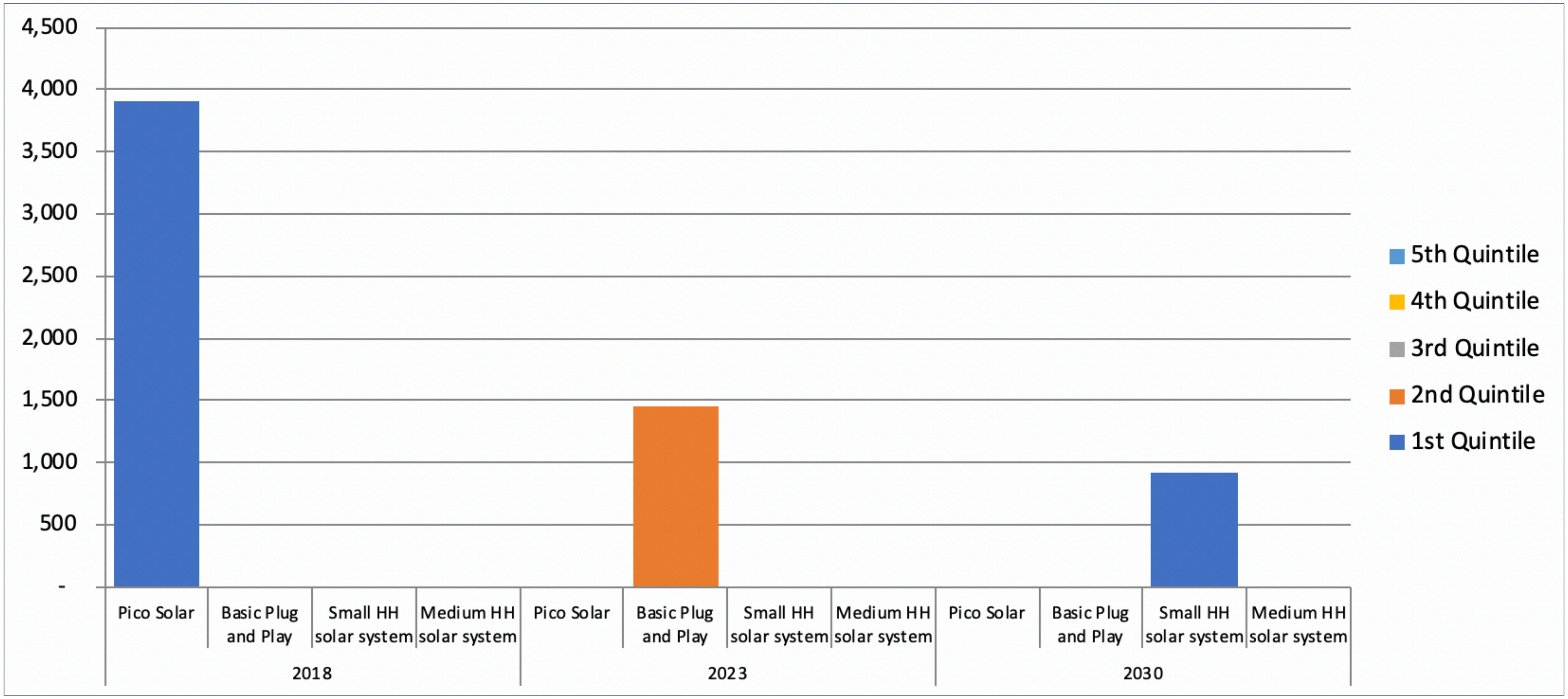
Source: African Solar Designs analysis

As presented in **Figure 61**, with the addition of consumer financing, the estimated OGS market for Category 4 Countries in 2018 more than triples in size from USD 147 million to USD 490 million, mainly due to the larger systems that households are able to purchase.

- **Category 5 – Outlier: Cabo Verde**

In Cabo Verde, the only Category 5 country, all the off-grid households are able to acquire an OGS system regardless of the availability of financing as shown in **Figures 62-64**. However, financing enables households to purchase the larger systems, with the potential market size for Category 5 in the 2018 scenario increasing from USD 87,812 to USD 487,846 as shown in **Figure 64**.

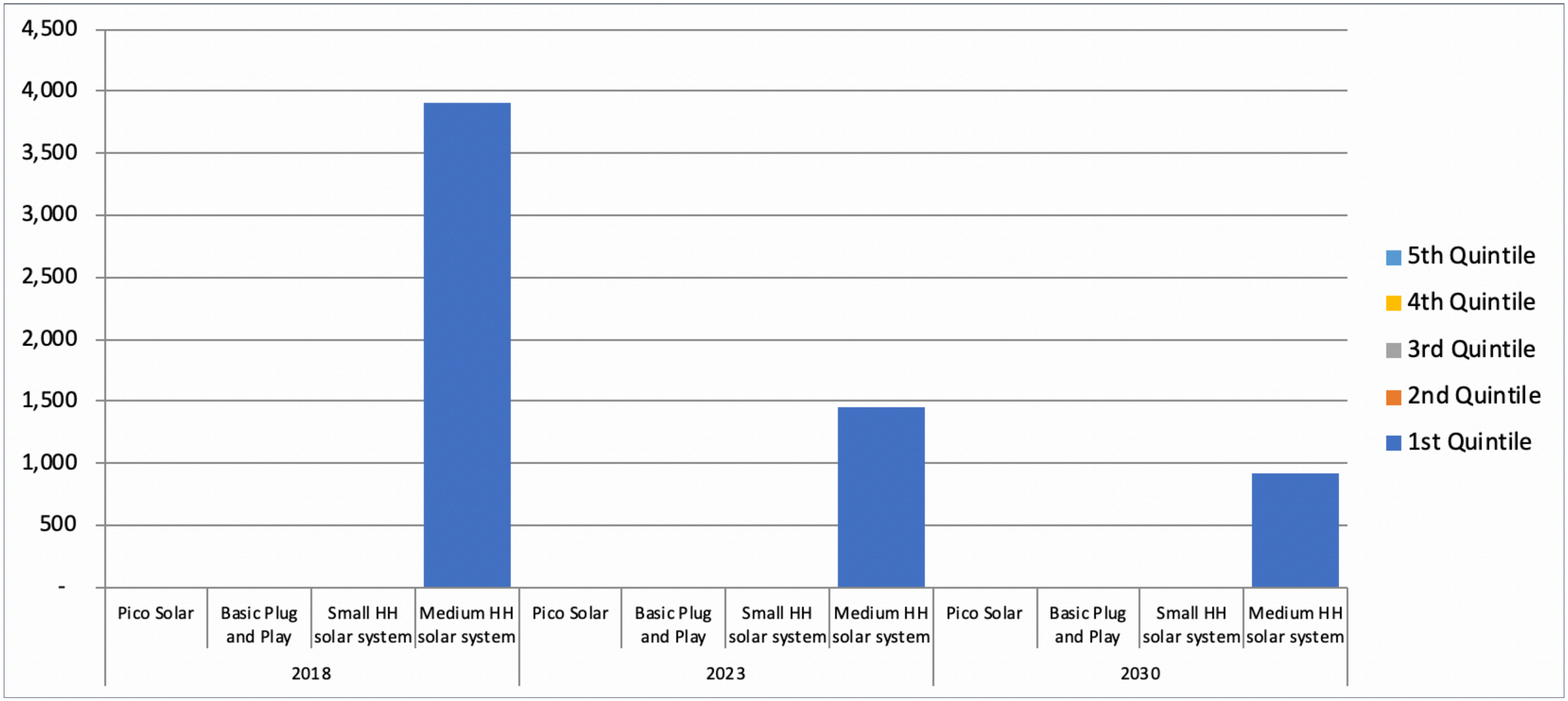
Figure 62: Estimated Number of Households with Ability to Pay for Cash Purchase of OGS Systems – Category 5



Source: African Solar Designs analysis

As presented in **Figure 62**, pico solar systems are the only OGS solution adopted by the cash market in Cabo Verde in 2018. In 2023, basic plug-and-play solar home systems are adopted by the lowest (first and second) income quintiles. By 2030, the first income quintile will shift to a larger system size (small solar home system).

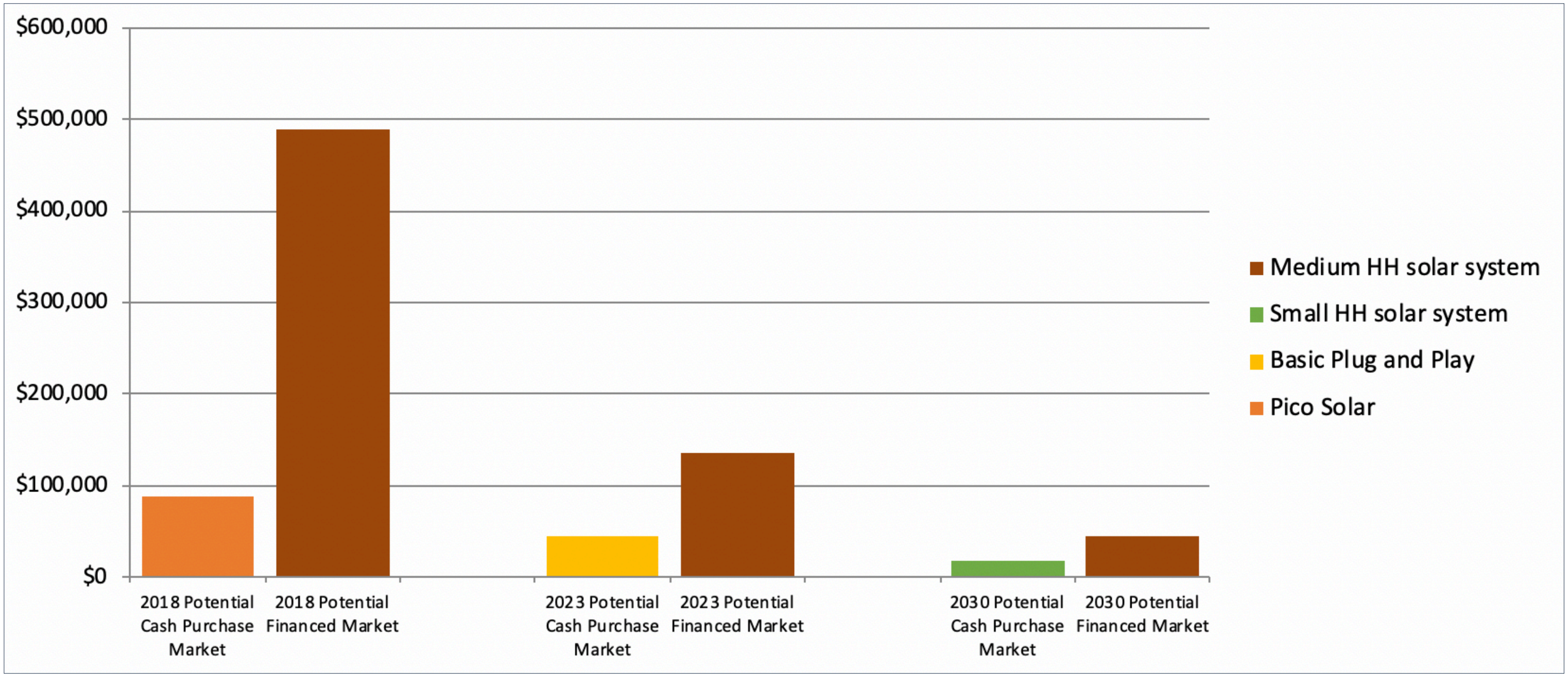
Figure 63: Estimated Number of Households with Ability to Pay for Financed Purchase of OGS Systems – Category 5



Source: African Solar Designs analysis

Consumer financing allows households already in the market to afford larger systems. As presented in **Figure 63**, with financing, medium solar home systems are the most common OGS solution for the first income quintile of households in Cabo Verde under all three scenarios (2018, 2023 and 2030).

Figure 64: Estimated OGS Cash and Financed Market Potential for Household Sector by System Type – Category 5



Source: African Solar Designs analysis

As presented in **Figure 64**, with the addition of consumer financing, the estimated OGS market in Cabo Verde in 2018 increases *fivefold* from USD 87,812 to USD 487,846, as financing allows households to purchase larger systems.

6.3.3 Consumer Perceptions, Interest and Awareness

This section is a summary of the perceptions, level of interest and awareness of off-grid solar consumers in West Africa and the Sahel, based on feedback from focus group discussion participants as well as insights from stakeholder interviews.

- **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: 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, with no warranty or fault management system
  - 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 understanding the difference between the products. Since most of the retail battery-powered lighting products are extremely low cost, 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. Consumer awareness campaigns can grow the demand for quality products.

6.4 Regional Institutional Sector Demand

6.4.1 Overview of Institutional Market Segment

This section estimates the demand and market potential for off-grid solar products for public/institutional users in the region. The analysis combined 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 countries in the same category (**Figure 35**) to estimate off-grid solar demand accordingly. See **Annex 2** for details on the methodology used to asses each market segment.

6.4.2 Analysis of Regional Institutional Market Demand

According to the analysis, the annualized regional off-grid solar cash market potential for the institutional sector is USD 212.9 million. The market segment with the largest potential is village water supply (USD 178.4 million), followed by education (USD 17.6 million), healthcare (USD 11.6 million) and public lighting (USD 5.1 million). With an estimated market potential of USD 83.5 million, Nigeria's institutional sector accounts for more than one-third of the region's total demand (**Table 23** and **Figure 65**).

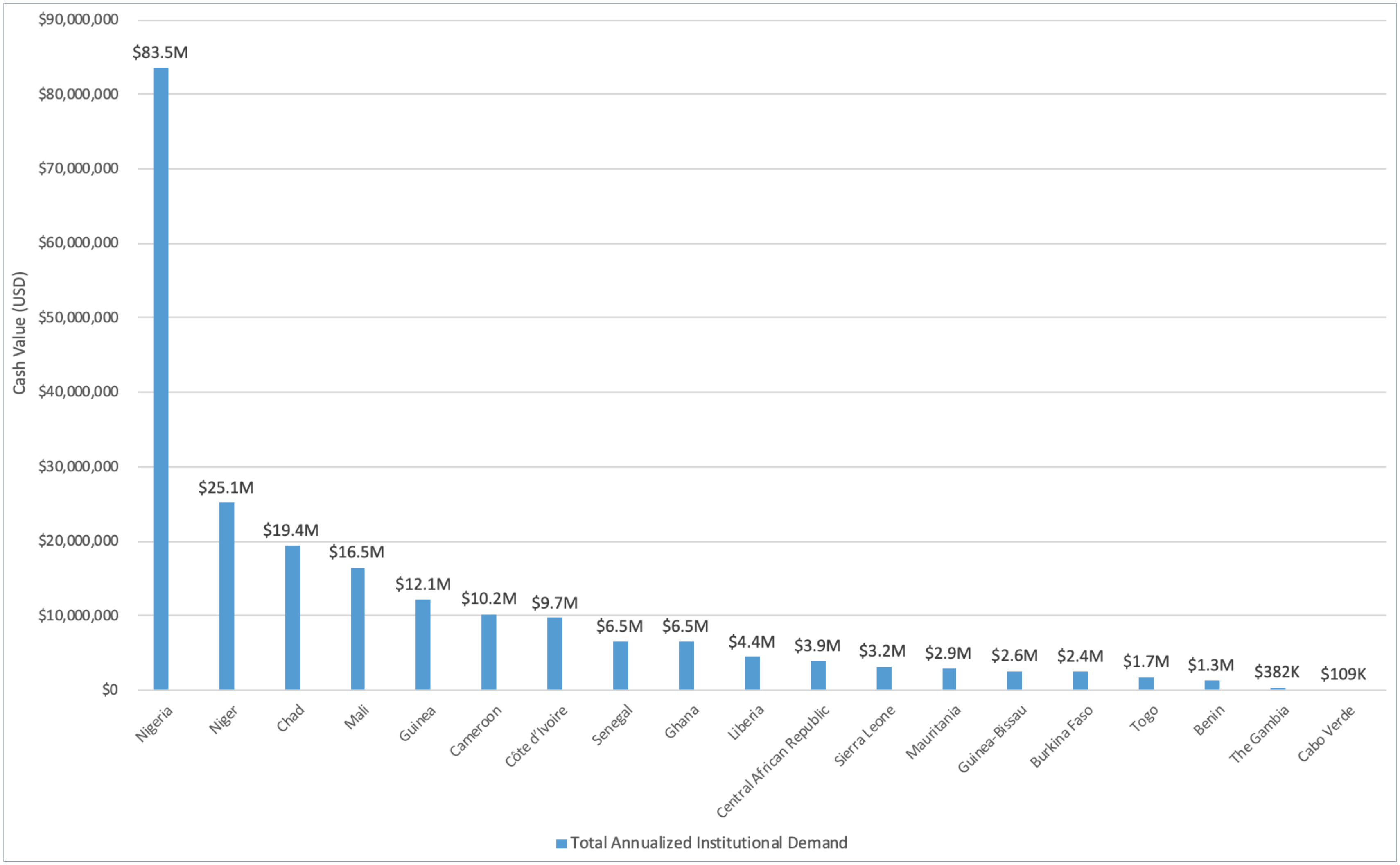
Table 23: Estimated Regional OGS Cash Market Potential for Institutional Sector[203]

Market Segment	Units	kW Equivalent	Cash Value (USD)
Water supply	18,919	71,375	$178,424,250
Healthcare facilities	8,500	4,666	$11,659,375
Primary/secondary schools	8,246	6,413	$17,681,235
Public lighting	3,449	1,726	$5,173,875
Total	**39,114**	**84,180**	**$212,938,735**
Country	**Units**	**kW Equivalent**	**Cash Value (USD)**
Benin	448	482	$1,293,383
Burkina Faso	1,005	953	$2,485,523
Cabo Verde	50	40	$108,925
Cameroon	1,654	4,031	$10,251,310
Central African Republic	802	1,529	$3,893,738
Chad	4,018	7,693	$19,457,250
Côte d'Ivoire	1,841	3,808	$9,704,423
The Gambia	116	149	$382,863
Ghana	998	2,585	$6,506,178
Guinea	2,350	4,829	$12,157,303
Guinea-Bissau	485	1,033	$2,602,348
Liberia	963	1,752	$4,459,970
Mali	2,826	6,514	$16,501,798
Mauritania	565	1,137	$2,902,715
Niger	5,036	9,980	$25,188,838
Nigeria	13,573	33,161	$83,527,850
Senegal	1,271	2,552	$6,524,245
Sierra Leone	798	1,249	$3,204,413
Togo	315	703	$1,785,668
Total	**39,114**	**84,180**	**$212,938,735**

Source: African Solar Designs analysis

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

Figure 65: Estimated Regional OGS Cash Market Potential for Institutional Sector[204]



Source: African Solar Designs analysis

[204] Estimated cash values are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

➢ **Water Supply**

The water supply sector analysis considered the electricity needs for water supply for communities in off-grid areas. Available GIS data identified off-grid water points that would benefit from solar water pumping systems. The availability and quality of GIS data was limited; data on water points was available only in six countries – Benin, Burkina Faso, Chad, The Gambia, Ghana and Liberia. For the remaining countries, per capita comparisons were made using data from countries in the same category to estimate off-grid solar demand accordingly (see **Annex 2** for more details).

The analyzed potable water points cover a wide range of sources, from wells to boreholes, each of which has different energy supply needs. Thus, to estimate the market size, solar pumping systems were categorized by their size (low, medium and high power systems). The specifications for each type of pump and the assumptions used in the market sizing calculation are described in **Annex 2**.

According to the analysis, the annualized regional off-grid solar cash market potential for the water supply sector is USD 178.4 million (**Table 24**). With an estimated market potential of USD 72.5 million, Nigeria accounts for about 40% of the region's total demand for off-grid solar water pumping systems. Niger has the next largest estimated market potential (USD 21.6 million), followed by Chad (USD 16.4 million) and Mali (USD 14.5 million).

Table 24: Estimated Regional OGS Cash Market Potential for Water Supply[205]

Country	Off-Grid Water Points	Units	kW Equivalent	Cash Value (USD)
Benin	1,283	64	241	$601,688
Burkina Faso	771	39	141	$352,188
Cabo Verde	86	4	16	$39,125
Cameroon	17,370	869	3,587	$8,966,250
Central African Republic	6,046	302	1,062	$2,655,063
Chad	38,684	1,934	6,581	$16,452,750
Côte d'Ivoire	18,078	904	3,286	$8,215,688
The Gambia	579	29	105	$261,563
Ghana	11,085	554	2,289	$5,721,875
Guinea	23,893	1,194	4,094	$10,232,938
Guinea-Bissau	4,927	247	885	$2,211,313
Liberia	5,662	283	995	$2,486,188
Mali	34,275	1,714	5,831	$14,577,313
Mauritania	5,359	268	974	$2,435,438
Niger	50,843	2,543	8,650	$21,623,688
Nigeria	140,588	7,030	29,028	$72,569,125
Senegal	10,171	508	2,099	$5,246,813
Sierra Leone	5,117	257	897	$2,240,188
Togo	3,506	176	614	$1,535,063
Total	**378,323**	**18,919**	**71,375**	**$178,424,250**

Source: African Solar Designs analysis

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

➢ **Healthcare**

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

Available GIS data identified off-grid health centers (HC) categorized by their size – health post (HC1), basic health facility (HC2), and enhanced health facility (HC3) – that could be electrified by stand-alone systems. The availability and quality of GIS data was limited; where data was unavailable, per capita comparisons were made using data from countries in the same category to estimate off-grid solar demand accordingly (see **Annex 2** for more details).

According to the analysis, the annualized regional off-grid solar cash market potential for the healthcare sector is USD 11.6 million. Nigeria (USD 4.8 million), Niger (USD 1.7 million) and Chad (USD 1.3 million) account for two-thirds of the region's total demand (**Table 25**).

Table 25: Estimated Regional OGS Cash Market Potential for Healthcare Facilities[206]

Country	Off-Grid Health Facilities	Units	kW Equivalent	Cash Value (USD)
Benin	322	27	51	$127,425
Burkina Faso	2,185	313	150	$375,500
Cabo Verde	7	1	1	$1,400
Cameroon	677	64	62	$153,925
Central African Republic	754	82	75	$186,350
Chad	7,723	1,105	531	$1,326,450
Côte d'Ivoire	1,384	175	119	$296,625
The Gambia	193	29	13	$31,900
Ghana	2,348	252	189	$470,713
Guinea	4,830	692	332	$829,500
Guinea-Bissau	908	130	62	$155,925
Liberia	706	77	70	$174,488
Mali	1,560	183	142	$353,925
Mauritania	410	53	35	$87,838
Niger	10,151	1,454	697	$1,743,475
Nigeria	29,669	3,541	1,935	$4,836,850
Senegal	628	117	34	$85,713
Sierra Leone	1,571	185	142	$356,350
Togo	286	20	26	$65,025
Total	**66,312**	**8,500**	**4,666**	**$11,659,375**

Source: African Solar Designs analysis

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

- **Education**

The education sector analysis considered the electricity needs of off-grid primary and secondary schools.[207] These include lighting, ICT (computers, tablets etc.), communication, staff housing etc. The size of a school and number of students determines the amount of energy it requires. Available GIS data identified off-grid primary and second schools that could be electrified by stand-alone systems. The availability and quality of GIS data was limited; where data was unavailable, per capita comparisons were made using data from countries in the same category to estimate off-grid solar demand accordingly. In some countries, data was obtained from other sources (e.g. national statistics bureaus/agencies, education ministries etc.). See **Annex 2** for more details.

According to the analysis, the annualized regional off-grid solar cash market potential for the education sector is USD 17.6 million (**Table 26**). With an estimated market potential of USD 4.6 million, Nigeria accounts for about 25% of the region's total demand. Liberia has the next largest estimated market potential (USD 1.7 million), followed by Niger (USD 1.5 million) and Burkina Faso (USD 1.6 million).

Table 26: Estimated Regional OGS Cash Market Potential for Primary and Secondary Schools[208]

Country	Off-Grid Primary and Secondary Schools	Units	kW Equivalent	Cash Value (USD)
Benin	5,008	250	137	$404,145
Burkina Faso	11,474	574	622	$1,639,185
Cabo Verde	36	2	2	$4,350
Cameroon	13,438	672	357	$1,057,185
Central African Republic	6,273	314	340	$896,175
Chad	12,450	623	403	$1,144,125
Côte d'Ivoire	12,093	605	324	$956,310
The Gambia	219	11	7	$18,900
Ghana	1,672	83	52	$149,490
Guinea	5,874	294	318	$839,190
Guinea-Bissau	1,104	56	60	$157,710
Liberia	10,861	543	657	$1,709,370
Mali	11,076	554	354	$1,008,735
Mauritania	3,374	169	90	$266,415
Niger	17,171	859	543	$1,551,825
Nigeria	39,972	1,999	1,696	$4,617,375
Senegal	5,609	280	236	$642,270
Sierra Leone	6,388	319	192	$552,525
Togo	765	39	23	$65,955
Total	**164,857**	**8,246**	**6,413**	**$17,681,235**

Source: African Solar Designs analysis

[207] 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.

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

- **Public Lighting**

The public lighting analysis assessed the lighting needs for off-grid market centers (it did not assess public street lighting). District population figures from each country were used to determine the number of market centers per district. Each market center was assumed to have two public lighting points. According to the analysis, the annualized regional off-grid solar cash market potential for the public lighting sector is USD 5.1 million (**Table 27**). The analysis found that Nigeria (USD 1.5 million), Senegal (USD 549,450), Mali (USD 561,825) and Chad (USD 533,925) represent the largest public lighting markets in the region.

Table 27: Estimated Regional OGS Cash Market Potential for Public Lighting[209]

Country	Off-Grid Market Centers[210]	Units	Size (kW)	Cash Value (USD)
Benin	2,135	107	53	$160,125
Burkina Faso	1,582	79	40	$118,650
Cabo Verde	854	43	21	$64,050
Cameroon	986	49	25	$73,950
Central African Republic	2,082	104	52	$156,150
Chad	7,119	356	178	$533,925
Côte d'Ivoire	3,144	157	79	$235,800
The Gambia	940	47	24	$70,500
Ghana	2,188	109	55	$164,100
Guinea	3,409	170	85	$255,675
Guinea-Bissau	1,032	52	26	$77,400
Liberia	1,199	60	30	$89,925
Mali	7,491	375	187	$561,825
Mauritania	1,507	75	38	$113,025
Niger	3,598	180	90	$269,850
Nigeria	20,060	1,003	502	$1,504,500
Senegal	7,326	366	183	$549,450
Sierra Leone	738	37	18	$55,350
Togo	1,595	80	40	$119,625
Total	**68,985**	**3,449**	**1,726**	**$5,173,875**

Source: African Solar Designs analysis

6.4.3 Ability to Pay and Access to Finance

The analysis also reviewed institutional user ability to pay for OGS solutions. Financing for institutional off-grid systems is typically managed through budget allocations made directly by relevant ministries, local government, or more commonly through donor-supported projects. In most of the countries, operation, maintenance and replacement of parts in energy systems is typically the responsibility of the institution and community following the purchase by a donor agency or government.

Schools, clinics and other public institutions in off-grid areas have the ability to pay for solar, as they already purchase fuel for generators on a regular basis. The challenge with switching to solar is that repairing and maintaining systems is difficult, particularly in remote areas where there is usually a lack of qualified solar technicians available. Moreover, many public institutions have limited funds to maintain systems, which consequently will often fall into disrepair. While donor-funded projects are increasingly being structured to account for the sustainability of systems, a long-term operations and maintenance plan is critical when considering public budget allocations for solar electrification.

[209] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[210] https://www.citypopulation.de

6.5 Regional Productive Use Sector Demand

6.5.1 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. This is particularly relevant for West Africa and the Sahel, as a large share of the region's population lives in rural areas and relies on the agricultural sector, which can benefit from a wide range of off-grid solar solutions. Focus group participants noted that productive use applications in the agricultural, food processing and informal sectors already exist in several countries, 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, connectivity applications for mobile phone charging enterprises and value-added applications for irrigation, milling and refrigeration.

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.

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 each country.

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 for the region's economic development, particularly given the sector's importance to GDP in many of the countries.

6.5.2 Analysis of Productive Use Market Demand

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 (see **Annex 2** for more details on the PUE methodology and calculations). The assessment found that there is a sizeable market for productive use applications across the region (**Table 28** and **Figure 66**). According to the analysis, the annualized regional off-grid solar cash market potential for the productive use sector is USD 1.8 billion, with the largest market potential coming from value-added applications (USD 1.25 billion), followed by applications for microenterprises (USD 432 million) and connectivity/mobile phone charging (USD 177 million).

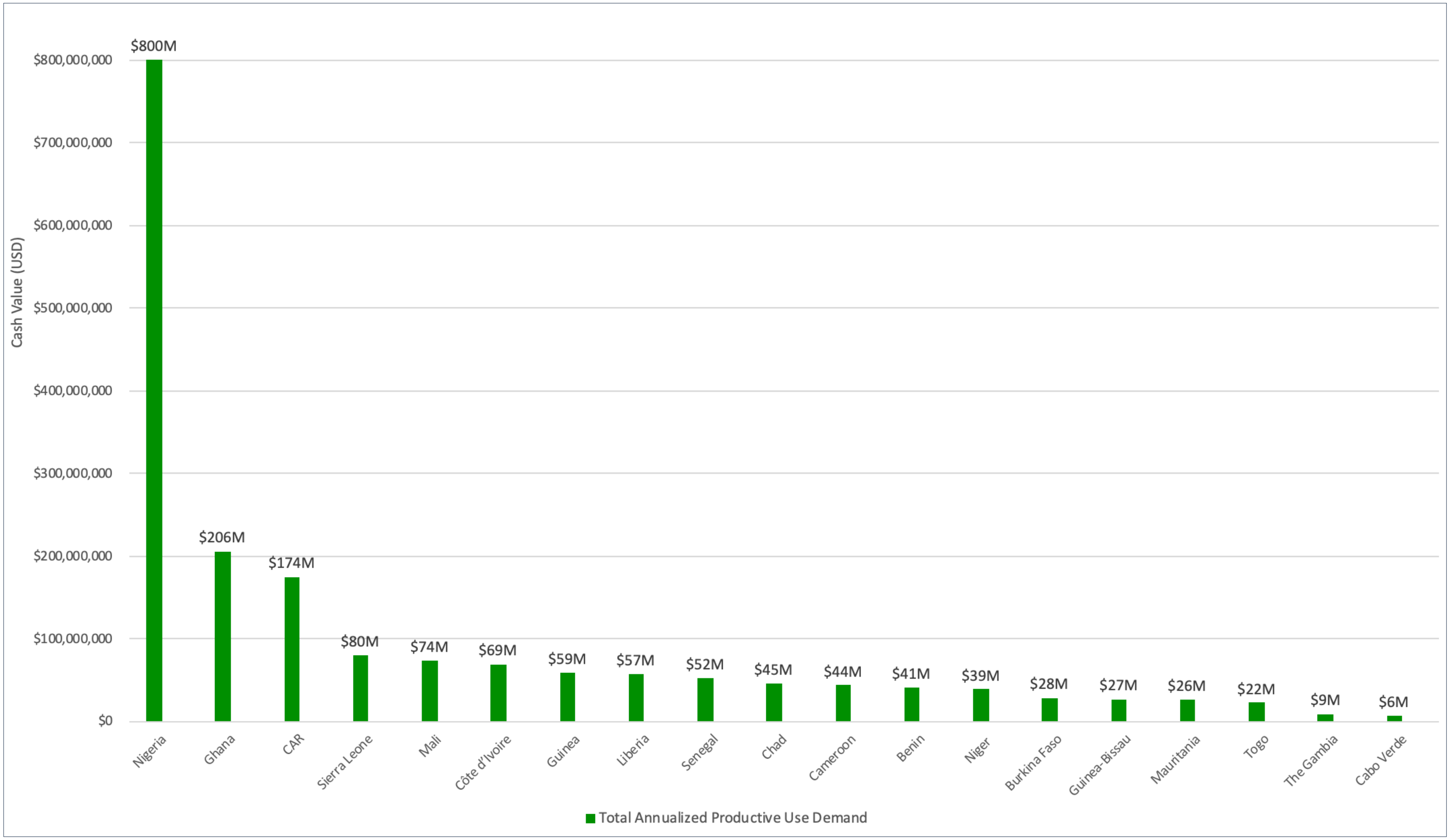
Table 28: Estimated Regional OGS Cash Market Potential for Institutional Sector[211]

Market Segment	Units	kW Equivalent	Cash Value (USD)
Microenterprises (barbers and tailors)	691,466	172,867	$432,166,625
Connectivity (mobile phone charging)	206,036	82,414	$177,602,737
Value-added applications	1,642,952	272,532	$1,252,030,852
Irrigation	1,630,596	195,672	$1,059,888,194
Milling	8,907	57,887	$144,715,467
Refrigeration	3,449	18,973	$47,427,191
Total	**2,540,454**	**527,813**	**$1,861,800,214**
Country	**Units**	**kW Equivalent**	**Cash Value (USD)**
Benin	51,513	10,495	$41,106,207
Burkina Faso	35,185	8,725	$28,363,325
Cabo Verde	8,845	1,414	$6,367,362
Cameroon	52,719	12,335	$43,729,645
Central African Republic	265,415	33,109	$174,948,879
Chad	56,856	12,289	$45,673,488
Côte d'Ivoire	86,998	19,110	$69,308,103
The Gambia	12,329	2,101	$8,987,054
Ghana	283,563	46,371	$205,888,608
Guinea	80,457	13,935	$59,102,096
Guinea-Bissau	40,085	5,398	$27,074,090
Liberia	85,457	11,294	$57,167,505
Mali	93,047	19,254	$73,783,397
Mauritania	38,152	5,982	$26,663,292
Niger	47,545	10,689	$38,613,693
Nigeria	1,088,939	279,673	$800,298,878
Senegal	67,869	13,383	$52,042,111
Sierra Leone	116,260	16,581	$80,222,058
Togo	29,220	5,675	$22,460,423
Total	**2,540,454**	**527,813**	**$1,861,800,214**

Source: African Solar Designs analysis

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

Figure 66: Estimated Regional OGS Cash Market Potential for Productive Use Sector[212]



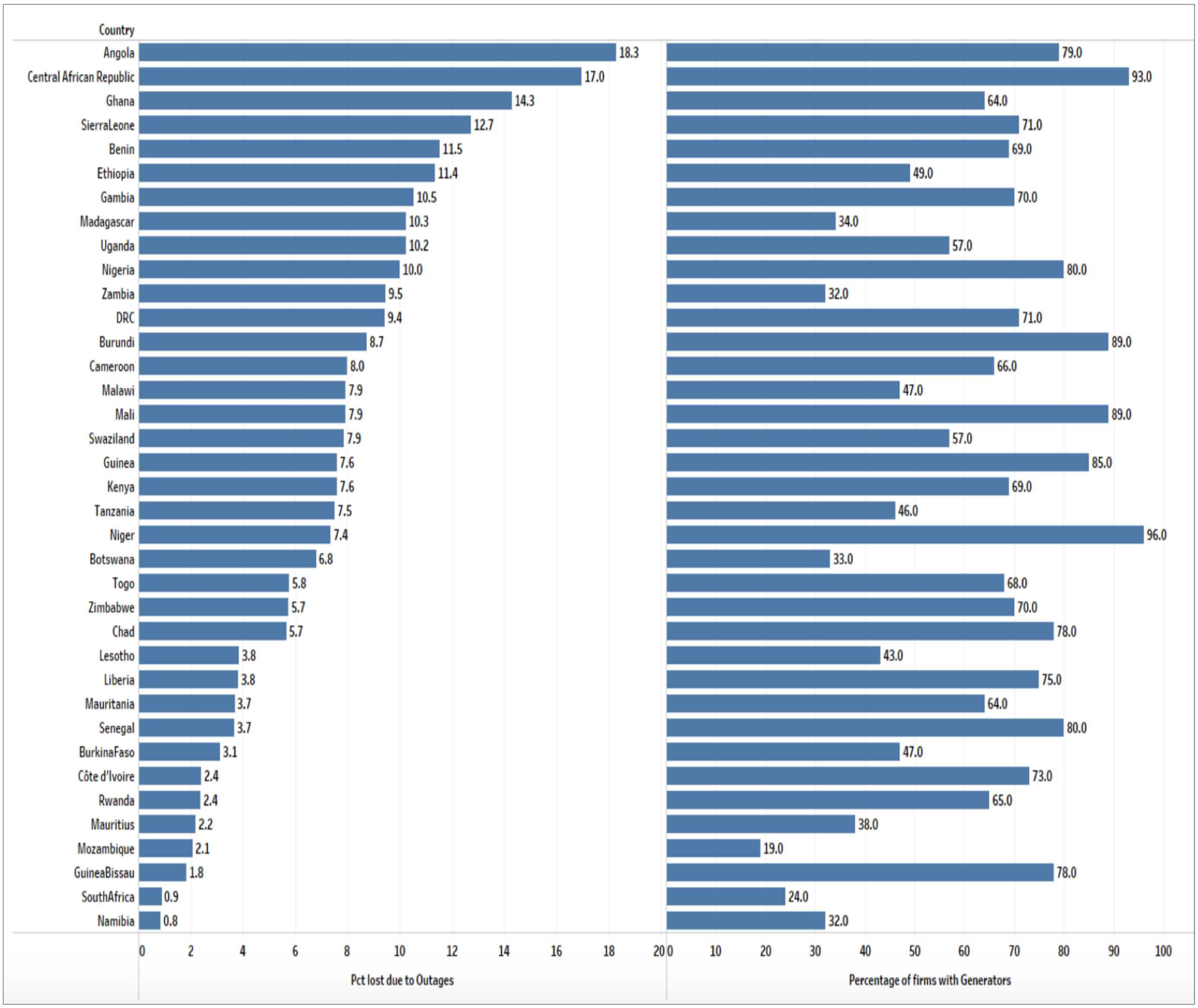
Source: African Solar Designs analysis

[212] Estimated cash values are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

➢ **SME Applications**

Access to solar-powered appliances can have a wide-ranging impact on SMEs, many of which 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 insecurity.[213] This practice is extremely common in West Africa and the Sahel, where power outages account for significant annual sales lost and where a large share of firms own generators (**Figure 67**).

Figure 67: Percentage of Sales Lost due to Power Outages and Percentage of Firms with Generator[214]



Source: Center for Global Development

[213] 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
[214] Ramachandran, V., Shah, M. K., Moss, T., "How Do African Firms Respond to Unreliable Power? Exploring Firm Heterogeneity Using K-Means Clustering," Center for Global Development, (August 2018): https://www.cgdev.org/sites/default/files/how-do-african-firms-respond-unreliable-power-exploring-firm-heterogeneity-using-k-means.pdf

According to the data collected from surveys conducted in off-grid villages in countries throughout the region, the most common rural microenterprises include small retail shops, small restaurants and bars, barbershops and tailors. In most of the villages, there was at least one shop serving cold drinks from a refrigerator powered by a diesel generator. Cold beverages are essential for retail shops in rural areas since cold drinks have higher demand than warm drinks leading to increased incomes for shop owners.

While many enterprises would benefit from access to solar power, it may not be a requirement for a commercial enterprise to have access to powered appliances. Further, while petit trade is facilitated greatly by the availability of electricity (kiosks and market stalls 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. Tailoring and barbering appliances (i.e. sewing machines and hair clippers designed or marketed for off-grid solar powered settings) were analyzed 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.[215]

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.

Table 29 presents the estimated annualized regional off-grid solar cash market potential for barbers and tailors, which has an estimated cash value of USD 432 million. With an estimated market potential of USD 419 million, Nigeria accounts for nearly all of the region's total demand, followed by Côte d'Ivoire (USD 5.6 million) and Cameroon (USD 2 million).

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[215] 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

Table 29: Estimated Regional OGS Market Potential for SMEs – Barbers and Tailors[216]

Country	No. of SMEs with Constrained Access to Finance[217]	Units	kW Equivalent	Cash Value (USD)
Benin	3,459	692	173	$432,375
Burkina Faso	6,888	1,378	344	$861,000
Cabo Verde	1,684	337	84	$210,500
Cameroon	15,976	3,195	799	$1,997,000
Central African Republic	292	58	15	$36,500
Chad	1,011	202	51	$126,375
Côte d'Ivoire	45,260	9,052	2,263	$5,657,500
The Gambia	247	49	12	$30,875
Ghana	5,636	1,127	282	$704,500
Guinea	2,613	523	131	$326,625
Guinea-Bissau	1,265	253	63	$158,125
Liberia	1,684	337	84	$210,500
Mali	953	191	48	$119,125
Mauritania	585	117	29	$73,125
Niger	3,517	703	176	$439,625
Nigeria	3,354,277	670,855	167,714	$419,284,625
Senegal	6,176	1,235	309	$772,000
Sierra Leone*	2,905	581	145	$363,125
Togo	2,905	581	145	$363,125
Total	**3,457,333**	**691,466**	**172,867**	**$432,166,625**

* No data was available for Sierra Leone; data from Togo was used (Togo was grouped in the same category); See **Annex 2**.

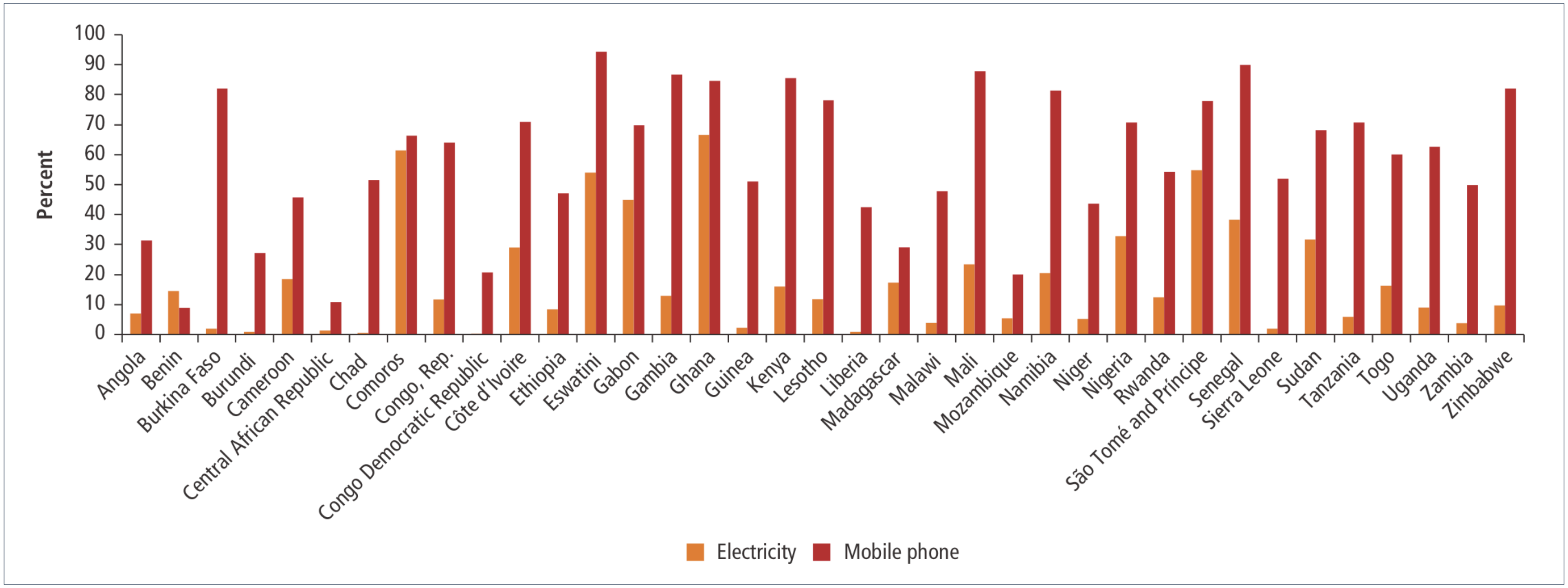
Source: World Bank; African Solar Designs analysis

➢ **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 region over the near-term. Household rates of mobile phone ownership in nearly all of the countries across the region greatly exceed rates of electricity access (**Figure 68**), while households spend a significant share of income on lighting and phone charging (**Figure 69**). Increasingly, off-grid solar devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

[216] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[217] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap

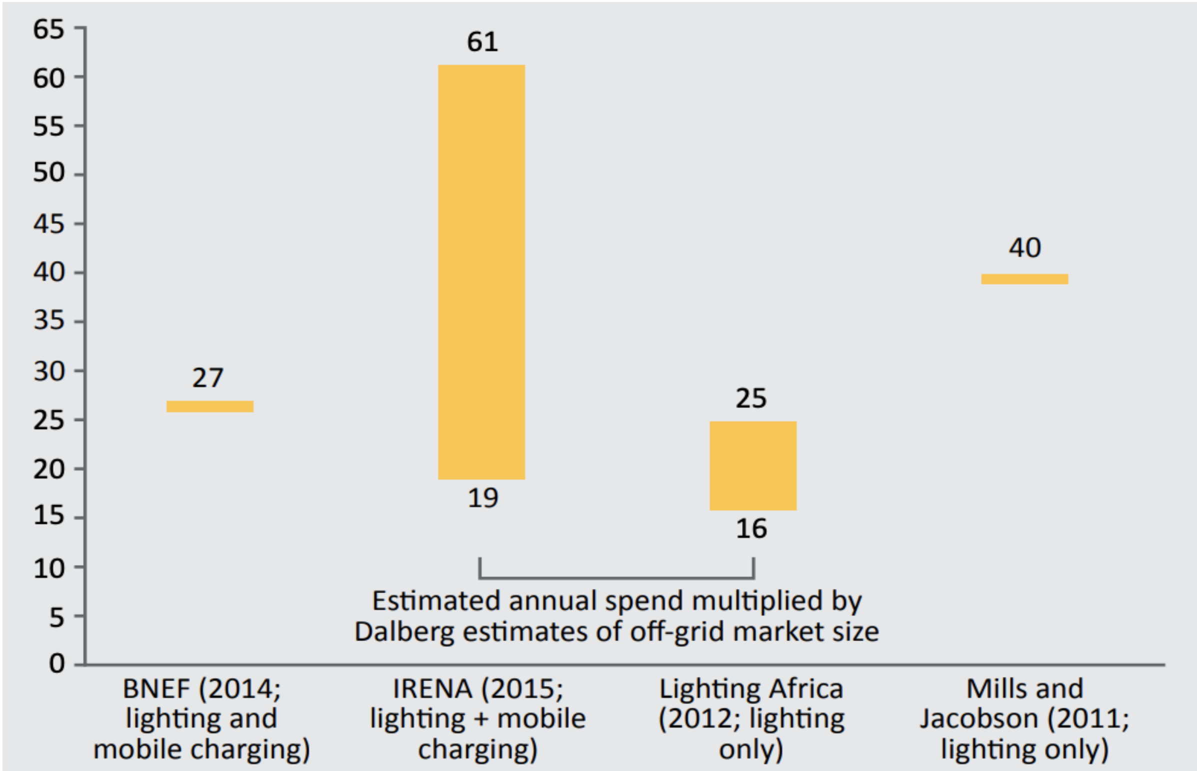
Figure 68: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)[218]



Source: World Bank

[218] Blimpo and Cosgrove-Davies, 2019.

Figure 69: Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging[219]



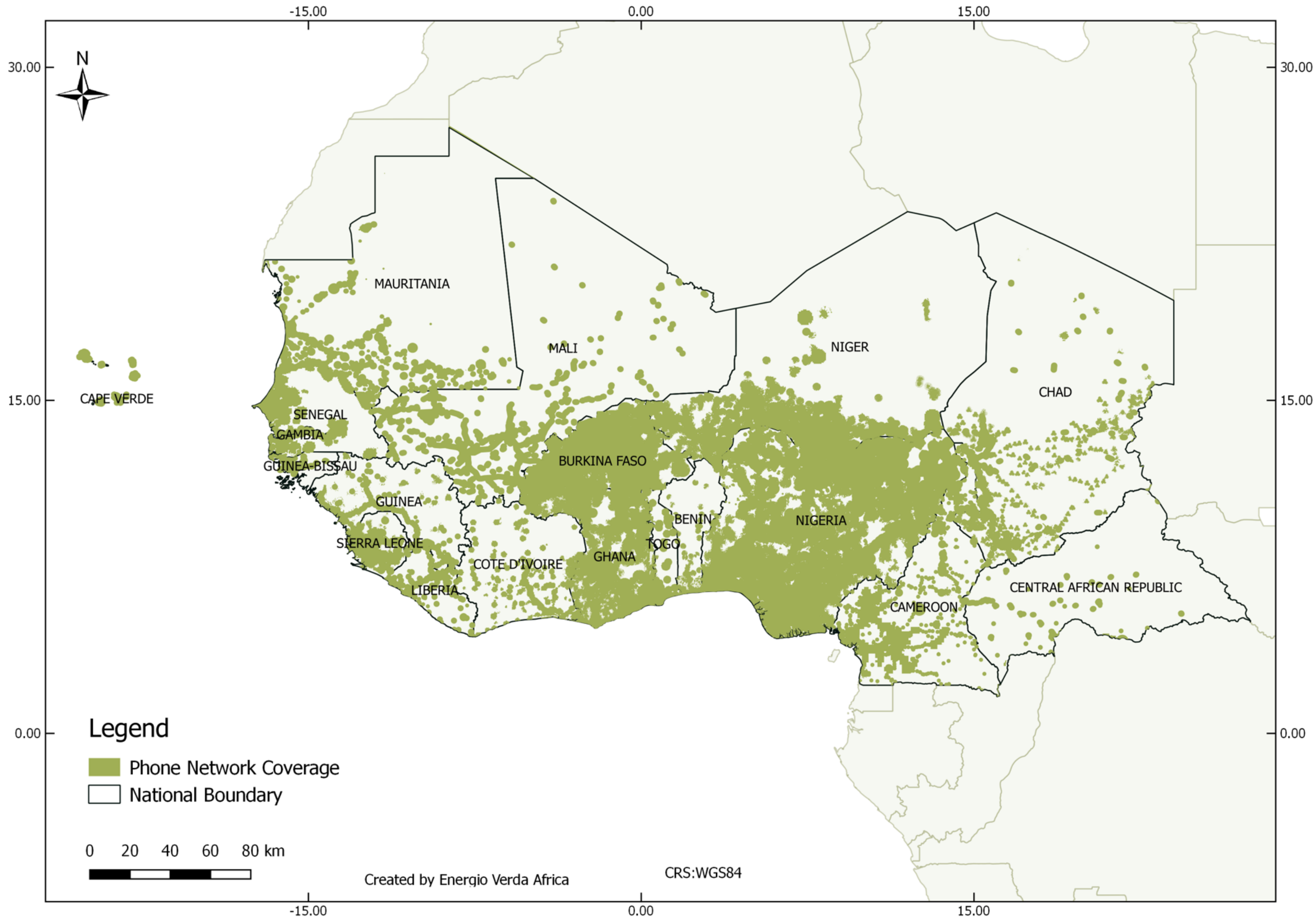
NOTE: Figures in Billion USD

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

Figure 70 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 (see **Section 7.2.3: The Digital Revolution and Electricity Access**).

[219] "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 70: Mobile Phone Network Geographic Coverage in West Africa and the Sahel[220]



Source: GSMA

[220] See **Annex 2** for more details.

The analysis of the potential solar-powered phone charging market was based on each country's mobile phone penetration rate, rural population rate, and the average costs of OGS phone charging appliances (see **Annex 2** for more details on the methodology and market sizing calculation).

Table 30 presents the estimated annualized regional off-grid solar cash market potential for connectivity applications, specifically for mobile phone charging enterprises. The estimated cash value for the region is USD 177.6 million. With an estimated market potential of USD 76 million, Nigeria accounts for over 40% of the region's total demand, followed by Ghana (USD 14.9 million), Mali (USD 11.6 million), Côte d'Ivoire (USD 9.7 million), and Burkina Faso (USD 9.2 million).

Table 30: Estimated Regional OGS Cash Market Potential for Connectivity Applications[221]

Country	Mobile Subscribers[222]	Rural Population (%)[223]	Units	kW Equivalent	Cash Value (USD)
Benin	5,100,000	56%	5,669	2268	$4,886,476
Burkina Faso	7,700,000	69%	10,668	4267	$9,195,488
Cabo Verde	400,000	34%	270	108	$232,985
Cameroon	9,700,000	45%	8,746	3498	$7,538,746
CAR	1,100,000	60%	1,313	525	$1,131,665
Chad	6,231,009	77%	9,641	3857	$8,310,940
Côte d'Ivoire	12,500,000	45%	11,270	4508	$9,714,878
Gambia	1,400,000	40%	1,114	446	$960,200
Ghana	18,900,000	46%	17,381	6952	$14,982,022
Guinea	5,900,000	62%	7,348	2939	$6,334,187
Guinea-Bissau	700,000	50%	698	279	$601,935
Liberia	1,700,000	50%	1,696	678	$1,461,841
Mali	11,400,000	59%	13,515	5406	$11,649,582
Mauritania	4,074,157	40%	3,225	1290	$2,780,249
Niger	5,500,000	81%	8,939	3576	$7,705,557
Nigeria	86,000,000	51%	88,370	35,348	$76,174,985
Senegal	8,400,000	56%	9,387	3755	$8,091,740
Sierra Leone	2,800,000	60%	3,336	1334	$2,875,776
Togo	2,900,000	60%	3,450	1380	$2,973,485
Total	**192,405,166**	**55% (average)**	**206,036**	**82,414**	**$177,602,737**

Source: GSMA; World Bank; African Solar Designs analysis

[221] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[222] "The Mobile Economy: Sub-Saharan Africa," GSMA, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[223] World Bank: Rural Population (% of total population) https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS

- **Value-Added Applications**

Agricultural practices, especially for smallholder farmers, can benefit from a wide range of off-grid solar technologies. Cold rooms and ice production are valuable investments for economies engaged in aquaculture. Solar refrigeration, cooling and processing equipment would enable traders and livestock farmers to sell dairy products. Solar drying of cocoa and palm oil processing are productive use applications that would greatly benefit rural farmers in countries like Cameroon, Côte d'Ivoire and Ghana, where these products contribute significantly to export revenues (Côte d'Ivoire is the largest producer/exporter of cocoa in the world).

Off-grid solar can support productive use applications in the rural cash-crop regions of many countries in West Africa, where solar power for cocoa and coffee dryers and electrification of storage facilities can increase output for local farmers.[224]

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

<u>Solar Powered Irrigation</u>:

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.

[224] http://agesplc.com/projects/cameroon/

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.[225] 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 across the region are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 71**).

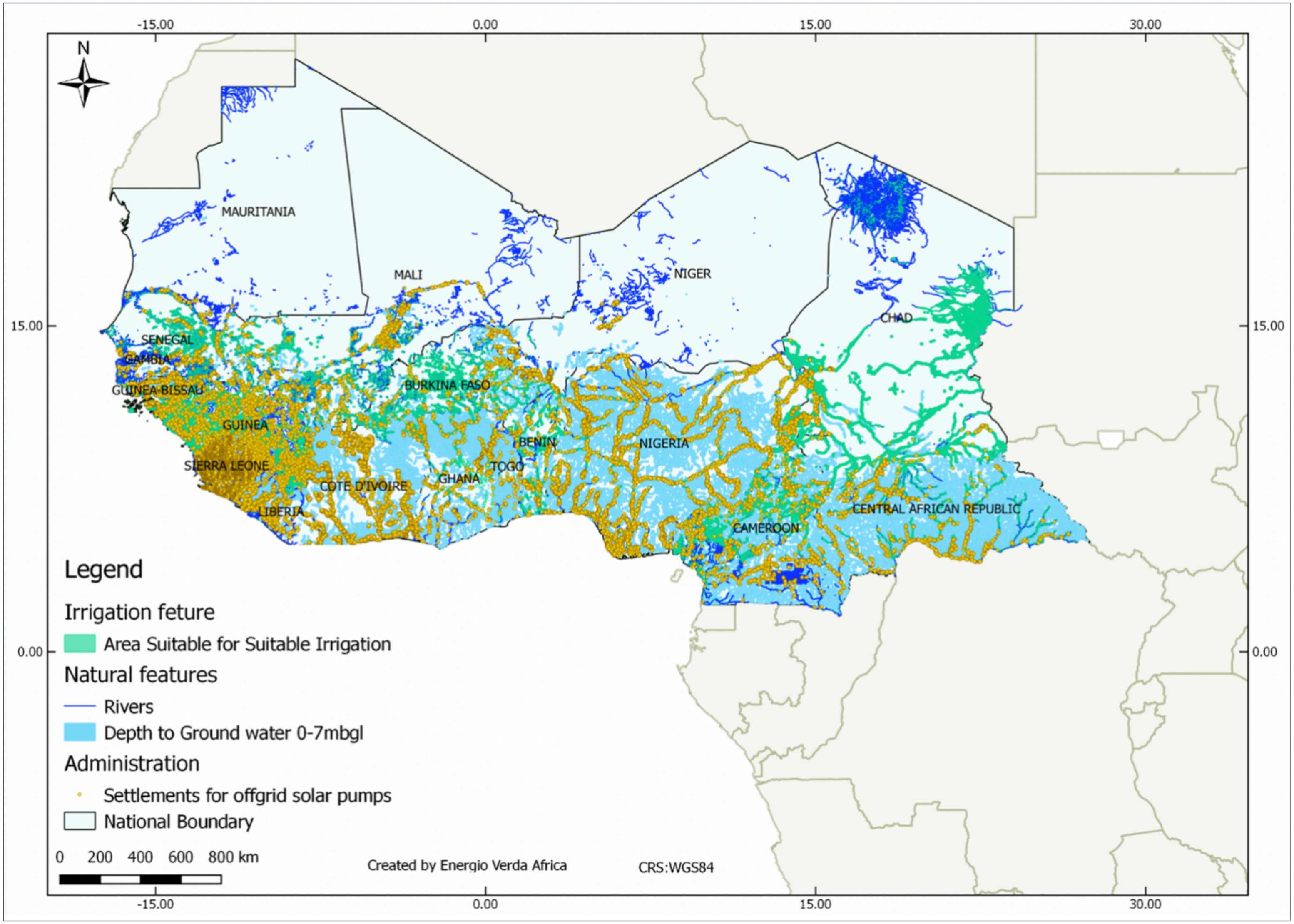
It should be noted that land is not registered in some countries (e.g. Benin, Burkina Faso, Mali, Mauritania, Niger and Togo), with most land managed on a local customary basis. Land ownership issues creates uncertainty, which hinders investment in agricultural production and limits access to finance for landowners and generally constrains economic growth. A recent study in Burkina Faso found that land tenure security serves as a source of economic power for farmers and can lead to a 30% increase in the productivity of their soil, due in part to the increased investment in inputs such as irrigation.[226] As a result, several countries like Togo have enacted wide-ranging reforms relating to agriculture and rural land that is intended to simplify the land registration process and decrease uncertainty and tenure insecurity.[227]

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 31 presents the estimated annualized regional off-grid solar cash market potential for smallholder value-added solar irrigation applications (see **Annex 2** for more details). The estimated cash value for the region is USD 1.05 billion. With an estimated market potential of USD 210 million, Nigeria accounts for the largest market, followed by Ghana, and CAR.

[225] *See* GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS
[226] Korsaga, S., "Land Tenure Security, Land-Related Investments and Agricultural Performance in Sub-Saharan Africa: Efficiency or Equity? A Microeconomic Analysis Applied to Burkina Faso," (2018): https://ideas.repec.org/p/hal/wpaper/halshs-01699118.html
[227] "Togo engages land reforms to reduce related conflicts," Togo First, (March 7, 2018): https://www.togofirst.com/en/economic-governance/0803-419-togo-engages-land-reforms-to-reduce-related-conflicts

Figure 71: Areas Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps



NOTE: mbgl = meters below ground level

Source: Energio Verda Africa GIS analysis

Table 31: Estimated Regional OGS Cash Market Potential for Value-Added Applications – Irrigation[228]

Country	Irrigation Potential (hectare)[229]	Smallholder Irrigation Potential (hectare)[230]	Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation[231]	Units	kW Equivalent	Cash Value (USD)
Benin	322,000	80,500	268,333	44,722	5,367	$29,069,444
Burkina Faso	165,000	41,250	137,500	22,917	2,750	$14,895,833
Cabo Verde	59,000	14,750	49,167	8,194	983	$5,326,389
Cameroon	290,000	72,500	241,667	40,278	4,833	$26,180,556
CAR	1,900,000	475,000	1,583,333	263,889	31,667	$171,527,778
Chad	335,000	83,750	279,167	46,528	5,583	$30,243,056
Côte d'Ivoire	475,000	118,750	395,833	65,972	7,917	$42,881,944
Gambia	80,000	20,000	66,667	11,111	1,333	$7,222,222
Ghana	1,900,000	475,000	1,583,333	263,889	31,667	$171,527,778
Guinea	520,000	130,000	433,333	72,222	8,667	$46,944,444
Guinea-Bissau	281,300	70,325	234,417	39,069	4,688	$25,395,139
Liberia	600,000	150,000	500,000	83,333	10,000	$54,166,667
Mali	566,000	141,500	471,667	78,611	9,433	$51,097,222
Mauritania	250,000	62,500	208,333	34,722	4,167	$22,569,444
Niger	270,000	67,500	225,000	37,500	4,500	$24,375,000
Nigeria	2,331,000	582,750	1,942,500	323,750	38,850	$210,437,500
Senegal	409,000	102,250	340,833	56,806	6,817	$36,923,611
Sierra Leone	807,000	201,750	672,500	112,083	13,450	$72,854,167
Togo	180,000	45,000	150,000	25,000	3,000	$16,250,000
Total	**11,740,300**	**2,935,075**	**9,783,583**	**1,630,596**	**195,672**	**$ 1,059,888,194**

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

Solar Powered Milling:

Cereal crops like maize, sorghum, millet, and rice are grown in most countries in the region and provide an opportunity for value addition through hulling or milling. Off-grid communities throughout the region use maize or rice milling equipment that is typically powered by diesel generators. Discussions with off-grid community groups in several countries 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 32 presents the estimated annualized regional off-grid solar market potential for smallholder value-added solar grain milling applications, which has an estimated cash value of USD 144.7 million (see **Annex 2** for more details). With an estimated market potential of USD 80 million, Nigeria accounts for more than half of the region's total demand, followed by Ghana (USD 17 million), Cote d'Ivoire (USD 8.8 million) and Cameroon (USD 7.3 million).

[228] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[229] AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
[230] 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
[231] 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/

Table 32: Estimated Regional OGS Cash Market Potential for Value-Added Applications – Milling[232]

Country	Cereals, roots and tuber crops (tons)[233]	Smallholder Milling Potential (tons)[234]	Estimated No. of Solar Mills[235]	Units	kW Equivalent	Cash Value (USD)
Benin	9,434,024	3,301,908	6,462	323	2,100	$5,250,099
Burkina Faso	4,174,934	1,461,227	2,860	143	929	$2,323,379
Cabo Verde	18,622	6,518	13	1	4	$10,363
Cameroon	13,181,272	4,613,445	9,028	451	2,934	$7,335,468
CAR	1,476,282	516,699	1,011	51	329	$821,561
Chad	3,771,389	1,319,986	2,583	129	840	$2,098,804
Côte d'Ivoire	15,978,745	5,592,561	10,944	547	3,557	$8,892,281
Gambia	229,121	80,192	157	8	51	$127,507
Ghana	30,853,273	10,798,646	21,132	1057	6,868	$17,170,058
Guinea	5,665,971	1,983,090	3,881	194	1,261	$3,153,152
Guinea-Bissau	376,259	131,691	258	13	84	$209,391
Liberia	905,979	317,093	621	31	202	$504,184
Mali	10,363,584	3,627,254	7,098	355	2,307	$5,767,405
Mauritania	367,310	128,559	252	13	82	$204,411
Niger	6,504,657	2,276,630	4,455	223	1,448	$3,619,886
Nigeria	144,850,900	50,697,815	99,213	4961	32,244	$80,610,518
Senegal	2,188,894	766,113	1,499	75	487	$1,218,135
Sierra Leone	6,507,764	2,277,717	4,457	223	1,449	$3,621,615
Togo	3,193,582	1,117,754	2,187	109	711	$1,777,250
Total	**260,042,562**	**91,014,897**	**178,111**	**8,906**	**57,886**	**$144,715,467**

Source: Food and Agriculture Organization; African Solar Designs analysis

Solar Powered Cooling and 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 some countries like Côte d'Ivoire, the focus group participants noted that frozen fish fetches better prices than smoked fish and therefore freezers would increase fishermen's income. 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 33 presents the estimated annualized regional off-grid solar market potential for smallholder value-added solar refrigeration applications, which has an estimated cash value of USD 47.4 million (see **Annex 2** for more details). With an estimated market potential of USD 13.7 million, Nigeria accounts for about 30% of the region's total demand, followed by Mali (USD 5.1 million), and Senegal (USD 5 million).

[232] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[233] Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
[234] Assumptions: 70% of crops are milled; 50% of milled crops are processed at smallholder farmer level
[235] 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/

Table 33: Estimated Regional OGS Cash Market Potential for Value-Added Applications – Refrigeration[236]

Country	Off-Grid Market Centers[237]	Units[238]	kW Equivalent	Cash Value (USD)
Benin	2,135	107	587	$1,467,813
Burkina Faso	1,582	79	435	$1,087,625
Cabo Verde	854	43	235	$587,125
Cameroon	986	49	271	$677,875
Central African Republic	2,082	104	573	$1,431,375
Chad	7,119	356	1,958	$4,894,313
Côte d'Ivoire	3,144	157	865	$2,161,500
Gambia	940	47	259	$646,250
Ghana	2,188	109	602	$1,504,250
Guinea	3,409	170	937	$2,343,688
Guinea-Bissau	1,032	52	284	$709,500
Liberia	1,199	60	330	$824,313
Mali	7,491	375	2,060	$5,150,063
Mauritania	1,507	75	414	$1,036,063
Niger	3,598	180	989	$2,473,625
Nigeria	20,060	1,003	5,517	$13,791,250
Senegal	7,326	366	2,015	$5,036,625
Sierra Leone	738	37	203	$507,375
Togo	1,595	80	439	$1,096,563
Total	**68,985**	**3,449**	**18,971**	**$47,427,188**

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.

6.5.3 Ability to Pay and Access to Finance

The above analysis illustrates that many of the countries in the region have a sizeable estimated cash market potential for off-grid solar productive use applications. 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 microenterprises, further study would be needed to determine the impact of off-grid solar on this sector, especially as it relates to income and affordability of the sectors analyzed (phone charging,

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[236] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[237] https://www.citypopulation.de
[238] 5.5kW solar powered refrigeration system – *See*: https://www.deutschland.de/en/solar-powered-coldhubs-nigeria

barbers and tailoring). Providing solar-kits through subsidized micro-credit schemes can lead to productive uses and boost households income. A study in Eastern Burkina Faso found that 22% of households subsequently entered into economic activity (usually phone charging, video screening and sale of chilled products) after receiving off-grid solar devices.[239]

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:

- Focus group participants indicated that the biggest barrier to widespread adoption of solar for productive applications is the high upfront cost of the solar appliances/machinery. For many off-grid SMEs, the upfront costs of off-grid solar appliances and systems are prohibitively high. Innovative loan structures can therefore have a transformative impact on the productive use market; they would need to be carefully developed, with tailored terms (attractive interest rates, currency hedging, guarantee instruments etc.), but there is clearly a market for these instruments.
- In some countries, stakeholders noted that some MFIs operating in rural areas have provided consumer financing for solar drip irrigation systems, mills and other products on a PAYG basis. The IFC has also recently established The Global SME Finance Facility that has been deployed funding to countries throughout the region. The Risk Sharing Facility covers a portfolio of up to USD 110 million in loans to SMEs providing coverage for up to 50% of the risk of loans to SMEs that are investing in smart climate equipment including solar appliances.
- Solar kiosks can bridge financing gaps by offering financial and credit services to customers for the acquisition of electric appliances and equipment. In villages with limited energy consumption, companies/projects often finance solar kiosks instead of larger-scale mini-grids as solar kiosks (e.g. in Togo).[240]
- There are some solar companies offering these PAYG solutions to partially finance systems for productive use (e.g. in Sierra Leone). It can be difficult, however, to appropriately vet/select customers for this option, given that there is often no system/registry in place with information about borrowers to assess their creditworthiness. A related challenge is that these companies can only operate in countries with high rates of mobile money penetration in order to consistenly recover periodic payments from consumers. In general, many interviewed suppliers from across the region commented that "they do not want to be the financier," and would prefer to focus only on selling, installing, operating and maintaining their products.
- Focus group participants also stressed that there is a need to raise awareness of productive use applications in rural areas. This can be achieved through targeted information campaigns to demonstrate the successes of solar PUE in communities by making off-grid solar products and appliances available.
- It will also be necessary to engage with/build the capacity of local banks and MFIs to invest and support the sector. Initiatives such as USAID's Climate Economic Analysis for Development Investment and Resilience (CEADIR) program and AFD's Sustainable Use Natural Resources and Energy Finance (SUNREF) program (discussed in **Section 7** below) are working with commercial banks across the region to build capacity on clean energy technologies and business models with the aim of increasing lending to the sector.

[239] Holt, S., "Solar Microcredit, or how to facilitate access to electricity in rural areas: an example in Burkina Faso," Field Actions Science Reports, 15, (2016): http://factsreports.revues.org/4202
[240] Galichon, I. and Payen, L., "Energy Access in Rural Togo: The Relevance of the Energy Kiosk Solution," ENEA (2017): http://www.enea-consulting.com/wp-content/uploads/2017/04/ENEA-Consulting-Energy-access-in-rural-Togo-the-Energy-Kiosk1.pdf

6.6 Supply Chain Analysis

This section reviews the off-grid solar supply chain in West Africa and the Sahel, including an overview of key actors, solar products and services, business models, and sales volumes across the region. The section also analyzes the role of informal market players and the impact of uncertified products and 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. The tier system used to classify solar companies throughout this section is described in **Table 34**.

Table 34: Solar Company Tier Classification

Classification		Description
Tier 1	Startup companies	• 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	• 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	• 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

6.6.1 Overview of Commercial Market for Solar PV Equipment

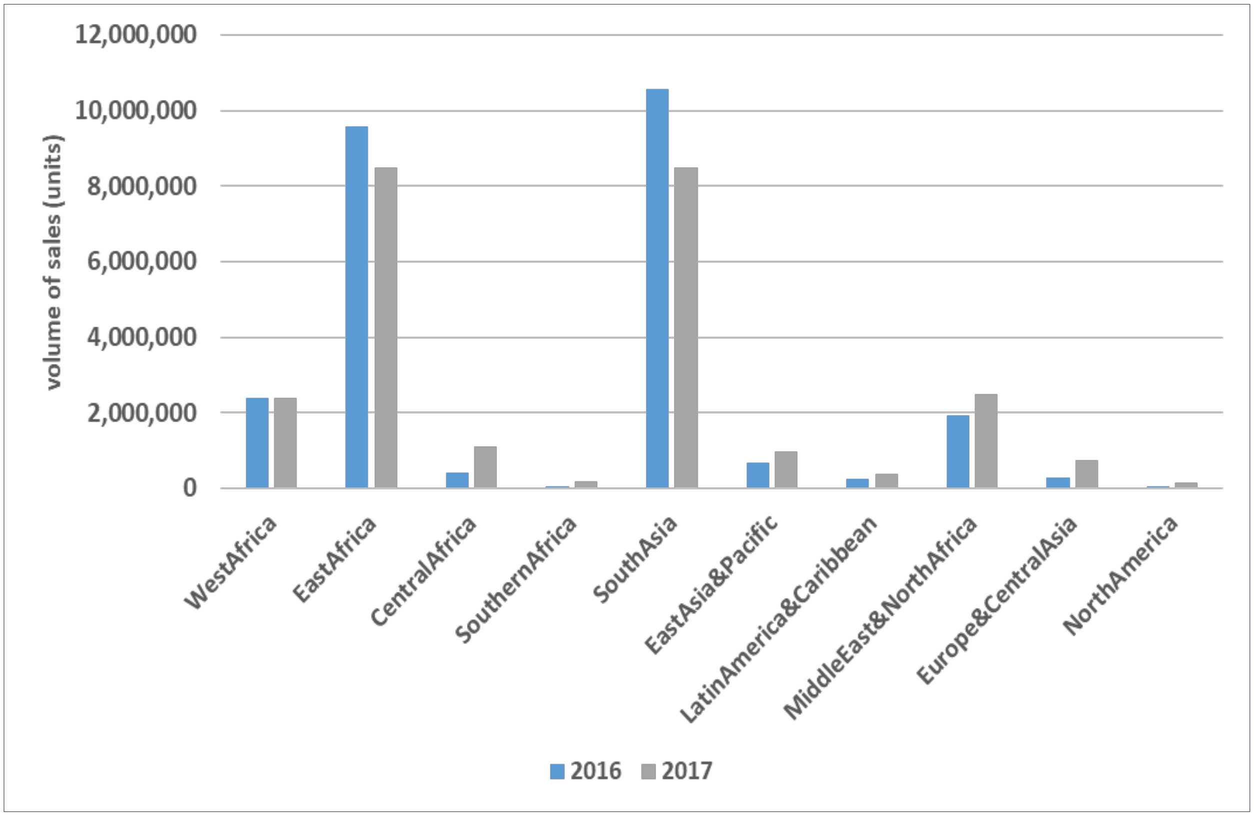
The regional market in West Africa and the Sahel, which was almost non-existent only five years ago, now consists of 500+ companies across the 19 countries and represented about 10% of worldwide sales (20% of Sub-Saharan Africa) in 2017 (**Figure 72**).[241]

In 2017, national markets across West Africa and the Sahel experienced high volatility in sales volumes – a trend that is common among nascent off-grid markets. The region's overall solar product sales volume in 2017 was boosted by increased sales from Nigeria, Côte d'Ivoire, Ghana, Mali and Sierra Leone among others.[242] Pico-solar products and systems continue make up the majority of sales volumes (**Figure 73**).

A number of actors participate in the off-grid solar supply chain (**Figure 74**), which 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 region, 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. This is especially true in countries where the reliability of grid electricity is poor (see **Figures 9-11**).

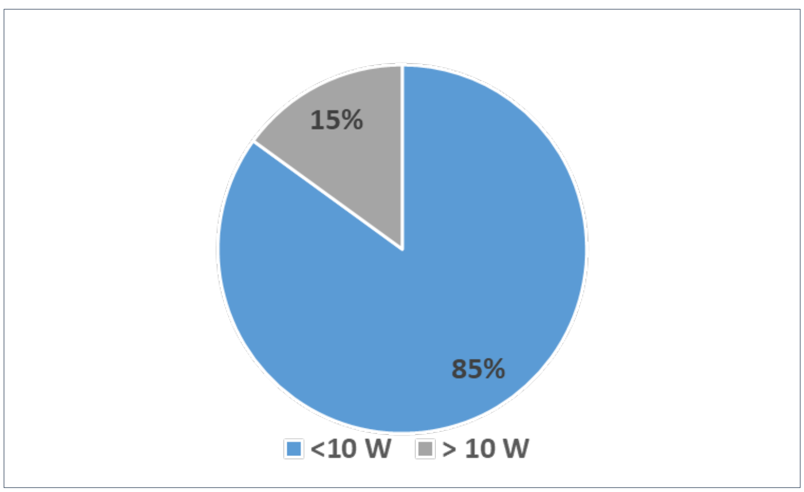
[241] "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA and Lighting Global, (July-December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf
[242] "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA and Lighting Global, (January-June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf

Figure 72: Off-Grid Solar Product Sales Volume by Region, 2016-2017



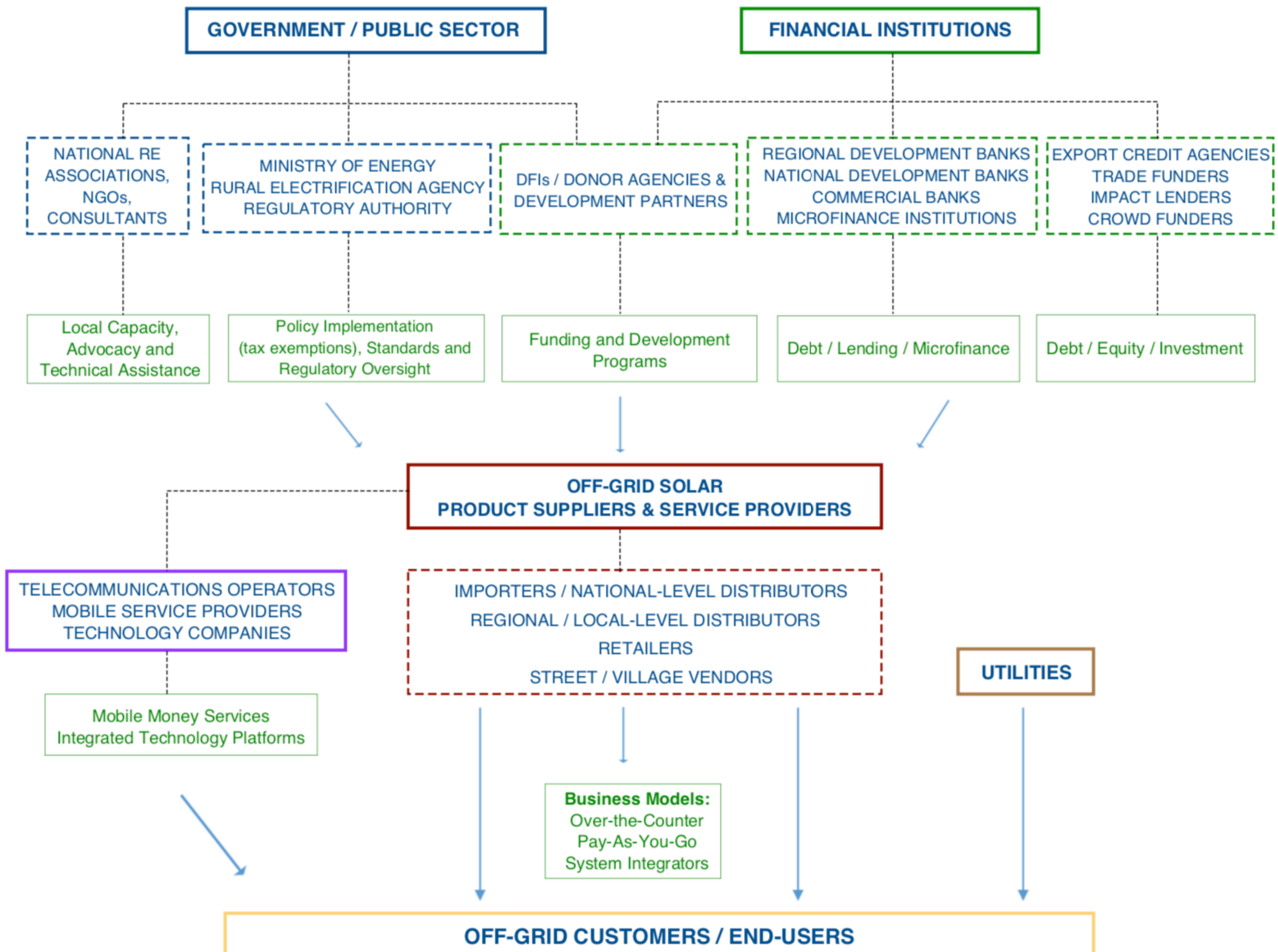
Source: Global Off-Grid Lighting Association

Figure 73: Off-Grid Solar Product Sales Volume by System Size, 2017



Source: Global Off-Grid Lighting Association

Figure 74: Off-Grid Solar Market and Supply Chain Overview



Source: GreenMax Capital Advisors

There are market actors involved at every level of the off-grid solar supply chain, including importers, distributors, retailers and vendors. Many firms are engaged in multiple areas of the supply chain, covering product importation, distribution and in many cases also managing retail outlets. An overview of these supply chain stakeholders and the challenges they face are addressed in **Table 35**.

Table 35: Off-Grid Solar Supply Chain Stakeholders and Key Challenges

Supply Chain Stakeholder	Description	Key Challenges
Importers / National Level Distributors	• Involved in ordering and purchasing solar products in large quantities and selling wholesale to regional/district distributors	• Delay in clearing of solar products at airport/port due to bureaucracy and corruption • High cost involved in transportation of goods to reach regional/district agents due to poor transport infrastructure • Damaged products due to improper handling during transportation, loading and off-loading • Lack of large warehouses for the storage of their goods • Lack of product standards and/or improper enforcement of product standards • Downsizing the importation of branded products due to inferior local products
Regional / District Level Distributors	• Tend to be located in capitals of regions or districts • Responsible for ordering products from importers and selling them to the retailers • May act as agents of national distributors or operate independently	• High cost involved in transportation of goods purchased from national distributor to their destination (poor road infrastructure may result in delays of the products reaching their destination) • Lack of space for storage of goods (distributors cannot stock goods in large quantities, which increases operating costs) • Damaged products due to improper handling of the goods during transportation • Market competition from sales of inferior products
Retailers	• Includes kiosks, convenience stores, and electrical shops • Tend to be located in fixed locations (stores) in economic centers close to customers • Sell products either to vendors or directly to end users • Buy products from the regional/district distributors and typically use hired trucks for transportation of purchases • Only have storage facilities within the store	• Complaints from customers due to relatively high cost of products and/or price fluctuations • Lack of access to consumer credit to bridge the higher cost of the product • Lack of trained technicians in off-grid locations to maintain, repair and service products • Absence of regional/district wholesalers in certain areas, forcing retailers to travel to city hubs to buy goods • Market competition from sales of inferior products (especially from street vendors) • Lack of general consumer awareness of products • Length of time from ordering to delivery of products
Street/Village Vendors	• Typically divided into two categories (i) those who sell goods at markets and (ii) street hawkers who move with items along thoroughfares • Keep their goods at their homes or shops (normally do not have established places of business) • Buy a few items for selling and/or enter into an agreement with a retailer for a commission	• Paucity of inventory supply and product choice • Limited quality control • Limited technical support/advice • Logistical related losses/damages • Transactions are on cash basis • Limited promotional opportunities for individual brands

Source: Supplier surveys; Stakeholder interviews; African Solar Designs analysis

6.6.2 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.[243] 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.

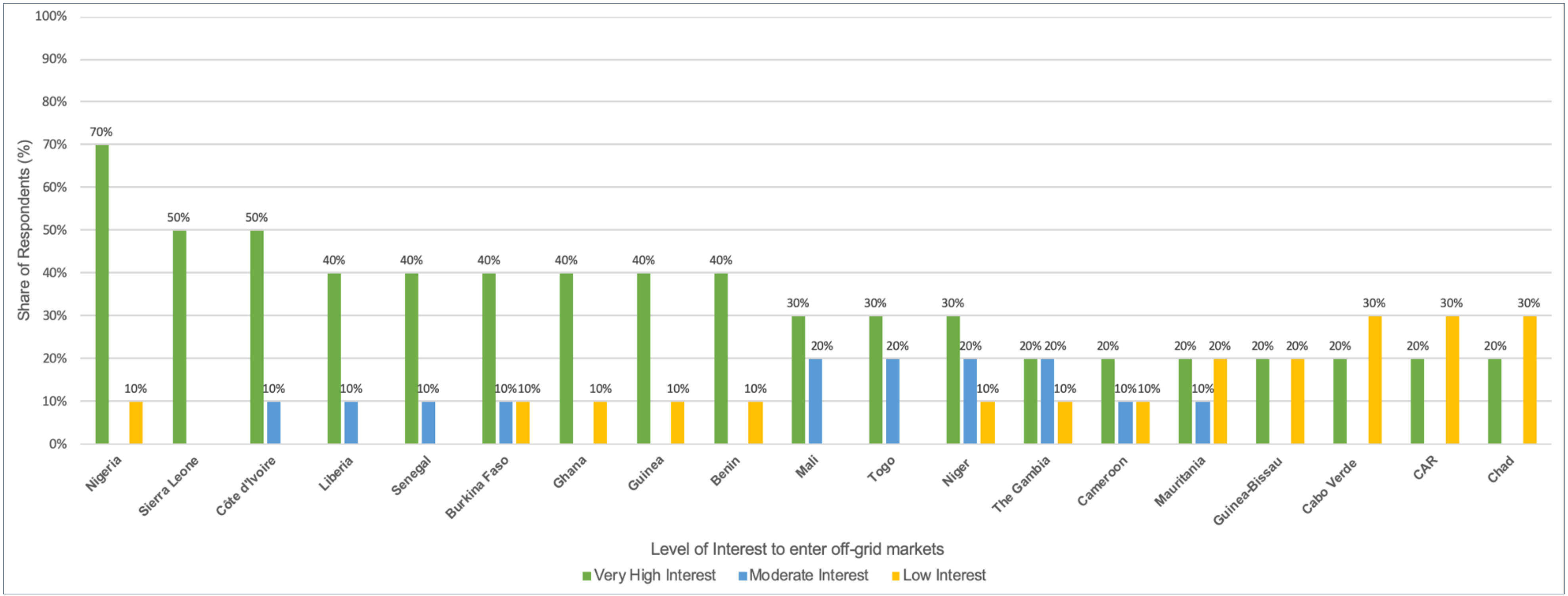
Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money 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.[244]

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.[245]

A survey of large international solar companies that assessed *inter alia* their level of interest in entering the off-grid markets of West Africa and the Sahel is presented in **Figure 75**. 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.

[243] "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
[244] Ibid.
[245] "Insights from Interviews with Off-Grid Energy Companies," ECREEE, (June 2018).

Figure 75: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[246]



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

[246] 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.

6.6.3 Overview of Regional Solar Market

This section characterizes the current formal solar market (local and international companies), including recent sales trends, main solar products and brands and importation procedures (**Table 36**).

➢ **The Formal Market – Local and International Companies**

Table 36: Main Active Off-Grid Solar Companies in West Africa and the Sahel[247]

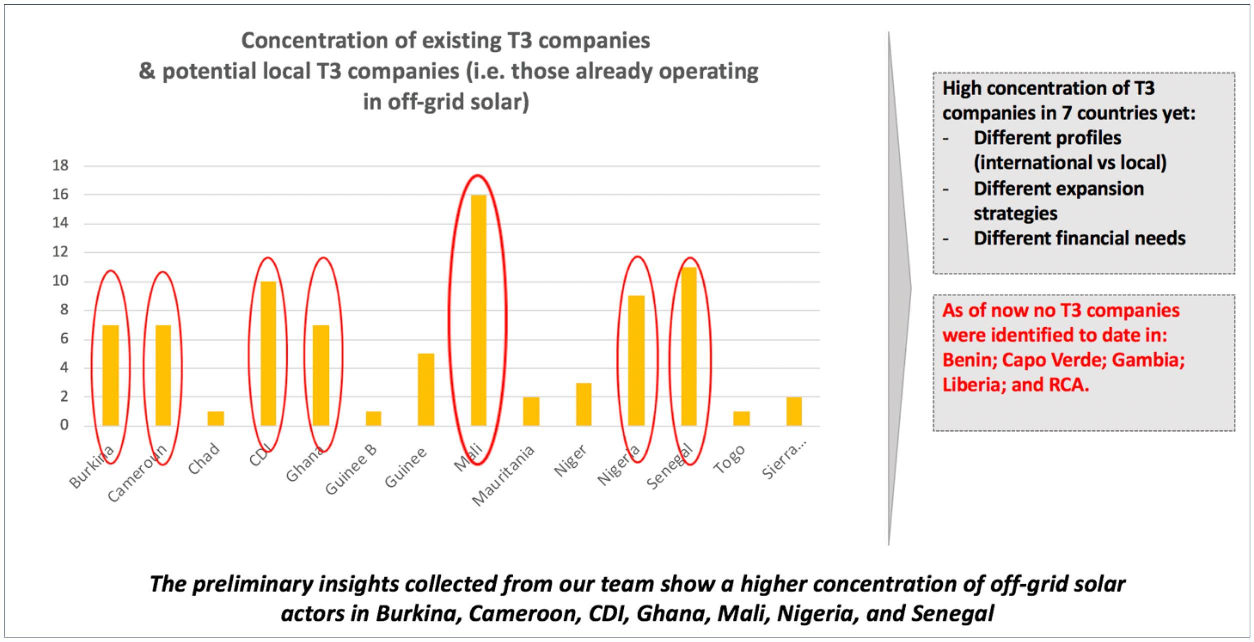
Country	Main Off-Grid Solar Companies and Distributor	Tier	Business Model	
			Supply chain	Customer model
Benin	ARESS (Lagazel), ASEMI, Cetra, Ego Services, Enerdas, Ismat Energy, Soconeme	Tier 2	No manufacturer Manufacturer representative Wholesalers and retailers	Over the counter/cash Hire purchase PAYG Microfinance (external finance)
Burkina Faso	Africa Energie Solaire (AES), Accès Services Énergétiques (ASE), BBOXX, Benoo, CB Énergie, Greenlight Planet (Sun King), Lagazel, Nafa (d.light), Projet Production International (PPI), Projet Production Solaire (PPS), Sahelia Solar, Total BF (d.light), Yandalux, Yeelen Ba (FRES)	Tier 2, Tier 3	Manufacturer representatives Distributors (wholesalers, retailers) Companies specialized in Pico Plug and Play distributors	Over the counter/cash PAYG and consumer finance Procurement
Cabo Verde	ARES, GTeK Lobosolar, Solar World Boundless Solutions, Repower, Speedsun	Tier 1	No manufacturer representatives	Procurement Over the counter/cash
Cameroon	BBOXX, Canopy Cameroon, Fenix International/ENGIE, Maguysama, Total Cameroon, UpOwa, Yandalux	Tier 3 mostly	Manufacturer representatives Distributors (wholesalers, retailers) Companies specialized in Pico	Over the counter/cash PAYG Procurement Rent-to-own
Central African Republic	Aptech Africa, IBM Technologie, Miracle Télécom, Startimes Media	Tier 1, Tier 2	Non-specialized players System integrator (only Aptech Africa is an OGS company) Manufacturer representative Wholesalers and retailers	Over the counter/cash
Chad	African Energy, Alternaprod, Noor Solar Energy, Promosol, Solar 23, Tchad Énergie, Tchad Solaire, FESCMT-Chad	Tier 1 mostly	Manufacturer representatives Retailers	Over the counter/cash
Côte d'Ivoire	AD Solar, Aphelion Energy (Sun King), Baobab+ (BBOXX), ENGIE, Fenix International, Lagazel, Lumos, PEG (BBOXX), Schneider, S.Tel (Phaesun), Yandalux, Zola	Tier 3 mostly	Manufacturer representatives System integrators Wholesalers and retailers Specialized Pico companies Plug and Play distributors	Over the counter/cash PAYG Procurement
The Gambia	All-in-one Entreprise, Eisem Solar, Gam-Solar, Gambia Electrical, KP Trading, Regional Solar, Swegam, Yingli Solar	Tier 1	Manufacturer representative Retailer	Over the counter/cash Consumer finance (rarely)
Ghana	Azuri, Barefoot Ghana, DENG, Franerix, Greenlight Planet, Northlite Solar, OGE, PEG Süka, Yingli Namene, Zola	Tier 2, Tier 3	Manufacturer representatives and distributors Companies specialized in Pico Plug and Play distributors	Over the counter/cash Procurement PAYG Hire purchase
Guinea	ARD Équipement, Batanko & Frères, Cebel Solaire, RKomp Énergie Solaire, Orange, Solar Guinée, Solec Énergie, SOGER, 2HK Énergie, Woco Solar Yandalux	Tier 1 mostly	Non-specialized OGS companies Manufacturer representatives Distributors (wholesalers, retailers) Plug and play sellers	Over the counter/cash Procurement Direct orders for large systems Hire purchase/leasing

[247] NOTE: This is not an exhaustive list. A complete list of companies in each country is included in Annex 2 of each country report.

Guinea-Bissau	Cidade Solar, Electro Djudan, N'Djudan, Elmi Guinée, FRES, Impar, JRL-Energia Solar, Prosolia	Tier 1 mostly	Manufacturer representatives Retailers	Over the counter/cash Hire purchase Procurement Fee-for-a-service
Liberia	Alternative Energy, Barefoot Liberia, Eco-Power Liberia, Jerrut Enterprise, Sjedi Green Energy (Fosera), RREA, Union Strong Group of Companies, Total, Universal Empowerment International West Coast Energy	Tier 1 mostly	Manufacturer representatives Retailers Companies specialized in Pico Plug and Play distributors	Over the counter/cash PAYG Direct orders for large systems Consignment sales (RREA) VSLA (financial and credit facility at the village level)
Mali	Access, Afrika, Atlas Électronique, Baobab+ (BBOXX), Horonya, Lagazel, Oolu Solar, Orange, Soninkara, Total (d.light), Yandalux, Yeelen Djiguima (Lagazel), Yeelen Kura (FRES),	Tier 3 mostly	Local assembler/producer Manufacturer representatives Distributors (wholesalers, retailers) Companies specialized in Pico	Over the counter/cash PAYG Fee-for-a-Service Microfinance (Microcred/Baobab+)
Mauritania	CDS, COGER, SOMER, TD, Techno Systèmes	Tier 1 mostly	Manufacturer representatives Wholesalers/Retailers Companies deals in all types of systems	Over the counter/cash
Niger	Benalya (Benafsol), Consultation Plus, ETS Lumières du Sahel, Ets Maman Sani, Ets Ténéré, Ets Yacouba Mahaman, Kanf Electronics, La Sahélienne du Génie Électrique, SES, Total, Yandalux	Tier 1, 2, 3	Manufacturer representatives/distributors System integrators Plug and play distributors	Over the counter/cash PAYG
Nigeria	Arnergy, Asteven, Azuri, Blackbit Solar, Blue Camel, Creeds Energy, Consistent Energy, d.light, Go Solar, Greenlight Planet, GVE Project, Havenhill Synergy, JUA Energy, Lumos, Solarmate, Solar Sister, SOSAI Renewables (Fosera), Total, Yingli	Tier 2, Tier 3	Component manufacturer Manufacturer representatives Distributors (retailers and wholesalers) Companies specialized in Pico/HH segment	Over the counter/cash PAYG Fee-for-a-service Procurement
Senegal	Oolu Solar, Baobab+, BBOXX, Bonergie, d.light, Greenlight Planet, ENGIE/Fenix International, Lagazel, Little Sun, Nadji Bi, Rayon Vert, Salen Sol, Solar Energy Senegal (SES), SPEC, Touba Solar Rama	Tier 1, Tier 2, Tier 3	Local manufacturers Manufacturer representatives Distributors (wholesalers and retailers) Plug and play distributors	Over the counter/cash PAYG Procurement
Sierra Leone	Aptech Africa, Azimuth, Barefoot, BBOXX agent, Easy Solar (Sun King), Energy Efficient Solutions (EES), Energen Wao, FLS Power, Solar Era (Fosera), Synergy SL, Teleficient, (Azuri) Western Africa Off-Grid	Tier 1, Tier 2, Tier 3	Manufacturer representatives System integrators Plug and play distributors	Over the counter/cash PAYG
Togo	Africa Digibiotech, BBOXX agent, Benoo, Eco Energy (Sun King), Entrepreneurs du Monde/EDM (Sun King, Barefoot), Ezo Energie, Jeunes Volontaires pour l'Environnement (JVE), Kya-Energy Group, Lagazel, PES-Togo, Solartec, Total	Tier 1, Tier 2	Manufacturer representatives Companies specialized in Pico and HH segment	Over the counter/cash PAYG Hire purchase

Source: ECREEE; Focus Group Discussions; Supplier surveys; Company websites; GreenMax Capital Advisors analysis

Figure 76: ROGEP Supplier Market Insights



Source: ECOWAS Center for Renewable Energy and Energy Efficiency

Overall, as shown in **Table 36**, there is an uneven presence of both international and local companies operating across the 19 countries, with approximately 500 companies registered as of 2018. Given the range of companies across the three tiers, suppliers across the region have a variety of financial and technical assistance needs. As a region, the solar supplier market is indeed growing rapidly, with over 70 Tier 3 companies identified. More than five Tier 3 companies are present in seven countries – Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Mali, Nigeria and Senegal (**Figure 76**).

These countries are among the most mature off-grid solar markets in the region, characterized by the presence of large international companies and regional distributors such as BBOXX, Greenlight Planet, d.light, Fenix International, Yandalux, Azuri and Total among others. In addition to large international players, these markets have a strong supply chain ecosystem that includes regional or national players, such as the Foundation for Rural Energy Services (FRES) in Mali, Burkina Faso and Guinea, UpOwa in Cameroon, AD Solar in Côte d'Ivoire, Yingli Namene in Ghana, Oolu Solar and Bonergie in Senegal, Solar Sister, Arnergy, and Consistent Energy in Nigeria, and Yeelen Djiguima and Soninkara in Mali among others. Although there are various manufacturer representatives and distributors, three markets – Nigeria, Mali and Senegal – have local manufacturers or international manufacturers operating locally. Horonya is a local assembler of solar panels in Mali, while several international component manufacturers operate in Nigeria (e.g. Canadian Solar, Yingli, Jinko Solar, Schneider Electric), and local manufacturers operate in Senegal (Bonergie, SPEC, Nadji Bi and Palette). As more and more companies offer PAYG consumer finance, a few companies in Mali (Yeelen Kura), Guinea (FRES) and Nigeria (Arnergy) have launched the fee-for-a-service model, targeting bottom of the pyramid population.

Benin, Chad, Guinea, Sierra Leone, Niger, and Togo are six nascent markets. Comparatively fewer Tier 3 companies operate in these markets. Some of large international and regional companies that were identified in these countries include BBOXX (Sierra Leone and Togo), Aptech Africa, Barefoot (Sierra Leone), EDM, JVE (Togo), Total (Togo, Niger), Yandalux (Benin, Niger). The PAYG sector is still in its early stages in most of these countries, as consumer financing is generally not available to customers in the household market segment.

Central African Republic, The Gambia, Guinea-Bissau, and Liberia are four smaller markets. Very few international or regional off-grid solar market players are active in these countries, as most of the companies identified in these markets are Tier 1 companies. Aptech is the only identified off-grid solar energy firm in CAR. In Liberia, the Rural Electrification and Renewable Energy Agency (RREA) is directly engaged in the sector as an importer and distributor of OGS products and systems. Village Savings and Loan Associations (VSLAs) in Liberia provide credit to consumer for the purchase of off-grid solar equipment.

Cabo Verde and Mauritania are two outlier markets. In Cabo Verde, the small scale nature of the market limits the number of off-grid solar service providers, all of which are Tier 1 companies. With Cabo Verde's high level of grid connectivity, there are limited opportunities for off-grid solar market growth compared to other countries in the region. Mauritania's Sahel market is concentrated around five players – with CDS as the only Tier 3 company identified in the country. Over the counter cash sales are the most common business model utilized in these markets, as PAYG/consumer financing remains limited.

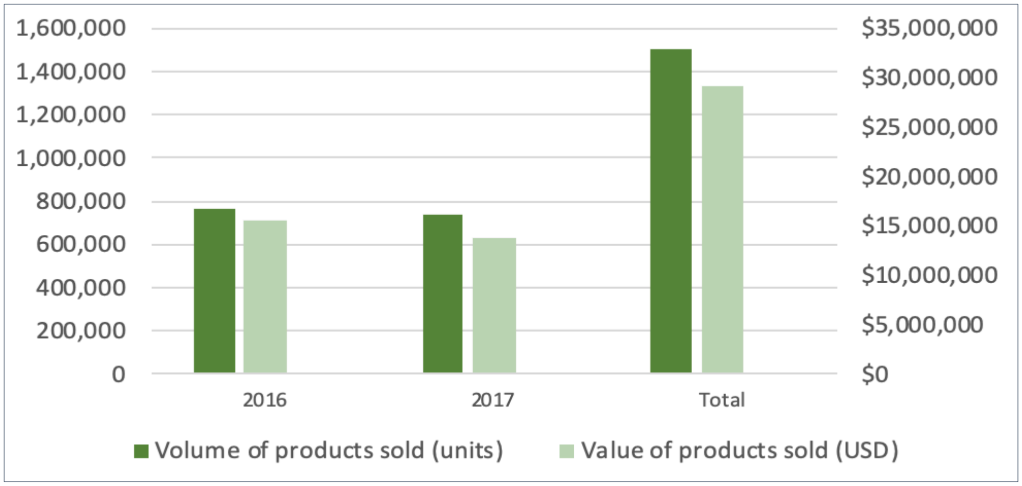
- **Estimated Sales Volumes and Revenue**

Focus group participants in countries throughout the region 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. Available market data indicates that sales volume of off-grid solar products and systems is distributed widely across the region, with hundreds of larger installations and tens of thousands of smaller product sales driving revenue and growth. A number of larger installations in the public/institutional sector also exist (although these tend to be larger mini-grid projects). Focus group participants estimated that households account for the majority of installed off-grid solar sales, followed by SMEs and public/institutional users.

Recently published data from GOGLA on off-grid solar product sales volume and revenue (**Figure 77** and **Table 37**) indicates that in 2016 and 2017, a total of about 1.5 million off-grid solar products were sold for an estimated cash sales revenue of USD 28.7 million in West Africa and the Sahel, with Nigeria (USD 10.7 million), Burkina Faso (USD 5 million), Mali (USD 4.1 million) and Ghana (USD 3 million) representing the markets in the region with the largest OGS product sales revenue during this period (among those with available data).

During this period, about 90% of the overall share of OGS products sold and 92% of total sales revenue in the region were pico solar products compared to 10% of products sold and 8% of sales revenue were SHS. Sales figures remain volatile in many of the countries, given the nascent state of the off-grid solar market throughout the region. It is also worth noting that these figures only include sales from GOGLA-affiliated companies/certified product sales, which represents a comparatively small share of market activity in the region given the size and level of activity of the informal market.

Figure 77: Sales Volume and Cash Revenue for OGS Systems in West Africa and the Sahel, 2016-2017



NOTE: Sales figures include both pico solar and SHS products; Cabo Verde, Central African Republic, Chad, Guinea, Guinea-Bissau and Mauritania excluded (no data)

Table 37: Sales Volume and Cash Revenue for OGS Systems in West Africa and the Sahel, 2016-2017[248]

Country	Total volume of products sold (units)			Total value of products sold (USD)		
	2016	2017	Total	2016	2017	Total
Benin	175,434	15,949	191,383	$1,507,935	$544,195	$2,052,130
Burkina Faso	54,006	170,526	224,532	$1,056,185	$4,021,564	$5,077,749
Cameroon	45,444	32,833	78,277	-	$456,294	-
Côte d'Ivoire	29,538	24,893	54,431	$128,856	$162,044	$290,900
The Gambia	576	-	576	-	-	-
Ghana	51,006	63,652	114,658	$2,293,028	$711,074	$3,004,102
Liberia	14,089	15,251	29,340	$217,558	$553,717	$771,275
Mali	41,601	73,211	114,812	$1,095,169	$3,023,285	$4,118,454
Niger	-	3,640	3,640	-	-	-
Nigeria	278,251	215,575	493,826	$7,802,775	$2,928,833	$10,731,608
Senegal	47,582	85,386	132,968	$945,746	$825,645	$1,771,391
Sierra Leone	24,517	33,471	57,988	$402,440	$409,300	$811,740
Togo	296	4,588	4,884	-	$91,714	$91,714
Total	**762,340**	**738,975**	**1,501,315**	**$15,449,692**	**$13,727,665**	**$29,177,357**
Total Pico Solar	**716,600**	**628,129**	**1,344,729**	**$13,286,469**	**$13,178,558**	**$26,465,027**
Total SHS	**45,740**	**110,846**	**156,586**	**$2,163,223**	**$549,107**	**$2,712,330**

NOTE: Cabo Verde, Central African Republic, Chad, Guinea, Guinea-Bissau and Mauritania excluded (no data)
Pico solar products = 0-10W; SHS products = >10W

Source (Figure 77 and Table 36): GOGLA, Lighting Global and World Bank

[248] "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

- **Main Solar Products and Components**

Table 38 lists the brands of common solar products and components in the region. The list does not include non-certified brands that are also common in the region's grey market.[249]

Table 38: Common Off-Grid Solar Products and Components in the Region

Country	Companies/Distributors		Brands			
	Pico solar	Solar Home System	Pico solar	Module/Panel	Inverter	Battery
Benin	Cetra, Ego Services, Greenlight, Ismast Energy, Lagazel	ARESS, Asemi Group, Enerdas	Sun King	Suntech, Hoppecke, Jinko Solar	Victron, Steca, SMA	Victron, Ritar, North Star
Burkina Faso	BBOXX, Benoo, Greenlight, Lagazel, Nafa Nafa, Orange, Total, Yeelen Bâ (FRES)	Avelux, EIA, Lagazel, Nafa Nafa, Solarfor, Speedtech Energy Africa	BBOXX	Photowatt, AEG, Yingli	SMA, Victron, MPP Solar	BAE, MPP Solar, XPower
Cabo Verde	GTeK	ARES, GTeK, Lobosolar, Speedsun	Ampersun	Open Renewables, Amerisolar, Aztech	SMA, Frokus, Victron	Powerball, Iskra, BAE
Cameroon	BBOXX, Fenix, ENGIE, Total	Canopy Cameroon, Global Corporation, Netora, Sapres Schneider Electric, Temdare T&D, Yandalux	D.light, Schneider, Oolux, BBOXX	Su-Kam, Axitec, Suntech	Su-Kam, Victron, MPPT	Su-Kam, Victron, Ultracell
Central African Republic	Aptech Africa IBM Technologie, Miracle Solar, Startime	Aptech Africa, IBM Technologie, Miracle Solar, Startime	Sunrise Solartech, Soleil Power (Aptech Africa), BBOXX	Soleil Power, Sunrise Solartech	Hollandia, Schneider Electric, Victron, Aptech Solar	Soleil Power
Chad	Tchad Solaire, ERDEP, Promosol	Alternaprod, ERDEP, 3A Énergie Group, 3A Commerce Énergie & Étude, Promosol Tchad Solaire,	Jinko, Yingli Solar, Solar World	Sunpower, Jinko, Suntech	Schneider, SMA, Jinko	Powervault, Samsung SDI, Jinko
Côte d'Ivoire	BBOXX, Baobab+, ENGIE, Fenix, Lagazel, PEG Africa, Schneider, Total, Zola Energy	Aphelion Energy, AD Solar, Yandalux, Zola Energy	Sun King Pro, BBOXX plug and play, ZOLA	Jinko, Amerisolar, Helios	Steca, Opti Solar, Frokus	Steca, Victron, Ritar Power
The Gambia	Power Up Gambia, KP Trading	Gam-Solar, Gambia Electrical, Power Up Gambia, Regional Solar, Swegam	Ying Li, Fosera, RTEC	Ying Li, Canadian Solar, Solar World	Morning Star, SMA, Sukam, Ying Li, Victron	Ritar, Su-Kam, Gel Bat, Hoppecke
Ghana	Azuri, Greenlight, OGE, PEG Africa, Yingli, North Lite Solar, Zola	Solar light, Süka, Franerix Solutions, Nocheski, Sunpower, Power and Co, Deng, YingLi	Sun King Pro, SOLelectric plug and play, Sunvis, Powetas, Barefoot	Jinko, Amerisolar, Helios	MPP Solar, Opti Solar, Frokus, Victron	Victron, Ritar Power, Narada
Guinea	Solar Guinée, ARD Équipement, 2HK Énergies, Orange	Doumbouya Solar Electric, RKomp Energie Solaire, SOGER, Solec Energy	Schneider Electric	AY Solar, Solar Resta, Suntech	AY Solar, Sukam, Victron	Sunstone, Rolls, Victron

[249] 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.

Guinea-Bissau	Electro Djudan N'Gjudau, Cidade Solar	FRES, Cidade Solar, Impar, JRL-Energia Solar, Prosolia	-	Solar World, Suntech, Trunsun, Canadian Solar, Kyocera	Studer/Victron, SMA, Outback, Su-kam	Victron, Hoppecke, Rolls, Ecotedi, EnerSys, Andel
Liberia	Jerrut Enterprise, Universal Empowerment International	RREA, West Coast Energy and Union Stroup Group	d.light, Sun King, Barefoot, Fosera	Sun Tech	Outback, Magnum, Kisae	Deka Solar
Mali	Access, Afrika Solar, Baobab+, Oolu, Orange, Total, Yeelen Djiguima (Lagazel), Yeelen Kura (FRES)	Atlas Electronique, Horonya, Oolu Solar, Orange, Soninkara, Total, Yandalux, Yeelen Kura,	d.light, Lagazel	Horonya, Yara, Diarra, Solar World	Power Inverter	Boya, BK, Hoppecke
Mauritania	CDS, COGER, Techno Systems, SOMER, TD	CDS, COGER, Techno Systems, SOMER, TD	Iso Photon, World Power, PB Solar, BLVD, Sun King Pro, d.light	-	Steca, Yackson (UEA), New Star (China)	Rolls, Fulmen
Niger	Groupe Benalya, ETS Ténéré, ETS Yacouba Mahaman	Consultation Plus, ETS Moussa Elhadji Abbasse, ETS Maman Sani, ETS Lumière du Sahel, Global Energy Solaire, La Sahélienne du Génie Electrique, Kanf Electronics, Yandalux	Sun King, Lagazel, GD Lite, Ningbo Solar, Suntech	Aleo Solar, Ningbo Solar, Suntech	Voltronic, Okey pure sine wawe, Victron, CS Power, SMA, Huawei	GS Yuasa, Victron, CS Power, Exide, Storace
Nigeria	Asteven, Azuri, d.light, Greenlight Planet, Lumos, Solar Sister	Arnergy, Asteven, Blackbit Solar, Blue Camel, Consistent Energy, Creeds Energy, JUA Energy, Protergia, Solarmate Engineering Sosai Renewables (Fosera), Yingli,	Solar Sisters, d. light, Sun King, Asteven	Suntech, Sunpower, Jinko	Schneider, Victron, Techfine, Manu Xantrex, SMA, Outback	Leoch, Vision, Luminous, Su-Kam
Senegal	Baobab+, Bonergie, Fenix/ENGIE, Lagazel, Oolu Solar, Orange, COPERES, Greenlight Planet,	Baobab+, Bonergie, IDM Services, Oolu Solar, SES, Solar Energy Senegal (SES), Salen Sol, Touba Solar Rama, Rayon Vert, COPERES	d.light, Sun King, Little Sun, Niwa	Argonie, Felicity, Sunny International, Varama, Yingli, Solar World	Steca, Victron	Hoppecke, Victron
Sierra Leone	Barefoot, Easy Solar, Energen, Energy Efficient Solutions (EES), Helios	Aptech, Barefoot, BBOXX, Easy Solar, Energen Wao, Energy, EES, Sinergy Solar, Western Africa Off-Grid	Sun King Green Light Planet, d.light, Fosera, Azuri	Hollandio, Suntech, Axitex, GCL Solar	Hollandia, Victron, SMA	Hollandio, Victron, Hoppecke
Togo	Barefoot, BBOXX, Benoo, Entrepreneurs du Monde (EDM), Greenlight, Jeunes Volontaires pour l'Environnement (JVE), PES-Togo, Total	Africa Digibiotech, BBOXX, EDM, Esco-Togo, Ezo-Energy, KYA-Energy-Group, Stable Energy, Solartec, PES-Togo	Sun King, d.light, Barefoot	Victron, Paris, Jinko, WinBright	Victron	Victron, Narada, Copex, WinBright
Brands found in several countries	Azuri, Baobab+, Barefoot, BBOXX, Benoo, d.light, ENGIE, Fenix International, FRES, Greenlight Planet, Lagazel, Lumos, Oolu Solar, Orange, PEG, Schneider, Total, Zola	Aptech, BBOXX, FRES, Lagazel, Orange, Yandalux, Yingli, Zola	Azuri, Barefoot, BBOXX, d.light, Fosera, Lagazel, Schneider, Sun King (Greenlight Planet), Yingli	Amerisolar, Jinko, Solar World, Suntech, Sunpower, Yingli	Victron, Schneider, SMA, Steca, Su-Kam, Frokus, Outback	Victron, Hoppecke, Ritar, Su-Kam, Steca

Source: Focus Group Discussions; Supplier surveys; Company websites; Stakeholder interviews; GreenMax Capital Advisors analysis

Surveyed stakeholders indicated that Azuri, Barefoot, BBOXX, d.light, Fosera, Lagazel, Schneider, Sun King and Yingli are among the most common pico solar brands across the region. Solar module brands present in several countries include Amerisolar, Jinko Solar, Solar World, Suntech, Sunpower and Yingli, generally imported from Asia, Europe or the U.S. The main inverter brands identified in multiple countries in the region include Victron, SMA, Steca, Schneider, Frokus and Outback, while Victron, Hoppecke, Ritar, Su-Kam and Steca are the most commonly sold batteries, typically imported from Asia and Europe.

➢ **Importation Clearance Processes**

The importation process for solar products, systems and components, including the government agencies involved, taxation rates/exemptions, approximate lead times, and quality standards are described in **Table 39**. In most countries, the agencies involved in the importation of OGS products typically include Ministries of Finance, Customs and Tax authorities, and Rural Electrification Agencies (REAs). Duty exemptions are most commonly applied to products imported by governments or REAs, typically for donor or development-funded projects. The REAs in Benin (ABERME) and Liberia (RREA) manage and oversee the importation of solar equipment in each country.

The market assessment identified trade barriers and tax-related challenges as key barriers to OGS market growth across the region. While most of the countries (14 of the 19) have some kind of tax-related financial incentive in place for solar equipment (e.g. VAT and/or customs/import duty reductions or exemptions), many of the identified initiatives do not target all solar products and components. For example, exemptions may only apply to solar panels but not to other system components (e.g. battery, inverter). Feedback from focus group discussions and local supplier surveys also highlighted concerns that even where tax exemptions exist, the implementation of these measures often lacks coordination between customs and regulatory authorities and is therefore ineffective. In practice, duty exemptions for solar equipment are not implemented consistently across national markets, nor are they harmonized at the regional level.

Interviews with local suppliers and industry stakeholders revealed that shipping lead times vary widely across the region. While shipping can take as little as 30 to 45 days in some countries (Ghana, Guinea, Mali and Sierra Leone), lead times can be significantly longer in others – averaging about 75 days in Burkina Faso, Côte d'Ivoire and Senegal, and going as high as to 125 to 150 days Nigeria and even higher in in CAR, Chad and Niger.

Product quality remains an ongoing challenge across the region, largely due to a lack of enforceable standards during the importation process. Although most countries have pledged to adopt international standards, in practice, standards are only applied to a small share of imported off-grid solar products. With the exception of a few countries (e.g. Cameroon, Gambia, Ghana, Nigeria, Senegal, Togo) there are few national agencies or regulatory bodies dedicated to implementing standards at a national level.

As described in **Section 4.2 (Capacity Building and Technical Assistance at Regional Level)**, the ECOWAS Trade Liberalization Scheme (ETLS) is an internal market liberalization initiative that aims to eliminate customs duties and non-tariff barriers across the region. This could be applied to solar equipment to expedite the importation process and ensure quality standards of products. The ECOWAS Common External Tariff (CET), which formally came into effect in 2015, is expected to expedite the region's progress towards a common market by removing obstacles to the free movement of goods within countries.[250] Trade integration, however, has been a slow-moving process, as the impacts of these schemes on countries like Nigeria complicate these dynamics.[251]

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[250] The Common External Tariff: http://www.ecowas.int/wp-content/uploads/2016/06/CET_Factsheet_EN.pdf

[251] "Political Economy Dynamics of Regional Organizations in Africa," ECDPM: http://ecdpm.org/wp-content/uploads/ECOWAS-Trade-Policy-Brief-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

Table 39: Importation Clearance Processes in West Africa and the Sahel

Country	Government agencies involved	Taxes applied on solar products	Approximate No. of days to import	International standards	National standard bodies/provisions
Benin	ABERME (Rural Electrification Agency)	Exemption on all off-grid products ordered by ABERME, Exemption on solar panels, 8% tax on other products/components	75 business days: - 45 for freight time, - 30 days for customs clearance	For cooperation and development aid projects (SNV, GIZ): - GOGLA; - Lighting Africa	None
Burkina Faso	1. Ministry of Finance 2. General Directorate of Customs 3. Ministry of Energy 4. ANEREE	Duty exemption on all products (VAT and taxes)	90 business days (av.): - 30 days for freight time - 7 to 21 days for customs clearance	Lighting Africa but only for a few brands (e.g. Lagazel)	ANEREE
Cabo Verde	-	Duty exemption (VAT and taxes) on all products Lack of clarity in implementation Provisions cover mini-grids but not off-grid Some components are applied an ecological tax (batteries).	60 business days	-	-
Cameroon	1. Ministry of Finance 2. Rural Electrification Agency (AER) 3. Ministry of Energy and Water (MINEE) 4. Cameroonian Customs Agency	Customs duty exemption, while a processing fee is still in place	-	Lighting Africa, not compulsory	ANOR (Cameroonian Agency for Standards and Quality) has started to develop national standards for solar PV
Central African Republic	Rural Electrification Agency (ACER)	No duty exemption and taxes that apply to solar panels and products include: - 31% for freight, - 19% for VAT, - 5% for customs.	95 business days: - 90 days for freight time, - 5 days for customs clearance	Lighting Africa for some imported component-based products	None
Chad	1. Ministry of Economy 2. Ministry of Trade and Tourism	No duty exemption. The CEMAC Common External Tariff applies to solar products: - community charges that amount to 1.45%, - 10% for primary material and equipment, 20% for intermediate goods and 30% for consumer goods (e.g. electronics) - 20% excise tax on luxury products (including home appliances), - 18% VAT to all imported goods, - 2% statistical tax to all goods entering Chad.	105 to 195 business days: - 90 days for freight time, - 15 days for customs clearance, - 90 days to get government approval	-	None
Côte d'Ivoire	1. Ivorian Customs 2. Abidjan Port Authorities 3. Directorate General for Taxation (DGI)	9% VAT on solar modules 18% tax on all other products	100 business days: -10 days to order, - 45 days for freight time, - 45 for customs clearance		None currently but two potential ones identified: 1. LBTP (the Construction and Public Work Laboratory) 2. CODINORM (the standardization agency)

The Gambia	1. Ministry of Finance 2. Ministry of Petroleum and Energy 3. The Gambia Ports Authority	Duty exemption on all products In practice, it only applies if a government agency is involved and a 25% tax apply for products ordered by private companies	Between 35 and 60 business days: - 30 to 45 days for freight time, - 3 to 14 days for customs clearance	-	None
Ghana	1. Energy Commission 2. Ghana Revenue Authority 3. Ghana Ports and Harbors Authority 4. Ghana Standards Authority	Customs duty exemption on all products	45 business days - 5 days to order, - 30 days for freight time, - 5 days for customs clearance, - 5 days to get approval by local authorities	GOGLA Lighting Africa	Specific national standards quality provisions based on GOGLA and Lighting Africa
Guinea	1. General Directorate for Customs 2. National Tax Directorate	-	37 business days - 30 days for freight time, - 7 days for customs clearance	Lighting Africa for some products	None but one body identified: 1. Professional Association of Renewable Energy and Solar (APER), which is a member of GOGLA international network.
Guinea-Bissau	1. Ministry of Finance and Economy (General Directorate of Customs) 2. Ministry of Commerce (General Directorate of Commerce) 3. Public Investment Department (General Directorate of Planning)	No duty exemption and solar products are applied a 10% government tax calculated ad valorem.	35 to 50 business days: - 10 to 15 days for freight time, - 14 for customs clearance, - 21 days for port clearance.	-	None
Liberia	1. Ministry of Finance and Development Planning 2. Ministry of Energy 3. Ministry of Commerce and Industry 4. Bureau Veritas Liberia (BIVAS)	Taxes are paid as follows: -1.5% Free on Board (FOB) price for BIVAC inspection -1.2% to the MOCI or a minimum of USD 190 - 15% customs duty - 10% ECOWAS Tax - 7% Good and Services Tax Taxes on solar Pico can reach 25%. Customs duty exemption for products imported by RREA.	Between 47 and 61 days: - 42 to 56 days for freight time, - 5 days for customs clearance (including approval by authorities)	Lighting Africa for products imported by RREA.	None
Mali	1. AMADER 2. AER-Mali	Customs duty exemption for VAT and certain taxes only. Remaining taxes are the community levy (CP), the community solidarity levy (PCS) and the statistical fee (RS)	Less than 35 days: - less than 30 days for freight time, - 2 to 5 days for customs clearance, - no need for authorities' approval for exempted products	-	-
Mauritania	1. Ministry of Finance 2. Ministry of Trade	No duty exemption Imported solar products are applied a 34% tax.	43 business days: - 40 days for freight time, - 3 days for customs clearance.	-	Technical specifications required by the Public Procurement Commission for invitations to tender.

Niger	1. Customs Authority 2. Tax Authority	Partial tax exemption. Taxes are paid as follows: - 1% statistical fee, - 1% Community Solidarity Levy, - a 1% import tax and all products, - 19% VAT.	120 business days: - 60 days for freight time, - 60 days for customs clearance.	IEC-approved standards for some imported products.	None
Nigeria	1. Ministry of Finance 2. Rural Electrification Agency (REA) 3. Nigeria Electricity Regulatory Commission (NERC) 4. Nigeria Custom Service 5. Standard Organization of Nigeria (SON) A total of 12 agencies can be involved in the customs clearance process.	Customs duty exemption is not total: - 10% tax on solar panels, - 20% tax on batteries and inverters.	Between 125 and 150 business days: - 75 to 90 days for freight time, - up to 60 days for customs clearance	GOGLA Lighting Africa	National standard provisions based on GOGLA, Lighting Africa, IEC and ISO.
Senegal	1. Ministry of Finance 2. Ministry of Petroleum and Energy 3. Rural Electrification Agency of Senegal (ASER) 4. Renewable Energy Agency (ANER).	High taxes and customs duty exemption only apply for licensed operators working under government contract. Taxes are paid by private companies as follows: - 24% on solar panels, - 48% on batteries and solar street lights - 30% on inverters and solar water pumps.	Between 21 to 75 business days: - 14 to 21 days for freight time from Europe, - or up to 60 days for freight time from Asia, - 7 days for customs clearance - 10 to 15 days for government approval	GOGLA Lighting Africa	None
Sierra Leone	1. Ministry of Finance (issues a certificate of attestation for the importer) 2. REASL (issues a certificate of good standing for the importer) 3. National Revenue Authority and Customs	-	Between 30 to 45 days (can be as short as 14 days or longer than 45 days)	Lighting Africa	Work underway to fasten the process by involving the Standards Bureau instead of the Ministry of Energy
Togo	1. Togolese Revenue Authority (ORT) 2. Standards Agency (ATN)	WAEMU common external tariff is applied: -18% VAT, - 5% Customs duty on Category 1 products (capital goods), -10% on Category 2 products (intermediate goods) and 20% on Category 3 (final consumption goods), - 1% Statistical charge, - 1% Community Solidarity Tax (PCS). Exemptions and reductions of import duties, company tax, minimum flat tax, property tax and VAT on solar (Togo Electrification Strategy).		Lighting Africa	Existing Togolese Standards Agency (ATN). The CIZO program aims to reduce taxes and import duties on solar products.

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

6.6.4 Overview of Off-Grid Solar Business Models

- **Company Approach to Market**

Historically, solar companies across the region have developed as vertically integrated companies, based on in-house design of solar systems, outsourcing of manufacturing and partnerships with international brands. While some companies have been in business for over ten years (e.g. Sogelux in Côte d'Ivoire since 2003, Yandalux in Burkina Faso since 2004, Maguysama in Cameroon since 2003), most international and regional companies targeting the household segment and offering PAYG (e.g. BBOXX, Total, Baobab+ etc.) only recently entered the region's market within the last five years.

In the most mature markets – e.g. Nigeria, Ghana, Côte d'Ivoire – solar players are long-term and well-established market players 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. Their supply chain includes a number of 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. In exchange, manufacturers often support local suppliers with technology transfer and capacity building. In other countries, large international solar companies have moved from the vertically integrated business model and have started to specialize, while also partnering with mobile money operators (e.g. Lumos with MTN in Nigeria, Fenix International with Orange in Côte d'Ivoire), or large energy utilities (e.g. Zola is a joint-venture between Off-Grid Electric OGE and EDF in Côte d'Ivoire).

The predominant business model utilized across the region remains cash/over-the-counter sales, although a growing number of firms are offering consumer financing solutions (e.g. PAYG and lease-to-own) to reach low-income households and base-of-the-pyramid (BoP) users in the market. In Côte d'Ivoire, for example, PAYG represented a majority of OGS product sales in the first half of 2018.[252] A few companies (e.g. Arnergy and GVE in Nigeria, Yeelen Kura in Mali and FRES in Guinea-Bissau) are expanding their consumer financing options by launching the energy-as-a-service business approach. Under this service, the off-grid provider retains ownership of the product (and the associated risk) and ensures maintenance and repairs. The client does not own the product and also does not have to pay upfront costs (like in the PAYG model), which is often a challenge for BoP populations with a low ability to pay.

On the other end of the spectrum, in markets where solar development remains limited (e.g. Central African Republic, Chad and Niger), off-grid solar is typically not the main business activity for companies operating in these markets. In Niger, for instance, most solar companies are Engineering Procurement and Construction (EPC) companies who recently started to offer OGS products (e.g. Benalya and La Sahélienne du Génie Électrique). In Chad, off-grid solar activities have developed as a side activity of energy and construction companies, and in CAR it is also a side business of larger telecommunications and ICT service providers (e.g. IBM Technologie Miracle Télécom, Startimes). Consumer financing is typically not offered in these markets and is usually only part of government or donor-funded initiatives.

Although some companies have started to focus on specific consumer market segments (e.g. households), most companies continue selling a wide range of products to a variety of customers. For most formal solar companies, their most important clients are large institutional groups such as government, NGOs, and public facilities (e.g. schools and health facilities), as well as high-income households. Companies that only use cash/over the counter sales are typically retailers selling low-quality products without a warrantee.

[252] "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

➢ Business Models

There are four primary business models used widely across the region, while one is currently only in its pilot phase (**Table 40**). In practice, solar companies utilize a number of business models to reach a variety of clients, depending on their technical and financial capacity to do so.

Table 40: Overview of Off-Grid Solar Business Models

Business Model	Description	State of Development
Over the counter cash sale solar market	• Over the country cash sales include both formal and informal market segments and typically account for the majority of market share in terms of cash value • Formal sector solar companies also stock modules batteries and balance of system components and offer them to sales agents and customers • Retailers of lighting / electrical solar products can be both large scale (suppliers and distributors) and medium size and are typically located in large cities and towns • Kiosks, street vendors form a pico-product retailer segment and usually sell low priced products which are often short-lived (seen as an entry point for black market low-quality solar products)	Mature commercial market
System integrators	• System integrators manage larger systems and projects and typically design, procure and install systems that range from high-end residential sites to institutional power, and mini-grids • Local integrators often represent international solar, inverter and battery brands with whom they partner with to develop projects • Operate out of central offices with small specialized staff • 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	• Plug- and-play and pico suppliers cooperate with many of the major OGS brands to distribute equipment to retailer, street vendors, rural agents, community groups and over the counter • Traders of plug-and-play systems normally sell these devices as part of other businesses	Early stage commercial development
PAYG Sales	• The PAYG sector is still in its early stages in West Africa and the Sahel • 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 platforms 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 already underway in many ROGEP countries • Suppliers are building up client bases and are evolving rapidly to develop credit mechanisms that fit with local income patterns	Early stage commercial development
Fee-for-a-service (or Energy-as-a-service)	• The energy-as-a-service model is relatively new in the region as well as 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 OGS products and systems. 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: African Solar Designs analysis

- **Company Financing**

With overall lack of financial assistance and dedicated financing mechanisms available for the off-grid sector, it can become difficult for companies to finance their operations and grow their business. In addition to financing customer payment options, suppliers also require significant working capital to purchase equipment, conduct marketing campaigns, cover field costs, high cost of merchandise transportation from supplier and estimated high risk of theft. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited. Most of the firms surveyed across the region are self-financed with cash flow covered by shareholders and founders and from on-going business transaction. A few firms are supported by FI/MFI loans, donor funding/grants, but these resources are limited for most. Most companies receiving GIZ's grants are initially self-financed, as grants are only awarded upon delivery of the off-grid systems and after a quality check by GIZ to verify the system is working properly.

As the majority of players are local companies operating in the country, they do not have access to loans, equity and other international funds to finance their growth and development. As a result, most of the solar companies in the region 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.

When importing, companies are exposed to considerable FOREX 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 FOREX losses. The lack of consumer financing arrangements 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**

West Africa and the Sahel presents a fertile ground for new business model innovations. New models will require partnerships between developers, solar distributors, telecommunications companies, commercial finance and the retail sector. One of the results of the FGDs was a list of potential partnerships that can be explored to enhance existing and new business models (**Table 41**).

Table 41: Off-Grid Solar Business Model Evolution

Partnership	Description
Solar Distributors	• 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 each country 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	• 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	• 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	• 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	• Capitalize on government 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: African Solar Designs analysis

6.6.5 The Role of Informal Market Players

Stakeholder interviews and FGDs were not able to estimate the size of the over-the-counter informal market. 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 controls the delivery of lighting products imported mainly from East Asia. Informal traders understand growing consumer interest in solar solutions and sell competitively-priced low-quality products. Informal traders do not actively cooperate with governments or on formal projects. In some of the countries, surveyed stakeholders indicated that informal suppliers sell low-quality products at the price of high-quality products.

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 region’s OGS market.

6.6.6 Equipment Quality and the Impact of Uncertified Equipment

Solar markets in West Africa and the Sahel are largely dominated by informal market players, selling equipment through electronics shops, hardware stores, kiosks and 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 warrantees.

A majority of suppliers who were surveyed cited counterfeit products as a significant barrier to market growth. Poor-quality and/or counterfeit 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. Feedback from focus group meetings suggested that there is a role either for government regulatory bodies, renewable energy and rural electrification agencies and/or associations to assist in enforcement of standards through mediation efforts between regulators, market players and consumers.

6.6.7 Local Capacity to Manage Business Development, Installation and Maintenance

The nascent solar markets across the region are 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.

Unfortunately, local capacity to support solar PV market development, installation and long-term O&M is lacking at the regional level. A few countries mentioned there was support from local Renewable Energy Associations (e.g. APER in Guinea and REAN in Nigeria), but this only exists in a few countries. Focus group participants indicated that as a result, large companies acquire technical support through donor-funded programs and capacity building initiatives. In more mature markets, solar companies also acquire technical support through existing partnerships outside of the country.

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:

- 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.[253] 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.

[253] Regional-level training initiatives can take advantage of regional networks that already provide these services throughout Africa, such as the African Network of Centers of Excellence in Electricity (ANCEE).

6.6.8 Capacity Building Needs of the Supply Chain

Feedback from focus group discussions, interviews with industry stakeholders and surveys of suppliers revealed a number of interrelated challenges for the OGS supply chain, including financial, capacity, awareness and regulatory challenges:

- Tax exemptions do not apply to all solar products
- Local financing is largely not available (or affordable) to support the sector's development, except for a minority of large local companies; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations
- Reasons for denied finance by financial institutions included lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion.
- An improved regulatory framework is necessary to ensure product quality. The lack of control of product quality and the import process has led to an influx of low-quality equipment, which negatively impacts perceptions of solar. There are few standards in place (outside of donor-related equipment) to address this critical issue. Tackling this challenge also requires harmonization of pricing in the market.
- Capacity building efforts are also lacking. The main areas that would require capacity building are at the technical level (installation, operation and maintenance of systems), and also marketing and sales.
- Knowledge, technical capacity and expertise is reserved to 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.

Table 42 presents various areas of support and associated capacity building for the OGS supply chain in the region. Attention should be given to the following:

- **Importers/Suppliers**: Reducing the cost of importing solar PV products and components must be a priority as a lack of financial incentives is a major barrier to market growth. Make financing available for importers and distributors to allow suppliers to more easily stock and renew inventory. The way many markets are currently structured inhibits their growth.
- **Over-the-counter/System Integrators/PAYG**: Focus on growing the number of solar technicians who are adequately skilled to support the supplier network, especially in rural areas. Formalizing this through regulation to require only licensed technicians to design and install solar PV systems is critical. This should be complemented by equally robust efforts to build the capacity of all supply chain stakeholders.
- **Consumers**: Deal with sociotechnical barriers – although solar technology has advanced tremendously in the last decade, there are still several sociotechnical barriers to adoption, including the local conditions of end-users and the political and financial arrangements of the market. In most countries in the region, various counterfeit solar PV products have infiltrated the market. Implementation of regulations and quality/standards to ensure product quality could significantly boost market growth.

Table 42: Capacity Building and Technical Assistance for the OGS Supply Chain[254]

Area of Support	Description	Rationale
Tax exemptions on solar technology	• Implementation of VAT and import duties exemption on all solar products, systems and components	• Costs of solar products are inflated by import duties; costs are passed on to customers, making solar less affordable.
Quality control/certification agency	• Suppliers are able to effectively monitor the quality of imported products • Ensure that imported products are suitable/relevant to the local country context	• Ensure the quality of products and face the influx of low-quality products • Maintain the trust established between solar industry and customers
Consumer education programs	• Supplier and consumer education and benefit awareness campaigns, targeting both segments, distributors and retailers, with a focus on rural populations	• Overcome negative perceptions and strengthen trust established over the years • Influence purchase decisions, with a focus on rural areas and ease access to distribution channels
Inventory financing facility	• 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	• 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	• Private sector lending portfolio is de-risked through guarantees/loss sharing agreements	• De-risking encourages private sector lending to solar sector; initial security until economic viability of lending to solar businesses has been established
Market entry and expansion grants	• Combination of upfront grants and results-based financing to invest in infrastructure and working capital	• Significant upfront investment to build distribution network and source inventories to serve household market
Technical assistance	• Help solar companies set up technology platforms for PAYG • Capacity building for solar technicians to enable installation and O&M of equipment • Assess rural communities needs to inform the right business model case by case • Capacity building for rural suppliers	• Make the business environment more conducive and profitable • Strengthen the overall ecosystem surrounding the solar market • Strengthen capacity across the sector • Ensure knowledge transfer from abroad for faster, more cost-efficient progress

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

[254] Capacity building interventions are proposed for all ROGEP countries at national and regional level under ROGEP Component 1B: Entrepreneurship support, which includes TA and financing for companies in the solar product value chain. Through this component, TA 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.

6.7 Key Barriers to and Drivers of Off-Grid Solar Market Growth

This section reviews the key barriers to and drivers of off-grid solar market growth in the region. 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.

6.7.1 Barriers to Off-Grid Solar Market Growth

As the off-grid market continues to develop in West Africa and the Sahel, a number of barriers have been identified that are hampering growth of the sector. **Table 43** examines the key barriers to OGS market growth in the region from the perspective of both the demand and supply side of the market.

Table 43: Barriers to Off-Grid Solar Market Growth

Market Segment	Market Barrier	Description
All market segments	Policy/regulatory barriers	• Governments are yet to develop coherent policies to support development of the off-grid sector as coordination of policy measures needs to be improved at both national and regional levels; consultations are needed for policy initiatives to be more aligned and efficiently implemented in practice. • Import duties and taxation for solar products are high—only some countries have adopted exemptions and other supportive policy measures, which are critical for private suppliers to enter a market. • Duty exemption measures exist in most countries but do not target all solar products (for example, exemption is only on solar panels but not on other solar components) or implementation lacks effectiveness; very often, there is little planning to coordinate this with customs authorities, the National Revenue Authority, standards bodies, and other institutions (Port Authority); in practice, duty exemptions have not been offered consistently. • Customs clearance procedures can be lengthy and expensive, which adds to retail pricing and decreases profit margins for suppliers. • While some tax exemptions for solar products exist, Governments have not done enough to disincentivize substitutes of solar (for example, diesel generators) to make solar a more attractive option. • There is a lack of consumer protection, and in general, there is a lack of a regional licensing or standards framework to regulate the products and models that are being imported and disseminated to the solar market; there is a need for some standards in the solar industry, which would improve safety of the product, the reputation of the solar products, and harmonization of the equipment for the ease of maintenance and spare parts; there is also no coordinated or standardized regional licensing framework for solar installers and technicians to ensure installation and O&M practices are in place. • Global Off-Grid Lighting Association (GOGLA) and Lighting Africa standards are not applied in most countries, and when there is a national initiative to develop standards, it does not seem to be coordinated with international standards. • In many countries, the lack of a supportive regulatory framework has contributed to growth of the informal OGS sector, which continues to import and distribute low-quality solar products (lanterns and panels) that account for more than half of the sales on average across the region.
	Currency risk	• 11 of the ROGEP countries do not face major currency risks, as 8 countries are part of WAEMU and 3 are part of the Central African Economic and Monetary Community (CEMAC). • Other countries (for example, Sierra Leone, Nigeria, and Ghana) have high currency risks; for example, in Sierra Leone, the very high currency risks of the country make investment in stock and PAYGO also risky (products in rural

Market Segment	Market Barrier	Description
		areas are sold in Sierra Leoneans, which is depreciating at an increasing rate against the U.S. dollar, for which the products are bought outside the country).
	Lack of local technical capacity	• There is a general skills gap/lack of local technical capacity throughout the OGS supply chain, adversely affecting all market segments and hampering the sector's growth; a common theme across countries (and market segments) is the overall lack of qualified technicians to support ongoing O&M, which is critical for the market's long-term sustainability.
	Limited access to finance	• Although the need for efficient solar power solutions is high, purchasing power for solar products of all varieties among consumers is low. Except for donor programs in select countries and PAYGO schemes offered by certain market actors, consumer finance is generally not available in most countries throughout the region; during focus group meetings across the 19 countries, the cost of solar systems was identified as the biggest impediment to the growth of the sector. • Local OGS businesses lack access to working capital, which is a primary constraint to their growth/ability to expand operations.
Household	Consumers are unable to afford solar systems	• Low rural incomes and lack of access to finance among households. • Relatively high costs of OGS systems with disparities between low-cost informal systems and high-quality licensed systems. • This is a significant issue for low-income countries (for example, Sierra Leone, Niger, Chad, and Central African Republic), where purchasing power for solar products of all varieties among end consumers is low—despite the demand for these products.
	Lack of understanding of and trust in solar solutions among consumers and actors impedes the development of the market	• There is still considerable lack of general awareness and familiarity with OGS technology solutions, especially in low-income and rural areas, where products are not widely available. • Lack of awareness also leads to misperceptions/a lack of trust, particularly if consumers previously had bad experiences with poor-quality solar products. • There is an inability to distinguish between solar products or product quality. • Consumers lack information and understanding about the most suitable design options, funding options, PAYGO benefits and options, points of sales and support, and so on. • Consumers need to understand the quality and value issues of quality solar products in relation to inferior over-the-counter lighting products and generators—educated consumers drive markets.
Institutional	Limited financing available for institutions	• Institutional solar solutions are often larger installations that are more expensive and require higher initial capital investment that many institutions lack (due to budgeting and so on).
	Lack of experience in procuring the right solution for the institution	• Similar to the households, any poor history/track record with OGS will deter institutions from taking expensive risks.
	Lack of data	• Clear data, figures, and so on, on the actual needs and energy usage or experience among institutional users are very limited. • Difficulties in estimating the current market size (value, number, and units sold).
Productive Use	Consumers are unable to afford solar systems	• Low rural incomes and lack of access to finance. • Higher up-front costs of OGS systems designed for productive use (for example, agricultural or milling equipment). • Although the need for efficient solar power solutions is high, purchasing power for solar products of all varieties among end consumers is low. Absence of end consumer markets for solar PV systems deters most new entrants.
	Misperceptions about value of OGS for productive use	• Educating productive sector clients that solar is robust enough to meet their needs is very important (and it is not only about small household lighting); many commercial clients only believe that solar can simply replace the generator.

Market Segment	Market Barrier	Description
	Supportive policies targeting productive use	• Lack of supportive policy for stand-alone solar systems appliances—East African markets are finding that appliances for productive use sector are driving demand and they require special policy and regulatory support.
Supplier	Financial and logistical constraints	• Devices and equipment are shipped from overseas (China, India, the United States, and Europe), which creates long delivery lead times (in some cases up to several months); this in turn creates other logistical and financial barriers for companies that must in turn manage storage to maintain inventory and meet consumer demand on time. • High transportation costs of inventory from sources deter new entrants; transport by container would reduce the costs dramatically but requires purchases in bulk, which local solar distributors are not able to make without financing. • Solar companies are geographically concentrated in the capital or in regional capitals and must allocate significant financial resources to serve rural areas.
	Lack of technical capacity/transportation and skills	• Overall lack of skilled technicians and low level of qualifications and training. • Very few companies integrate O&M into their business model,[255] which is critical to the long-term sustainability of the sector.
	Poor sales and performance history of the sector	• A lack of investment into the sector prevents growth due to the perceived high risks resulting primarily from lack of track record of sales. • Solar distributors have limited alternative financing options; while major solar companies can get a credit from their suppliers, the majority do not have access to credit and are self-financed. • Many solar suppliers do not provide trade financing/credit; international companies and distributors representing international brands are offered credit by suppliers. • Commercial financiers including banks and MFIs are largely not positioned to service the financing requirements of solar distributors.
	Lack of company finance	• 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 easier to obtain debt financing and other loans once the solar companies have sufficiently grown and reached the 'level of interest' of the bigger funds, but until the number of customers and sales volumes are reached, they need some equity investors that would share higher risks with the original founders of the companies. • Foreign exchange risk mitigation measures are needed for the local companies, for countries where the majority of supplies are paid in U.S. dollars (not WAEMU or CEMAC zone where the euro is commonly used).
	Informal sector competition and market spoilage	• The informal market is problematic for OGS consumers and suppliers—the presence of unlicensed products results in poor-quality products for consumers and prevents licensed private players from sustainably developing market share.

[255] One notable exception is in Mali, which has an interesting example of Yeleen Kura, a company which operates in rural areas and has put in place a leasing solar pico type of contract including O&M.

6.7.2 Drivers of Off-Grid Solar Market Growth

Table 44 is a summary of the key drivers of OGS market growth in the region from the perspective of both the demand and supply side of the market.

Table 44: Drivers of Off-Grid Solar Market Growth

Market Segment	Market Driver	Description
All Market Segments	Strong off-grid electricity demand	• The population across the region is underserved, as electricity needs are much higher than what national utilities can offer in the short and medium-term (e.g. through grid extensions) • While consumer awareness is still a barrier to market growth, end-users are gradually becoming aware of the high costs associated with energy access and consumption and are willing to take on cost-effective alternatives
	Increasing demand for consumer appliances and electrical equipment	• There is rapidly increasing demand for consumer appliances that require electricity (e.g. cellphone, radio, TV, refrigerator etc.)
	Decreasing trends in the cost of solar equipment	• Solar system costs (panels, batteries, inverters etc.) have been rapidly declining for several years and will continue to decrease, which should continue to increase the affordability of the technology for customers
	Increase rates of mobile phone ownership, mobile internet penetration and mobile money services	• Increasing rates of mobile phone ownership, mobile internet usage and penetration rates of mobile money services in many countries across the region indicate that the market is ready to adopt off-grid PAYG solutions
	Governments are willing to support the industry	• Governments across West Africa and the Sahel are giving increasing policy attention and momentum to the OGS sector as part of rural electrification targets and planning, which provides clear market signals to the private sector and attracts sustained investment • Governments are also adopting rural electrification agencies, policies and master plans to meet targets
	The presence of 'anchor markets' will spur best practices for the region	• Although the region is a late adopter of solar PV technology, some markets have developed more rapidly and can serve as 'anchor markets' (e.g. Nigeria, Ghana, Togo) that other countries can leverage for best practices and lessons learned (the same was that Kenya has done for East Africa).
	Strong donor/NGO presence and engagement	• Many donor agencies, development partners and NGOs are active in the off-grid sector across the region (e.g. World Bank, AfDB, EU, AFD, USAID, DFID, GIZ) and are working to provide financing and technical assistance necessary to catalyze market growth • The wide range of donor-funded activities in the region provides confidence that the market will continue to receive the support it needs to develop
	Engaged and adaptive private sector	• Dozens of international solar companies are either already active in countries across the region or have expressed interest in entering the market • Local solar companies are willing to lead market reforms to the sector, accept new business models and strategies and implement improvements to attract external investments

VII. ANALYSIS OF THE ROLE OF FINANCIAL INSTITUTIONS

7.1 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 stand-alone 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 microfinance institutions (MFIs) in providing debt financing to off-grid solar consumers and enterprises.

7.1.1 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 micro enterprises on this basis while FIs often limit their lending to SMEs with strong balance sheets and available collateral.

- **Commercial and Industrial**

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.

7.1.2 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 up to 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.[256]

- **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.[257]

[256] 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.

[257] 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.

7.2 Financial Inclusion

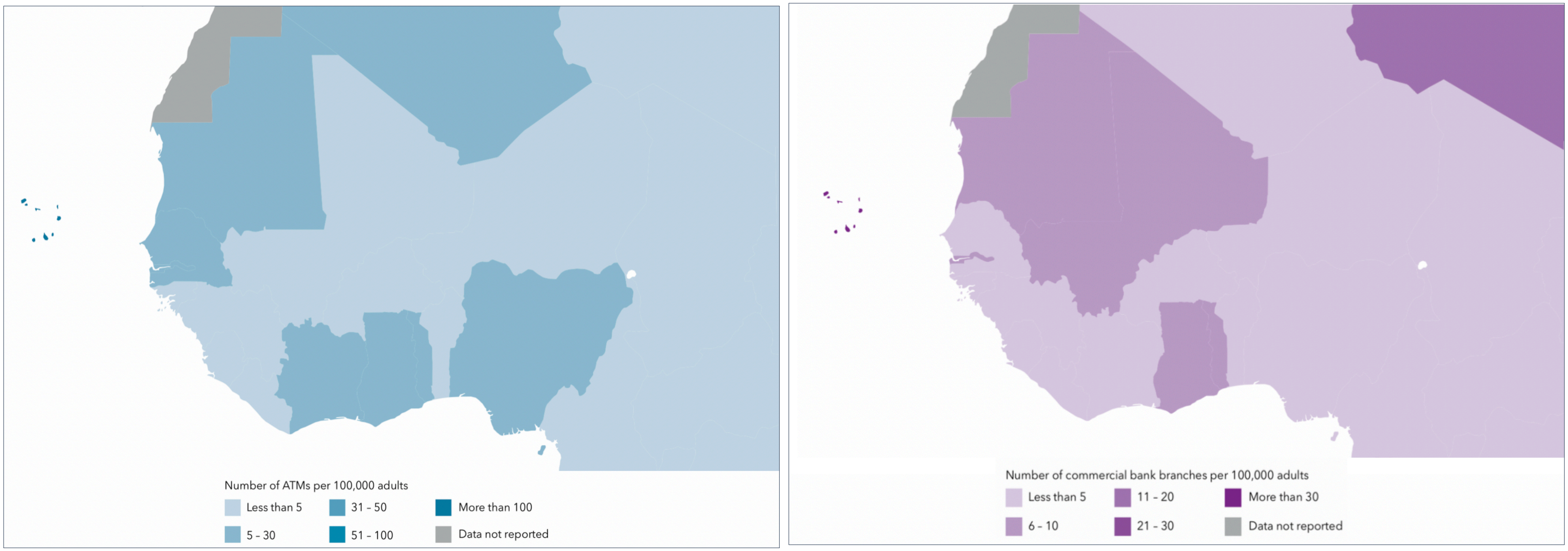
7.2.1 Access to Financial Services

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 78**).[258] 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%.[259] Many countries across the region have also seen a sharp increase in mobile money account ownership (**Figure 79**) and transaction volume (**Figure 80**).

[258] "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

[259] Demirguc-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 78: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017[260]

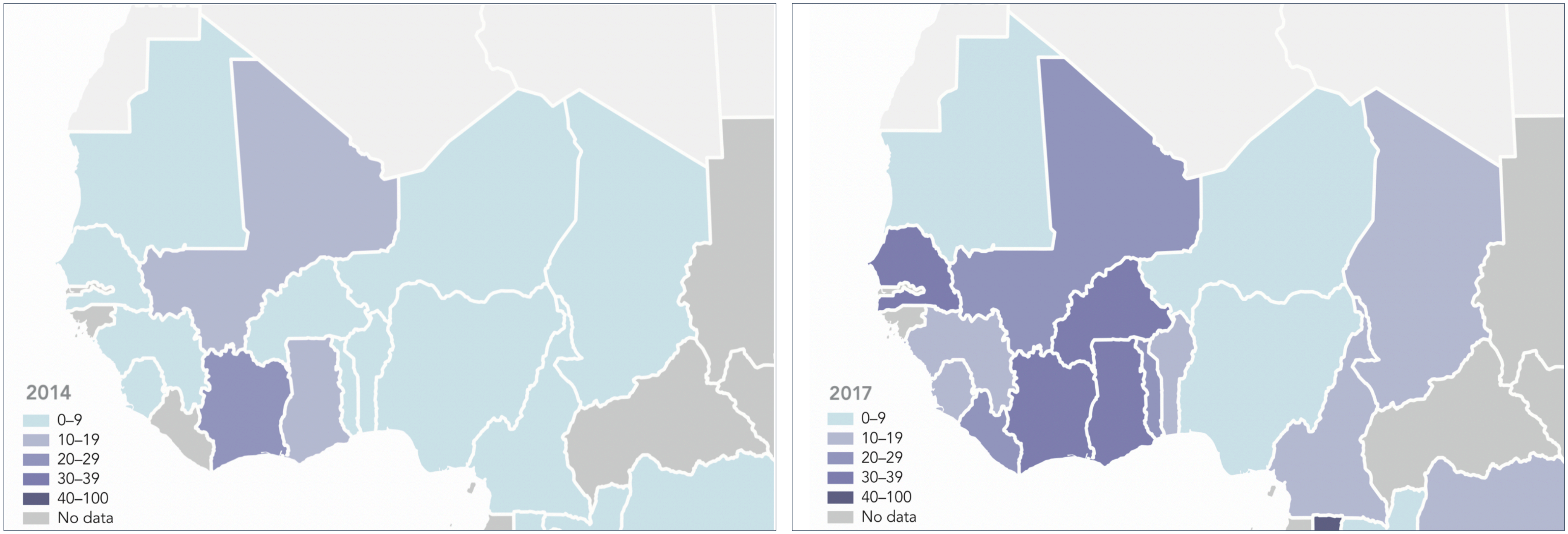


Source: International Monetary Fund

Figure 78 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.

[260] International Monetary Fund – Financial Access Survey: http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460054136937

Figure 79: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[261]

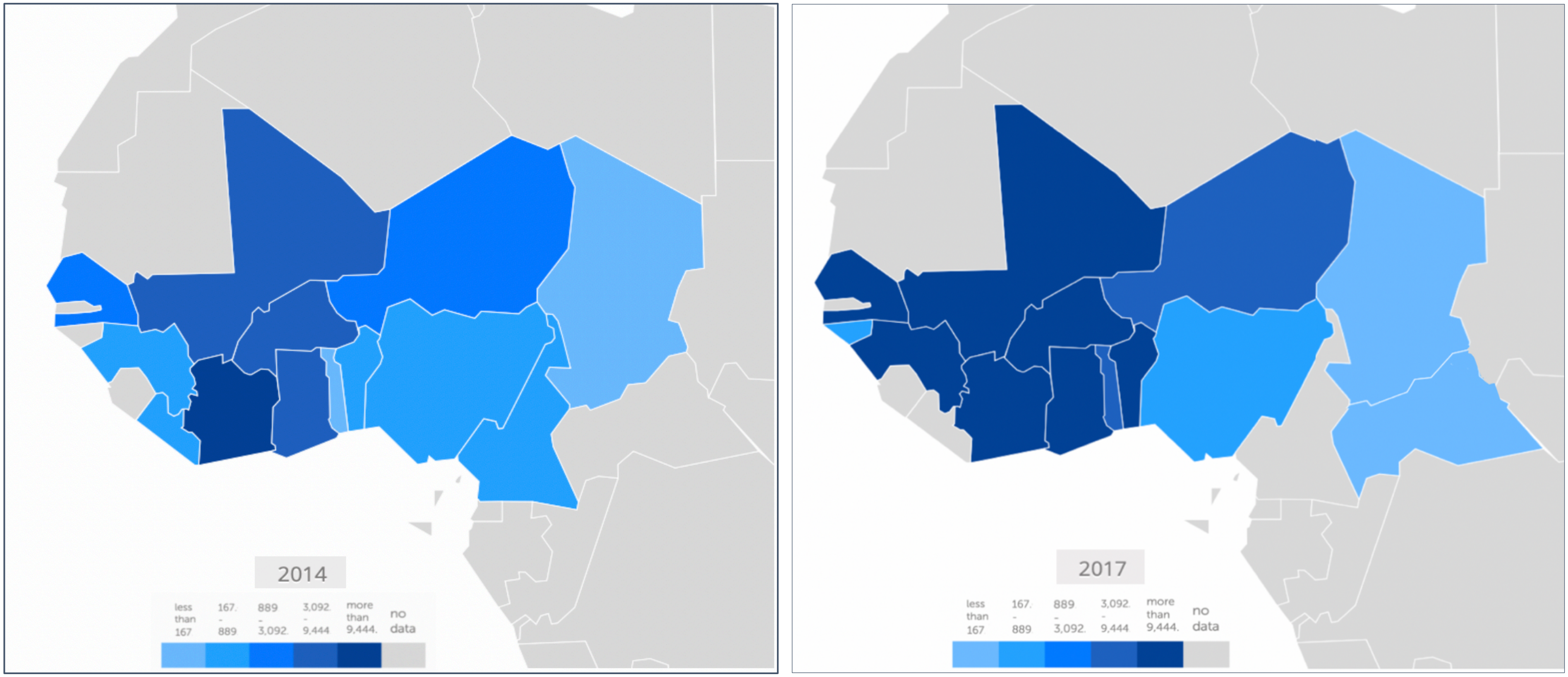


Source: World Bank Global Findex Database

Figure 79 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.

[261] Demirguc-Kunt et al., 2017.

Figure 80: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[262]



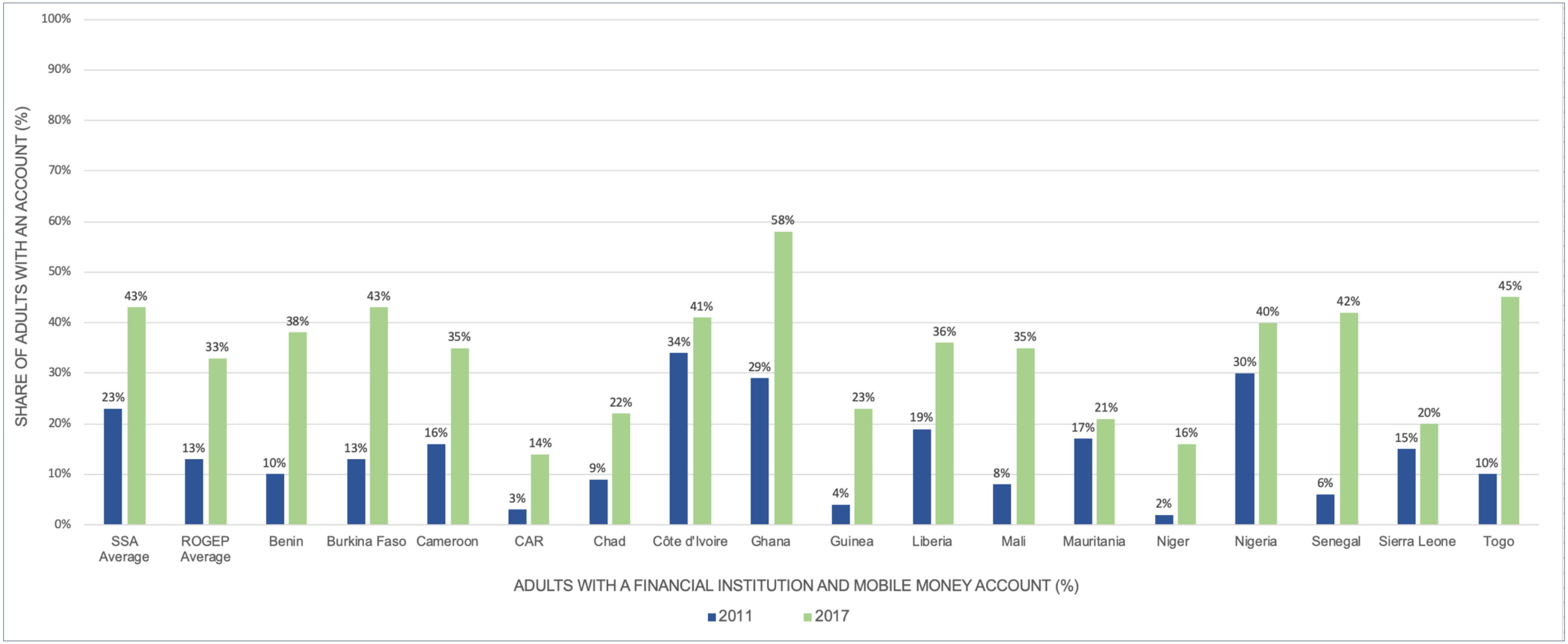
Source: International Monetary Fund

Figure 80 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.

[262] International Monetary Fund – Financial Access Survey: http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460054136937

In 2017, 33% of the adult population in West Africa and the Sahel had an account at a financial institution or with a mobile money service provider, up from 13% in 2011. In 2017, the region was 10% below the average for Sub-Saharan Africa (**Figure 81**).

Figure 81: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017[263]



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

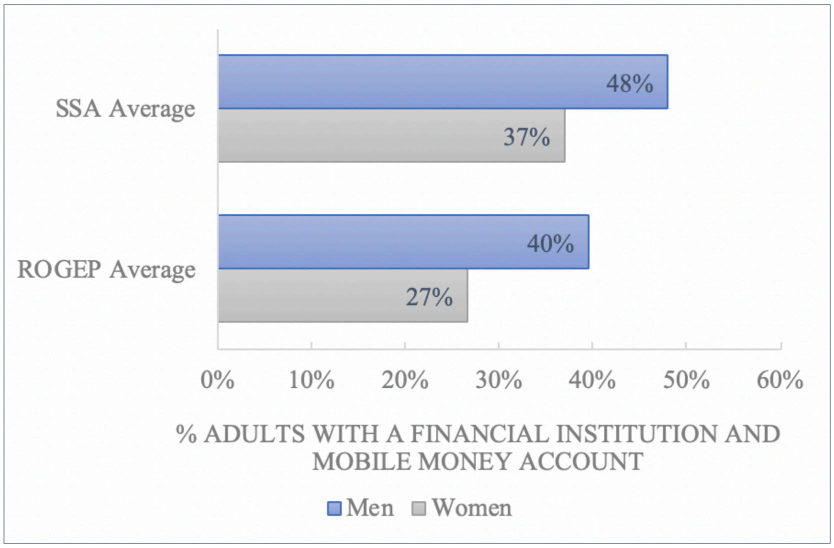
Source: World Bank Global Findex Database

[263] Demirguc-Kunt et al., 2017.

7.2.2 Gender and Women's Financial Inclusion

According to data from the World Bank's 2017 Global Findex survey – which examines, among many things, the extent of financial inclusion in Sub-Saharan Africa (SSA) – women in the region are about 10% less likely to have an account at a financial institution or with a mobile money service provider than men. As of 2017, the financial inclusion gender gap in West Africa and the Sahel was 13%, slightly higher than the average for SSA (**Figure 82**).

Figure 82: Financial Inclusion Gender Gap in Sub-Saharan Africa and West Africa and the Sahel, 2017

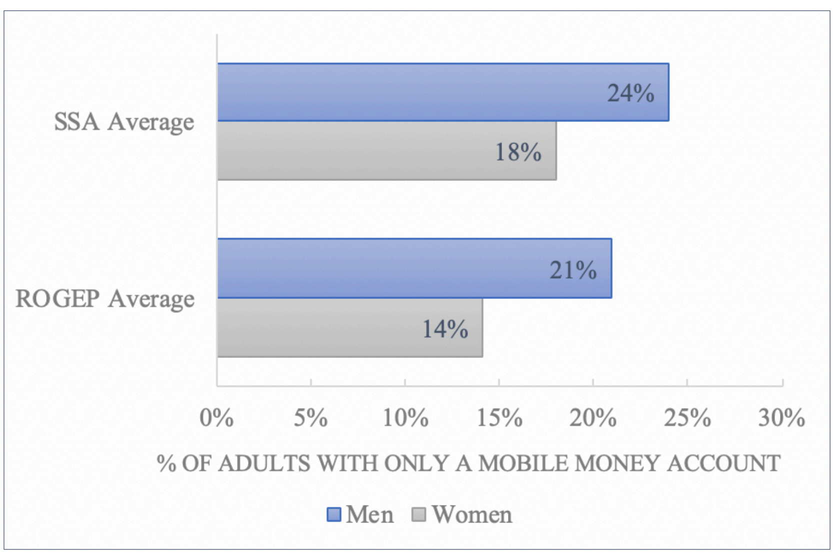


NOTE: Cabo Verde, Guinea-Bissau and The Gambia excluded (no data)

Source: World Bank Global Findex Database

As of 2017, 21% of adult men compared to 14% of women in West Africa and the Sahel only had a mobile money account (**Figure 83**), which is similar to the mobile money gender gap in Sub-Saharan Africa (6%).

Figure 83: Mobile Money Gender Gap in Sub-Saharan Africa and West Africa and the Sahel, 2017

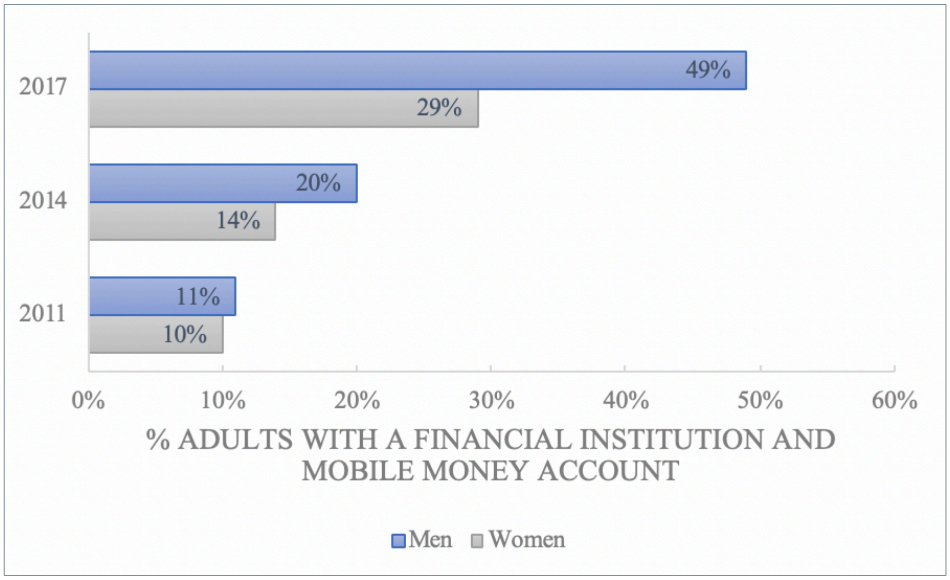


NOTE: Cabo Verde, Guinea-Bissau and The Gambia excluded (no data)

Source: World Bank Global Findex Database

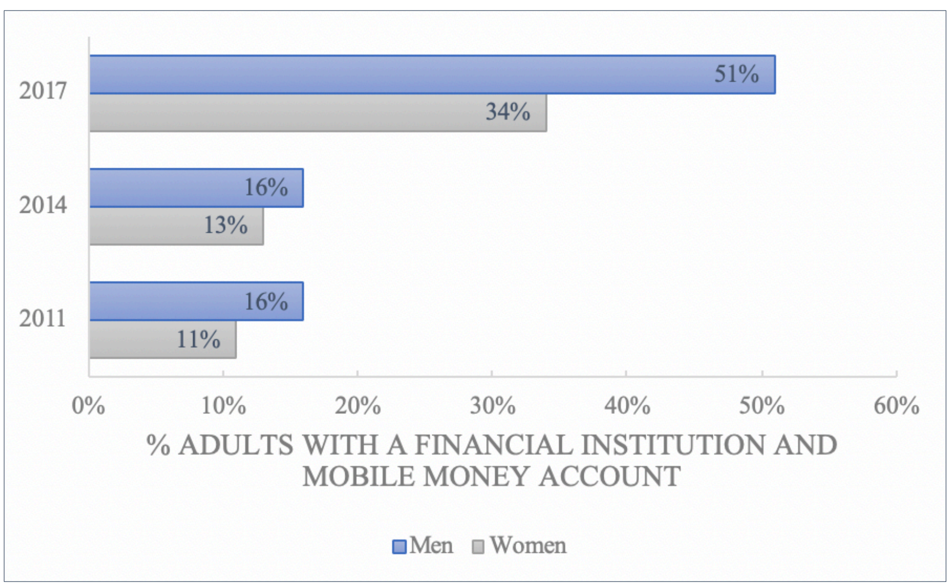
A total of 16 of the 19 ROGEP countries were included in the Global Findex survey (Cabo Verde, Guinea-Bissau and The Gambia are excluded). The results of the survey from 2011, 2014 and 2017 are presented below, highlighting the evolution of the gender gap in access to financial services in each country over the analyzed timeframes. While the financial inclusion gender gap increased in many countries across the region, only Mauritania (**Figure 94**) and Nigeria (**Figure 96**) witnessed a decline in access to financial services for women in absolute terms between 2014 and 2017.

Figure 84: Financial Inclusion Gender Gap in Benin



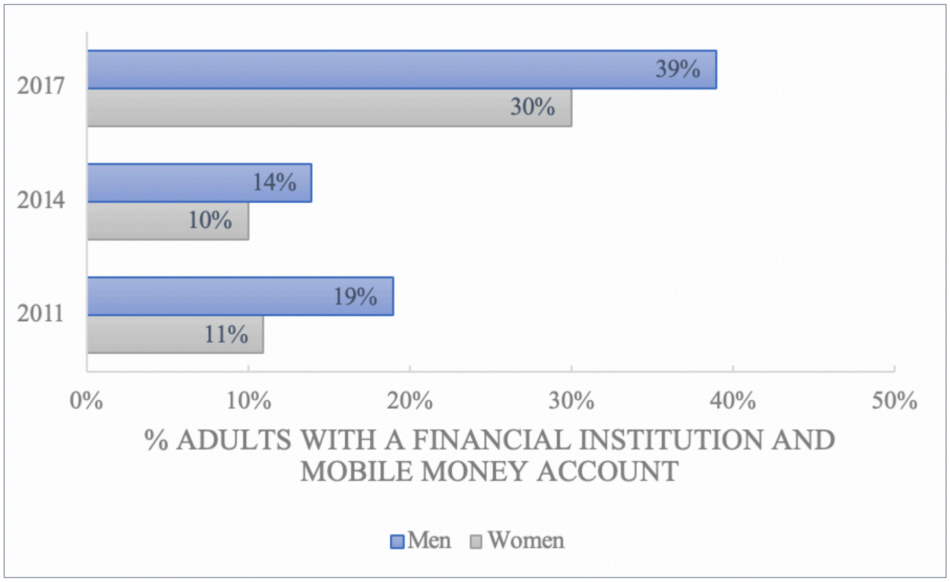
Source: World Bank Global Findex Database

Figure 85: Financial Inclusion Gender Gap in Burkina Faso



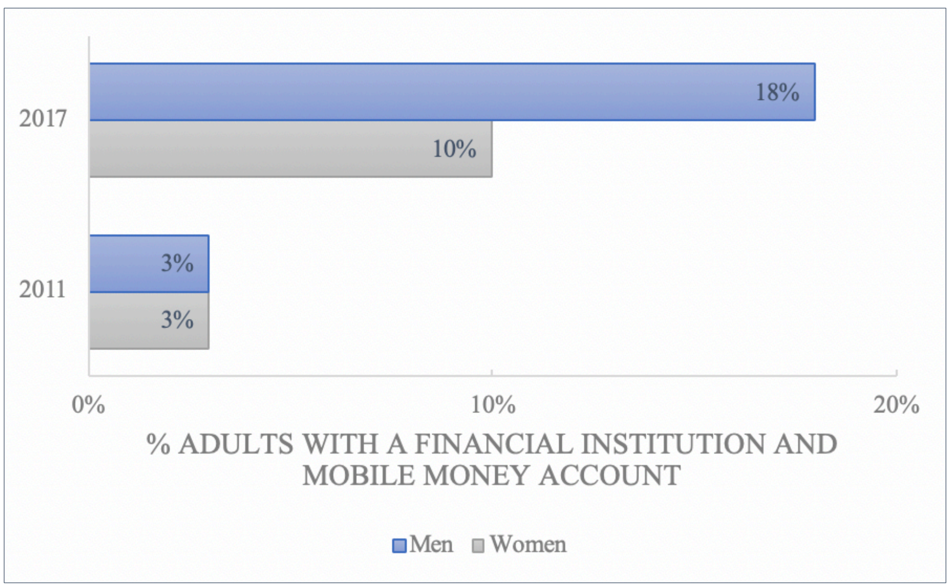
Source: World Bank Global Findex Database

Figure 86: Financial Inclusion Gender Gap in Cameroon



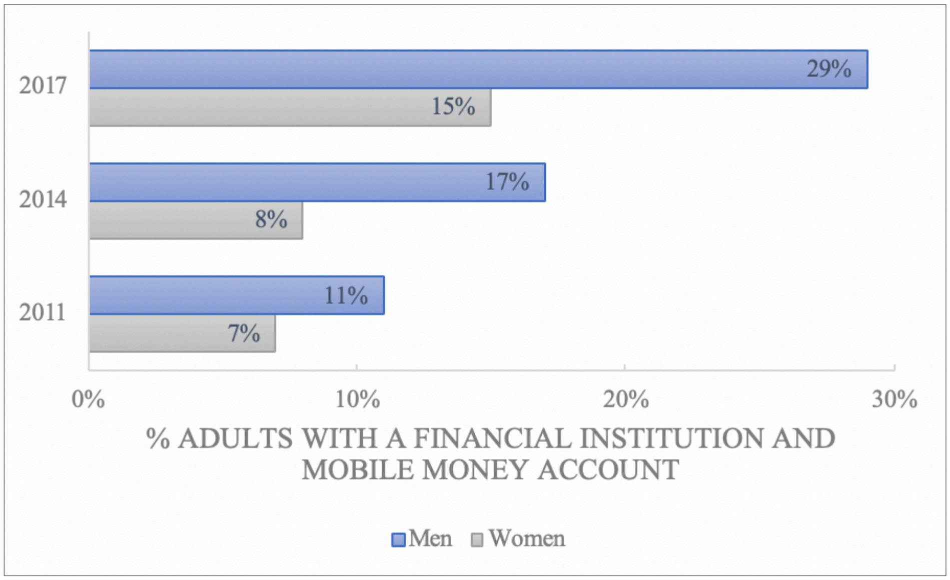
Source: World Bank Global Findex Database

Figure 87: Financial Inclusion Gender Gap in Central African Republic



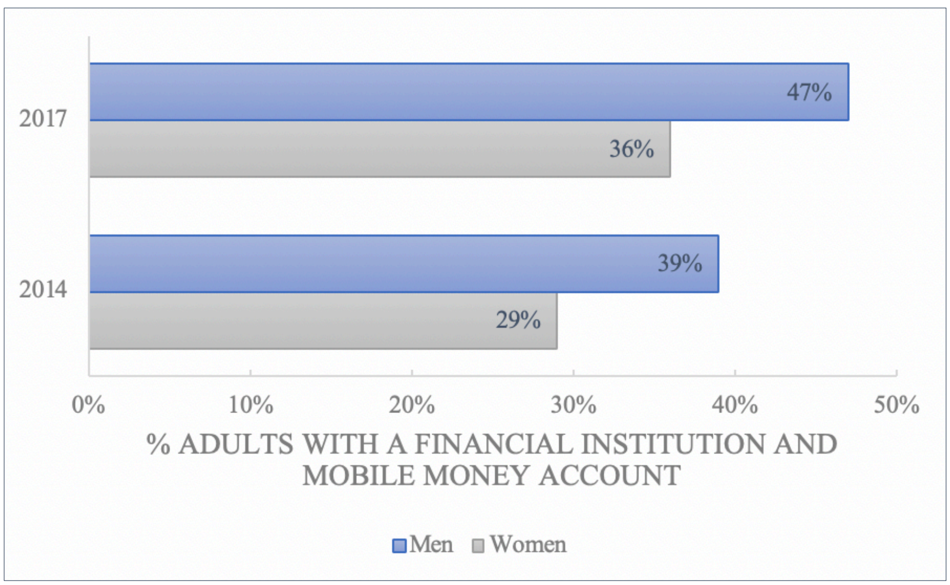
Source: World Bank Global Findex Database

Figure 88: Financial Inclusion Gender Gap in Chad



Source: World Bank Global Findex Database

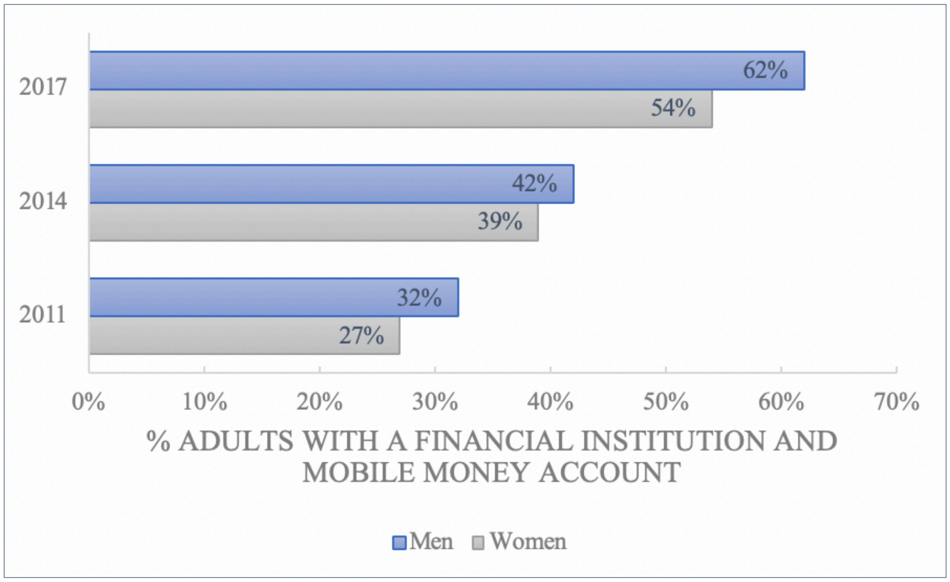
Figure 89: Financial Inclusion Gender Gap in Côte d'Ivoire



NOTE: No data available for 2011

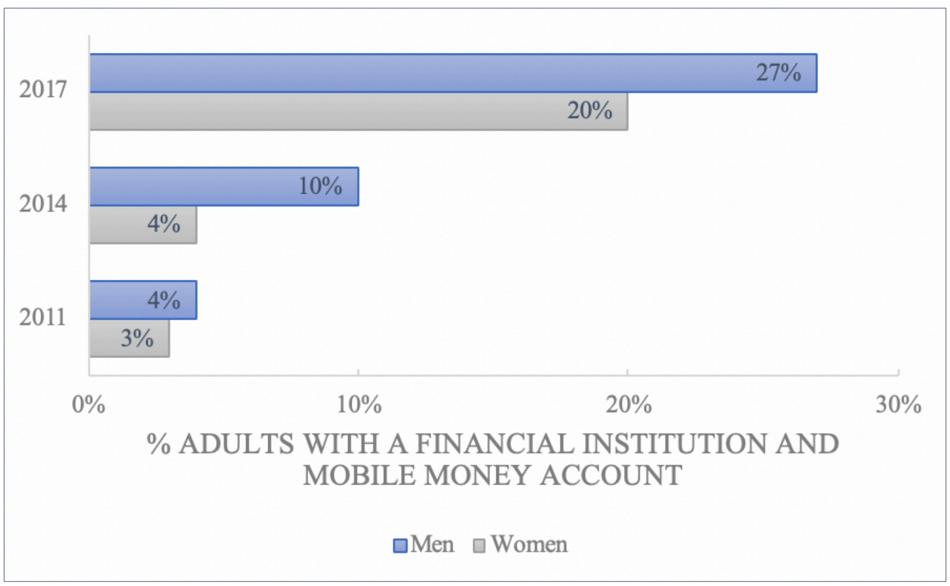
Source: World Bank Global Findex Database

Figure 90: Financial Inclusion Gender Gap in Ghana



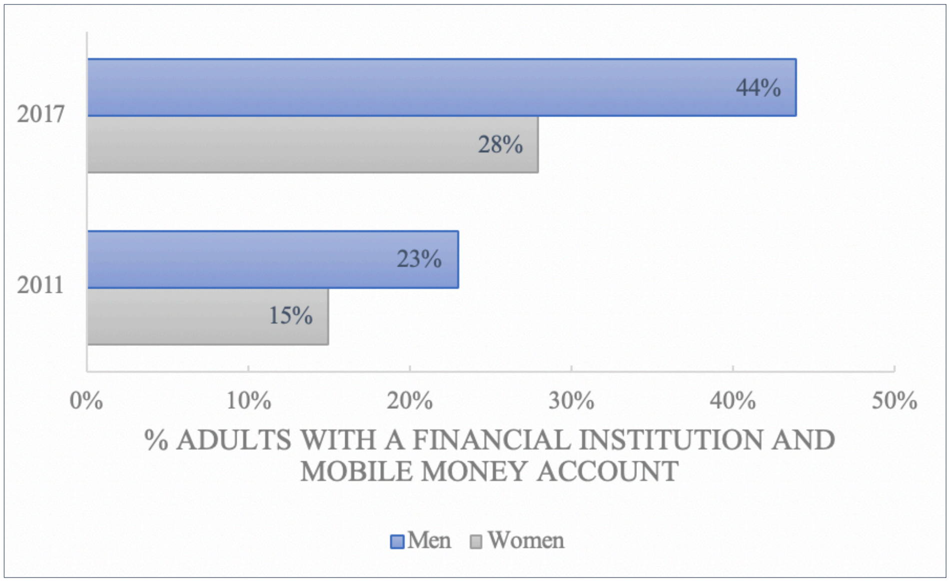
Source: World Bank Global Findex Database

Figure 91: Financial Inclusion Gender Gap in Guinea



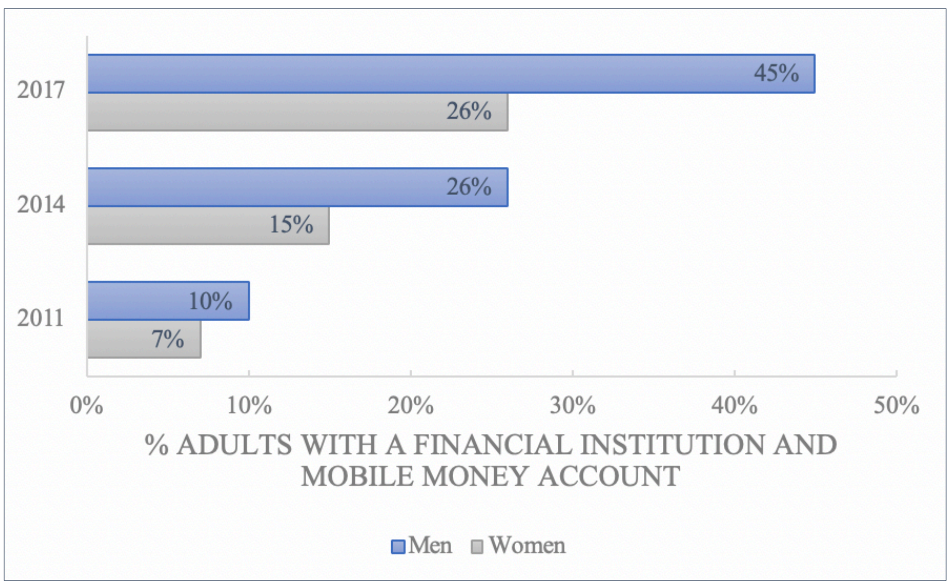
Source: World Bank Global Findex Database

Figure 92: Financial Inclusion Gender Gap in Liberia



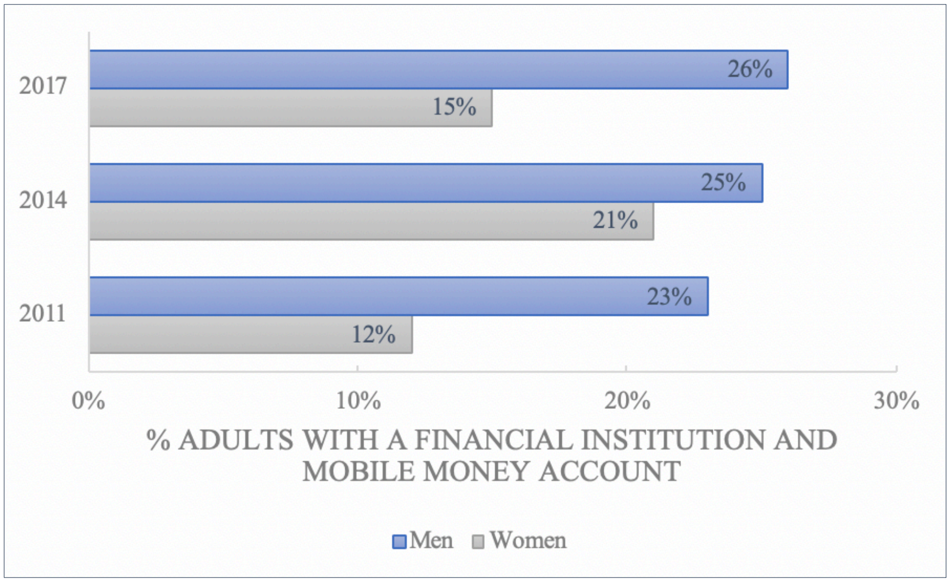
Source: World Bank Global Findex Database

Figure 93: Financial Inclusion Gender Gap in Mali



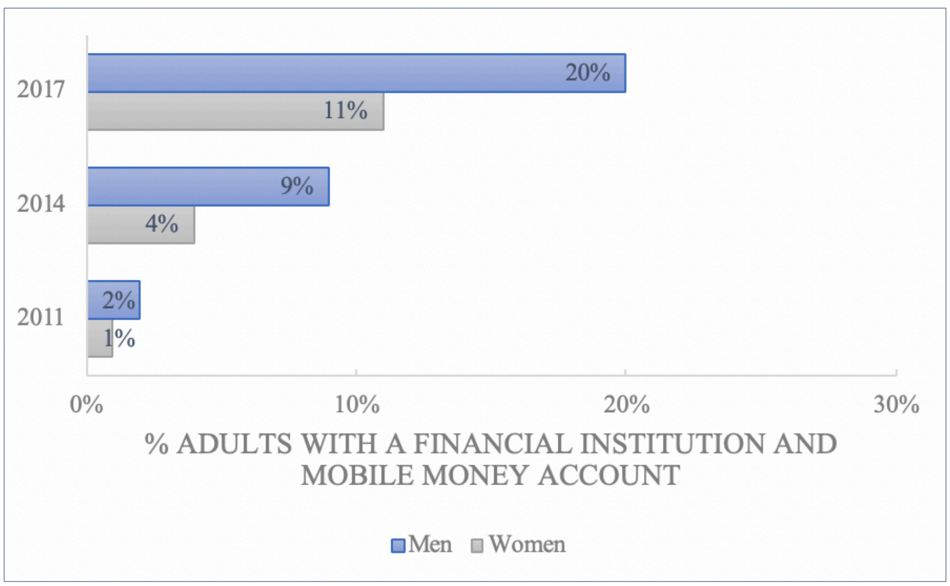
Source: World Bank Global Findex Database

Figure 94: Financial Inclusion Gender Gap in Mauritania



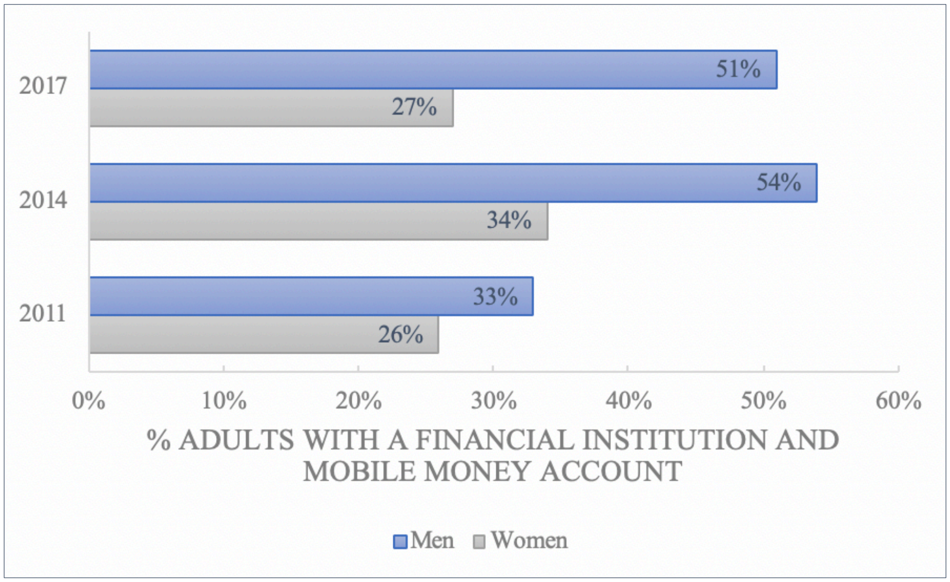
Source: World Bank Global Findex Database

Figure 95: Financial Inclusion Gender Gap in Niger



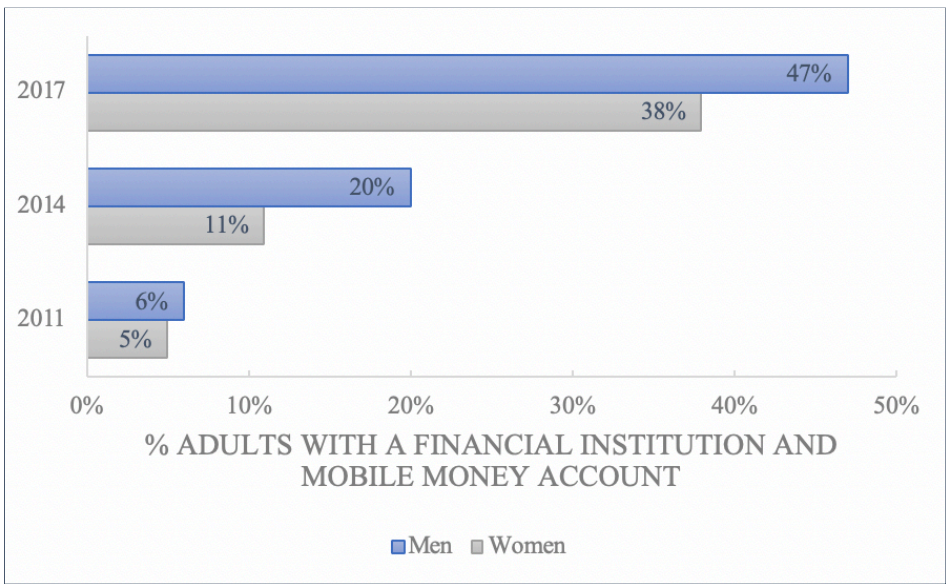
Source: World Bank Global Findex Database

Figure 96: Financial Inclusion Gender Gap in Nigeria



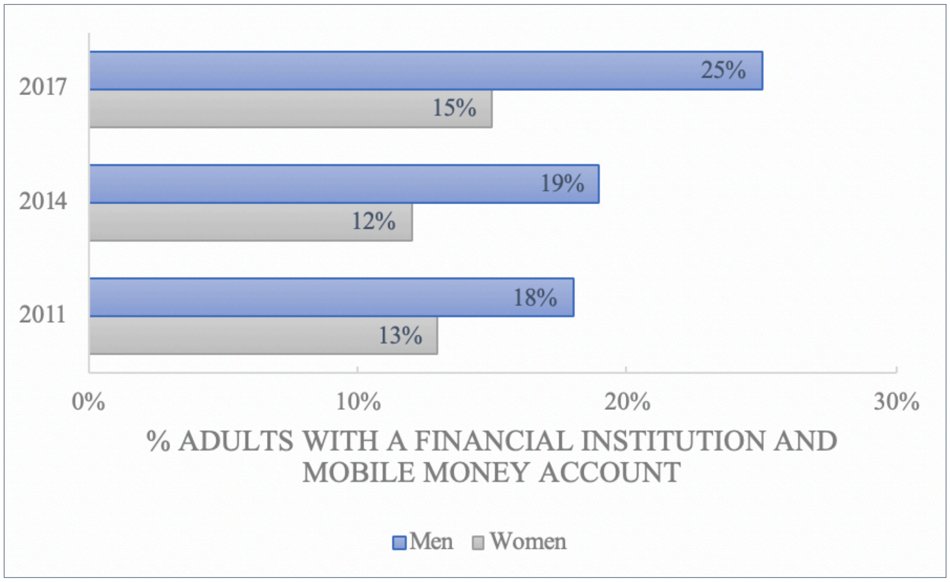
Source: World Bank Global Findex Database

Figure 97: Financial Inclusion Gender Gap in Senegal



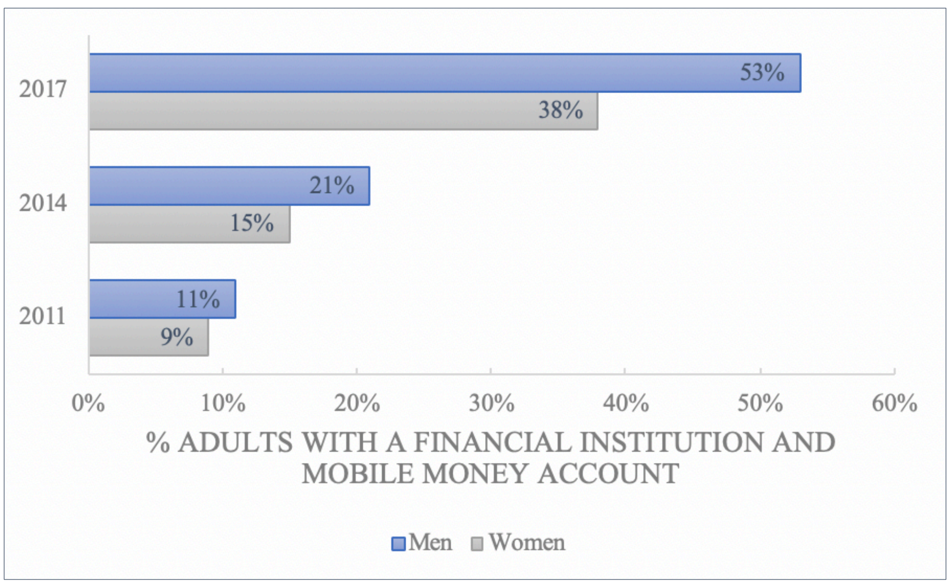
Source: World Bank Global Findex Database

Figure 98: Financial Inclusion Gender Gap in Sierra Leone



Source: World Bank Global Findex Database

Figure 99: Financial Inclusion Gender Gap in Togo

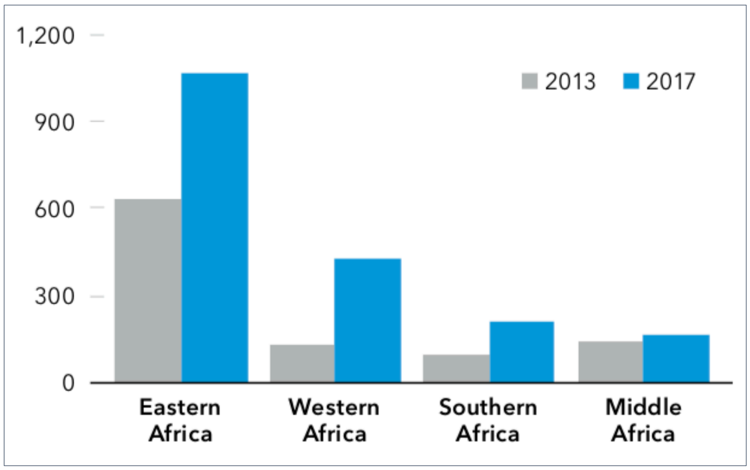


Source: World Bank Global Findex Database

7.2.3 The Digital Revolution and Electricity Access

The expansion of digital financial services, especially mobile money, has created new opportunities to better serve women, the lower-income population and other groups that are traditionally excluded from the formal financial system. Digital payments increase transparency across the private, public, and development sectors, and support economic growth by driving major cost savings, efficiencies, and higher productivity.[264] 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. In fact, most of the growth in the off-grid solar sector to date has been limited to countries with strong mobile money ecosystems, with particular crowding-in in East Africa, although the sector is also growing rapidly in West Africa (**Figure 100**).

Figure 100: Registered Mobile Money Accounts in Africa by Region



Source: International Monetary Fund

7.2.3.1 Mobile Phone Ownership

In most of Sub Saharan Africa, where utility networks often stop at the edge of urban centers, mobile telephony is often the primary infrastructure for most of the population. In recent years, mobile technologies and services have driven a variety of disrupting technologies delivering inclusive business models directly targeting the poor. The mobile-enabled solar PAYG model converges mobile technology to enable affordable and sustainable access to clean energy. Mobile technologies are contributing in four key ways:[265]

- Enabling remote payment collection through mobile money or other mobile payments
- Updating and controlling PAYG-enabled assets or services through machine-to-machine or keypads;
- Enabling communication between service providers, customers and local agents through mobile devices and services such as SMS or mobile apps; and
- Supporting service providers through mobile operator assets, such as sales networks, logistics support, warehousing, after-sales support, branding and marketing.

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[264] "The Fight for Light: Improving Energy Access through Digital Payments," United Nations Capital Development Fund, (July 2017): https://btca-prod.s3.amazonaws.com/documents/291/english_attachments/Full-Energy-Case-Study.pdf?1499786348

[265] "Going greenfield with utility pay-as-you-go models: Enabling access to water, sanitation and energy in and beyond East Africa," GSMA, (2017): https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/12/Going-greenfield-with-utility-pay-as-you-go-models-Enabling-access-to-water-sanitation-and-energy-in-and-beyond-East-Africa.pdf

Most importantly, PAYG solar businesses provide household-scale solar energy with a payment scheme tailored to the budgets of bottom-of-the-pyramid customers, thus allowing poor households to pay for solar products in small affordable increments. Given the importance of mobile technologies to the PAYG solar sector, sufficient mobile money infrastructure is a key enabler to scale solar off-grid energy. It is estimated that digital payment-enabled solar units will bring distributed, renewable electricity to 15 million households and 75 million people by 2020.[266]

USAID has developed a research assessment framework for determining the suitability of a country market for PAYG services (**Figure 101**).[267] Mobile access, mobile coverage, and availability of mobile money are all key drivers.

Figure 101: PAYG Market Assessment Framework

01	**How broad is rural mobile coverage?** PAYG solar can only drive MM adoption if customers can get a signal.
02	**How much of the country is unelectrified and has access to mobile phones?** PAYG solar is most attractive in areas without grid access, possibly also in areas with unreliable grid access. In either case, the off-grid populations need to have access to mobile phones to utilize an MM payment option.
03	**How strong is mobile money infrastructure?** MM-based business models are easier when there is some level of existing mobile money infrastructure.
04	**How affordable is PAYG to target populations?** Low incomes of off-grid populations and fuel energy subsidies can make it harder for solar energy to compete with alternatives.
05	**How easy is it to do business?** PAYG solar companies start small and tend to grow quickly. Ease of doing business, access to credit, and workforce capacity are important considerations for scale.

Source: United States Agency for International Development

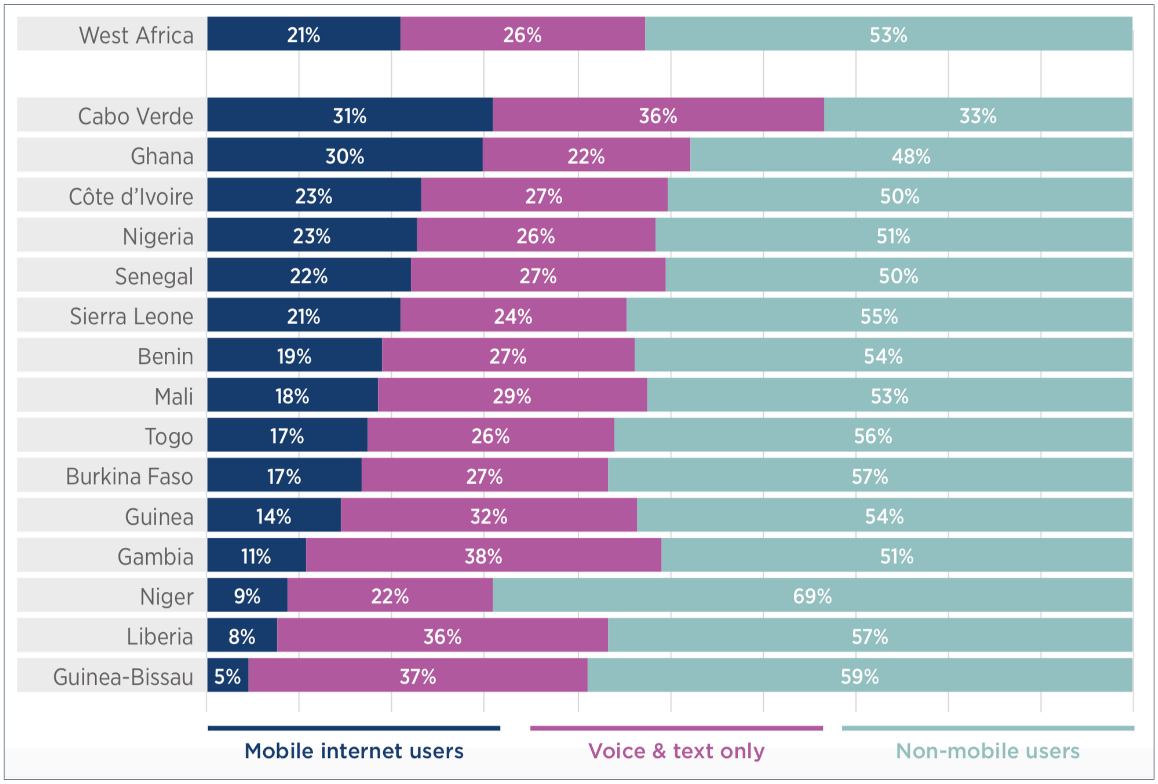
Widespread mobile phone ownership (**Figure 68**), growing mobile network coverage (**Figure 70**) and mobile internet penetration rates (**Figure 102**) have led to the proliferation of mobile money services and platforms across the region. These dynamics are collectively increasing overall access to financial services and driving financial inclusion. Several countries in West Africa and the Sahel are showing promising mobile money sector growth (**Figures 79-80**). This signals both high growth potential in the future, but also the challenges of operating successfully in different regulatory environments across the region.[268]

[266] "Off-Grid Solar Market Trends Report 2016," Bloomberg New Energy Finance, World Bank, IFC and Global Off-grid Lighting Association, (2016): https://www.lightingglobal.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Summary.pdf
[267] "Rapid Assessment Framework: Pay-As-You-Go Solar as a Driver of Financial Inclusion," USAID Global Development Lab Center for Digital Development Strategy & Research, (2017): https://cleanenergysolutions.org/sites/default/files/documents/payg_oec_deck_amy-paul_craig-jolley.pdf
[268] Ibid.

7.2.3.2 Mobile Network Coverage

Mobile network coverage and corresponding subscription rates are rapidly expanding in West Africa and the Sahel, although the share of mobile internet users varies widely by country (**Figure 102**).[269]

Figure 102: West Africa Mobile Internet Penetration, 2017



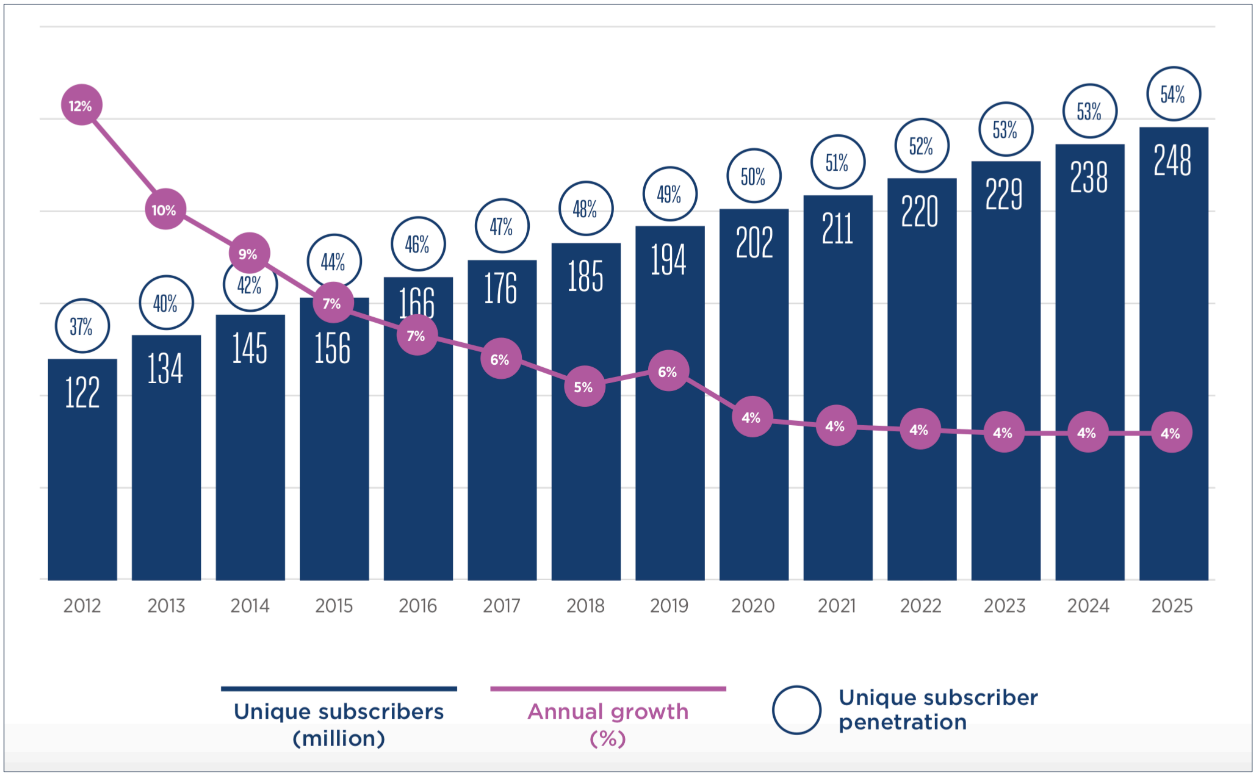
Source: GSMA Intelligence

By the end of 2017, there were 176 million unique subscribers across the ECOWAS region, while the overall subscriber penetration reached 47% (**Figure 103**). It is estimated that by 2025, around 72 million new mobile subscribers will be added in West Africa, taking subscriber penetration to 54%. Nigeria will account for the largest share of new subscribers, while Niger will record the fastest growth over this period.[270]

In the non-ECOWAS ROGEP countries, the trends are largely similar. In 2017, Cameroon had 9.7 million subscribers and a 40% penetration rate, while CAR's rate was lower at 22%.[271] By 2016, Mauritania had 2.6 million subscribers to reach an overall penetration rate of 64%.[272] No data was available for Chad.

[269] "The Mobile Economy: West Africa 2018," GSMA Intelligence, (2018): https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download
[270] Ibid.
[271] "The Mobile Economy: Sub-Saharan Africa, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[272] "The Mobile Economy: The Middle East and North Africa," GSMA, (2016): https://www.gsmaintelligence.com/research/?file=9246bbe14813f73dd85b97a90738c860&download

Figure 103: Projected Annual Growth in West Africa Mobile Subscriber Penetration Rates



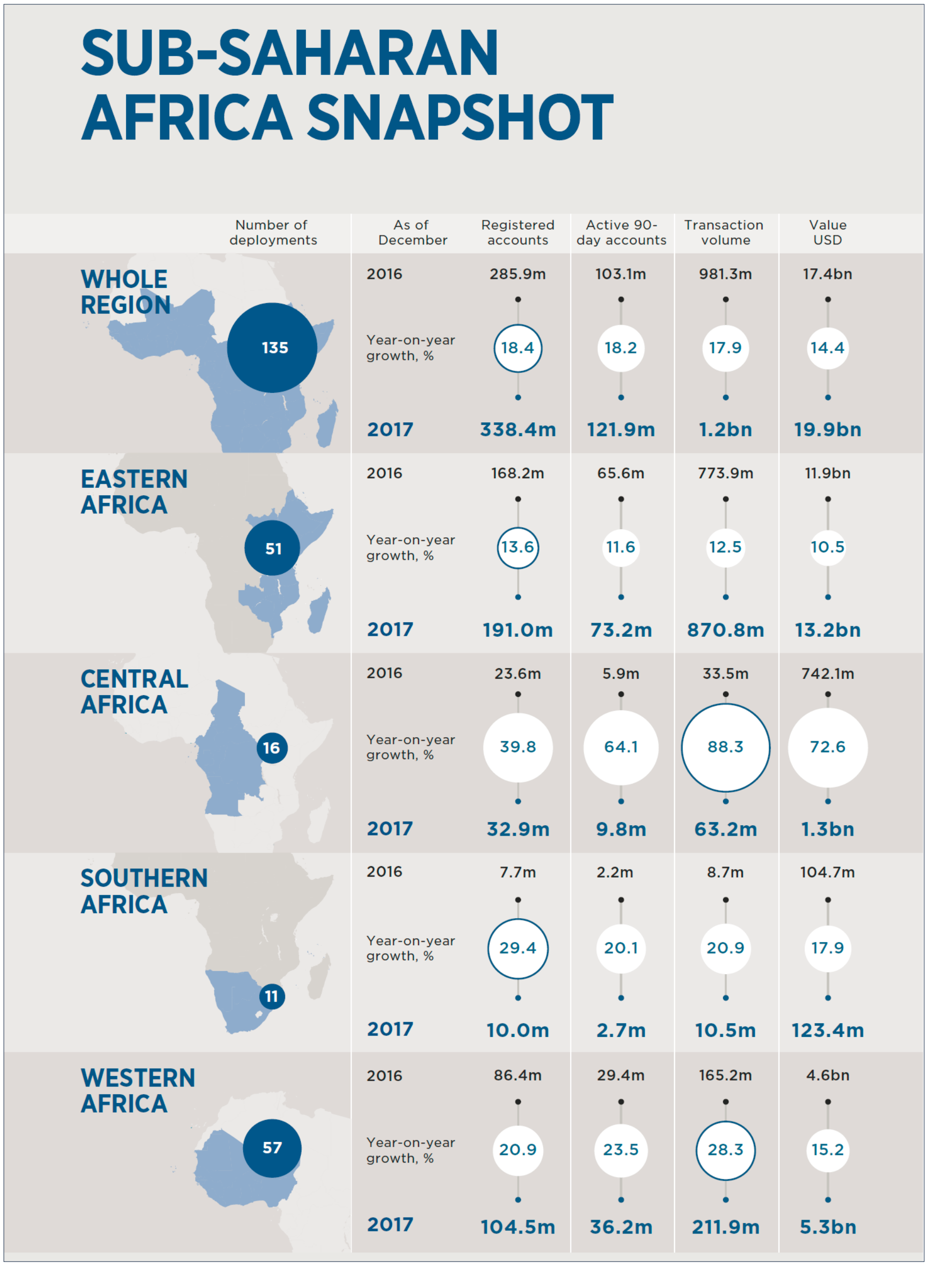
Source: GSMA Intelligence

7.2.3.3 Mobile Money

Digital financial services, particularly mobile money are growing rapidly across West Africa and the Sahel (**Figures 79-80**). While East Africa remains the global leader in the sector, West Africa is rapidly gaining ground. The number of registered mobile money accounts in the sub-region reached 104.5 million in 2017, growing 20.9% over the previous year (**Figure 104**). West Africa's share of the total Sub-Saharan mobile money market increased from less than 17% in 2012 to nearly 31% in 2017; the total value of transactions for the same period reached USD 5.3 billion.[273]

[273] "Mobile Money Deployment Tracker," GSMA: https://www.gsma.com/mobilefordevelopment/m4d-tracker/mobile-money-deployment-tracker/?utm_source=mmm&utm_medium=web

Figure 104: Comparison of Growth in Mobile Money Penetration in African Regions, 2016-2017



Source: GSMA

According to GSMA's Mobile Money Deployment Tracker[274] there are now 79 live mobile money deployments in West Africa and the Sahel, covering 17 of the 19 ROGEP countries.[275] Growth is driven both by a rapidly expanding agent network and an enabling regulatory environment. There are 13 times more active mobile money agents in West Africa than the total number of bank branches and ATMs in the sub-region.[276]

[274] "Mobile Money Deployment Tracker," GSMA: https://www.gsma.com/mobilefordevelopment/m4d-tracker/mobile-money-deployment-tracker/?utm_source=mmm&utm_medium=web

[275] As of mid-2018, only Cabo Verde and Central African Republic did not have live mobile money services listed

[276] GSMA Mobile Deployment Tracker.

Expanding cooperation between PAYG solar providers and mobile money ecosystems takes time, including partnering with third party providers and carrying out mobile money integration. Where mobile money access is limited or does not exist, creatively using airtime can help support deployment of energy services business models. As in the case of Lumos' experience in Nigeria, for the initial stage of market development, airtime has proven a good way to facilitate access to a larger client base and align with a payment mechanism that consumers are already familiar with.[277]

7.2.3.4 Partnerships with Mobile Operators

Beyond just mobile money services, Mobile Network Operators (MNOs) have proven to be good partners to PAYG solar companies throughout Africa. These operators bring invaluable assets such as their sales network, logistics support, warehousing, after sales support and marketing/cobranding. They have far-reaching distribution and sales networks and recognizably trusted brands. Energy services providers have an opportunity to leverage these assets to reach underserved customers.

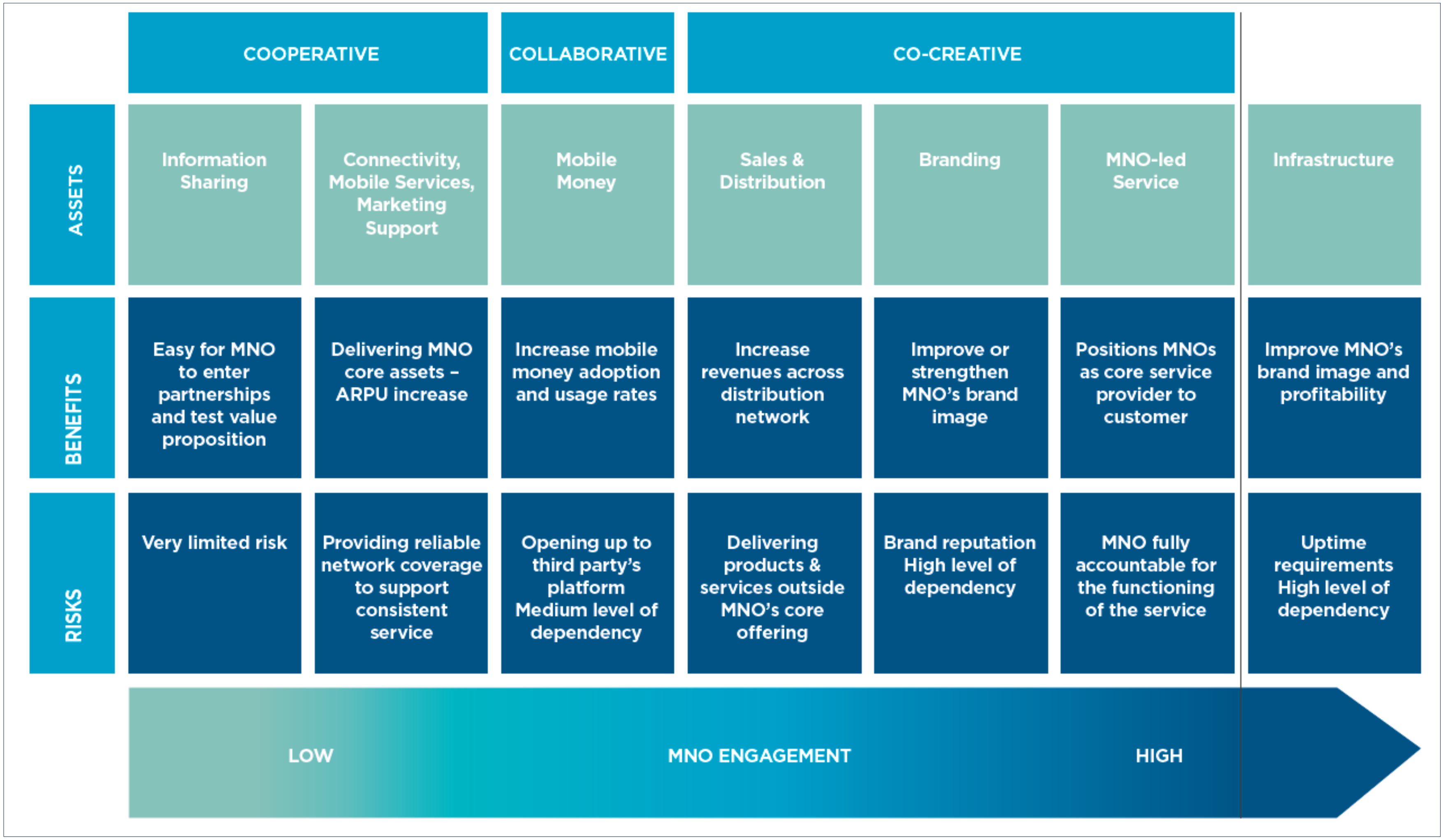
The synergies work both ways. PAYG utility services are helping mobile money providers to scale their agent networks to rural and off-grid areas and acquire new rural customers. PAYG solar companies are also becoming major contributors to overall mobile money volumes and frequency of transactions. The full spectrum of engagement between PAYG energy services providers and MNOs are illustrated in **Figure 105**.

MNOs have played a particularly transformative role in hastening market entries and ramp-ups of PAYG solar enterprises in West Africa because of the lessons learned from the East African PAYG experience. Examples include:

- In Nigeria, the Lumos solution is marketed, distributed and sold by MTN Nigeria as 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.[278]
- In Benin, SNV deploys a business model for the distribution of PAYG pico-solar lanterns through the existing network of MTN agents.
- In Ghana, PEG customers generated 122% more revenue per active user for Tigo Cash than non-PEG customers in the sample.[279]
- In Nigeria, Smarter Grid International is a solar distributor working with Airtel Nigeria to launch mobile payments for pay-as-you-go solar systems.
- In Burkina Faso Orange has piloted pre-paid smart metering on mini-grids in partnership with SINCO, a cooperative that manages electricity distribution through rural grids. This smart metering, software-as-a-service solution enables SINCO's customers to manage their energy expenditure

[277] "Mobile for Development Utilities: Lumos: Pay-as-you-go solar in Nigeria with MTN," GSMA, (October 2016): https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/11/Case-Study-Lumos-Pay-as-you-go-solar-in-Nigeria-with-MTN.pdf
[278] Ibid.
[279] Waldron, D. and Wolvers, M., "Daily Energy Payments Powering Digital Finance in Ghana," CGAP, (February 27, 2017): https://www.cgap.org/blog/daily-energy-payments-powering-digital-finance-ghana

Figure 105: Spectrum of Engagement Between Solar Companies and Mobile Network Operators[280]



Source: GSMA

[280] "Mobile for Development Utilities: Lumos: Pay-as-you-go solar in Nigeria with MTN," GSMA, (October 2016): https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/11/Case-Study-Lumos-Pay-as-you-go-solar-in-Nigeria-with-MTN.pdf

7.2.3.5 Key Policy Support

In 2017, Western and Central Africa were the fastest growing areas of Sub-Saharan Africa for mobile coverage, led by tremendous growth in registered accounts in countries like Ghana, Côte d'Ivoire and Cameroon. Policy, regulation and taxation all have played key roles in this expansion – 13 out of 17 countries with a live mobile money service have enabling regulation. For example, 2015 regulatory guidelines from the Bank of Ghana have allowed customers to accrue interest on mobile money deposits, resulting in exponential growth in total deposits in that market. Mobile money customers can also purchase treasury bills through their devices, thanks to a collaboration between Ecobank and MTN Ghana.[281]

Figure 106: Key Drivers of Mobile Money Markets

DRIVING GROWTH IN WESTERN AFRICA – MTN GHANA

In just four years, MTN Ghana has experienced exponential growth in mobile money account activity; growth that was accelerated by the introduction of the E-Money Issuers Guidelines by the Bank of Ghana in July 2015.

From the end of June 2012 to the end of June 2017, registered accounts increased five-fold from two million to 10 million accounts. Active 90-day[19] accounts increased 11-fold as a result of activity rates growing from seven per cent to over 70 per cent.

Behind this growth was an understanding that an increase in registered customers does not necessarily translate into more customer activity. With this in mind, MTN Ghana used five key strategies while maintaining high registration levels:

Education An early and continued focus on ensuring every customer was shown how to conduct a transaction when registering and then conducted one on their own in the presence of an agent.

Customer and agent incentives Customers were monitored and incentivised to continue transacting via mobile money with frequent public holiday promotions (e.g. over Independence Day). For agents, incentives tied to customer activity enticed them to encourage customer transactions. For example, agents received remuneration for the second and third transaction a new customer made within their first month of registering.

Increased engagement Door-to-door information sharing and use of community activators who spread awareness of the potential benefits of mobile money.

Immediate mobile money registration When a customer registers as an MTN Ghana customer, they are instantaneously registered as an MTN Ghana mobile money customer.

Increased investment For example, proactive investment in agent visibility, training and increasing the number of agents in the field.

Building partnerships with banks, merchants (e.g. satellite TV and utility providers), small and medium-sized enterprises (SMEs) and microfinance institutions (MFIs) was also critical to MTN Ghana's success, and would not have been possible without CEO and senior-level buy-in and support. Additionally, customers are responding to the opportunity to earn interest by keeping more funds in their mobile money accounts and performing more digital transactions.

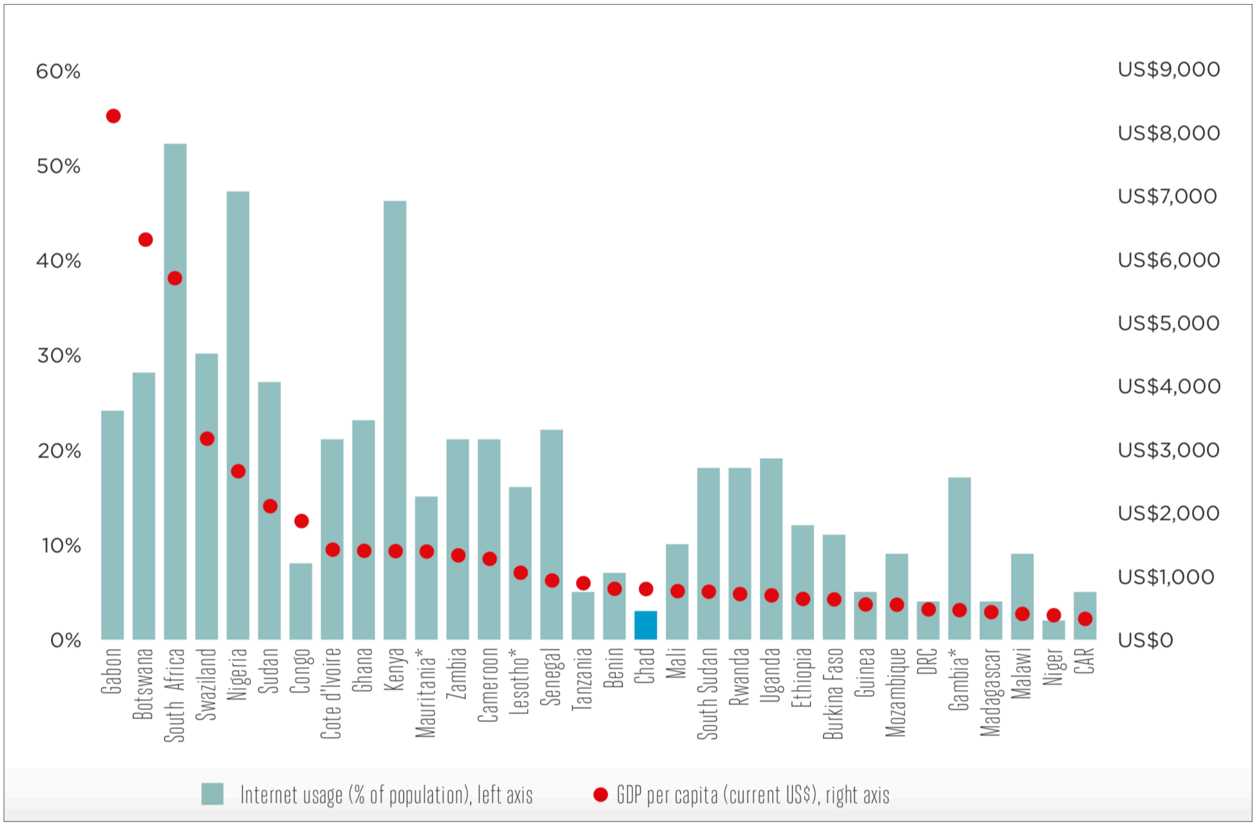
Source: GSMA

Taxation affecting the mobile sector, varies across the West Africa and Sahel region. In November 2017, the government of Niger voted to abolish the country's tax on incoming international traffic, which contributes around CFA 20 billion (USD 36.2 million) to the state treasury annually, under the Finance Act 2018. Consequently, the country's telecommunications operators have committed to making significant investments in improving coverage and service quality. Côte d'Ivoire, on the other hand, has implemented a 0.5% levy on mobile money services, a move that could directly impact the affordability and usage of the services, especially among the most vulnerable users.

[281] "Ecobank launches mobile money treasury bill product," Ghana Business News, (October 1, 2016): https://www.ghanabusinessnews.com/2016/10/01/ecobank-launches-mobile-money-treasury-bill-product/

In Chad, the government's taxation policy of the mobile sector has drastically limited the use of mobile services in the country. Mobile penetration in Chad lags behind many other African countries; mobile broadband networks are still in their infancy, with 3G penetration only around 2%, and internet usage is the lowest among countries with comparable GDP per capita (**Figure 107**).[282]

Figure 107: Internet Usage and GDP Per Capita in Selected African Countries, 2015



Source: Deloitte and GSMA

ECOWAS and ECCAS play important roles in harmonizing mobile sector policies, regulations and taxation approaches among their member states, as well as in standardizing digital and telecommunications infrastructure across the region to support the deployment of innovative mobile-based services and technology platforms.

[282] "Digital Inclusion and Mobile Sector Taxation in Chad," Deloitte and GSMA, (November 2016): https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/01/Digital-Inclusion-and-Mobile-Sector-Taxation-in-Chad_English_report.pdf

7.3 Financial Institutions and the Regional Off-Grid Lending Environment

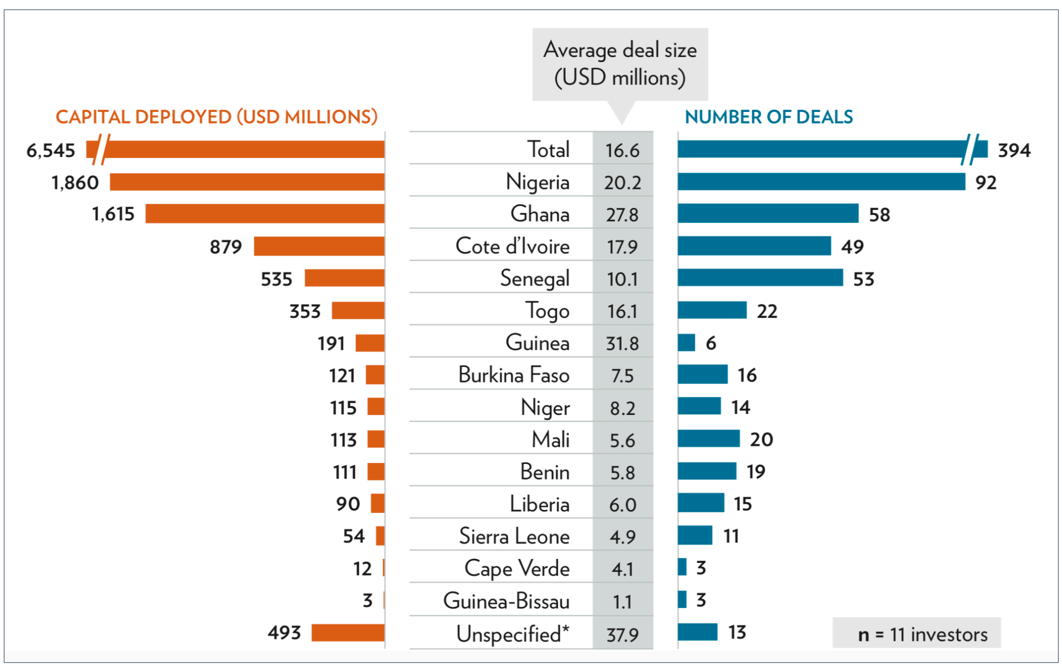
The off-grid lending environment includes Development Finance Institutions (DFIs), regional and national economic development banks, commercial banks, microfinance institutions, export credit agencies, trade funders, impact investors and crowd funders. Under Task 3, the GreenMax team analyzed these segments of the financial market in each country to characterize the current commercial lending environment and assess how accessible financing is for companies and consumers in the stand-alone solar sector. With extensive support from ECREEE, the GreenMax team also conducted an assessment of FIs in each country across the region to assess their level of awareness, interest and capacity to lend of the off-grid sector. The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate report (see **Annex 3** for more details). In general, financial markets in West Africa and the Sahel are still in early stages of development with respect to lending to the off-grid sector, and a number of challenges and barriers exist that hinder access to financing for companies and consumers in the OGS market (see **Section 7.7: Summary of Findings**).

The section that follows examines the financial institutions and market players that make up the off-grid solar lending environment across the region. Commercial banks and MFIs are excluded from the list below, as they are analyzed extensively in each country report.

7.3.1 Development Finance Institutions

An assessment carried out by the Global Impact Investing Network found that between 2005 and 2015, most of the DFI investment in West Africa was highly concentrated, with Nigeria and Ghana accounting for the majority of investment. During this period, a total of USD 6.5 billion was deployed across 394 deals, with an average deal size of USD 16.6 million (**Figure 108**).[283]

Figure 108: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

[283] "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

A selection of DFI programs that are supporting the OGS sector in West Africa and the Sahel are described below. Please refer to **Section 2: Regional Off-Grid Development Programs and Initiatives** above for more details on these programs and other DFI and donor-funded initiatives that are not included here.

- **AFD – Sustainable Use of Natural Resources and Energy Finance (SUNREF)**

The **SUNREF** program is an AFD-sponsored initiative that provides concessional financing and technical assistance to financial institutions to fund clean energy projects. The TA component aims to validate projects and their eligibility for the program, which are then presented to partner banks for financing. In 2014, Orabank, Société Générale and AFD signed a partnership agreement to launch SUNREF's West Africa program, which makes a EUR 30 million credit line available to banks in the West African Economic and Monetary Union. To date, the program has deployed financing to partner banks in Benin, Côte d'Ivoire, and Senegal, with projects in Togo and Nigeria scheduled for implementation in 2019.[284] Prior to its expansion into West Africa, the SUNREF initiative achieved success in East Africa's off-grid sector, where it increased lending particularly to the commercial and industrial (C&I) market segment.

- **USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR)**

The CEADIR program in West Africa was a multi-year initiative that took place from 2016 to 2018 in eight West African countries – Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone. The program's objective was to strengthen the clean energy lending capacity of participating local FIs in each country. CEADIR engaged with local banks by delivering national workshops that provided training to bank staff covering the stand-alone solar sector, mini-grids and the pay-as-you-go business model. The workshops were complemented with one-on-one technical assistance to help banks develop clean energy lending strategies based on the specific capacity building needs of each bank in the context of each country.[285]

- **African Development Bank – Sustainable Energy Fund for Africa / Facility for Energy Inclusion**

The **Sustainable Energy Fund for Africa (SEFA)** is a USD 60 million multi-donor trust fund administered by the African Development Bank with the objective of supporting sustainable private sector led economic growth in African countries through the efficient utilization of clean energy resources and support small- and medium-scale renewable energy project development.[286]

The **Facility for Energy Inclusion (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 launch of the FEI in 2016 led to a significant increase in AfDB financing for distributed renewable energy throughout Sub-Saharan Africa, with Cameroon, Côte d'Ivoire, Niger, Burkina Faso, Mali and Ghana having received significant shares of energy access financing from AfDB between 2014 and 2017 (**Figure 109**).

The **FEI Off-Grid Energy Access Fund (OGEF)**, structured by Lion's Head in partnership with the Nordic Development Fund, supports transaction structuring, provides local currency options to reduce risk for borrowers and their customers, and also offers technical assistance to companies to support off-grid

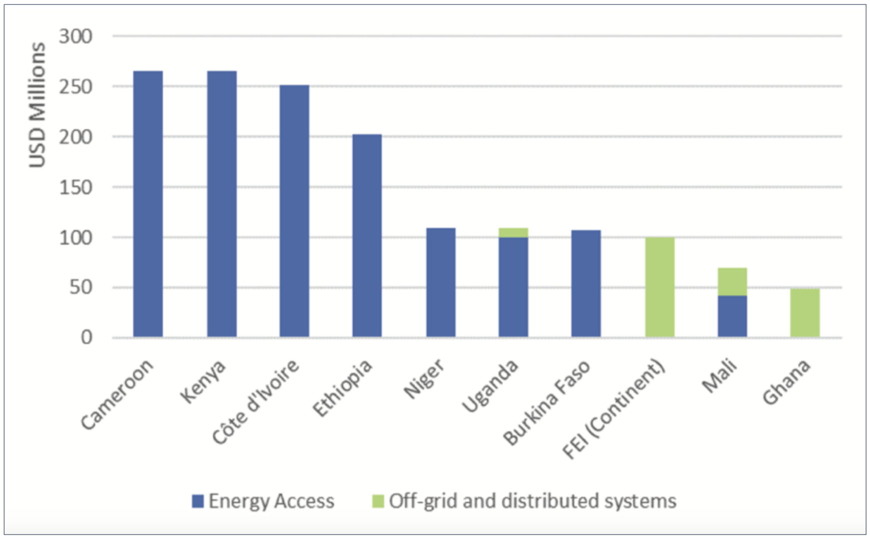
[284] Sunref West Africa: https://www.sunref.org/afriquedelouest/

[285] USAID CEADIR: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa

[286] "Sustainable Energy Fund for Africa," African Development Bank, (2018): https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/

market development.[287] The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[288]

Figure 109: Distribution of AfDB Energy Access Financing in Sub-Saharan Africa, 2014-2017[289]



Source: Oil Change International and Friends of the Earth U.S.

- **International Finance Corporation**

In June 2018, the IFC announced it had invested USD 60 million in a regional risk-sharing facility to support Bank of Africa Group's lending to SMEs in eight African countries – including six ROGEP countries: Burkina Faso, Ghana, Mali, Niger, Senegal and Togo. Half of the facility is earmarked for women-run businesses, and for climate-related improvements, such as energy efficient equipment upgrades, small solar systems, and climate-smart agricultural supply chains. IFC's investment will cover up to 50% of the risk on these SME loans.[290]

7.3.2 Private Equity Investors

One of the key findings of GreenMax's survey of both off-grid equity and debt financiers as well as of stand-alone solar entrepreneurs, is that there is a dearth of available equity, particularly for seed and Series A investment rounds in the off-grid space. As a result, many off-grid entrepreneurs are left with no source for early stage development aside from grant funding, which has become ever more competitive. Moreover, even many established off-grid enterprises find themselves overleveraged with debt. A recent study by Wood Mackenzie and Energy4Impact indicates that of more than USD 1.1 billion raised by Solar Home System companies to date, more than 50% has been through debt facilities.[291]

[287] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com
[288] "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/
[289] Lee, A. Doukas, A. and DeAngelis, K., "The African Development Bank and Energy Access Finance in Sub-Saharan Africa: Trends and Insights from Recent Data," Oil Change International and Friends of the Earth U.S., (November 2018): http://priceofoil.org/content/uploads/2018/11/AfDB-Energy-Access-Finance-report-high-quality.pdf
[290] "IFC Invests in Bank of Africa to Expand SME Lending in Eight Countries," International Finance Corporation, (4 June 2018): https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/947B76E4C106A246852582A200440E1C?OpenDocument
[291] "Strategic investments in off-grid energy access: Scaling the utility of the future for the last mile," Energy4Impact, (February 2019): https://www.energy4impact.org/file/2086/download?token=9-hw5RF1

With some notable exceptions, most of the early stage equity invested in Africa focused off-grid enterprises to date have come either from a handful of specialized Energy Access Investors, from general Impact Investors or from DFIs making direct investments. An early trend of investment by global tech venture funds seems to have ended due to slow results. A few investments, generally at Series B stage, have been made by Africa focused Private Equity or Infrastructure Funds. Most recently, several specialized energy funds, originally designed to focus on larger scale IPPs have ventured into the off-grid space. Strategic players are becoming increasingly active in the sector. **Table 45** provides a roadmap to these investments.

Table 45: Summary of Private Equity Investment in Africa Off-Grid Enterprises

Energy Impact Investors	
Fund	**Africa Off-grid Investments**
Energy Access Ventures	• Kivu • Zonful • Solarize • Zola Electric • PEG* • d.light* • Inspira Farms
KawiSafi	• d.light* • BBOXX* • Lendable • Redavia
Blue Haven	• MKopa • PEG* • Crossboundary Energy*
Persistent	• Daystar* • Zonful • SolarWorks* • Oolu* • PEG* • Rensource* • Devergy • BBOXX* • Upowa* • Altech
Shell New Energies	• Sunfunder • SolarNow
Acumen Energy Access	• Easy Solar* • PEG* • d.light* • SolarNow • Devergy
Bamboo	• Rensource* • BBOXX* • Husk • Devergy • Greenlight Planet* • Oolu* • PEG*
Differ	• Vitalite • BrighterLite
Gaia	• Oolu* • Easy Solar* • Upawa* • Solaris

FactorE	• Zola Electric • Redavia • Inspira Farms
General Impact Investors	
Grey Ghost	• MKopa • d.light*
Ceniarth	• Crossboundary Energy Access* • Off-grid Electric • Sunfunder • Lendable
I&P	• Cogelec* • PEG* • CDS*
PG Impact	• Greenlight Planet*
Apis Partners	• Greenlight Planet*
Omidyar	• Sunfunder • Zola Electric • Rensource*
LGT Impact	• Sunfunder
Village Capital	• ARED • PAYGO Energy
AHL Ventures	• MKopa • Powergen
Treehouse	• MKopa • Crossboundary Energy* • Koko
Novastar	• Solar Now • PayGo Energy
The Social Enterprise Fund	• Angaza
Seeds Life Caban Goodwill Grassroots Business Fund Palladium Blue Orchard	• Will consider investments
Specialized Africa Energy Funds	
Inspired Evolution	• d.light* • Solar Africa
Berkeley Energy	• Berkeley C&I
Ariya Capital Globeleq DI Frontier Metier ResponsAbility Renewable Energy Holding (rAREH) Climate One Archem	• Will consider investments
Africa Infrastructure Funds	
AIIM	• BBOXX • Starsight*
Amaya	• Rensource*
AP Moller Africa Finance Corp Pembani Rempro ARM Harith	• Will consider investments

Africa General Private Equity	
Verod	• Daystar *
CRE	• Rensource*
Helios	• Starsight*
DBL	• Zola Electric
Adlevo Singularity AFIG 8 Miles Africa Capital Alliance Amethis Emerging Capital Partners Synergy Platform Capital	• Will consider investments
Global Tech Venture Capital	
Prelude	• Powerhive
Zouk	• Zola Electric
Vulcan	• Zola Electric
Khosla	• BBOXX*
Strategic Investors	
Investor	**Africa Off-grid Investments**
Iberdrola	• Sunfunder
Total	• Awango • Solargie • Off-grid Electric • Powerhive • Zola Electric
EGIS	• RVE.Sol
Caterpillar	• Powerhive
Unilever	• Azuri*
Siemens	• SolarKiosk
GE	• BBOXX • Zola Electric
EON	• Mobisol
Engie	• Fenix • ESD • Husk Power • BBOXX • Equatorial Power
Enel	• Powerhive
Sumitomo Mitsui	• MKopa
EDF	• BBOXX • Off-grid Electric • Neot Off-grid Africa • Zola Electric
Tesla	• Zola Electric
Facebook	• Sunfunder • MiniGrid Accelerator
Microsoft	• Mini-Grid Accelerator

* Indicates presence in West Africa region

Source: GreenMax Capital Advisors

7.3.3 Specialized Off-Grid Debt Funds

In recent years, responding to a lack of debt financing overall for all off-grid energy sub-segments, there have emerged a plethora of specialized debt funds dedicated solely to lending for African off-grid projects and enterprises. GreenMax has identified 18 specialized lenders either already in operation or nearing their first close (**Table 46**). If all of those listed below accumulate the funds they have indicated, there will be a total of close to USD 2 billion in funds under management available to lend to the African off-grid space by sometime in 2019. Unfortunately, at time of writing only a handful of these are actively seeking mini-grid lending opportunities, as most are focused on asset-based lending for SHS portfolios. Of special note of course is Crossboundary Energy Access (CBEA), which is the only specialized mini-grid lender and which has already provided a term sheet to SMZ. As more of these funds become available and the market becomes more competitive, most of these lenders have indicated that they may consider lending to mini-grid developers in the future.

Table 46: Summary of Specialized Off-Grid Debt Facilities

Specialized Debt Facility	Description
SunFunder	Second fund of $80M now active; seeking more opportunities in the C&I and mini-grid space. Have closed a $2.1M debt facility for mini-grid developer PowerGen.
CDC Off-grid Local Currency Facility	Not a fund per se, business plan to deliver up to $150M in local currency debt available across next three years; inherently taking first loss risk themselves. Intention is to finance one or more mini-grid portfolios, although to date they have only focused on SHS
Sima Funds	Second $80M fund now active, focused on receivables lending to SHS companies. Say that they may consider mini-grids in future.
Lion's Head Off-Grid Energy Access Fund	First close of $60M in September 2018, expect total of $100M, focused mainly on receivables lending to SHS companies but will also consider working capital
Neot	First close at $20M now active, expect $100M by mid-year 2019, focused on receivables lending to SHS companies. Say that they may consider mini-grids in future.
Lion's Head/Fieldstone JV	$100M first close expected by mid-year 2019 focus on mini-grids and C&I
Solar Frontier	Now active with $30M, expect to have $100M under management before end of 2019, focused on receivables lending to SHS companies. May consider lending to MGs in future.
DWS Energy Access Fund	$80M first close with GCF expected Q1 2019, expect to have $500M under management by 2020, focused on all off-grid segments. However, they are finding the mini-grid segment "difficult" and will likely only provide credit lines to local FIs who include mini-grids in a diverse portfolio of off-grid assets.
Lendable	Not focused only on off-grid but it is majority of their portfolio. Appear to have roughly $30M available. Focused on receivables lending to SHS companies. Might consider lending to mini-grids in the future.
responsAbility Energy Access Fund	First fund fully committed, fundraising second fund, expected $100M by Q2 2019. Focused on all off-grid segments. Also considering lending to mini-grids.
Shell Foundation Energy Access Growth Vehicle	Fundraising for first $70M close by Q2 2019. All off-grid, including mini-grids.
Triple Jump Energy Entrepreneurs Fund	First close at $50M, focused on mezzanine financing to off-grid enterprises including mini-grids.
Energize Africa	Although a crowdfunding platform, have a tranche of DFID funds to deploy in first loss position; focused on low-priced, mid-term debt up to $2M for all off-grid segments. Looking for mini-grid deals.
Bettervest	Also a crowdfunding platform, however already with a history of placing medium term debt, reasonably priced with mini-grid developers in Nigeria.
CrossBoundary Energy	Active $25M fund financing PPAs for the C&I space
CrossBoundary Energy Access	First close in January 2019 of $16M for long term debt to mini-grids. First fund of its type to specifically target the mini-grid segment.
Catalyst – Venture Builder Fund	Now active with initial $10M available as early stage convertible debt for off-grid entrepreneurs. Including mini-grid developers.
Blue Orchard	Existing SME debt facility with more than $200M under management seeking off-grid lending opportunities; new $150M energy infra fund expected to close by Q2 2019 targeting both equity and debt to small scale renewables and off-grid enterprises. Uncertain policy still on mini-grids.

Source: GreenMax Capital Advisors

7.3.4 Loan Guarantee Programs and Other Risk Mitigation Instruments

Governments, DFIs and donors can offer guarantees to private lenders that loans will be repaid in the event of default by an off-grid project owner or developer. A loan guarantee is a promise by a guarantor to an identified lender to assume the debt obligations of an identified borrower (i.e. the mini-grid developer or project owner). Such guarantees usually cover 50% of the outstanding principal of the loan but can be more – even 75% – to encourage banks to offer more-attractive terms. Common sources of these guarantees include the IFC Small Loans Guarantee Program (SLGP), the USAID Development Credit Authority (DCA), the African Guaranty Fund (AGF), the Swedish International Development Cooperation Agency (SIDA), GuarantCo, the African Export-Import Bank (Afrexim Bank) and African Trade Insurers.

- **IFC Small Loans Guarantee Program (SLGP):** Under the SLGP, which is being launched in West Africa, IFC will enter into risk sharing agreements with Partner FIs, to provide a 50% loss cover against future non-performing loans in the Partner FI's SME portfolio. Pre-agreed eligible criteria will be set for loans to be included in the portfolio. The key parameters of the risk sharing arrangement are to be integrated as much as possible with the Partner FIs' origination, risk assessment/approval, supervision and recovery procedures (subject to IFC review). The guarantee is in local currency or it can be in US Dollars depending on the Partner FIs' preference/portfolio assets. The Risk Sharing Facility is wholesale, which means that IFC commits a maximum exposure amount for a 3-year Ramp-up period during which the Partner FI builds the portfolio. The Partner FI owns the portfolio and takes all commercial decisions. ROGEP is already developing a cooperation framework with SLGP as 16 of the 19 ROGEP countries are eligible under SLGP.

- **USAID Development Credit Authority (DCA):** DCA provides partial risk guarantees backed by the full faith and credit of the US Government, generally up to 50% coverage through a suite of standard products that allow for guarantees to be issued to qualifying financial institutions for individual loans, loan portfolios or bond issues. DCA has provided a portfolio guarantee for sustainable energy loans at Ecobank Nigeria. From October 2019, DCA will be merged with US OPIC into the new US International Development Finance Corporation.

- **African Guarantee Fund (AGF):** The AGF is a non-bank financial institution that was launched in 2012 and supported by a group of DFIs and donors. AGF's key mandate is to help FIs increase their financing to African SMEs through the provision of partial risk guarantees and capacity development assistance.[292] One of AGF's investors, Nordic Development Fund (NDF), established a special Green Finance facility at AGF for provision of partial risk guarantees to clean energy companies or FIs lending to such companies or projects. The Green Finance facility allows AGF to go as high as 75% on its guarantee coverage and may allow for some concession on the guarantee fee. The AGF in 2018 provided a 50% pari passu guarantee on a USD 4 million in debt financing from Togo-based bank Union Togolaise de Banque (UTB) to BBOXX to support the company's entry into the Togolese off-grid market.

- **SIDA Loan Guarantees:** SIDA provides partial risk guarantees backed by the full faith and credit of the Swedish Government, on an individual loan or loan portfolio basis or bond issues. In the off-grid energy sector SIDA has provided portfolio guarantees for the Rwanda Development Bank's loans to SACCOs to provide consumer financing for solar installations and for the crowdfunder Trine, to support its overall portfolio of loans to off-grid entrepreneurs in Tanzania, Rwanda, Kenya, Uganda and Zambia.

[292] African Guarantee Fund: http://www.africanguaranteefund.com/en_new/about-us-ten

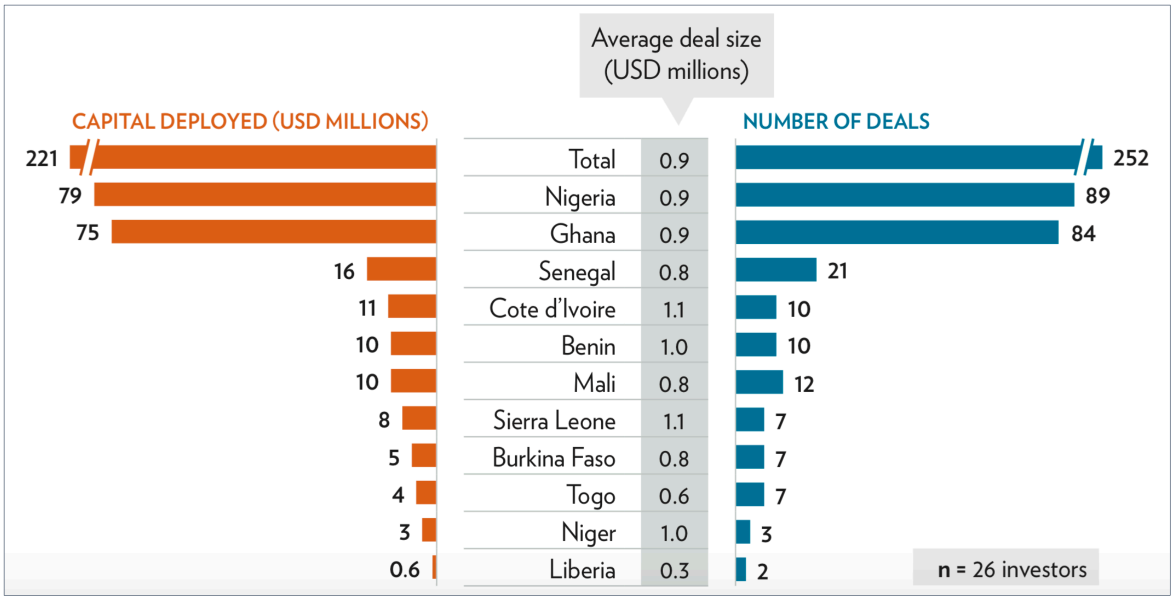
- **GuarantCo:** Provides guarantees to support projects and companies in order to raise debt financing for the development of infrastructure in emerging economies. GuarantCo credit enhances local currency debt issuance by private, municipal and parastatal entities. GuarantCo can provide a variety of risk mitigation products including partial credit and partial risk guarantees, first loss guarantees, tenor extension or liquidity guarantees and can provide joint guarantees or country guarantees as may be required for a particular product. GuarantCo is currently developing a risk mitigation approach jointly with InfraCredit in Nigeria to launch a new fund to provide equity and debt financing for off-grid and mini-grid projects. As with all financial products, the benefit of a loan guarantee is in the details of the product terms and conditions. Some key issues to examine:

  - ✓ **"First loss" or Pari Passu?** A first loss guarantee, as the name implies covers a certain percentage of the first losses occurring on the project. Therefore it is a more powerful instrument as it insulates the lender fully up to a given amount of loss. A pari passu guarantee covers a certain percentage of all losses on a shared basis (i.e. 50:50, 75:25) with the lender. Guarantors often are reluctant to issue first loss guarantees as they see a "moral hazard" in the lender not properly administering the local and pursuing collections if they have nothing at risk in the initial losses. From GreenMax's own experience, we find that managing such "moral hazard" can be properly handled through establishment of proper protocols and by an appropriate fee structure.
  - ✓ **"Repayment Guarantee" or "Risk Guarantee"?** Repayment guarantees cover full and timely repayment of a loan up to a predetermined amount. A risk guarantee covers all or part of a loan or investment and is paid out only if specific risks or events cause a default. Examples of such risks include non-payment or late payment by an anchor customer and lower-than-expected electricity sales. Electricity sales risk could be partly mitigated by a full or partial guarantee to cover short-term liquidity problems caused by seasonal variations in electricity demand. Such guarantees will be particularly important in the early years of the operation of a micro-grid when there is little or no demand history.
  - ✓ **Single Project or Portfolio Guarantee?** A loan portfolio guarantee is potentially a better instrument for micro-grids than an individual loan guarantee because it allows for multiple borrowers, each of which can be smaller in size. It guarantees a portfolio of loans made by a lender to a target borrower segment (e.g., energy access companies, including micro-grid developers and projects) for which the parameters have been defined (e.g., rates, terms, geography, technology, business model) but the individual borrowers are not known.
  - ✓ **Payout on a Guarantee Claim.** Does the guarantee instrument provide for a guarantee payout on notice of the lender that there has been a payment default? Or must the lender wait until completion of recovery proceedings to make a claim? The latter dramatically reduces the value of the guarantee to a lender as they would have to wait perhaps several years to realize a payout net of proceeds of recovery.
  - ✓ **Protocols Governing Recovery.** What is the order of use of proceeds from recovery? Does the lender get their balance of principal (not covered by guarantee payment), legal costs of recovery and interest before or after the guarantor gets reimbursed for the guarantee payment and its own legal costs?
  - ✓ **Credit Rating of the Guarantor.** Generally the guarantors presently offering products on the market and listed above carry sufficient credit ratings to allow a guarantee from them to a lender to proportionally replace statutory collateral requirements of banking regulators. However, as new guarantee instruments come on the market it will always be important to be aware of their credibility vis a vis banking regulations.

7.3.5 Impact Investors

An assessment carried out by the Global Impact Investing Network found that while impact investing steadily increased across Africa between 2005-2015, most of the investment in West Africa was highly concentrated, with Nigeria and Ghana together accounting for about 70% of the total capital deployed in the region. During this period, a total of USD 221 million was deployed across 252 deals, with an average deal size of USD 900K (**Figure 110**).[293]

Figure 110: Non-DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

7.3.6 Crowd Funders

Crowdfunding is a relatively novel approach for the financing off-grid solar projects and companies in Africa, though the sector has quickly grown in importance. Crowdfunding for energy access projects and off-grid energy companies reached USD 8.7 million in 2016, and this figure is expected to grow rapidly.[294] By 2018, the total transaction value of international crowdlending in Africa has reached USD 3.7 billion, with a 12% combined annual growth rate.[295] Although most of the international financing for off-grid energy has focused on East Africa to date, this dynamic is gradually shifting, as a growing number of crowdfunding platforms are expanding their operations into West Africa. As an example, Bettervest, a German-based crowdfunding portal, has supported at least 20 off-grid energy projects in West Africa, raising over USD 3 million in just the last three years.[296]

Generally, crowdfunding portals that offer debt in the off-grid energy sector offer speed and flexibility that traditional financing sources, local and international, cannot provide. Nonetheless, each crowdfunding debt

[293] "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

[294] Cogan, D. & Collings, S., 'Crowd Power; Can the Crowd Close the Financing Gap?'" Energy 4 Impact (2017): https://www.energy4impact.org/file/1883/download?token=aft0NCOX

[295] Statistica: https://www.statista.com/outlook/334/100/crowdlending--business-/worldwide

[296] Bettervest: https://www.bettervest.com/en/funded-projects/

provider differs in its financing approach and focus, also certain crowdfunders may be more suitable funding source based on the company's business model or growth stage. For example, Trine may able to process and fund an inventory financing loan more quickly than other sources of financing, while Bettervest is able to offer longer tenors and lower interest rates, and Crowdcredit may be able to take on larger transactions while targeting more mature companies with stronger financials.

7.3.6.1 Development Finance Institutions and Crowdfunders

Crowdfunders, especially those that focus on energy access, have usually already engaged Development Finance Institutions (DFIs). Crowdfunder engagements with DFIs in order to further catalyze private sector investment for off-grid electrification have been wide-ranging. Some DFIs have supported the crowdfunding business model in the off-grid sector by directly supporting crowdfunding portals through programs such as Energize Africa, the DFID program that co-finances crowdfunding campaigns. GIZ has also directly supported the crowdfunder, Bettervest, in establishing legal structures to allow it to lend in Nigeria with greater regulatory ease. SIDA, a Swedish DFI, has supported Trine by providing portfolio level guarantees for loans in certain Sub Saharan African countries. Crowd Power, a program funded by UK Aid and run by Energy 4 Impact, has supported 100 campaigns in 28 African countries in partnership with multiple crowdfunding platforms including Kiva, TRINE, Lendahand, Bettervest. DFIs have also less formally supported the sector, serving as references for crowdfunders in carrying out their due diligence and sourcing clients. Crowdfunders generally agree that as a marketing tool investing alongside a donor or government sponsored program is an effective way to market deals on their portal.

7.3.6.2 Credit Enhancements and Financial Structuring Among Crowdfunders

With regard to credit enhancements, portfolio level instruments are most preferred, with first loss reserves as the most favored credit enhancement. Furthermore, most crowdfunding platforms have already deployed such instruments with the support of DFIs and donors. Crowdfunders find first loss reserve structures more advantageous than 3rd party guarantees because such structures offer the flexibility to restructure a loan that has fallen into arrears rather than requiring that the loan must be in default in order the credit enhancement to be accessed. Yet first loss reserves are not as popular amongst DFIs and donors that are concerned that such flexibility will lead to a higher levels of loss and less judicious loan administration. Receivables financing, as a tool for growing the off-grid energy sector, received a mixed response from interviewed crowdfunders. Crowdfunders such as Trine and Bettervest were enthusiastic about the potential for bundling portfolios to increase capital inflows. Ecoligo and Lendahand were more skeptical, suggesting that portfolio quality has been maintained through the recent pioneering receivables financing deals and felt that the sector may not yet be mature enough for such deals to become commonplace.

Most of the interviewed crowdfunders emphasized that they are quicker in their ability to support African off-grid energy companies compared to commercial banks. At the same time, crowdfunders would also like to have the capability and access to participate in larger financings. Crowdfunders consider portfolio-level credit enhancements and structured financing as means to further their goals of raising and deploying more capital while managing risks and increasing returns. The interviewed crowdfunders also found partnering with local banks to be complementary and supportive of their business model. Interviewees generally felt that they could serve as a source of liquidity and hard currency access for local banks, while local banks are well placed to assess risks and enforce agreements on the behalf of crowdfunding backed loans.

7.3.6.3 Grants and Results-Based Financing

The interviewed crowdfunders generally appreciate the importance of grants for opening up new markets to off-grid energy enterprises. Some are wary of businesses that rely too heavily on grants, and thus lack sustainability without subsidies; on the other hand, there is also a recognition that being able to access and manage donor funds reflects well on the capacity of a company's management. Results-based financing (RBF) is generally considered by those interviewed a minimally market distorting subsidy that would positively affect lenders by reducing market risks. Nonetheless, RBF programs should be designed to support the quality of portfolios, for example results based payments should be based on performing accounts rather than just new sales.

7.3.6.4 Crowdfunders in West Africa and the Sahel

Country related issues that are of concern to crowdfunders are usually related to compliance and regulatory issues, such as ease of repatriating funds. Country-specific market risks were also highlighted by interviewees, who noted a difference in capacity between companies operating in more mature markets and those in more frontier markets. Similarly, a difference was noted in capacity between companies with international ownership and management vis-à-vis local companies. Although raising local capacity is a relevant priority for all sectors of sustainable development, it is particularly important in the financially sophisticated off-grid electrification sector, as more needs to be done to build local capacity and provide training on alternative financing and fintech solutions.

Below is an overview of the crowdfunders active in Africa with an interest in carrying out off-grid solar financings in ROGEP countries. The information shared below was obtained through a program websites as well as stakeholder interviews.

- **BETTERVEST**

Bettervest is a German company that brokers deals on its crowdfunding site. The platform started by supporting energy efficiency investment projects in Germany. Now Bettervest is focused on supporting other financing of clean energy and sustainable development. Their network of energy specialists allows Bettervest to calculate the amount of CO_2 reductions accrued from each of its projects. Bettervest finances companies that are at the scale up stage and has a track record of more than 70 successfully financed projects. Bettervest has carried out approximately EUR 10 million in investments, from six-thousand investors, who provide between EUR 100 to 500,000 to Bettervest's platform. Although Bettervest considers itself to be solely a financial broker, Bettervest also has some technical expertise in-house.

- **Africa Off-Grid Deals**

Bettervest has done deals across Sub-Saharan Africa. They can lend directly to companies in Nigeria, as GIZ has supported them in establishing a legal structure to do so. Otherwise, for international transactions, Bettervest must lend through its special purpose vehicle (SPV) to accommodate the legal issues regarding crowd-investing outside of Germany, such as foreign banking regulations related to the issuance of financial instruments the repatriation of funds, as well as other German banking regulations under the newly enacted Small Investors Protections Act.

- **Instruments Offered**

In accordance with Germany's Small Investors Protections Act, the only instruments Bettervest offers are subordinated loans and mezzanine debt, which they broker through their crowdfunding portal. Collateral is not required, nor are the borrower's existing credit lines burdened. Bettervest can also provide project financing, refinancing and inventory financing, but not startup financing. Bettervest provides euro-denominated loans to Sub Saharan Africa and India. In Nigeria they can issue loans in dollars. The loan tenors are between 2 to 10 years and have interest rates in the range of 5-10% per annum. Loan sizes are between EUR 50,000 and EUR 2.5 million, but Bettervest's ideal size is between EUR 50,000 and EUR 500,000.

- **Engagement in ROGEP Countries**

Bettervest has financed 13 deals in ROGEP countries thus far, including: Benin, Ghana, Mali, Nigeria and Senegal and they seek to expand their activities in West Africa. Their investees in West Africa include the following companies: Bonergie GmbH & Co. KG, Havenhill Synergy, GVE Projects, Sosai Renewable Energies Company Limited, Nayo Tropical Technology Ltd., Rubitec Nigeria Ltd., EnergieKonzepte Schiffer GmbH, UMAWA Deutschland UG (haftungsbeschränkt), Mobile Solarkraftwerke Afrika GmbH & Co. KG. Bettervest usually raises between EUR 100,000 to EUR 300,000 for its borrower's projects. Bettervest has not yet worked with local banks on financings but is open to engaging in such partnerships in the future, including working with local banks to provide forex solutions for its borrowers and on syndicated loan transactions.

- **Deal Sourcing and Due Diligence**

Bettervest hires external consultants to conduct feasibility studies as part of its due diligence, but much of the credit checking is done through a referral system whereby Bettervest partners with other actors in the sector including:

- GIZ
- Winrock (through an USAID project)
- UNFCCC
- World Bank
- Equipment suppliers

In order to mitigate risk, Bettervest asks for proof of pre-orders or of previous sales. Bettervest does have preferred implementation partners for the projects that it finances, and Bettervest is generally established non-exclusive relationships with its company partners. Bettervest issues loans only to companies with medium risks, or lower, according to assessment by their partners. Borrowers must have two years of operations and audited annual accounts must be provided.

- **Credit Enhancements and Structuring**

Bettervest has been approached by a number of DFIs that have shown interest in their work as digital financial intermediaries. Bettervest has recently started working with GIZ to establish a first-loss facility for the projects on its portal and have also had discussions on accessing credit enhancements from Guarantco, Afrexim, Deustche Bank and GCF for its entire portfolio. Bettervest is partial to first-loss instruments because they serve as an investment multiplier.

The main point at which Bettervest would appreciate donor support would be to enable them to lend to smaller borrowers. Bettervest believes that this could best be achieved through bundling, providing a first loss facility for around 100 projects, with transactions totaling around EUR 250,000. The credit risk of this portfolio could then be wrapped in a guarantee or insurance policy where the donors would also cover the premiums for the policy.

➢ **TRINE**

Trine is a Swedish-based crowdfunding platform. Through their online platform, investors can earn a reasonable return while their solar energy lendees can scale their businesses. Trine provides support for companies that are at pilot, demonstration and scale up stages. Trine has supported mini-grid developers, PAYG energy providers and other off-grid business models. Trine requires that all of the solar lamps and solar home systems it finances must meet Lighting Global Quality Standards. They have partnered with Azuri, BBOXX, and Vitalite among other solar companies.

- **Africa Off-Grid Deals**

Trine's borrowers must satisfy two minimum criteria: (1) they must be an off-grid solar company, and (2) they must operate in the developing world. At the time of this writing Trine has provided EUR 7.75 million into solar energy companies and projects. In Africa it has mostly provided loans to projects and borrowers in East Africa (Kenya, Tanzania, Uganda and Rwanda).

- **Instruments Offered**

Trine offers inventory financing and other structured financing instruments such as receivables financing, syndicated loans and subordinated debt. All of its loans are offered in euros. It charges an interest rate of 10-15% per annum. The tenor of its loans are between 6 to 24 months. Trine's deals tend to be in the range of EUR 250,000 to EUR 1.5 million.

- **Engagement in ROGEP Countries**

Trine has participated in Azuri's USD 20 million off-balance-sheet debt financing providing working capital package lead by ElectriFi and to support Azuri's activities in Nigeria. Trine is committed to frontier markets because of its impact driven business model and its view that its services are more valuable in less developed markets. Trine is sensitive to the issue that companies in less mature markets can become dangerously overburdened with debt, as companies in less developed markets with less capacity tend to have a less sophisticated view of the risk of taking on too much debt too early in the business cycle.

- **Deal Sourcing and Due Diligence**

Trine sources its funding largely through direct solicitations and from past borrowers. Trine leverages it relationship with donors and impact investors in evaluating the reputation of its prospective borrowers. Trine's initial due diligence is conducted via email and Skype conversations.

Trine then asks prospective borrowers to provide a loan application that includes at least one worth of financial reporting and interim year-to-date unaudited financials, company cash flow forecasts for 3 years, as well as the company registration, articles of association, business plan and related documentation. Trine also reviews the prospective borrower's operational data and records including recent invoices or recent sales receipts. Finally, prospective borrowers must provide details of previous grants, grant providers, and use of prior donor funds, if any.

- **Credit Enhancements and Structuring**

Recently UNDP and Trine have partnered on an initiative to scale-up private investment for high-impact energy access projects, with an initial focus on Kenya and then expanding to Rwanda, Nigeria, Tanzania and Zambia. UNDP will assess and monitor the impacts of Trine's investments using UNDP's Climate Action Impact Tool which offers investors a way to quantify and track the social and environmental impacts of their investments.

Trine has also received legal and compliance support from the US program Power Africa. Trine has secured from ElectriFi first loss cover for part of its portfolio through its participation in the receivables financing structure. Trine has started examining implementing shariah compliant financial instruments to allow it to engage borrowers operating within Islamic communities. Trine has also negotiated up to 30% guarantee cover from manufacturers such as Fosera. Also, until 2022 SIDA will guarantee payments from each of Trine's loans to projects in Tanzania, Rwanda, Kenya, Uganda and Zambia, for the benefit of Trine's crowd investors, in such a way that if the borrower is 90 days overdue on a loan principal payment SIDA will then provide the crowd investor 60% of the amount invested. The total amount guaranteed under this facility is 60M SEK. Since SIDA's program is only for a small selection of African countries, it indicates that donor programs can do much to dictate the regional expansion of off-grid businesses and lending activities of crowd-investors.

Trine is open to transferring more of its credit risk and portfolio risk to DFI and institutional investors through guarantees and first-loss cover. First-loss protection is more useful for Trine because guarantees require the triggering of default provisions, thus complicating Trine's current practice of seeking to restructure loans that have fallen into arrears. Trine is also interested in partnering with local banks to help address borrowers' forex exposure by bundling loan repayments. Through such a partnership local banks could benefit from increased access to hard currency, while Trine would have access to local fiduciary partner to support its deal flow.

Trine has partnered with MFX to offer their cross currency swapping solutions to its borrowers, but few borrowers have found the terms attractive due to the high cost as reflected in the increased interest rates.[297] Trine is also interested in collaborating with other non-traditional lenders in financing deals and establishing standards.

- **LENDAHAND**

Lendahand is a Dutch-based crowdfunding platform that lends to companies and ventures that are at the pilot, demonstration and scale-up stages. Lendahand has a track record of more than 2,000 fully funded campaigns across 14 countries. On average, a EUR 100,000 campaign on its crowdfunding portal is funded within eight days. Lendahand has over 3,000 active investors on its platform.

- **Africa Off-Grid Deals**

In 2017, Lendahand began developing a pipeline of off-grid renewable energy investments and has since greatly expanded its off-grid energy financing activities. To date, Lendahand has supported the financing of over 12,000 solar home systems. Since 2016, it has provided EUR 10 million of debt to clean energy companies and plans to double that amount by 2020. To date, Lendahand has provided senior debt credit lines to the following companies: Azuri, BBOXX, Solarworks, Sollatek and New Light Africa.

- **Instruments Offered**

Lendahand has recently obtained the authorization under Dutch law to serve as an investment and brokerage firm, enabling them to market financial instruments, beyond loans, on its platform. Nonetheless, currently Lendahand only provides senior debt and other structured financing instruments (inventory financing, receivables financing to it borrowers and promissory notes (secured and unsecured) to its investors.

Upon the completion of Lendahand's due diligence, a company is granted access to its "flexible notes program" for a period of two years. During this period a company can raise debt funding through Lendahand's platform by uploading projects to the platform. For each project it can decide - within the agreed upon parameters – on the amount and maturity of the debt it will take, in line with its funding needs. For each funding campaign on Lendahand's platform interest is only paid on the outstanding principal.

[297] For example, as of August 2018, the interest rate provided by MFX for Kenya would be in the range of 10%, and for Zambia 18%.

Once the company's project is fully funded, Lendahand issues a note to the crowd-investors, which starts paying on the first day of the month once the campaign has been fully funded. Importantly, a company can have multiple notes funded in a month, with payments on those notes linearly amortized every six months.

In establishing lending relationships Lendahand always intends for their borrowers to extend the partnership beyond the initial two-year contract period. Use of funds raised through Lendahand's platform fall into two categories:

(1) Flexible working capital facility (usually between EUR 500,000 - EUR 2.5 million notes applied to working capital needs); and
(2) Tailored receivables financing (usually in the amount of EUR 1 million - EUR 2.5 million, but for financial institutions or companies with a need for financing of their installed assets. Off-balance sheet financing for solar off-grid companies through receivables financing vehicles fits within this category).

- **Engagement in ROGEP Countries**

Lendahand has provided financing to New Poa, a company operating in Cameroon. They have done investments in 19 countries. Their investment strategy in "opportunistic" and will pursue deals in any country. The only major concerns they have regarding frontier markets , including some ROGEP countries, would be AML/KYC issues and whether a country is on an international transfer blacklist. The latter issue, Lendahand has noted, was often overcome by the borrower establishing an entity in Mauritius.

- **Deal Sourcing and Due Diligence**

In carrying out its due diligence Lendahand seeks out references of other debt funders in the region regarding the reputation of the prospective borrower and the risk of the off-grid business model in that setting. Companies approach Lendahand for the most part, then together they explore if the financing sought is eligible based on Lendahand's criteria which include:

- Having a strong social mission and operating in emerging markets;
- Having a track record of > 2 years;
- Demonstrating Profitability or scale-up;
- Having a leverage ratio > 20% (unless balance sheet is relatively large);
- Having no history of repayment issues with creditors;
- The funding requirements for the company for the next 12 months > EUR 500K

If a company successfully passes this screening Lendahand then launches its due diligence (over the course or 2-6 months) by analyzing the following:

- The company: The company's management, business plan, projections, ability to raise more capital if needed, and legal framework;
- The Financials: Balance sheet, P&L and cashflow, how well capitalized is the company, it liquidity and reserves, FX exposure, return on assets and equity, capacity of debt servicing, operational leverage and cashflow;
- Company Ownership: ownership structure, cap table & debt providers, debt maturity profile, cost of funding, has company delivered so far;
- Portfolio of obligations: sound credit policy, good track record, current portfolio health;
- Operations and governance: efficient and sensible operations and procedures, proper systems and checks and balances;
- Country Risk: repatriation and investment climate.

- **Credit Enhancements and Structuring**

In 2017, DFID and Good Energies Foundation launched Energize Africa, a program to support private capital flows to off-grid energy in Sub-Saharan Africa. Lendahand partnered with Ethex, won the call for proposals and launched their partnership in August 2017. Under the Energize Africa program, the UK Government provides an additional 25% to all funds raised from the crowd (so one GBP would catalyze 3 GBP from the crowd). In some cases the UK Government's tranche in a crowd campaign would be in a first-loss position. From Lendahand's perspective first-loss is a very effective risk mitigation tool allows them the opportunity to take more risk in its loans, and thus spurring it to further participate in frontier markets.

Lendahand also has the capacity to participate in an SPV financing but would only be interested in doing so if they were backed by shares so that at least there is a real asset underlying the financing. Lendahand is not enthusiastic about participating in receivables SPVs for off-grid companies at this early stage in the industry's maturation. Lendahand feels that under such structures, companies are not adequately incentivized to have a healthy portfolio of receivables. This risk ultimately depends on particular structure deployed, and Lendahand's thoughts on the matter are evolving.

Regarding working with local financial institutions, they plan to start co-lending as well as team up with local banks in carrying out due diligences. Lendahand is also very interested in exploring opportunities with local banks as a source of liquidity for those banks, especially if credit risk is transferred to the crowd, and local currency exposure could be covered by the local bank. Such partnerships are strongly complementary since local banks often cannot lend to off-grid companies due to local regulations regarding collateral and risk, and thus would require another liquidity source in order to take on such loans. Local banks could provide local currency access, while Lendahand could participate in the financing by covering the credit risk and managing the repayment of hard currency to its investors.

Lendahand is in dialogue with credit risk guarantee providers such as SIDA and Africa Guarantee Fund; nonetheless, Lendahand are not very interested in third party guarantees because of the cumbersomeness of collecting claims. First-loss structures, on the other hand, are easier to manage, as well as having a strong marketing effect on investors on the platform to thus catalyze additional capital inflows.

Lendahand is currently working on selling their receivables to institutional investors through guarantee-wrapped financial instrument and is considering the following possible structure: Lendahand would establish a prefunded receivables financing facility backed by payments from promissory notes issued to its borrowers, institutional investors would fund the facility. Additionally, DFI's would provide guarantee to the investors to mitigate the risk of default, while institutional investors may also require an equity cushion within the vehicle. Lendahand would serve as an assent manager, lending to companies according to pre-established guidelines. Additionally, Lendahand could also crowdfund capital that would be lent through the vehicle. One of the main benefits of this approach is that it would allow Lendahand to participate in both smaller and much larger financings by bundling smaller transactions, allow it to raise additional capital and expanding its deal pipeline. Lendahand is still developing this concept and ROGEP could serve as a source of financing and technical assistance.

Lendahand also suggested that more technical assistance could be offered to off-grid companies to help address the low capacity of local entrepreneurs. It is Lendahand's experience that very few of the companies which they ultimately finance are truly local, as most of Lendahand's borrowers have an international educational or professional background. Financial advisors for local off-grid solar companies would also support its operations by serving as authoritative sources to vet the borrower's business, legal and financial disclosures, thereby reducing risks and perhaps also reducing interest rates for borrowers.

Regarding grants, Lendahand believes that extending grants to off-grid companies has its pros and cons, for it is a risk if companies rely too much on grant funding. On the other hand, results-based financing can align the interests of borrowers and financiers if the adequate milestones and payment triggers are built into the facility.

- **ECOLIGO**

Ecoligo supports commercial and industrial (C&I) developers by closing the financing gap which prevents businesses and industries from accessing low-cost, clean, electricity. Ecoligo provides financing for C&I projects between 10 kW and 1 MW.

- **Africa Off-Grid Deals**

Ecoligo was founded in 2016. To date, Ecoligo's African solar financing have mostly been in Ghana and Kenya, where it has financed about EUR 500,000 of solar projects in total. Ecoligo's deals have focused on those two countries due to their high electricity prices, supportive regulatory environment and due to professional networking. For the founders have had past professional experience in Kenya and Ghana. Notably, Ecoligo claims to be able to raise funding for projects posted on its platform within days instead of weeks like some of its crowdfunding competitors.

- **Instruments Offered**

Ecoligo only offers financing for C&I projects and supports projects in two ways: either Ecoligo owns the project and earns revenue on behalf of the crowd investors, or the project developer takes out a collateralized loan and repays Ecoligo and the crowd investors from the project revenues. Though Ecoligo would consider financing a mini-grid project with an anchor tenant, but only if exposure to demand risk is fully mitigated. Ecoligo believes that load uptake studies, as part of a C&I expansion project, rather than willingness to pay studies, are more useful for supporting the finance-ability of such projects.

Ecoligo offers interest rates in the range of 5% to 8%. Their transactions range from EUR 100,000 to EUR 2.5 million and they can offer loans in dollars as well. Loan tenors are from 2-10 years and repayment structures are either annuities, bullet repayments or mixed. It usually take four weeks to complete due diligence and fundraising. Ecoligo does not participate in receivables financing structures.

- **Engagement in ROGEP Countries**

Although Ecoligo has a strong presence in Ghana and Kenya, Ecoligo has no geographical preference for the projects it finances. Because Ecoligo has a strong interest in working with new project developers, commercial and industrial offtakers, EPC's and local financiers, it is often pulled into new markets through working with project developers that are bidding on tenders or call for proposals. In such cases, Ecoligo may often be offering financing to multiple developers for a single tender or call.

- **Deal Sourcing and Due Diligence**

Ecoligo has a qualification process for the developers and EPC's with whom they work. Ecoligo undertakes a technical and commercial due diligence before promoting projects on its platform. Because most of Ecoligo's clients are C&I developers, Ecoligo's financings are based on the strength of the off-take agreement.[298] The due diligence focuses on the project financials and the offtaker risk, similar to a project

[298] E.g. Ariya Leasing: http://www.ariyaleasing.com/

financing due diligence. Ecoligo has in-house technical capacity while also retaining supporting external expertise to ensure the bankability of the project.

- **Credit Enhancements and Structuring**

Although Ecoligo has the ability to take a subordinated debt position, so far they have only issued senior debt. They have not engaged in any receivables financings, syndications, or other structured financing arrangements. Ecoligo has looked at taking on first-loss protection from DFI's, but their ticket sizes tend to be too small (under EUR 200,000) on a per-deal basis.

In their view, the C&I sector does not receive adequate support from donors, which focus more on either rural electrification or larger utility-scale projects. Ecoligo has not been engaged by any DFIs. Furthermore, in their view, the availability of donor capital for off-grid solar projects has hindered the C&I business models, for it greatly depresses the cost expectations of offtakers. Ecoligo is interested in accessing credit enhancements such as portfolio guarantees and first-loss cover from donors, since such credit enhancements are a useful marketing tool for funding their campaigns. Nonetheless, Ecoligo finds that the requirement that a loan must be declared to in default in order to make a claim under a guarantee is cumbersome. For Ecoligo would prefer to restructure underperforming loans in such cases.

Ecoligo is also concerned that there is a downward pressure on project quality due to the intense competition within the increasingly crowded market space, and thus leading to market distortions. They are concerned that donor grant funding does not help in this regard. Ecoligo believes that the C&I sector requires more support for developers and better returns on each project.

Regarding working with local financial institutions, Ecoligo also thinks local banks should participate in more in financings, especially to help address the important issues such as currency exposure. They have engaged in such fruitful partnerships with local banks in Ghana.

➢ **CROWDCREDIT**

Crowdcredit was launched in 2013 and has brokered cross-border financings since 2014. Crowdcredit is based in Tokyo, Japan, but also has subsidiaries in Peru, Mexico and Estonia. Its current book value is approximately 10M USD. Through Crowdcredit, Japanese investors are able to fund investments in overseas assets, while Crowdcredit serves as an investment broker and partners with local financial institutions to source deals and arrange financings. As of March 2018 Crowdcredit has established partnerships with 20 international partners which include non-bank financial institutions and micro financial institutions (MFI). Although Crowdcredit is able to provide personal loans and participate in trade financings, its borrowers tend to be foreign local financial institutions which then on-lend to local SMEs. Crowdcredit has issued USD 100 million in loans as of this writing.

- **Africa Off-Grid Deals**

Crowdcredit wants to expand its sector coverage to the agricultural and off-grid energy sectors. As part of their business expansion efforts they represented themselves at the Zambian Off-Grid energy conference in Lusaka, Zambia in June of 2018. Crowdcredit has two African financial partners. It's financings in Cameroon, its only West African partner, are facilitated by Ovamba.[299] Crowdcredit is in the process of establishing a Kenyan local financial partner.

[299] Ovamba: https://www.ovamba.com/

- **Instruments Offered**

Crowdcredit only offers loans and mostly issues non-collateralized loans in order to provide higher returns for its investors. The loans are usually corporate loans, but Crowdcredit also offers credit lines to MFIs and thereby severs as a source of liquidity for local financial institutions. In rare cases, Crowdcredit's loans are also used for trade financing, secured car loans, personal loans and real estate financings. The maximum tenor of Crowdcredit's loans is three years. This is due to the preference for Japanese investors which prefer shorter tenor loans. Crowdcredit's interest rates start at around 10% per annum and the preferred ticket size is USD 1 million to USD 1.5 million.

Crowdcredit's loans are usually in USD, though it can also lend in EUR, RUB, GEL, PEN and MXN. Crowdcredit's investors takes the FX risk of converting from yen to the loaned currency. The repayment of the loaned principal is fixed in yen, but the interest payments would be based on the forex rate of the dollar (or other loaned hard currency) to yen on the exchange date. Crowdcredit's investors can opt for a forex hedging option provided by MFX. With regard to the borrower's forex exposure, although transfer risk is part of Crowdcredit's due diligence, the borrower bears the forex risk of exchanging its local currency to the loaned hard currency.

Since Crowdcredit is not a bank, it has considerable flexibility in negotiating the commercial terms of its financing agreements. Although the interest rate applied is based on the strength of the borrower's balance sheet, the amount of principal, the denomination, the ideal repayment schedule, tenor and disbursement schedule are all points of negotiation.

- **Engagement in ROGEP Countries**

Crowdcredit admits that it has not yet thoroughly researched the African market, though it is very keen to break into the African agricultural and off-grid energy sectors. Furthermore, Crowdcredit have recently taken on a new equity partner, an insurance company, which has highly prioritized environmental and social governance ("ESG") and social impact. Crowdcredit has issued loans to companies in Cameroon but has not issued loans in the off-grid sector yet. Of the ROGEP countries, they have noted that Mali may be problematic due to security issues.

- **Deal Sourcing and Due Diligence**

Crowdcredit does not guarantee that a campaign on its site will raise the targeted amount within the campaign period. Nonetheless, Crowdcredit has been able to consistently fundraise about USD 1 million every two weeks. Based on this frequency, borrowers should be able to determine how frequently they would need to issue campaigns to meet their financing needs.

Crowdcredit's financial due diligence includes reviewing and analyzing the prospective borrower's certificate of incorporation, disclosing shareholders and board members, audited financial statements of the last 3 years, including the latest balance sheet, the most recent pro forma statements, and business plan. In reviewing the financial information Crowdcredit particularly pays attention to any outstanding loans, repayment status and terms. Crowdcredit also reviews the prospective borrower's anti-money laundering and know-your-customer policies.

After financial due diligence, Crowdcredit and its borrower negotiate terms and bring the financing proposal to their investment committee. Necessary documentation is subsequently drafted and on-sight due diligence takes place before the loan is placed on the site and fundraising begins.

When issuing a loan to a company in a country where Crowdcredit has not yet completed a transaction, Crowdcredit first checks the local foreign remittance regulations of the borrower's country. Crowdcredit then sends a small amount to and from the borrower's country as a test to check the flow of funds. Finally, it provides the details of the financing to Japanese authorities. Fundraising campaigns usually last two weeks, then disbursement of the loan takes place six days after the fundraising concludes. The entire process of issuing a financing agreement with a borrower takes about one month, an additional month is necessary if the loan is issued to a borrower in a country that Crowdcredit has not loaned to yet, due to additional procedures under Japanese compliance regulations.

- **Credit Enhancements and Structuring**

Crowdcredit also provides currency risk solutions for its investors in partnership with MFX. Crowdcredit would be interested in providing a subordinated loans alongside a local bank in a structured financing deal but has not done so yet. Since Japanese compliance guidelines for brokerages constrain Crowdcredit's ability to lend to risky companies credit guarantees would also be useful, especially at the portfolio level. Such guarantee protection would also serve as useful marketing tool to its crowd investors.

➢ **SUN EXCHANGE**

Sun Exchange is a South African based fintech startup that allows its online users to buy solar cells and then lease them to offtakers over the life of the project. Like crowdfunding portals, Sun Exchange solicits the sale of solar cells to be leased to offtakers for various projects on its website. Unlike other crowdfunding portals investments are made either in the project's local currency (usually South African Rand) or via a bitcoin currency. One of the main aims of the company's founders is to demonstrate the applicability of cryptocurrencies, such as bitcoin, to support real world projects. Recently, Sun Exchange has entered into an agreement with Powerhive, an East African mini-grid developer, whereby Sun Exchange would finance and own Powerhives's generation installations, while Powerhive would be responsible for the transmission, distribution, maintenance, and supporting the mini-grid's customers to establish small enterprises such as chicken hatcheries. Most of Sun Exchange's offtakers are C&I clients, but the company is branching out to rural electrification through mini-grids. Sun Exchange has also developed its own cryptocurrency to be used on the platform as a rewards program.

- **Africa Off-Grid Deals**

As a startup based in South Africa, most of Sun Exchange off-grid financings are in South Africa as well. Through its partnership with Powerhive Sun Exchange hopes to carryout financings elsewhere throughout Africa, including ROGEP countries, though they have not yet thoroughly scoped other African markets.

- **Instruments Offered**

Sun Exchange is able to source projects from local developers and offtakers through its website. Nonetheless, thus far it has tended to rely on a handful local engineering firms to make referrals. Sun Exchange has recently increased its sales staff in order to more widely originate deals.

Sun Exchange accepts investments from the crowd in various currencies, including a cryptocurrencies. For Sun Exchange the advantage of cryptocurrencies is the ease of transferring funds. On the other hand, cryptocurrency transfers entail significant risks such as their volatility and the risk of fraud.

Sun Exchange is furthering its utilization of cryptocurrencies by issuing its own coin called SUNEX. SUNEX will serve as a rewards program for users of the Sun Exchange platform. Rewards will include privileged access to invest in projects and increased leasing rates. Users will be able to earn SUNEX through participation in the financing of projects on the platform after the completion of an in initial coin offering (the cryptocurrency analog to initial public offerings). The proceeds of the SUNEX initial coin offering will support the expansion of SUNEX's enterprise by establishing additional regional hubs in a yet-to-be-determined locations, supporting marketing efforts and the execution of more diverse projects (e.g. rural cellular towers, micro-grids, cold storage/pack housed for small holder farming cooperatives). SUNEX will also support Sun Exchange's Solar Project Insurance Fund, a facility on the Sun Exchange platform to let users insure against lease non-payment. Holders of SUNEX would be able to commit it to projects to allow them to collect upon the default of the offtaker on its lease payment obligations.

- **Engagement in ROGEP Countries**

Sun Exchange has two main regulatory concerns that affects its ability to enter into new markets. The first is compliance with local regulations concerning installation of solar PV facilities and the ability to feed-in to the grid via net-metering. The second is the securities and banking laws of a country. Sun Exchange have structured their financings as purchases by investors and leases to offtakers. Under U.S. regulations, their transactions are classified as securities therefore they can only allow accredited investors to participate on their platform. On the other hand securities regulations do not pose an issue for Sun Exchange's South African investors and offtakers. Through a typical Sun Exchange transaction, the crowd investor purchases the solar asset (a "solar cell") and then enters into a lease agreement with the offtaker. The offtaker may also choose to have the option to buy the solar asset at a later point while paying a rental rate. These structures ensure that the transaction is not be classified as a PPA, whereby Sun Exchange and its investors are power producers and sellers. Rather these structures allow the transaction to considered self-consumption, and therefore not subject to as much regulatory scrutiny. Sun Exchange plans to continue to analyze the project development and securities issues of its model as they arise and once they begin to receive more deal flow from other countries.

- **Deal Sourcing and Due Diligence**

In assessing whether to engage in the financing of an off-grid solar project Sun Exchange first reviews the initial installation plans drafted by the offtaker's chosen EPC. Then it then carries out a site visit; conducts an in-depth technical and financial analysis, reviewing three years of the offtaker's audited financial statements and 12 months of its power bills, and lastly conducts a telephonic meeting with the offtaker and EPC to go over the transaction. Throughout the project development the offtaker and EPC work together to establish an agreed upon installation design. Also, if the offtaker changes location then it must buy the solar installation outright from Sun Exchange's investors.

Currently Sun Exchange has not executed O&M contracts for its installations, but it has established what it characterizes as a "gentleman's agreement" with its EPC's to provide ongoing maintenance services. Sun Exchange still has the option to secure O&M contractors though. Sun Exchange accredits and carries out the due diligence of its EPC partners by reviewing their reference projects then entering into a cooperation agreement with them.

Under the Sun Exchange's partnership with Powerhive a similar process for the financing installations is envisioned. The main difference will be the credit assessment methodology, since rural communities will be the offtakers, and the support Powerhive will provide to the offtakers. Sun Exchange is able to carry out re-financings and also intends to work with Powerhive to provide credit backed by the revenue of their operating installations.

Sun Exchange accepts investments from the crowd in various currencies, including a cryptocurrencies. For Sun Exchange the advantage of cryptocurrencies is the ease of transferring funds. On the other hand, Sun

Exchange recognizes that cryptocurrency transfers entail significant risks such as their volatility and the risk of fraud.

Once Sun Exchange agrees to onboard a solar project to its crowdfunding platform crowd investors are then able to buy the solar cells through Sun Exchange's online marketplace, thereby entering into a lease agreement with the energy offtaker. The offtaker may also choose to have the option to buy the solar installation at some point and then pay a rental charge for the electricity consumed. The latter structure ensures that the transaction is not classified as a PPA in which Sun Exchange and its investors are power producers. This allows the transaction to be considered self-consumption for regulatory purposes, and therefore not subject to as much regulatory scrutiny.

- **Credit Enhancements and Structuring**

Sun Exchange has a unique perspective on concessional financing to catalyze private investment in off-grid solar development, for its business model straddles the C&I and rural electrification market sectors. As with other alternative financiers for off-grid solar, Sun Exchange's concerns focus on expanding the quality and quantity of its deal pipeline, market risks and transaction costs. In its view donor funding could be deployed in a variety of ways to support the financing of projects on its platform.

Because micro-grids have a ramp-up period during which energy usage and revenue is low and uncertain, thus affecting the optimal sizing of the installation, a subsidy to top-up the IRR of a micro-grid over the first two years, if below a pre-established threshold, would be a very effective de-risking instrument. Also, because of the high transaction costs associated with international repayments in and out of crowdfunded projects (high frequency low volume transfers), a low-cost foreign exchange facility for rural electrification, or a subsidy to use pre-approved providers of forex hedging services, would lower the threshold for crowdfunding portals to engage in off-grid energy financing. A donor supported facility to provide these financial services would be a boon to project developers and financiers.

Theft of installations is also growing issue for off-grid solar projects, but low-cost theft insurance for assets in rural African communities is rarely available. Such an insurance policy could be developed or subsidized by donors. Subsidies for local insurance would be preferable because it would further support the local economy, but otherwise a low-cost reinsurance product via international insurers or DFIs could also be very effective.

There is a lack of C&I offtakers in rural areas, and the presence of such "anchor" tenants greatly improves the viability of off-grid projects. To support the enabling environment for off-grid solar projects, donors could provide a subsidy for newly established commercial/industrial/educational/health offtakers, whereby a minimum amount of energy demand must be established before the subsidy is accessible. Such a subsidy could spur rural electrification and support livelihoods. Under this proposed subsidy, in order to meet the consumption threshold, businesses could pool their consumption demand, i.e. two commercial consumers would combine their energy demand to qualify for the subsidy if the energy is consumed at the same point.

Sun Exchange's general concern over accessing concessional donor funding is the bureaucracy, especially for the smaller projects which it finances. This inefficiency might be streamlined by establishing a facility dedicated to small off-grid solar projects with minor conditions precedent to disbursement, no reporting obligations and wide latitude in the use of funds by the financier or developer.

➢ **KIVA**

Kiva, founded in 2005, is a U.S. based non-profit organization that offers zero-interest micro-loans while the organization supports itself through charitable donations. Kiva is the leading global micro-financial crowdfunding platform. Within Africa and internationally Kiva is also a leading lender to the off-grid energy sector by supplying consumer financing for the purchase of off-grid appliances. In 2013 Kiva initiated its Direct to Social Enterprise (DSE) program, a pilot project that would raise and deploy capital for social enterprises in amounts greater than those available through micro-loans loans, yet smaller than an investment by an angel investor, venture capital fund or even a traditional bank. This funding gap for small enterprises in the developing world is called “the missing middle”. The DSE initiative furthers Kiva’s mission to serve the under-banked and support sustainable economic growth. Kiva posts loans on its platform on the behalf of the social enterprise borrower to raise USD 10,000 to USD 50,000. The borrower social enterprises are operational companies that require access to working capital in order to grow. Although the Kiva DSE initiative is not specific to off-grid solar companies, in 2013 Kiva extended one of its first DSE loans to a Kenyan mini-grid developer and now DSE has become a well-known resource for short term working capital for off-grid energy enterprises.

- **Africa Off-Grid Deals**

The Kiva DSE initiative has funded the following off-grid energy companies (**Table 47**):

Table 47: Kiva Funded Off-Grid Energy Companies

Fund Name	Country
Pawame	Kenya
EcoZoom	Kenya
Sosai Renewable Energies	Nigeria
Sikubora	Tanzania
Vitalite	Zambia
Solar Home	Myanmar
Simusolar	Tanzania
Affordable Computers and Technology for Tanzania	Tanzania
Zonful Energy	Zimbabwe
Eco Energy	Pakistan
SCODE	Kenya
Azimuth	Sierra Leone

Source: KIVA

The Kiva Program does not specifically target off-grid solar projects or companies. Nonetheless, as with Kiva’s micro-loans for consumer financing, the DSE initiative has served as a useful source of capital for African off-grid solar startups such as Pawame, Azimuth, Simusolar and Vitalite. These companies use Kiva’s loans as a source of trade financing and working capital.

- **Instruments Offered**

The Kiva DSE program provides 0% interest loans from USD 10,000 to USD 50,000 with a 6 to 18 month tenor. The loans are provided and repaid in USD. The DSE loans are not specifically designed for off-grid solar companies, nonetheless they are well suited to address the short-term working capital needs of companies in the sector. After the first DSE loan is repaid companies may subsequently borrow up to USD 100,000.

- **Engagement in ROGEP Countries**

Enterprises in Ghana and Cameroon are currently eligible Kiva DSE loans. Over 60 companies have taken out loans through the Kiva DSE program across the world, and two in ROGEP countries (Nigeria and Sierra Leone). Kiva's activities (micro-loans and the DSE initiative) in the West African off-grid sector have received support from Energy 4 Impact (E4I) through the Crowd Power initiative. E4I referred off-grid companies to Kiva's program.

- **Deal Sourcing and Due Diligence**

Kiva has significant footprint in Africa, with an office in Nairobi as well as staff and volunteer fellows in most West African countries. Kiva has also worked closely with Energy 4 Impact (E4I), the UK based NGO supporting off-grid energy access. Through the Crowd Power program UK Aid and E4I have trialed providing matching funds (up to GBP 845,000) for energy access crowdfunding campaigns.[300] Under the Crowd Power program E4I has also generated in-depth research and analysis on the crowdfunding sector. E4I has also served as a source of referrals for Kiva's DSE program. Other alternative finance and crowdfunding platforms have referred companies to Kiva as well (e.g. Trine, Bettervest and Lendahand).

To be eligible for DSE financing the borrower company must be a legally registered company in the country of operation. Companies operating in the following countries are eligible for DSE support:

- **Africa**: Burundi, Cameroon, Ghana, Mozambique, Rwanda, South Africa, Uganda, Zambia
- **Asia**: Indonesia, Philippines
- **Americas**: Chile, Colombia, Costa Rica, Dominican Republic, Costa Rica, Dominican, Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, United States

Companies must also have a strong commitment to a social mission that is measurable and serves the needs of poor, vulnerable or excluded populations. Companies must have a business model with sustainable and justifiable unit economics and supports loan repayment based on its cashflows. Although applicant companies must have established some operating revenue, Kiva is flexible on the length of their financial track record. What is more important to Kiva is whether the company's turnover has reached USD 50,000 to USD 100,000. DSE borrowers must also be able to remit loan payments in dollars, and borrowers take on all of the currency risk. Kiva has no preference for how the funds are used. Upon repayment of its first loan a company is eligible for further loans.

- **Credit Enhancements and Structuring**

Concessional financing in the form of grants and forex solutions could greatly aid Kiva's efforts in supporting social entrepreneurs in Africa and ROGEP countries. Since Kiva only lends in USD, if donors created a facility whereby participating borrower companies would be protected from currency risk in such a way that if the local currency is devalued past a certain threshold the facility would assume the balance for repayment. Conversely, such a currency guaranteeing facility could also accrue the difference of any appreciations of the local currency within a certain threshold, and thus limit market distortions and further sustainability.

Donors could also provide grant funding to support new market entrants such as providing matching donations to crowdfunding campaigns like the subsidies provided through the Crowd Power program. Grants can also support capacity building for local entrepreneurs. Kiva has found that accelerator programs

[300] Energy4Impact: https://www.energy4impact.org/fr/%C3%A0-propos/programmes

such as the African Entrepreneur Collective[301] provide impactful and effective long-term support to local entrepreneurs in the solar off-grid sector. Such support would be critical for entrepreneurs in countries that more established off-grid players would not prioritize. Kiva believes that grant support for such accelerator programs to expand access to their services would significantly help broaden Kiva's deal pipeline. Also, for markets that are considered the most frontier the lack of even good MFI's and mobile money platforms makes developing the off-grid solar market that much harder. For those markets grants and programs to address the enabling environment (e.g. mobile penetration and payment platforms, financial literacy, etc.) could be more cost effective than funding specifically directed to the country's off-grid solar sector.

7.3.7 Informal Financial Institutions

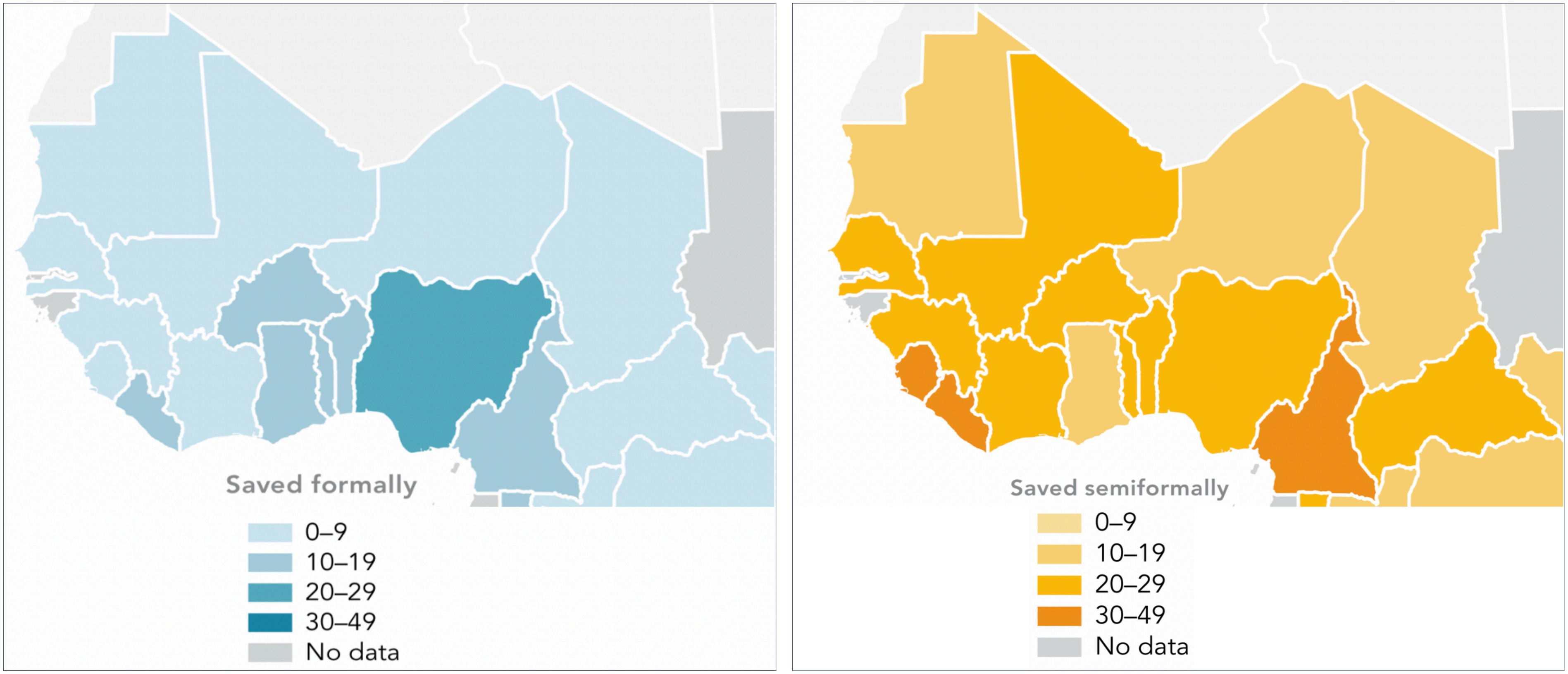
In addition to the range of formal sources of financing described above, informal financial services also play a critical role in the region. A 2017 World Bank study found that 38% of adults in Africa had borrowed money from an informal FI as opposed to 5% who borrowed from a formal FI. Although informal borrowing occurs at different rates across Africa, roughly 100 million adults in Sub-Saharan Africa use informal sources of finance.[302] The informal financial 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. Informal financial institutions typically include individual money lenders as well as collective entities such as Rotating Savings and Credit Associations and Accumulated Savings and Credit Associations, among other groups.[303] Much like in other African states, there is a large informal financial sector in West Africa and the Sahel (**Figure 111**).

[301] https://www.africanentrepreneurcollective.org/

[302] "Demirguc-Kunt, A., Klapper, L., and Singer, D., "Financial Inclusion and Inclusive Growth: A Review of Recent Empirical Evidence," World Bank Policy Research Working Paper 8040, (April 2017): http://documents.worldbank.org/curated/en/403611493134249446/pdf/WPS8040.pdf

[303] Klapper, L., Singer, D., "The Role of Informal Financial Services in Africa," Journal of African Economies, (24 December 2014): https://academic.oup.com/jae/article-abstract/24/suppl_1/i12/2473408?redirectedFrom=fulltext

Figure 111: Share of Adults Saving in the Past Year (%) in West Africa and the Sahel, 2017[304]



NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 46 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.

[304] Demirguc-Kunt et al., 2017.

7.4 Financial Institution Assessment – Summary of Findings

- **Opportunity for ROGEP Credit Lines:** Commercial banks across the region lack access to funding with the interest rates and tenors required to make off-grid solar projects attractive to end-users and SMEs. Local currency cost of capital remains very high for most FIs, which in turn results in prohibitively high pricing for typical loans. Furthermore, loans are usually short-term, as customer deposits (mostly short-term) remain the largest source of funding for banks. This dynamic severely constrains OGS market growth. Stakeholder interviews with FIs across the region revealed that there is indeed an opportunity for ROGEP credit lines to provide liquidity to local commercial banks and MFIs to support lending to the off-grid solar sector.

- **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. However, taking up hard currency denominated credit lines presents challenges for local lenders who would have to bear the foreign exchange (FX) risk. This risk is somewhat mitigated in countries that are part of the WAEMU or CEMAC monetary unions, as the CFA franc is pegged to the euro, which shields it from volatile currency fluctuations. As a result, even after pricing in a hedge to cover this risk, many hard currency denominated credit lines can stay attractive for FIs operating in these markets, as the all-in cost of capital to local FIs is manageable to provide competitive offers to borrowers.

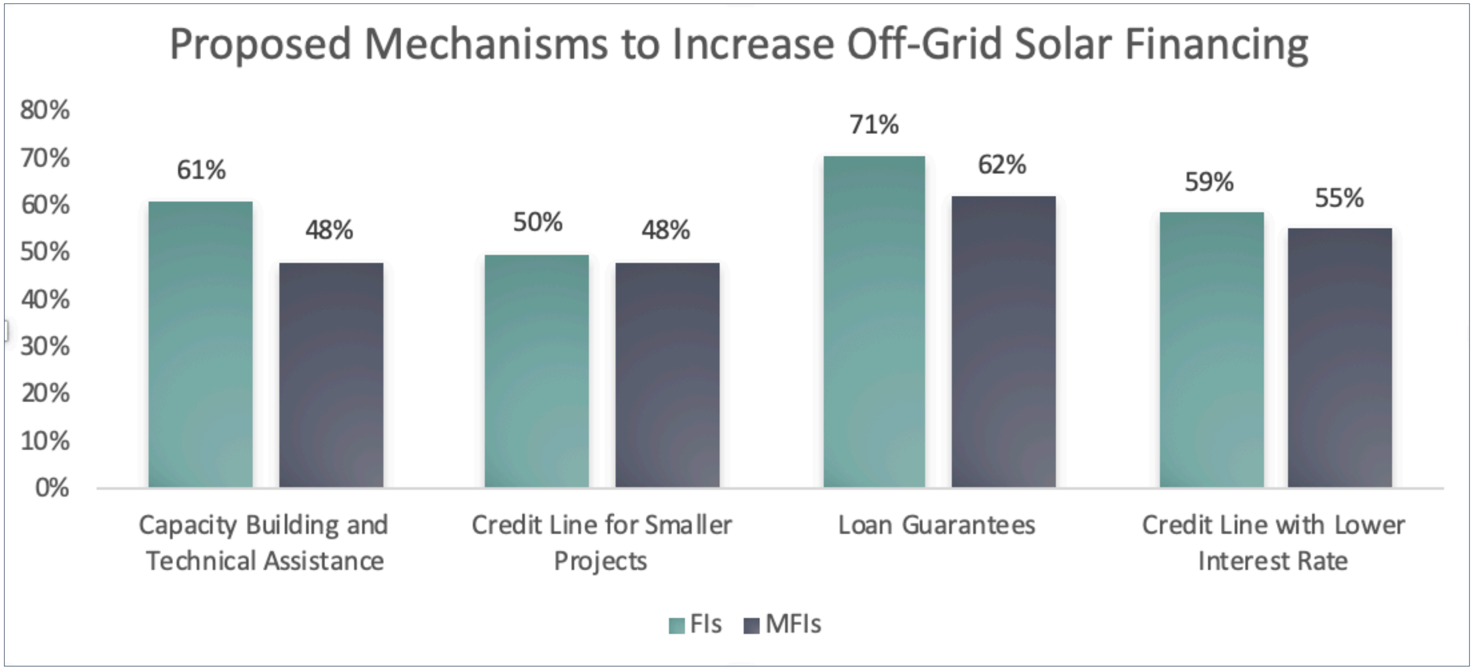
- **Collateral Requirements**: The collateral requirements of commercial banks across the region are generally high, particularly for small firms. Moreover, lenders already in the space are deeply constrained from originating loans where the borrower cannot meet these requirements. Hence, the use of third-party *pari-passu* guarantees as an alternative form of collateral would enable banks to extend loans to borrowers without such high collateral requirements. Accordingly, many of the interviewed commercial banks emphasized the need for partial credit guarantees to encourage lending to the OGS sector (50% coverage is helpful; 70-80% coverage could be transformative). However, pricing from most available third-party guarantors can be in the range of 3%+ per annum, which some lenders view as too high to remain competitive. 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**: In order to attract additional lenders into the off-grid solar market segment, there is need for strong, reasonably priced credit enhancement mechanisms. In order to cover "market entry" risks for lenders unwilling to enter this market, guarantee instruments that cover first-loss are needed. However, first-loss coverage, while necessary for attracting new lenders to the off-grid sector, does not address the key issue of collateral and is therefore likely insufficient on its own to stimulate growth in FI engagement unless coupled with third-party guarantee coverage.

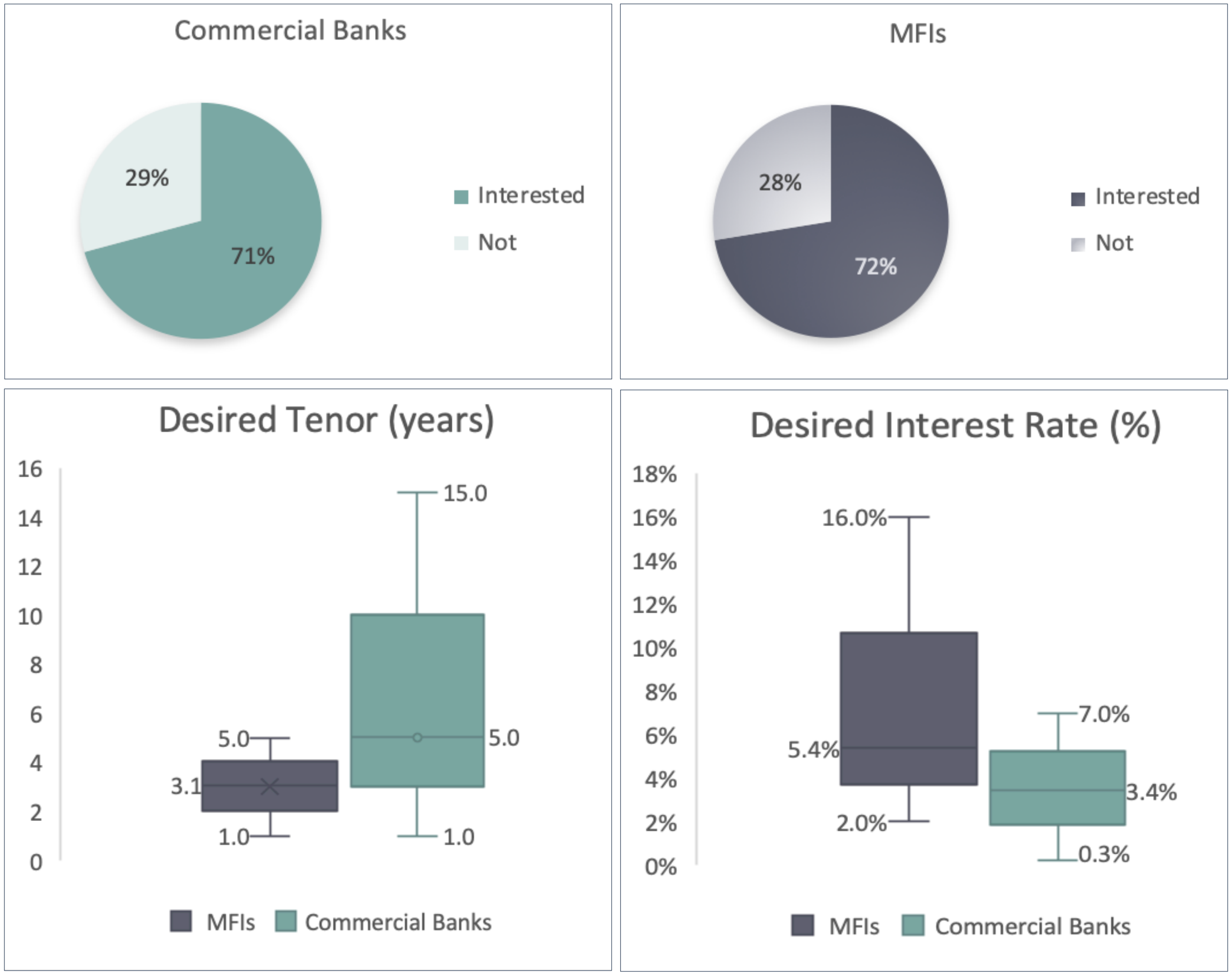
- **Technical Assistance:** A well designed TA intervention is critical to accelerating OGS lending. Stakeholder interviews with FIs across the region revealed the following key areas of support: training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of stand-alone solar firms and projects; extensive due diligence support to qualify products and approving 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 and existing programs such as CEADIR and SUNREF (among others) to avoid duplication of efforts. Special attention should also be paid to offering advisory services to stand-alone solar enterprises, as 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. Governments across the region 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.

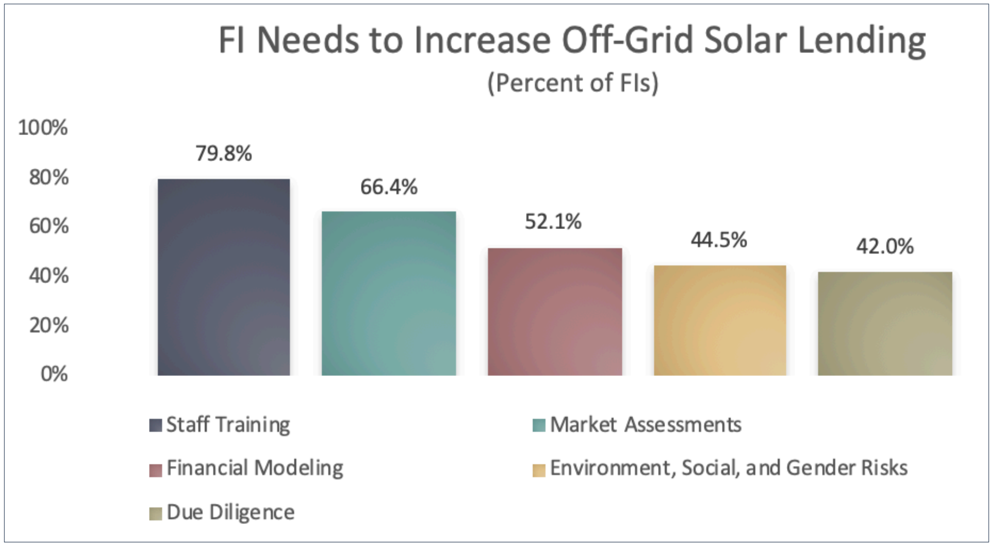
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from commercial banks and MFIs, which together account for 92% of all respondents. See **Annex 3** for more details.



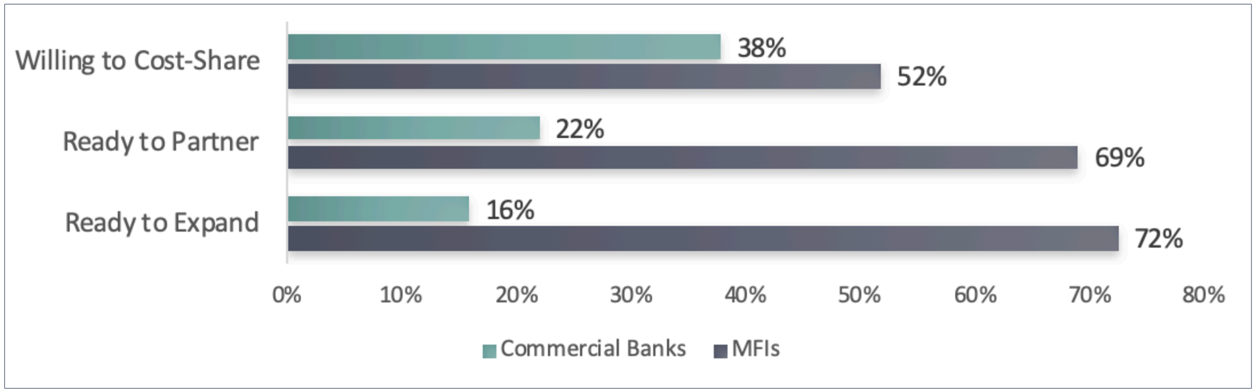
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy 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 a close distant of the current electrical grid network[305] (according to WAPP or national 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)[306]
- Are located within areas that have a high population density and are within 1 km[307] of a social facility (education center or health facility).

1.1.3. *Electrification by off-grid technologies* – 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 or within a close distant of planned future line extensions[308]

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

[305] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[306] 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
[307] Preferred maximum distance for mini-grids from discussions with different international developer.
[308] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

international developers.
- Are located within 15 km of economic growth centers – airports, urban areas and mines (where available); 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.[309]

1.2.3. *Electrification by off-grid technologies* – 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* in the table below)
- Outside 15 km night-lights of buffered areas to capture the densification within 5 years
- Within areas of low population density

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." [310]

A Voronoi polygon analysis[311] 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. Current annual national population growth rates were applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses in each country.

[309] Lall, Somik Vinay; Henderson, J. Vernon; Venables, Anthony J. 2017. Africa's Cities: Opening Doors to the World. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/25896 License: CC BY 3.0 IGO.
[310] https://www.worldpop.org
[311] To learn more about Voronoi polygons, see wikidot: http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons

2. Data Limitations

Official data was used where available. Where no official or authoritative data was available, the team collected data published on Humanitarian Data Exchange (HDX) and/or from OpenStreetMap (OSM). The limitations from OSM data are explained below.

OpenStreetMap is a map of the world, created by people like you and free to use under an open license (official definition). OSM has free to use data, which is often richer than other free map sources, as contributed by citizens/ volunteers (e.g. mapping water points within the volunteers' communities). This also results in more flexible data to quickly update changes (e.g. a new health center opening). On the other hand, the contribution of volunteers only can lead to a lack of quality and consistency as no systematic quality check is performed on the data. In areas with a community of local mappers, the quality of data is greater than without (like it is often the case in the countries of interest for this study) since the mappers are checking the data inputs of each other. In addition, the attributes of the data points are often not very accurate (e.g. the data is locating a school but does not mention the kind of school). Finally, the data is not authoritative. Therefore, it was used only where no authoritative data (e.g. from censuses) was available.

One example of the limitations of OSM data is clearly visible in the settlement data for Chad. Most settlements were mapped out in the Region Lac, South of Region Kanem and along the main roads of Hadjer-Lamis and Batha. Whereas few settlements were mapped in the populated southern areas of forest land along the rivers Chari and Logone. The contributing volunteers are most probably commuting in the central areas of Chad.

The table below summarizes the limitations of the key datasets for the least-cost option analysis per country. A common limitation were the lack of information for planned medium voltage lines (MV lines), partly because these long-term plans do not exist or the DESCO (Distribution Energy Service Company) did not make it available. Another challenging dataset were education and/or health facilities, which are a factor for the differentiation for mini-grid or for off-grid technologies.

Country	Dataset	Limitation
Benin	Health centers	Limited list of hospitals and clinics only; Data is from last census in 2014, facilities constructed after were not included in the data
	Education centers	Data is from last census in 2014; facilities constructed after were not included in the data
Burkina Faso	Education and health centers	Data is from last census in 2012; facilities constructed after were not included in the data
Cameroon	Health centers	Limited list of hospitals and clinics only
CAR	HV/MV lines	No future grid extension or construction plans were known
	Urban areas	Capitals of prefectures were used as urban areas; no other data was available
Chad	HV lines	One future HV line was known from the cross-country electrical grid connection project with Cameroon
	MV lines	No future/ planned MV lines were known
	Health centers	Limited list of hospitals and health center only
Côte d'Ivoire	Settlements	Settlements were not available. Therefore, points representing an approximate location of settlements had to be developed utilizing the high resolution layer of population.[312] The population density is represented in polygons; the center points of each polygon are regarded as one settlement for this analysis.
	MV lines	No future/ planned MV lines were known
	Health centers	Limited list of hospitals and clinics only
The Gambia	Education centers	Non were available for the analysis
Ghana	MV lines	No future/ planned MV lines were known
	Education centers	Exhaustive list of higher learning education facilities (high school, college, etc.), but few primary schools
Guinea	MV lines	No future/ planned MV lines were known
	Education centers	Primary schools only
Guinea-Bissau	HV lines	Non-existing in 2018; Future lines available from WAPP plans
	MV lines	Non available for 2018 and future/ planned lines were unknown
	Education centers	Two education centers were available for the analysis
Liberia	Education centers	Non were available for the analysis
Mali	Power Stations	From the decentralized power plants managed by private companies through development schemes from AMADER 64 out of 180 could be used for the analysis. Coordinates for the remaining were not available.
Mauritania	--	
Niger	MV lines	Three future/ planned MV lines were known
Nigeria	MV lines	No future/ planned MV lines were known
Senegal	MV lines	No future/ planned MV lines were known
	Settlements/ Education & health centers	Incomplete lists derived from OSM
Sierra Leone	--	
Togo	MV lines	No future/ planned MV lines were known
	Education centers	Non were available for the analysis
	Health centers	Limited list of hospitals and clinics only

[312] Resampled to pixel of $1km^2$ x $1km^2$.

3. Summary of Key Datasets

The table below summarizes the key datasets used for scenarios 2023 and 2030 as well as the criteria applied to all countries with the exception of Burkina Faso, Cabo Verde, Guinea, Mali and Mauritania, which are summarized in the table below).

Dataset	Description	Criteria used by technology					
		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
Electricity grid network (planned)	Future network planned to be built (HV & MV lines)	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance
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
Night-lights	Night-time light emissions used to identify electrified areas	Not considered	≤ 15km distance	≥ 15km distance	Not considered	Not considered	Not considered
Population density	Population distribution in people per km^2.	≥ 350 people per km^2 [313]	≥ 350 people per km^2	≤ 350 people per km^2	Used	Used	Used
Settlements	Settlement layer giving location of settlements across the countries	Used	Used	Used	Used	Used	Used
Social facility: education centers	All education centers with GPS coordinates; Indicator of active local economy	Not considered	≤ 1km distance[314]	≥ 1km distance	Not considered	Not considered	Not considered
Social facility: health centers	All health centers with GPS coordinates; Indicator of active local economy	Not considered	≤ 1km distance[315]	≥ 1km distance	Not considered	Not considered	Not considered
Growth center: airport, mines, urban areas	Economic growth centers for the analysis up to 2030 - defined for mini-grid areas	Not used	Not used	Not used	Not considered	≤ 15km distance	≥ 15km distance

[313] 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

[314] Preferred maximum distance for mini-grids from discussions with different international developer.

[315] Preferred maximum distance for mini-grids from discussions with different international developer.

Different criteria/thresholds were used for 5 of the 19 countries. The electricity utilities for Guinea and Mauritania stated a different distance from the main grid for settlements to be connected; the settlement data for Burkina Faso included reliable population data that was used to determine the different electrification method instead of population density; in Mali the analysis provides a more accurate result with a 6km distance buffer for the existing grid lines in 2018; for Cabo Verde the population data set is listed only, as it is the only dataset using a different threshold.

Country	Dataset	Different criteria used by technology					
		Scenario 2023			Scenario 2030		
		On-grid	Mini-grid	Off-grid	On-grid	Mini-grid	Off-grid
Guinea	Electricity Grid Network (HV/MV lines) – existing 2018	≤ 20km distance	≥ 20km distance	≥ 20km distance	≤ 50km distance	≥ 50km distance	≥ 50km distance
	Electricity Grid Network (HV lines) – planned	Not considered	Not considered	Not considered	≤ 20km distance	≥ 20km distance	≥ 20km distance
Mauritania	Electricity Grid Network (HV/MV lines) – existing 2018	≤ 4km distance	≥ 4km distance	≥ 4km distance	≤ 10km distance	≥ 10km distance	≥ 10km distance
	Electricity Grid Network (HV lines) – planned	Not considered	Not considered	Not considered	≤ 4km distance	≥ 4km distance	≥ 4km distance
Burkina Faso	Settlements	≥ 1,000 people per settlement	≥ 1,000 people per settlement	≤ 1,000 people per settlement	Not considered	≥ 1,000 people per settlement	≤ 1,000 people per settlement
Mali	Electricity Grid Network (HV/MV lines) – existing 2018	≤ 6km distance	≥ 6km distance	≥ 6km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance
Cabo Verde	Population living within the un-electrified villages	--	≥ 300 people per village	≤ 300 people per village	--	≥ 500 people per village	≤ 500 people per village

ANNEX 2: TASK 2 METHODOLOGY

OFF-GRID SOLAR PV MARKET ASSESSMENT METHODOLOGY

Focus Group Discussions (FGDs) were held in June-July 2018 in each country 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,[316] multiplied by electricity access rates from the International Energy Agency (IEA),[317] 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** of each country report 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 6.3** of this report, as well as in **Section 2.1.1** of each country report. 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.

316 World Bank Open Data, 2017: https://data.worldbank.org/

317 IEA Energy Access Outlook, 2017.

1.1.4 Tier 4 is not included in this analysis since the off-grid solar systems that can provide a Tier 4 level of service are beyond the reach of the vast majority of the population.

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 Focus Group Discussions (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 expected 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 each country, the number of off-grid households by income quintile was derived. For this, a percentage of off-grid households by quintile was assumed, as described in **Annex 2** of each country report.

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."[318] Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.[319] For the purpose of this research, it was assumed that households 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, a series of assumptions were made with guidance from the focus group discussions in each country:

- **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.

[318] Lai, K., Munro, P., Kebbay, 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).
[319] 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 = ([Capital system cost/average system life in years]+[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 each country).

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 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 up to three months 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 up-front payment is less than or equal to 3 months of their monthly energy budget.

1.3.8 The interest rate for consumer finance varied by country (please refer to the country reports for specific interest rates used in each country analysis).

2023 and 2030 Household Demand Scenario: Assumptions

1. The results of the GIS analysis varied by country based on available data. Please refer to Annex 2 of each country report.

2. Inflation rates varied by country (Please refer to Annex 2 of each country report). It was assumed that the inflation 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.

3. Based on a country-specific population growth rate (World Bank) and the population density dataset used in the study, the total population in 2023 and 2030 was estimated for each country.

4. The estimated share of the population with access to electricity via the national grid and mini-grids in 2023 and 2030 was taken from the least-cost electrification analysis.

5. To estimate GDP, it was assumed that the current annual GDP growth rate in each country will be maintained through 2023 and 2030.

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,[320] 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).

7. 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).

8. It was assumed the maximum interest rates in each country will stagnate at its current rate or possibly decline.

<u>Household Cost Savings and Affordability Calculation</u>:

- 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 same analysis was also completed for the 2023 and 2030 scenarios.

- Both the annual costs of current energy technologies and equivalent solar solutions considered the capital cost of each unit as well as the operating cost over the average lifetime of a unit.

- These costs were compared with a 10% monthly energy budget for households of different income quintiles. The analysis did not assess affordability for a cash vs. financed purchase over time.

[320] "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

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:

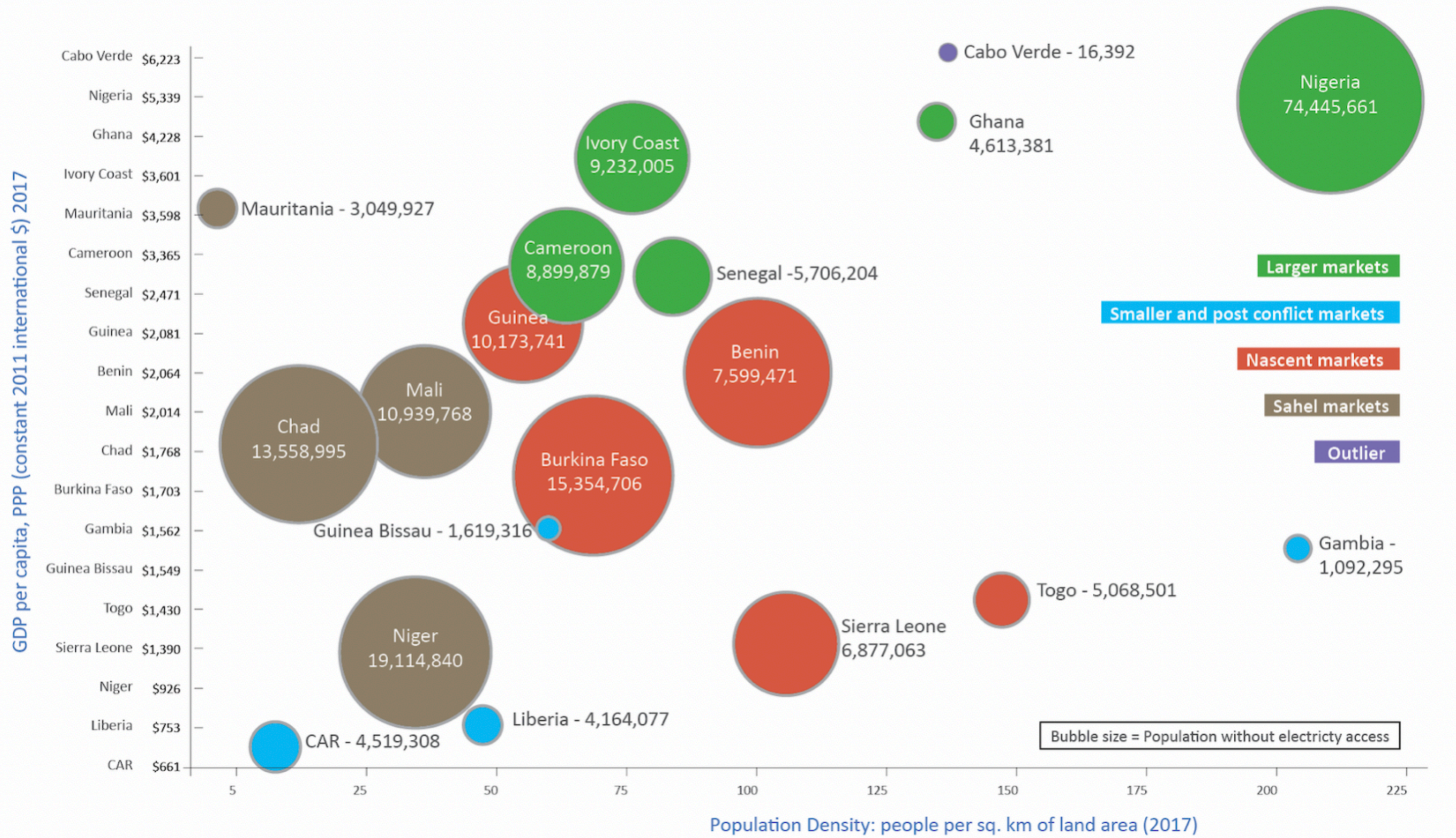
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	**Category 2:** Low-income / high population density	**Category 3:** High-income/ low population density	**Category 4:** High-income / high population density
Niger Burkina Faso Chad Mali Guinea 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



Market definitions	GDP per capita	Population Density	Population without electricity access
Larger markets	>$2,500	>75	>5 million
Nascent markets	$1500 - 2500	>50	>5 million
Smaller and post conflict markets	$0-1500	Varies	<5 million
Sahel markets	Varies	<20	>10 million
Outlier	>$5000		<50,000

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.[321] The solar PV sizing factor is based on the peak sun hours available across most of Africa.

[321] "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: The electricity needs of a given town/market center (assuming two [2] public lighting points per market center)

2.3 Institutional Market Sizing Calculations

Household systems, cost and price per watt:

System Type	Tier Rating	USD/Watt[322]	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

[322] 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						
HC 1	X	Cost per tier 3 system ($625)	X	Divided by system lifetime of 5 years	=	Estimated Annualized Off-Grid Solar Market Potential for Healthcare Sector
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						
Primary	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 Education Sector
Secondary		Size of solar system in Watts (1920W)		Cost per watt ($2.50) divided by system lifetime of 20 years		

Public Lighting						
# Off-Grid Market Centers by country[323]	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

Data was collected on the total number of off-grid institutions by institutional market segment for each country 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** of each country report.

Assumptions:

Water Supply: Of the identified potable water points, it was assumed that 50% will be equipped with a solar-powered water pump. Of the equipped water sources, the division of pumps between low, medium 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

[323] https://www.citypopulation.de

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:[324]

- **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.

[324] 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 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[325]	X	Cost per tier 3 system ($625)	Divided by system lifetime of 5 years	=	Estimated Annualized Off-Grid Solar Market Potential for SMEs

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[326]	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

* Indicative Costs for Phone Charging Appliances[327]

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. 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.

325 "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap
326 "The Mobile Economy, Sub-Saharan Africa," GSMA Intelligence, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
327 "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

3.3 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**.

3.3.1 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)[328]	X 25%	=	Smallholder Irrigation Potential (hectare)[329]	Divided by 0.3[330]	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	$650 (cost of solar pumping kit)[331]	Divided by 6 year (life of system)	=	Estimated Annualized Off-Grid Solar Market Potential for irrigation

3.3.2 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 are grown in most of the countries in the region and provide an opportunity for value addition through hulling or milling.

Value-Added PUE Applications – Solar Milling													
Cereals, roots tuber crops (tons)[332]	X	70%[333]	X	50%[334]	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor[335]	=	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

328 AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
329 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
330 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/
331 120W solar pumping kit: https://futurepump.com/futures-bright-farmers-kenya/
332 Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
333 Assumption that 70% of crops are milled
334 Assumption that 50% of milled crops are processed at smallholder farmer level
335 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/

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.

3.3.3 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[336]	X	5,500 W[337]	X	$2.50 per watt	Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Refrigeration

[336] https://www.citypopulation.de
[337] 5.5kW solar powered refrigeration system – *See*: https://www.deutschland.de/en/solar-powered-coldhubs-nigeria

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 June and July 2018 in each country
- Survey of locally-based solar companies/suppliers in each country
- Survey of 10 larger international solar product suppliers operating across the region
- ECREEE supplier database
- GOGLA semi-annual sales reports[338]
- 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 each country was also compiled (see **Annex 2** of each country report).

[338] "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

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 each country. 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.[339]

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.[340] The results of the survey are summarized in **Section 7.4** of this report.

- 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?

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[339] The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.
[340] 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-gird 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?

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

African Development Bank, 2018, "Côte d'Ivoire: African Development Bank to help mobilize over CFAF 15 billion to finance pay-as-you-go solar home systems," https://www.afdb.org/en/news-and-events/Côte-divoire-african-development-bank-to-help-mobilize-over-cfaf-15-billion-to-finance-pay-as-you-go-solar-home-systems-18244/

African Development Bank, 2018, "Energy Access for structural transformation and sustainable development in Africa," http://unohrlls.org/custom-content/uploads/2018/02/African-Development-Bank-Presentation-Access-to-electricity-in-Africa-FINAL.pdf

AllAfrica, 2017, "ECOWAS to Spend US$ 29 Billion on Development Projects in West Africa," https://allafrica.com/stories/201712290145.html

Alternative Energy Africa, 2019, "BBOXX Launches 'Tomorrow's Connected Community," https://ae-africa.com/read_article.php?NID=9968

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, Africa Development Forum, 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

Bloomberg New Energy Finance, World Bank, IFC and Global Off-Grid Lighting Association, 2016, "Off-Grid Solar Market Trends Report 2016," https://www.lightingglobal.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Summary.pdf

Cogan, D. & Collings, S., 2017, "Crowd Power; Can the Crowd Close the Financing Gap?" Energy 4 Impact, https://www.energy4impact.org/file/1883/download?token=aft0NCOX

Dalberg Advisors and Global Impact Investing Initiative, 2015, "The Landscape for Impact Investing in West Africa: Understanding the current trends, opportunities and challenges," https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.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

Deloitte and GSMA, 2016, "Digital Inclusion and Mobile Sector Taxation in Chad," https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/01/Digital-Inclusion-and-Mobile-Sector-Taxation-in-Chad_English_report.pdf

Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, Saniya Ansar, and Jake Hess, 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), 2009, "Renewable Energies in West Africa: Regional Report on Potentials and Markets," http://www.ecreee.org/sites/default/files/event-att/gtz_re_in_developing_countries.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

Economic Community of West African States, "ECOWAS Community Development Programme (CDP) Priority Projects," http://ecowas-events.ecowas.int/cdp-conference/wp-content/uploads/2016/06/Projects-English.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency, 2012, "Baseline Report for the ECOWAS Renewable Energy Policy (EREP)," http://www.euei-pdf.org/sites/default/files/field_publication_file/ecowas_baseline_report_en.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency, 2017, "From Vision to Coordinated Action: Consolidation of SEforALL Action Agendas, National Renewable Energy Action Plans, and National Energy Efficiency Action Plans," http://SEforALL.ecreee.org/sites/default/files/final_report_on_SEforALL_consolidation.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency, 2018, "Regional Progress Report on Renewable Energy, Energy Efficiency and Energy Access in the ECOWAS Region," http://www.ecreee.org/system/files/ecreee_report_-_regional_monitoring_framework_2016_0.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency and SEforALL, 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

ECOWAS Center for Renewable Energy and Energy Efficiency and SEforALL, 2017, "Standard Harmonization in the ECOWAS Region – ECOSHAM," http://www.ecowas.int/events/public-enquiry-stage-standard-harmonisation-in-the-ecowas-region-ecosham/

Energy Access Practitioner Network, 2018, "Launch of the Off-Grid Clean Energy Facility in Benin," http://energyaccess.org/news/recent-news/launch-of-the-off-grid-clean-energy-facility-in-benin/

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/

European Centre for Development Policy Management, 2017, "Political Economy Dynamics of Regional Organizations in Africa," http://ecdpm.org/wp-content/uploads/ECOWAS-Trade-Policy-Brief-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

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

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

Galichon, I. and Payen, L., 2017, “Energy Access in Rural Togo: The Relevance of the Energy Kiosk Solution,” ENEA, http://www.enea-consulting.com/wp-content/uploads/2017/04/ENEA-Consulting-Energy-access-in-rural-Togo-the-Energy-Kiosk1.pdf

Ghana Business News, 2016, “Ecobank launches mobile money treasury bill product,” https://www.ghanabusinessnews.com/2016/10/01/ecobank-launches-mobile-money-treasury-bill-product/

Global Impact Investing Network and Dahlberg Advisors, 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_westafrica.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., and Peters, J., 2016, “Solar off-grid markets in Africa. Recent dynamics and the role of branded products,” Field Actions Science Reports, Issue 15, http://factsreports.revues.org/4222

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

GSMA, 2016, “Mobile for Development Utilities: Lumos: Pay-as-you-go solar in Nigeria with MTN,” https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/11/Case-Study-Lumos-Pay-as-you-go-solar-in-Nigeria-with-MTN.pdf

GSMA, 2017, “Going greenfield with utility pay-as-you-go models: Enabling access to water, sanitation and energy in and beyond East Africa,” https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/12/Going-greenfield-with-utility-pay-as-you-go-models-Enabling-access-to-water-sanitation-and-energy-in-and-beyond-East-Africa.pdf

GSMA Intelligence, 2018, “The Mobile Economy: West Africa 2018,” https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download

Hystra, 2017, “Reaching Scale in Access to Energy: Lessons from Practitioners,” https://static1.squarespace.com/static/51bef39fe4b010d205f84a92/t/594a8a4f86e6c05c7d651eb1/1498057514242/Energy_Report+%28ADB+excluded+%2B+license%29.pdf

Holt, S., 2016, “Solar Microcredit, or how to facilitate access to electricity in rural areas: an example in Burkina Faso,” Field Actions Science Reports, 15, http://factsreports.revues.org/4202

Ikeonu, I., 2018, “Perspectives in Regulating a Regional Electricity Market: The ECOWAS Experience,” International Confederation of Energy Regulators (ICER): http://icer-regulators.net/wp-content/uploads/download-manager-files/Perspectives_in_Regulating_a_Regional_Electricity_Market.pdf

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

International Renewable Energy Agency, 2015, “Mauritania Renewables Readiness Assessment,” https://www.irena.org/-/media/Files/IRENA/RRA/Country-Report/IRENA_RRA_Mauritania_EN_2015.pdf

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

Karaki, K., 2017, “Understanding ECOWAS Energy Policy: From National Interests to Regional Markets and Wider Energy Access? European Center for Development Policy Management (ECDPM): https://ecdpm.org/wp-content/uploads/ECOWAS-Energy-Background-Paper-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf

Korsaga, S., 2018, “Land Tenure Security, Land-Related Investments and Agricultural Performance in Sub-Saharan Africa: Efficiency or Equity? A Microeconomic Analysis Applied to Burkina Faso,” https://ideas.repec.org/p/hal/wpaper/halshs-01699118.html

Lai, K., Munro, P., Kebbay, M., and Thoronko, A., 2015, “Promoting Renewable Energy Services for Social Development in Sierra Leone: Baseline Data and Energy Sector Research, Final Report,” European Union: https://pressd-sl.org

Lighting Africa, 2018, “US 7 Million Line of Credit for Solar Off-Grid Electricity to Launch in Niger,” https://www.lightingafrica.org/us-7-million-line-credit-solar-off-grid-electricity-launch-niger/

Moner-Girona, M. et. al., 2017, “Mapping the least-cost option for rural electrification in Burkina Faso: Scaling-up Renewable Energies,” European Commission – Joint Research Center, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC102198/102198_online_2017_2517_src_en_fr_final.pdf

Ramachandran, V., Shah, M. K., Moss, T., 2018, “How Do African Firms Respond to Unreliable Power? Exploring Firm Heterogeneity Using K-Means Clustering,” Center for Global Development, https://www.cgdev.org/sites/default/files/how-do-african-firms-respond-unreliable-power-exploring-firm-heterogeneity-using-k-means.pdf

Republic of Togo, 2017, “Togo electrification scheme gets boost from solar rollout,” http://www.republicofTogo.com/Toutes-les-rubriques/In-English/Togo-electrification-scheme-gets-boost-from-solar-rollout

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 Research Backgrounder series, https://www.oxfamamerica.org/explore/research-publications/energy-women-girls

Rural and Renewable Energy Agency, 2016, "Rural Energy Strategy and Master Plan for Liberia, 2030," http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf

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

Togo Electrification Strategy, 2018: https://www.lightingglobal.org/wp-content/uploads/2018/12/Togo-Electrification-Strategy-Short-EN-Final.pdf

Togo First, 2018, Togo engages land reforms to reduce related conflicts," https://www.togofirst.com/en/economic-governance/0803-419-togo-engages-land-reforms-to-reduce-related-conflicts

United Nations Capital Development Fund, 2017, "The Fight for Light: Improving Energy Access through Digital Payments," https://btca-prod.s3.amazonaws.com/documents/291/english_attachments/Full-Energy-Case-Study.pdf?1499786348

United Nations Economic Commission for Africa, 2015, "An assessment of progress towards regional integration in the economic community of West African states since its inception," http://repository.uneca.org/bitstream/handle/10855/23038/b11560721.pdf?sequence=1

USAID Global Development Lab Center for Digital Development Strategy & Research, 2017, "Rapid Assessment Framework: Pay-As-You-Go Solar as a Driver of Financial Inclusion," https://cleanenergysolutions.org/sites/default/files/documents/payg_oec_deck_amy-paul_craig-jolley.pdf

Waldron, D. and Wolvers, M., 2017, "Daily Energy Payments Powering Digital Finance in Ghana," CGAP, https://www.cgap.org/blog/daily-energy-payments-powering-digital-finance-ghana

World Bank, "West African Power Pool: CLSG Power System Redevelopment Sub-Program," http://siteresources.worldbank.org/INTENERGY2/Resources/exercise.pdf

World Bank, 2011, "Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa," http://siteresources.worldbank.org/INTARD/Resources/West_Africa_web_fc.pdf

World Bank, 2017, "Off-grid Solar Market Assessment in Niger and Design of Market-based Solutions," https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/

World Bank, 2016, "Poverty in a Rising Africa: Africa Poverty Report," https://www.un.org/africarenewal/sites/www.un.org.africarenewal/files/Poverty%20in%20a%20Rising%20Africa%20Overview.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