WORLD BANK GROUP

ECREEE

TOWARDS SUSTAINABLE ENERGY

REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

GUINEA-BISSAU REPORT

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GreenMax Capital Advisors

Energio Verda
Renewable Energy for Development

ASD

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ABBREVIATIONS & ACRONYMS

AD	Acção para o Desenvolvimento
ADPP	Ajuda de Desenvolvimento de Povo para Povo
AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ALF	Africa Leasing Facility
ASD	African Solar Designs
BOAD	Banque Ouest Africaine de Développement (West African Development Bank)
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAR	Capital Adequacy Ratio
CEMAC	Communauté Economique et Monétaire de l'Afrique Centrale (Economic and Monetary Community of Central Africa)
CFA	Communauté Financière Africaine (African Financial Community)
COD	Cash-on-Delivery
DENARP	Document stratégique National de Réduction De La Pauvreté (National Strategic Document for Poverty Reduction)
DFI	Development Finance Institution
DfID	Department for International Development
DGE	Director General of Energy
EAGB	Energia e Aguas da Guiné-Bissau (National Electricity and Water Corporation)
EBID	ECOWAS Bank for Investment and Development
ECA	Export Credit Agency
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ECOWREX	ECOWAS Observatory for Renewable Energy and Energy Efficiency
ECREEE	ECOWAS Center for Renewable Energy and Energy Efficiency
EIB	European Investment Bank
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUR	Euro
EVA	Energio Verda Africa
FAO	Food and Agriculture Organization of the United Nations
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion
FI	Financial Institution
FRES	Foundation for Rural Energy Services
FX	Foreign Exchange
GB	Guinea-Bissau
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information Systems
GNI	Gross National Income
GoGB	Government of Guinea-Bissau
GOGLA	Global Off-Grid Lighting Association
GSMA	Groupe Spéciale Mobile Association (Global System for Mobile Communications)
HC	Health Center

HDI	Human Development Index
HDX	Humanitarian Data Exchange
HH	Household
ICT	Information and Communications Technology
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
LPDSE	Policy Letter for the Development of the Energy Sector
LTO	Lease-to-Own
MEIRN	Ministério da Energia, Indústria e Recursos Naturais (Ministry of Energy, Industry and Natural Resources)
MFI	Microfinance Institution
MTF	Multi-Tier Energy Access Framework
MW	Megawatt
NGO	Non-Governmental Organization
NPL	Non-Performing Loan
O&M	Operation and Maintenance
OGS	Off-Grid Solar
OHADA	L'Organisation pour l'Harmonisation en Afrique du Droit des Affaires (Organization for the Harmonization of Business Law in Africa)
OMVG	Organisation pour la Mise en Valeur du Fleuve Gambie (Gambia River Development Organization)
PANER	Plano de Acão Nacional no Sector das Energias Renovaveis (National Renewable Energy Action Plan)
PAYG	Pay-As-You-Go
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PRODERE	Programme Régional de Développement des Énergies Renouvelables et de l'Efficacité Énergétique (Development Program for Renewable Energy and Energy Efficiency)
PUE	Productive Use of Energy
PV	Photovoltaic
RE	Renewable Energy
RISE	Regulatory Indicators for Sustainable Energy
ROA	Return on Assets
ROE	Return on Equity
ROGEP	Regional Off-Grid Electrification Project
ROSCA	Rotating Savings and Credit Associations
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SHS	Solar Home System
SILC	Savings and Internal Lending Community
SME	Small and Medium Enterprise
SPV	Special Purpose Vehicle
SSA	Sub-Saharan Africa
SUNREF	Sustainable Use of Natural Resources and Energy Finance

TA	Technical Assistance
UEMOA/WAEMU	Union Économique et Monétaire Ouest Africaine / West African Economic and Monetary Union
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak

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

KEY DEFINITIONS

ELECTRICITY ACCESS

For the purpose of this analysis, figures on national, urban and rural electrification rates are from the International Energy Agency (IEA) Energy Access Outlook Report, 2017.[1] Although local government authorities (energy ministries, rural electrification agencies, utilities etc.) may have different or more up-to-date electrification data, one single, uniformly-accepted source was necessary as a baseline to assess electricity access figures across all 19 of the countries analyzed under this regional market assessment.

There is no single internationally-accepted and internationally-adopted definition of modern energy access. The IEA defines energy access as "a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average."[2] A "basic bundle of energy services" means, at a minimum, several lightbulbs, task lighting (such as a flashlight or lantern), phone charging and a radio. This definition of energy access serves as a benchmark to measure progress towards UN Sustainable Development Goal 7.[3] The IEA electricity access statistics presented in this report include household connections, either from a grid connection or from a renewable energy-based off-grid source; the approach excludes illegal connections. The data is sourced wherever possible from governments, supplemented by data from multilateral development banks, various international organizations and other publicly available statistics.

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

OFF-GRID / STAND-ALONE SOLAR

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

- Pico solar/solar 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

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

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

WEST AFRICA AND THE SAHEL

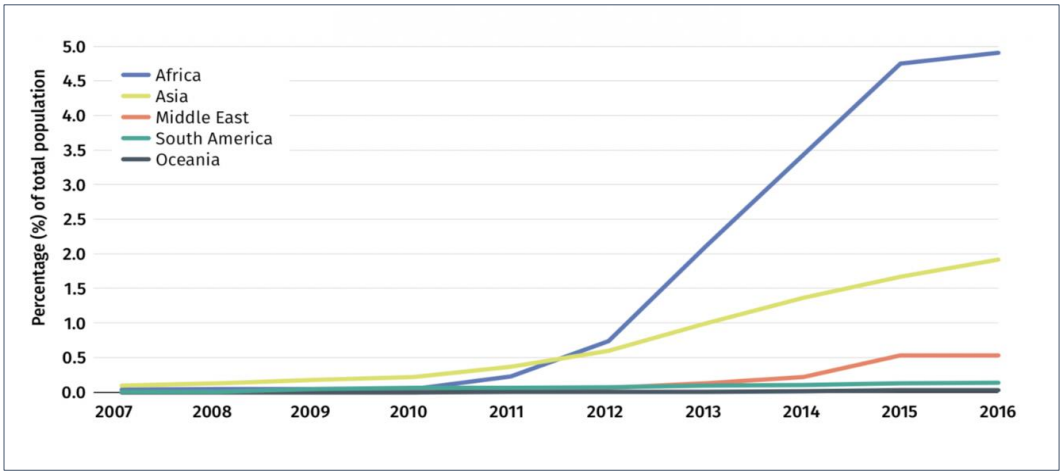
The term "West Africa and the Sahel" as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina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

EXECUTIVE SUMMARY

I. INTRODUCTION

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

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



Tier 1 access and above

Source: International Renewable Energy Agency

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

[9] "Energy Access Outlook, 2017: From Poverty to Prosperity," International Energy Agency, (2017): https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf
[10] "Tracking SDG7 – The Energy Access Report 2018," The World Bank, IEA, IRENA, UN Statistics Division and the WHO, (2018): https://openknowledge.worldbank.org/handle/10986/29812
[11] Tracking SDG7 – The Energy Access Report, 2018.
[12] IEA Energy Access Outlook, 2017.

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

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

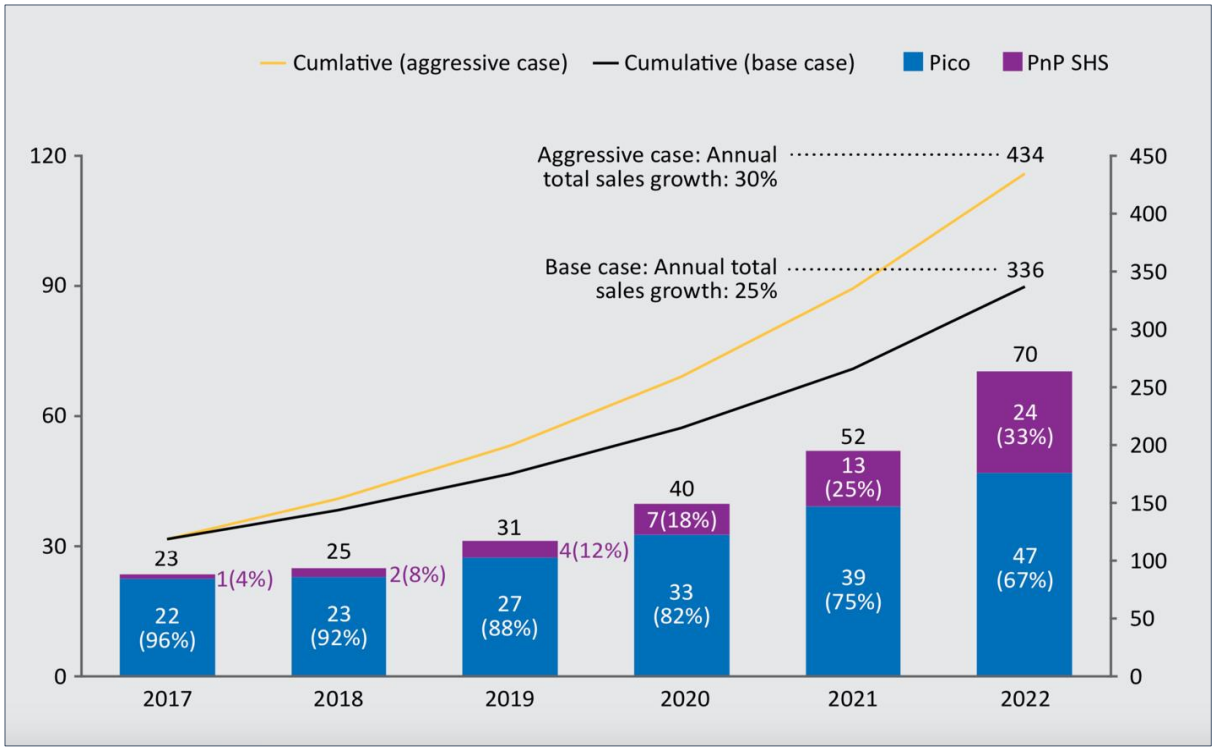
Until recently, diesel generators largely served as the expensive alternative both for rural electrification and for urban and peri-urban "bad grid" areas, where electricity was unreliable or only available for part of the day. However, the advent of decentralized renewable energy technologies, particularly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

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

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

[13] IEA Energy Access Outlook, 2017.
[14] "Derisking Renewable Energy Investment: Off-Grid Electrification," United Nations Development Programme (UNDP) and ETH Zurich, (December 2018):
https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20(20181210).pdf
[15] "Off-Grid Solar Market Trends Report 2018," Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018):
https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf
[16] Ibid.

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



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

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

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

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

[17] Bavier, J., "Off-grid power pioneers pour into West Africa," Reuters, (February 20, 2018): https://www.reuters.com/article/us-africa-power-insight/off-grid-power-pioneers-pour-into-west-africa-idUSKCN1G41PE
[18] "Accelerating Energy Access: The Role of Patient Capital," Acumen, (2018): https://acumen.org/wp-content/uploads/Accelerating-Access-Role-of-Patient-Capital-Report.pdf
[19] UNDP and ETH Zurich, 2018.
[20] "How can Pay-As-You-Go Solar Be Financed?" Bloomberg New Energy Finance, (7 October 2016): https://www.bbhub.io/bnef/sites/4/2016/10/BNEF_WP_2016_10_07-Pay-as-you-go-solar.pdf

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

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

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

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

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

[21] UNDP and ETH Zurich, 2018.
[22] "Scaling Access to Energy in Africa: 20 Million Off-Grid Connections by 2030," Scaling Off-Grid Energy: A Grand Challenge for Development, USAID, UK DFID, Shell Foundation, (2018): https://static.globalinnovationexchange.org/s3fs-public/asset/document/SOGE%20YIR_FINAL.pdf?uwUDTyB3ghxOrV2gqvsO_r0L5OhWPZZb
[23] ECOWAS Renewable Energy Policy, 2013: http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf

II. BACKGROUND AND CONTEXT OF THE ASSIGNMENT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

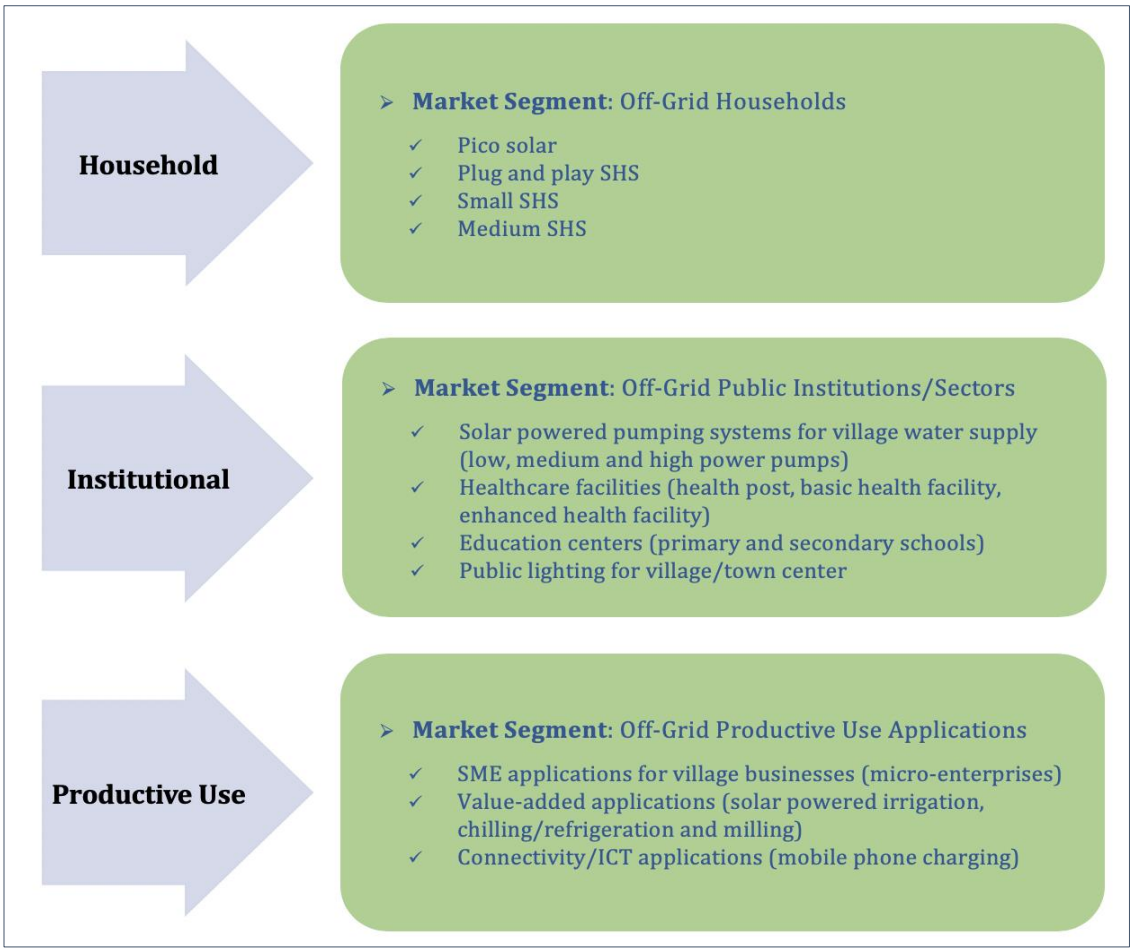
The institutional sector analysis combines available GIS data with secondary research to estimate potential demand based on assumptions about the electricity needs, usage patterns and associated costs of solar electrification of four public/institutional markets – water supply for off-grid communities,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

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

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

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

Figure ES-3: Analyzed Off-Grid Market Segments



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

III. EXECUTIVE SUMMARY

Guinea-Bissau is one of the world's poorest nations and has a long history of political instability. The country's current government is now the fifth to hold power since national elections last took place in 2014. The economy relies heavily on the agricultural sector, which accounts for the majority of export revenues and is the main source of income for over 80% of the population. Economic growth is driven mainly by the cashew and fishing industries. While urbanization has increased sharply over the past few decades, about half of the population lives in rural areas and relies on subsistence agriculture.

Guinea-Bissau has one of the lowest electrification rates in Africa. In 2016, 87% of the overall population – an estimated 2 million people – did not have access to electricity, with a significant disparity in rates of access between urban (23%) and rural (1%) areas.[24] About 60% of the capital city, Bissau, is electrified. Even where grid connections exist, power supply is often unreliable. Off-grid electrification is a policy priority for the Government of Guinea-Bissau (GoGB), which aims to increase the national electrification rate to 80% by 2030.[25]

With support from ECREEE, the Government has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan (Plano de Acão Nacional no Sector das Energias Renovaveis, PANER). In addition to electrification targets, the PANER also aims to increase the share of renewable energy in the generation mix to 50%, as well as to increase energy efficiency and reduce losses to improve the reliability of electricity supply. The plan also calls for the Government to establish a Rural Electrification Agency within the Ministry of Energy, Industry and Natural Resources (Ministério da Energia, Indústria e Recursos Naturais, MEIRN) to take responsibility for implementation of the policies and actions necessary to support development of the off-grid sector.[26]

To date, the Government's efforts to establish a supportive policy and regulatory framework for the clean energy and off-grid sectors have been limited. The 2011 National Strategic Document for Poverty Reduction (Document Stratégique National de Réduction De La Pauvreté, DENARP) emphasized the importance of renewable energy development to reduce poverty and expand rural energy access.[27] Under the Development Programme for Renewable Energy and Energy Efficiency (Programme Régional de Développement des Énergies Renouvelables et de l'Efficacité Énergétique, PRODERE), the GoGB aims to replace public lighting with solar PV powered lighting throughout the country.[28]

This report assesses the market opportunity for off-grid solar products and systems by estimating demand from the household, institutional, and productive use sectors in Guinea-Bissau (**Figure ES-4**). According to the assessment, there is a significant OGS market opportunity, with the annualized cash market potential in 2018 estimated to be USD 33.9 million. The productive use sector (USD 27M) makes up the majority of estimated demand, followed by the household (USD 4.3M) and institutional (USD 2.6M) sectors.

[24] IEA Energy Access Outlook, 2017.
[25] "Energy Profile Guinea-Bissau," United Nations Environment Programme, (2015): https://wedocs.unep.org/bitstream/handle/20.500.11822/20507/Energy_profile_GuineaBissau.pdf?sequence=1&isAllowed=y
[26] "SEforALL Guinea-Bissau Country Action Agenda," SEforALL, (2017): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/web_agenda_de_acao_optimized.pdf
[27] "Guinea-Bissau: Second Poverty Reduction Strategy Paper," IMF, (2011): https://www.imf.org/external/pubs/ft/scr/2011/cr11353.pdf
[28] "ECOWAS Renewable Energy and Energy Efficiency Status Report," ECOWAS, (2014): http://www.ren21.net/Portals/0/documents/activities/Regional%20Reports/ECOWAS_EN.pdf

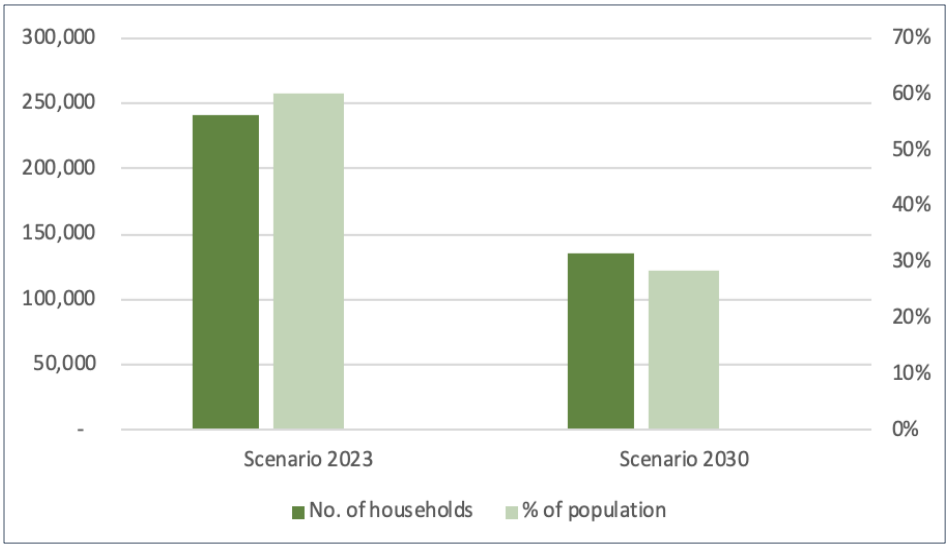
Figure ES-4: Indicative Total Cash Market Potential for Off-Grid Solar Products in Guinea-Bissau, 2018

Source: African Solar Designs analysis

According to the geospatial analysis, by 2023, 49 settlements across Guinea-Bissau (104,984 households) will be connected to the main grid, representing 26,1% of the population. By 2030, this figure will increase to 771 settlements (214,637 households), equivalent to 45% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030.

In the off-grid sector, the analysis identified 2,866 settlements (241,542 households) and 60.1% of the population in 2023 are suitable for off-grid stand-alone solutions, decreasing to 1,568 settlements (135,388 households) and 28.4% of the population in 2030 (**Figure ES-5**). The total size of the OGS market will decrease over time, while also becoming somewhat more concentrated in more remote districts. However, because the reach of the national grid is so limited, off-grid households will remain spread across all districts of the country through 2030.

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

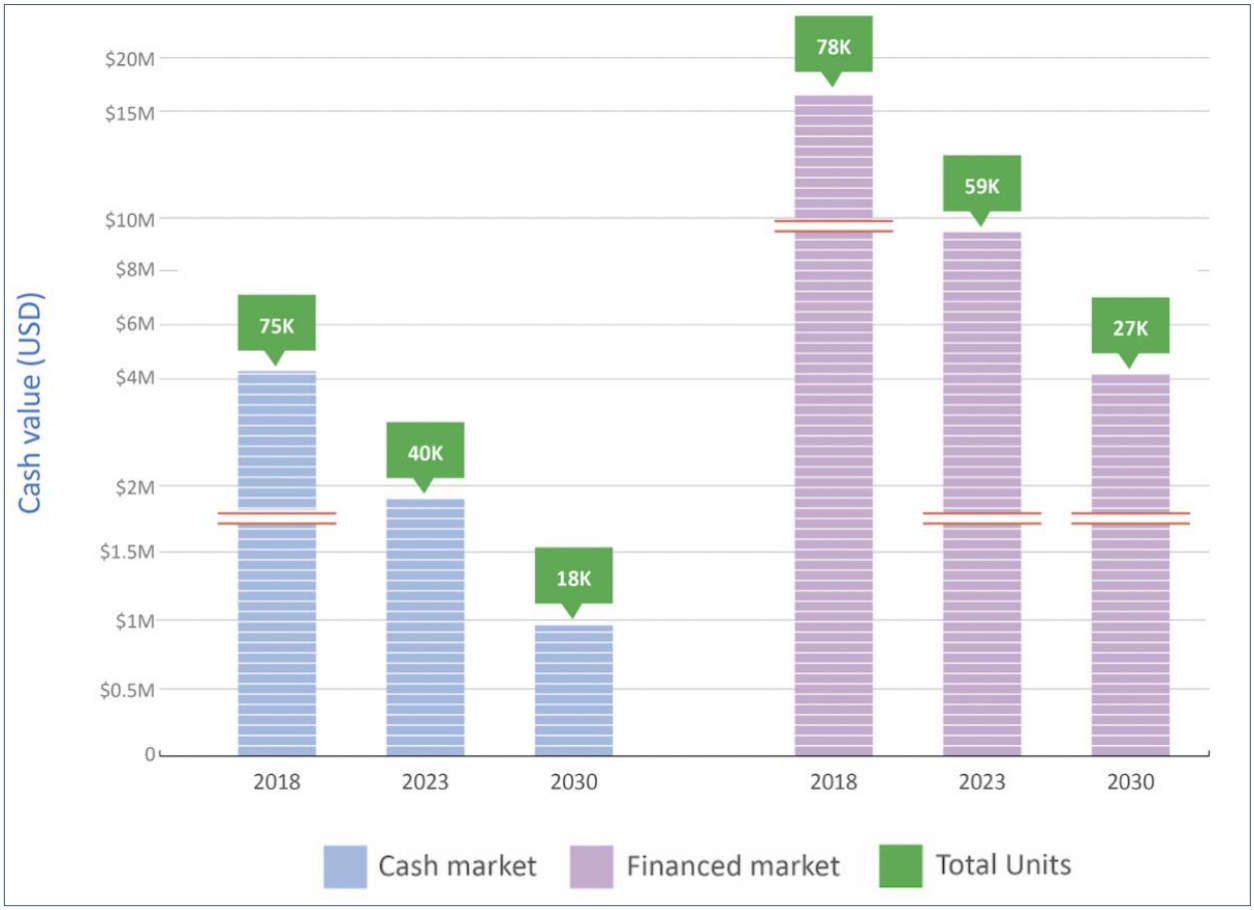


Source: Energio Verda Africa GIS analysis

According to the analysis, the annualized off-grid solar cash market potential for the household sector in 2018 is USD 4.3 million, with the estimated market value more than tripling in size to USD 16.4 million with the addition of consumer financing (**Figure ES-6**). Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems.

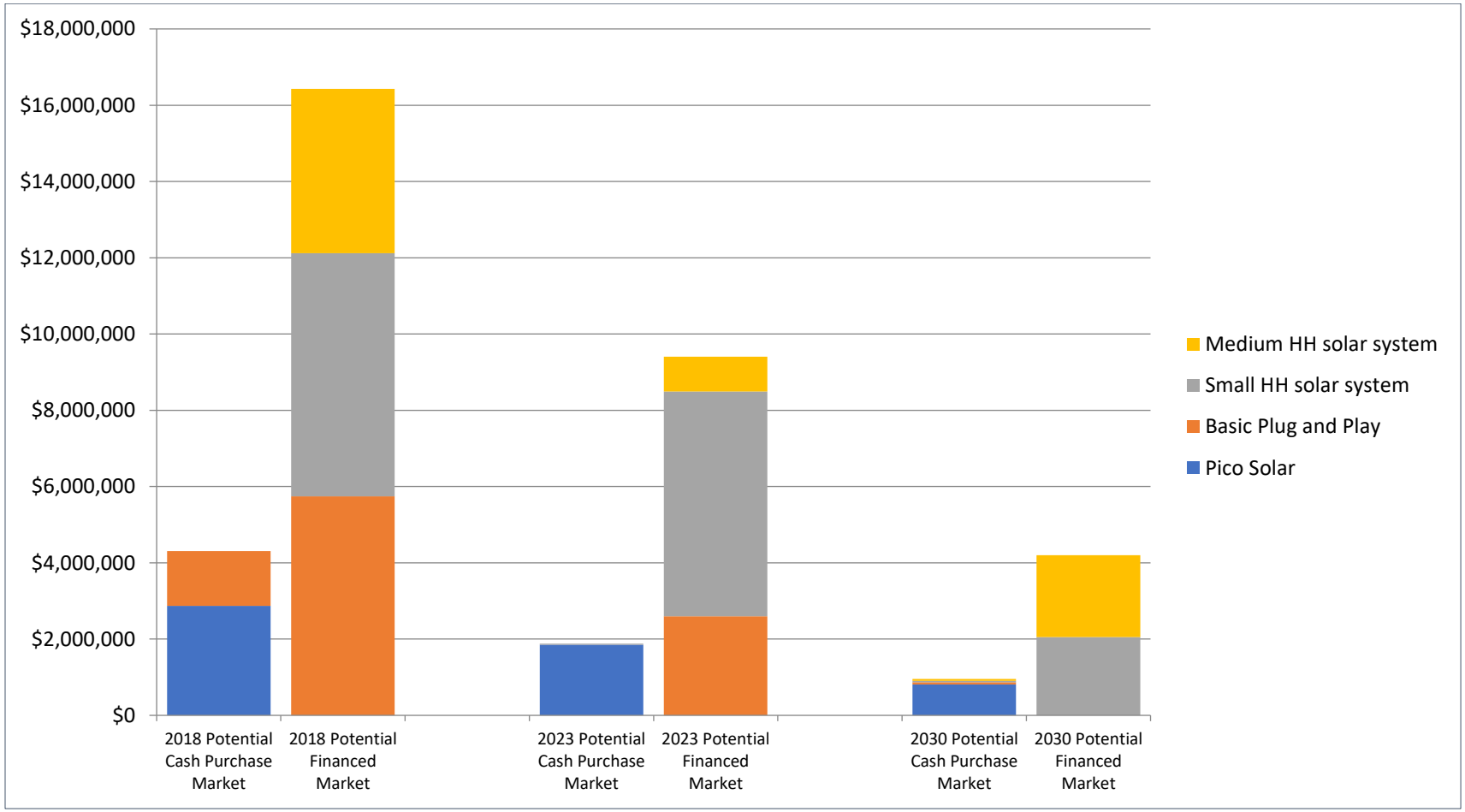
According to the assessment, the most common types of systems the market can afford on a cash basis are pico solar and small plug and play systems; however, this changes significantly with the introduction of financing (**Figure ES-7**). While affordability improves over time, households in the lowest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

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



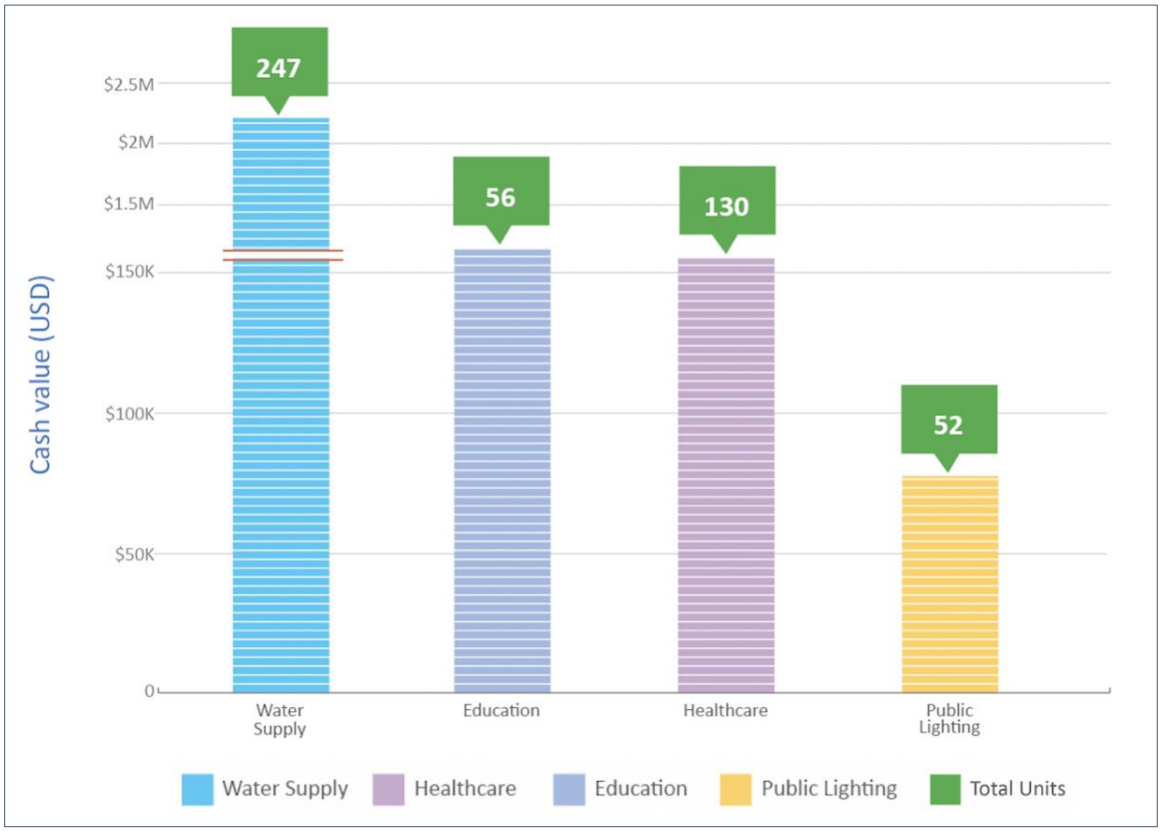
Source: African Solar Designs analysis

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



Source: African Solar Designs analysis

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

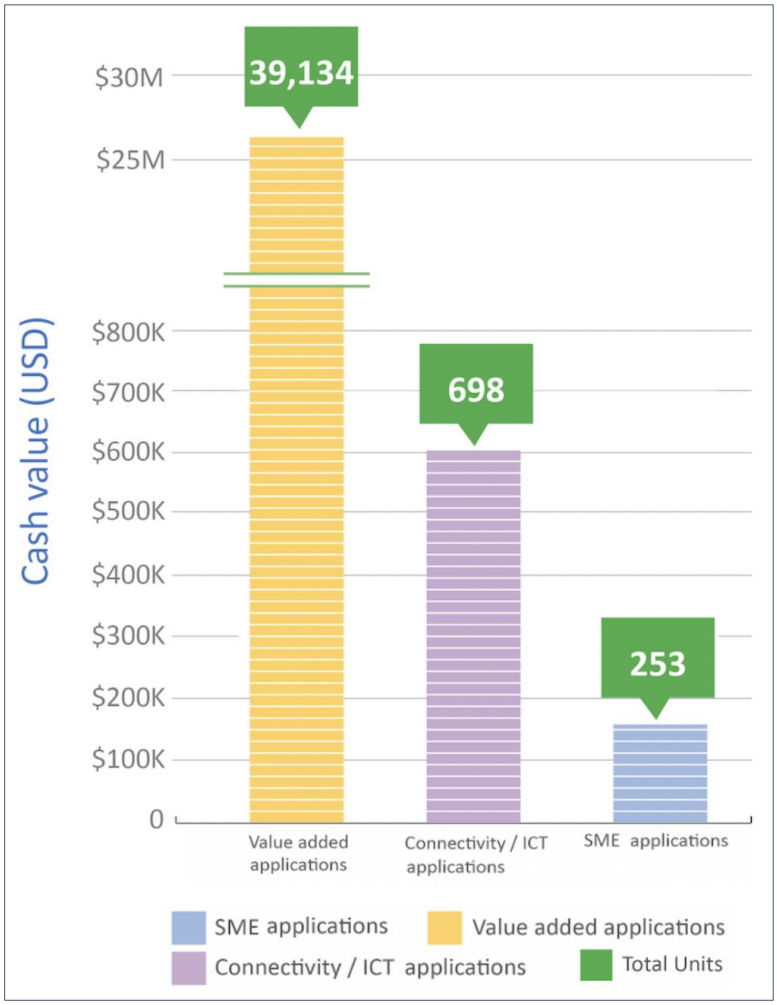


Source: African Solar Designs analysis

The estimated annualized cash market potential for Guinea-Bissau's public/institutional sector in 2018 is USD 2.6 million (**Figure ES-8**). The institutional market segments with the largest potential are water supply (USD 2.2M), followed by education (USD 157K), healthcare (USD 155K), and public lighting (USD 77K). The water supply sector analysis identified off-grid water points such as boreholes and wells that could benefit from solar technology for water pumping. The healthcare sector analysis identified off-grid health facilities categorized by their size (from basic clinics to enhanced health facilities) that could be electrified by stand-alone systems. The education sector analysis identified primary and secondary schools that could be electrified by stand-alone systems. The public lighting analysis assessed the lighting needs for off-grid villages and market centers (excluding street lighting).

According to the analysis, the annualized off-grid solar cash market potential for the productive use sector in 2018 is USD 27 million (**Figure ES-9**). The estimated demand from value-added applications represents most of the PUE market potential (USD 26.3M), followed by applications for connectivity (USD 602K) and SMEs (USD 158K).

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



Source: African Solar Designs analysis

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

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

ownership and mobile internet penetration to estimate the market potential for mobile phone charging enterprises (stations/kiosks).

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.

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.

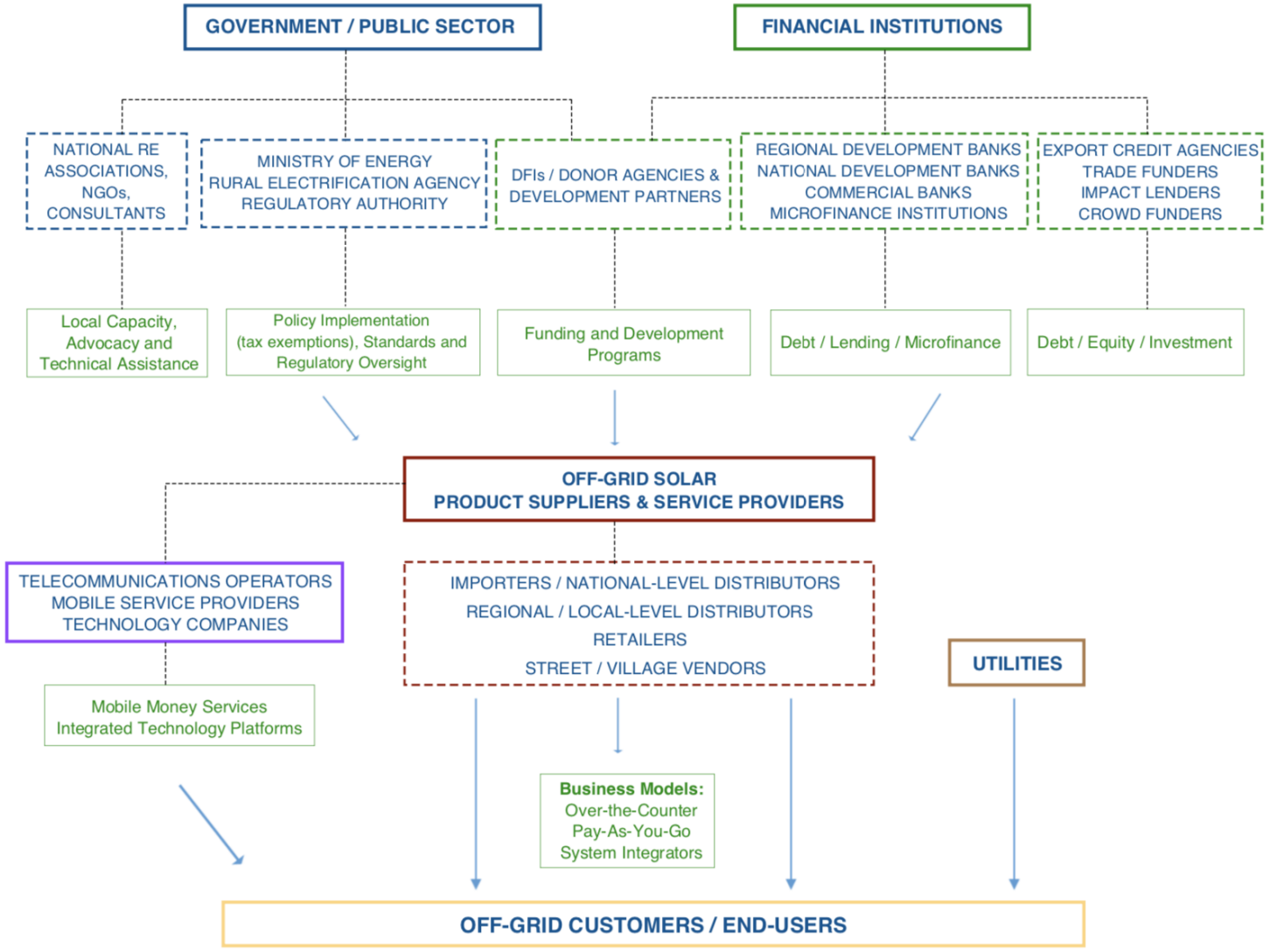
For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realties, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely 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.

Following the estimates of market demand, this report analyzes the supply chain for off-grid solar products and services in Guinea-Bissau, which includes a wide range of stakeholders, including importers, distributors, wholesalers, retailers and end-users (**Figure ES-10**). The solar supply chain is made up of both formal and informal companies that offer a variety of solar products and systems and deploy several business models. Rural households make up the main market for OGS products in the country, as the demand for lighting products and household electrical appliances is growing. Nevertheless, urban households, both electrified and non-electrified, are also a key consumer market, as they may have greater ability to afford solar products and systems.

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.

Guinea-Bissau'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 must manage a number of technical competency requirements, including the selection of business models, importation and distribution channels, solar PV technologies, as well as the design and implementation of associated marketing instruments and related initiatives.

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



Source: GreenMax Capital Advisors

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

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

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

Access to financing is critical for off-grid solar market growth. Solar companies need financing for working capital needs, while off-grid solar consumers need financing for the purchase of systems. This report analyzes the willingness and capacity of national and regional financial institutions to provide financing to businesses and consumers in Guinea-Bissau and throughout the region to support development of the OGS sector.

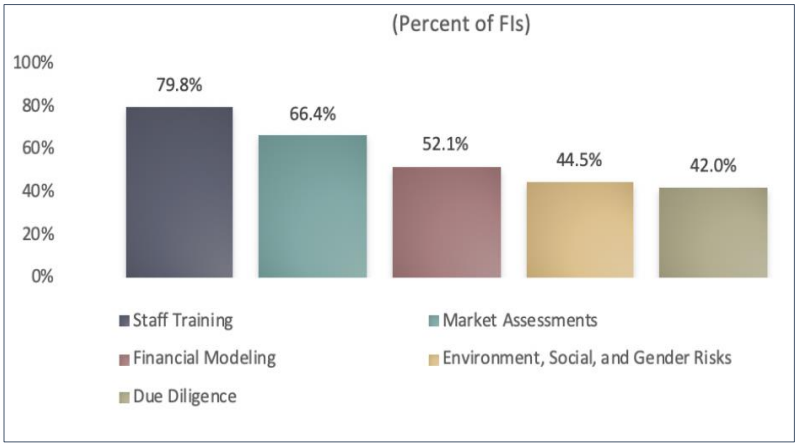
Although access to banking and financial services through formal institutions remains limited, overall rates of financial inclusion are improving thanks to the growing availability and usage of digital financial services and mobile banking. Mobile money account ownership in Guinea-Bissau more than doubled between 2015 and 2017, driven by widespread mobile phone ownership and growing mobile internet penetration. This dynamic is also driving greater financial inclusion. Expanding digital financial services, especially mobile money, can create new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. Moreover, mobile money technology also plays a critical role in the application of off-grid solar solutions, particularly for PAYG systems that rely on the interoperability between digital financial services and stand-alone solar devices. Two mobile financial service providers are active in the country – MTN and Orange – but there is a need to expand coverage in rural areas, as only an estimated 30% of the population has access to mobile network services.[29]

While there are several donor and DFI-funded programs and initiatives that have provided financing to support development of Guinea-Bissau's off-grid solar market, these funds have not been channeled through local commercial banks or MFIs. ROGEP is therefore a pioneering initiative in the country, as it endeavors to boost OGS lending via engagement with local financial partners. Local FIs are increasingly becoming more aware of off-grid market opportunities, and interviews FIs revealed a willingness to participate in providing financing to the sector.

[29] "Energias Renováveis e Eficiência Energética na Eelatório Nacional de Ponto de Situação," UNDP, Renewables and Energy Efficiency in Guinea-Bissau and Lusophone Renewable Energy Association (ALER), (December 2018): http://aler-renovaveis.org/contents/files/aler_relatorio_gb_2018.pdf

According to the Task 3 survey of financial institutions in Guinea-Bissau and across the region,[30] there is strong interest to provide financing to the off-grid solar sector. Respondents identified loan guarantees and credit lines as the most important measures to reduce market entry risks for lenders and stimulate FI engagement in the sector. Surveyed FIs also identified several areas of internal capacity that require improvement in order to lend (or increase lending) to the OGS sector (**Figure ES-11**). The most common need among FIs was training for bank staff, which includes *inter alia* assistance to originate deals and appropriately assess the credit risk of off-grid solar firms and projects, due diligence support to qualify products and approve vendors, and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. Technical assistance for solar enterprises (as is envisioned under Component 1B of ROGEP) will also be necessary, as entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

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



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

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 Guinea-Bissau, women are not yet highly engaged in the sector. The overall lack of inclusive participation in the off-grid space is attributable to a wide range of factors. A 2018 survey conducted by IRENA found that nearly three-quarters of respondents cited cultural and social norms as the most common barrier to women's participation in expanding energy access, which reflects the need for gender mainstreaming (**Figure ES-12**). More than half of the women surveyed in Africa identified a lack of skills and training as the most critical barrier, compared to just one-third of respondents globally.[31]

The same survey found that access to necessary technical, business or leadership skills development programs was the single most important measure that could be taken to improve women's engagement in energy access. Over half of survey respondents also highlighted the need to integrate gender perspectives in energy access programs, mainstream gender in energy policies and to enhance access to financing for women (**Figure ES-13**).[32]

[30] 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.
[31] "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
[32] Ibid.

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

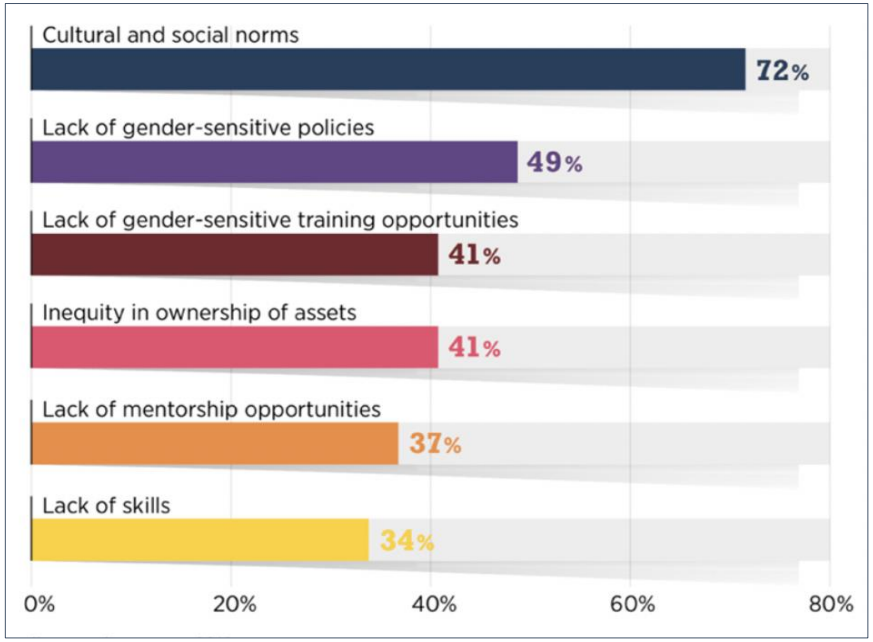
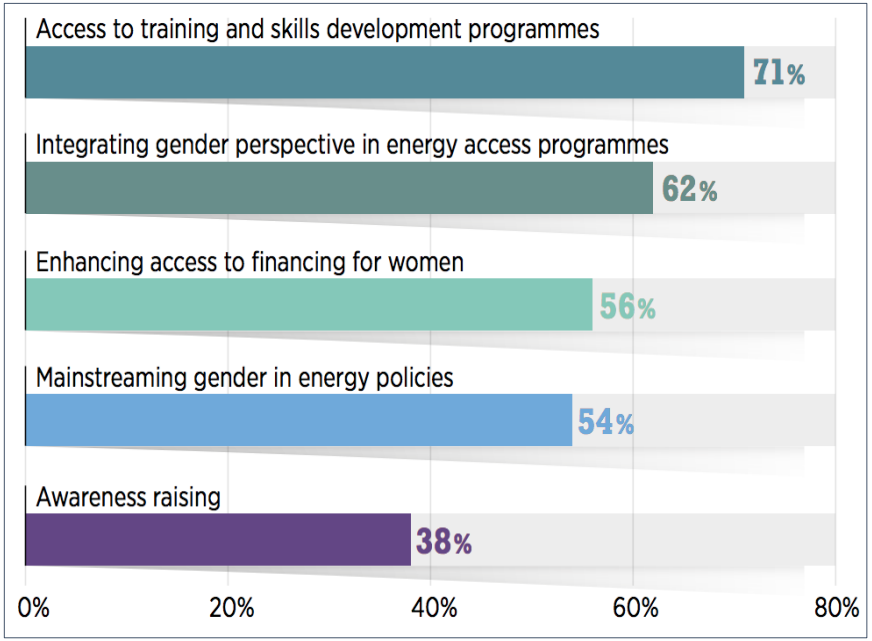


Figure ES-13: Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

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

A number of initiatives exist that seek to address some of these challenges and help improve gender inclusion in the country's energy and off-grid sectors. For example, in 2018, ECREEE partnered with AfDB to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of female inclusion in the energy value chain, as women represent only 2% of energy sector entrepreneurs in West Africa. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Guinea-Bissau.[33]

[33] "Feasibility study promotes women's participation in energy transition," ESI Africa, (7 May 2018): https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/

I. STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

This section begins with a brief introduction of key macroeconomic and social indicators in Guinea-Bissau (**Section 1.1**). This is followed by an overview of the country's existing energy sector (**Section 1.2**), with a focus on the status of energy access, including an assessment of both the on-grid and off-grid markets, a least-cost electrification analysis and a review of gender policies. **Section 1.3** examines national energy policy and regulation vis-à-vis the off-grid solar market, including detailed analysis of the existing framework for stand-alone systems[34] in Guinea-Bissau as well as gaps in the framework. **Section 1.4** is a summary of all relevant national and donor-funded development initiatives in the off-grid sector. **Annex 1** provides an overview of the Task 1 methodology.

1.1 Country Overview

Guinea-Bissau is one of the world's poorest nations and has a long history of political instability. The country's current government is now the fifth to hold power since national elections last took place in 2014. The economy relies heavily on the agricultural sector, which accounts for the majority of export revenues and is the main source of income for over 80% of the population. Economic growth was estimated at 5.5% in 2017 and is projected to be 5.2% in 2018, driven mainly by the cashew and fishing industries.[35] While urbanization has increased sharply over the past few decades, about half of the population lives in rural areas and relies on subsistence agriculture.

Table 1: Macroeconomic and Social Indicators

Population	1.8 million[36]
Urban Population	51% of total
GDP	USD 1.34 billion
GDP growth rate	5.5%
GNI per capita	USD 660
Unemployment rate	6.1%
Poverty rate	69.3% (2010)
Urban	51%
Rural	75.6%
Currency	West African CFA franc (CFA/XOF)
Official language	Portuguese
Natural resources	Agricultural (cashews, fisheries); ores (bauxite, phosphates, gold, uranium)

* World Bank Atlas method (current USD)[37]
All figures from 2017 unless otherwise indicated
Source: AfDB and World Bank

[34] NOTE: The term "off-grid" as it is widely used throughout this report (e.g. "off-grid sector") refers to both mini-grids and stand-alone systems. When "off-grid solar" or its acronym "OGS" are used, this refers *only* to stand-alone systems and does not include mini-grids
[35] "Guinea-Bissau Economic Outlook," African Development Bank, (2017): https://www.afdb.org/en/countries/west-africa/guinea-bissau/guinea-bissau-economic-outlook/
[36] 50.78% Female/49.22% Male
[37] "World Bank Open Data: Guinea-Bissau," (2017): https://data.worldbank.org/country/guinea-bissau

1.2 Energy Market

1.2.1 Energy Sector Overview

The energy sector in Guinea-Bissau is managed by the Ministry of Energy, Industry and Natural Resources (Ministério da Energia, Indústria e Recursos Naturais, MEIRN). The Director General of Energy (Direção Geral da Energia, DGE) oversees development and implementation of all energy policies, laws and regulations, including the promotion of renewable energy technologies. The National Electricity and Water Corporation (Energia e Aguas da Guiné-Bissau, EAGB) is a vertically-integrated state-owned utility with a monopoly over electricity transmission and distribution in the capital Bissau while the generation segment has been liberalized. There are very few private operators in the country.[38] In 2018, the Government of Guinea-Bissau (GoGB or "the Government") signed a five-year contract with Karpower to supply 30 MW of diesel-based power supply to the city of Bissau.[39] Electricity consumption in Guinea-Bissau is almost entirely reliant on imported petroleum fuels. Renewable energy (RE) only accounts for a small percentage of energy use throughout the country and outside of a preliminary RE plan supported by the United Nations Industrial Development Organization (UNIDO),[40] the Government has yet to develop a plan to support development of the country's off-grid sector.

Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Ministry of Energy, Industry and Natural Resources (Ministério da Energia, Indústria e Recursos Naturais, MEIRN)	Ministry responsible for managing the energy sector, including development and implementation of related policies related to energy investments, tariffs, concessions, RE and EE promotion, acceleration and expansion of production and distribution, validation of standards and overall regulation of activities in the sector.
Directorate General of Energy (Direção Geral da Energia, DGE)	Office within MEIRN responsible for executing energy policies formulated by MEIRN, including management of all legal, regulatory, and administrative matters necessary to implement policy
Energy and Water Company of Guinea-Bissau (Energia e Aguas da Guiné-Bissau, "EAGB")	State-owned utility managed by MEIRN with a monopoly over energy production, transportation, distribution and commercialization, despite the liberalization of the production segment in the city of Bissau. Originally, EAGB had a monopoly over the country's electricity but never managed to expand beyond Bissau due to structural constraints. In the last five years the electricity sub-sector has been liberalized as IPPs are responsible for production in Bissau while EAGB is responsible for transport, distribution and commercialization. In other regional capitals and cities, the service is guaranteed either by public operators (decentralized technical units) under DGE supervision (e.g., in Bafata, Gabu, Farim and Bissorã) or by private operators in a PPP schemes (e.g. in Canchungo, Cacheu, Quinhamel, Mansoa). EAGB only sets tariff for Bissau while other operators agree to tariffs with the DGE.

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

[38] "Energy Profile Guinea-Bissau," UNEP, (2015): https://wedocs.unep.org/bitstream/handle/20.500.11822/20507/Energy_profile_GuineaBissau.pdf?sequence=1&isAllowed=y

[39] "Guinea-Bissau: Karpower to supply 30 MW," African Energy, (8 November 2018): https://www.africa-energy.com/article/guinea-bissau-karpower-supply-30mw

[40] "UNIDO backs the creation of renewable energy-based mini-grid industries for rural electrification in Guinea-Bissau and the rest of West Africa," UNIDO, (2015): https://www.unido.org/news/unido-backs-creation-renewable-energy-based-mini-grid-industries-rural-electrification-guinea-bissau-and-rest-west-africa

1.2.2 Electricity Access: *Grid and Off-Grid*

Guinea-Bissau has one of the lowest electrification rates in Africa. In 2016, 87% of the overall population – an estimated 2 million people – did not have access to electricity, with a significant disparity in rates of access between urban (23%) and rural (1%) areas.[41] About 58% of the capital city, Bissau, is electrified. The Government aims to increase the national electrification rate to 80% by 2030.[42]

1.2.2.1 Off-Grid Market Overview

The country's low rates of electricity access can largely be attributed to mismanagement, inefficiencies, and underinvestment. Despite the country's significant potential for alternative energy sources such as hydropower, the GoGB continues to import expensive petroleum products to meet demand. The existing electricity network infrastructure is poor; in the capital of Bissau almost half of all electricity generated is lost due to aging infrastructure, illegal connections and irregular billing patterns. Load shedding occurs regularly, sometimes with lengthy interruptions in some areas of the city.[43]

To remedy the country's low electrification rate and encourage development in the off-grid sector, Guinea-Bissau worked with ECREEE to develop and implement its SEforALL Action Agenda and Renewable Energy Action Plan (Plano de Acão Nacional no Sector das Energias Renovaveis da Guinea-Bissau, PANER) to set its 2030 renewable energy policy and rural electrification strategies.[44] The agenda's objective is to achieve 60% electrification, reach 50% renewable energies in the national grid, and increase energy efficiency. The plan calls for the Government to establish a Rural Electrification Agency under MEIRN to take responsibility for implementation of the policies and actions necessary to support development of the off-grid sector.[45]

Outside of Guinea-Bissau's commitments aligned with the regional efforts of ECOWAS, the Government's policy initiatives to promote sustainable energy have been relatively modest. The 2011 National Strategic Document for Poverty Reduction (Document Stratégique National de Réduction De La Pauvreté, DENARP) emphasized the importance of renewable energy development to reduce poverty, increase energy efficiency and expand rural energy access.[46] Under the Development Programme for Renewable Energy and Energy Efficiency (Programme Régional de Développement des Énergies Renouvelables et de l'Efficacité Énergétique, PRODERE), the GoGB aims to replace public lighting with solar PV powered lighting throughout the country.[47] As of late 2018, the Government was also in discussions with the World Bank about a five-year plan that would drastically overhaul the electricity grid in an effort to increase electricity access nationwide.

[41] "Energy Access Outlook, 2017: From Poverty to Prosperity," International Energy Agency, (2017): https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf
[42] "Energy Profile Guinea-Bissau," United Nations Environment Programme, (2015): https://wedocs.unep.org/bitstream/handle/20.500.11822/20507/Energy_profile_GuineaBissau.pdf?sequence=1&isAllowed=y
[43] "Bissau City Electricity Supply Improvement Project, Project Appraisal Report," African Development Bank, (2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/GUINEA-_BISSAU_-_AR_-_Bissau_City_Electricity_Supply_Improv__Project.pdf
[44] "Guinea-Bissau National Renewable Energy Action Plan," SEforALL/ECREEE, (2015): http://se4all.ecreee.org/sites/default/files/plano_de_acao_nacional_no_sector_das_energias_renovaveis_paner_para_a_guine-bissau.pdf
[45] "SEforALL Guinea-Bissau Country Action Agenda," SEforALL, (2017): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/web_agenda_de_acao_optimized.pdf
[46] "Guinea-Bissau: Second Poverty Reduction Strategy Paper," IMF, (2011): https://www.imf.org/external/pubs/ft/scr/2011/cr11353.pdf
[47] "ECOWAS Renewable Energy and Energy Efficiency Status Report," ECOWAS, (2014): http://www.ren21.net/Portals/0/documents/activities/Regional%20Reports/ECOWAS_EN.pdf

In the off-grid space, no framework has been adopted to prioritize rural electrification and development of the sector. In an effort to address this, in 2015, UNIDO, ECREEE, and the Government organized a workshop on renewable energy mini-grid systems for rural electrification to strengthen the Guinea-Bissau's institutional capacity to engage the private sector to plan, install and maintain renewable energy based mini-grids. The workshop coincided with the launch of the project, "Promoting investments in small to medium-scale renewable energy technologies in the electricity sector of Guinea-Bissau," funded by the Global Environmental Facility and implemented by UNIDO, ECREEE and the Ministry of Energy and Industry.[48]

To date, very few solar companies have entered the market in Guinea-Bissau, which further illustrates the country's need for a supportive regulatory framework to attract private sector participation and accelerate growth. These companies have been largely providing solar home system (SHS) services to households and small businesses in the off-grid on a cash basis. FRES Guinea-Bissau, founded in 2011, is the only company that has been providing SHS systems using a fee-for-service model through its local affiliate, Sociedade de Serviços Descentralizados, S.A. There are also two mini-grids that are operational in the country – the Bambadinca mini-grid (312kW solar PV with battery storage), funded by the EU and GEF-UNIDO, and the Contuboel mini-grid (100kW solar PV with battery storage), built, owned and operated by FRES. There is also a new 500 kW mini-grid that was installed in Bissorã by Prosolia with funding from the West African Economic and Monetary Union and GEF-UNIDO, but it is not yet operational.

1.2.2.2 Demand and Supply/Generation Mix

In 2018, Guinea-Bissau had an installed power generation capacity of 15 MW, all of it coming from diesel fuel generators operated by Aggreko. Poor network maintenance and planning has left electricity supply irregular, with virtually permanent load shedding and frequent and prolonged outages. The result is a total grid capacity of around 10-12 MW, which falls well short of the electricity needs of the population, estimated at 30 MW.[49] Most large consumers are forced to rely on expensive diesel generators or other independent sources of electricity. For instance, 24 MW of installed capacity were used by IPPs and autonomous producers using diesel generators in 2017.[50]

The electricity supply system, managed by EAGB, continues to experience significant financial, technical and capacity constraints, as the utility does not cover the cost of power generation and lacks adequate funding for grid extensions and maintenance. Thus, the World Bank, African Development Bank and other donors have engaged with EAGB in several ongoing projects to rehabilitate and reinforce the grid. Despite having one of the lowest electrification rates in Africa, Guinea-Bissau has the highest average electricity tariff in the ECOWAS region and one of the highest electric service costs in all of Africa – electricity tariffs are especially high for commercial and industrial users.[51]

Despite its potential, renewable energy has yet to occupy a substantial portion of the nation's energy mix. Several utility-scale solar projects are currently being considered for development.[52] In 2019, Guinea-Bissau launched a call for tenders for the installation of 22 MW of solar power plants, including the construction of a 20 MW power plant in Gardete, near the capital Bissau. Once completed, this plant will

[48] "UNIDO backs the creation of renewable energy-based mini-grid industries for rural electrification in Guinea-Bissau and the rest of West Africa," UNIDO, (2015): https://www.unido.org/news/unido-backs-creation-renewable-energy-based-mini-grid-industries-rural-electrification-guinea-bissau-and-rest-west-africa

[49] "Bissau City Electricity Supply Improvement Project, Project Appraisal Report," African Development Bank, (2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/GUINEA-_BISSAU_-_AR_-_Bissau_City_Electricity_Supply_Improv__Project.pdf

[50] "Guinea-Bissau Power Africa Fact Sheet," USAID, (2017): https://2012-2017.usaid.gov/powerafrica/guinea-bissau

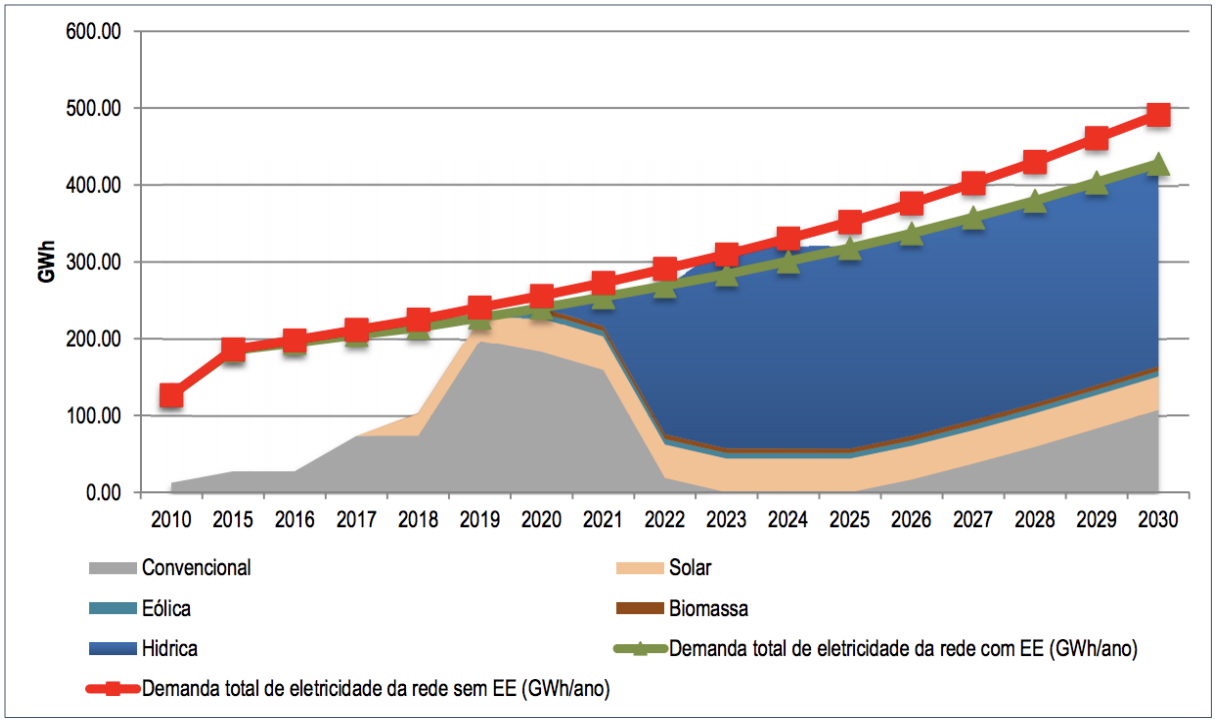
[51] "Guinea-Bissau," IMF, (2017): www.imf.org/~/media/Files/Publications/CR/2017/cr17380.ashx

[52] "Guinea-Bissau mulls up to three utility-scale solar PV plants," CCE, (2018): http://cceonlinenews.com/2018/04/04/guinea-bissau-mulls-up-to-three-utility-scale-solar-pv-plants/

supply its production to EAGB under a power purchase agreement. The project also includes the establishment of two mini-hybrid solar power plants of 1 MW each, in the localities of Gabu and Canchungo.[53] There are also future plans to exploit the country's untapped hydropower potential from the rivers Corubal and Geba.

At the national level, demand for electricity in Guinea-Bissau is increasing at a rate of about 7% each year (**Figure 1**).[54] It is estimated that national peak demand for electricity will increase from 78 MW in 2018 to 129 MW in 2025 to 191 MW in 2030.[55]

Figure 1: Project Electricity Demand and Supply



Source: SEforALL Renewable Energy Action Plan

1.2.2.3 Transmission and Distribution Network

Guinea-Bissau's electricity transmission and distribution network, managed by EAGB, is a fragmented, old and incomplete network that only covers the capital of Bissau (**Figure 2**). The grid experiences frequent outages and significant technical and commercial losses estimated at 39%.[56] Losses can be attributed to not only to the aging infrastructure but also to fraud (illegal connections) and the absence of an appropriate billing system (lack of billing software).[57] EAGB has no electrical infrastructure in the country outside of Bissau city. This is in part a consequence of the utility's financial constraints but is also a result of the

[53] "Guinea-Bissau Launches Solar Tender," Alternative Energy Africa, (March 31, 2019): https://ae-africa.com/read_article.php?NID=9898
[54] "SEforALL Guinea-Bissau Country Action Agenda," SEforALL, (2017): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/web_agenda_de_acao_optimized.pdf
[55] West African Power Pool (WAPP) Master Plan Update, Tractebel Engineering, (2018).
[56] World Bank analysis, 2018.
[57] "Bissau City Electricity Supply Improvement Project, Project Appraisal Report," African Development Bank, (2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/GUINEA-_BISSAU_-_AR_-_Bissau_City_Electricity_Supply_Improv__Project.pdf

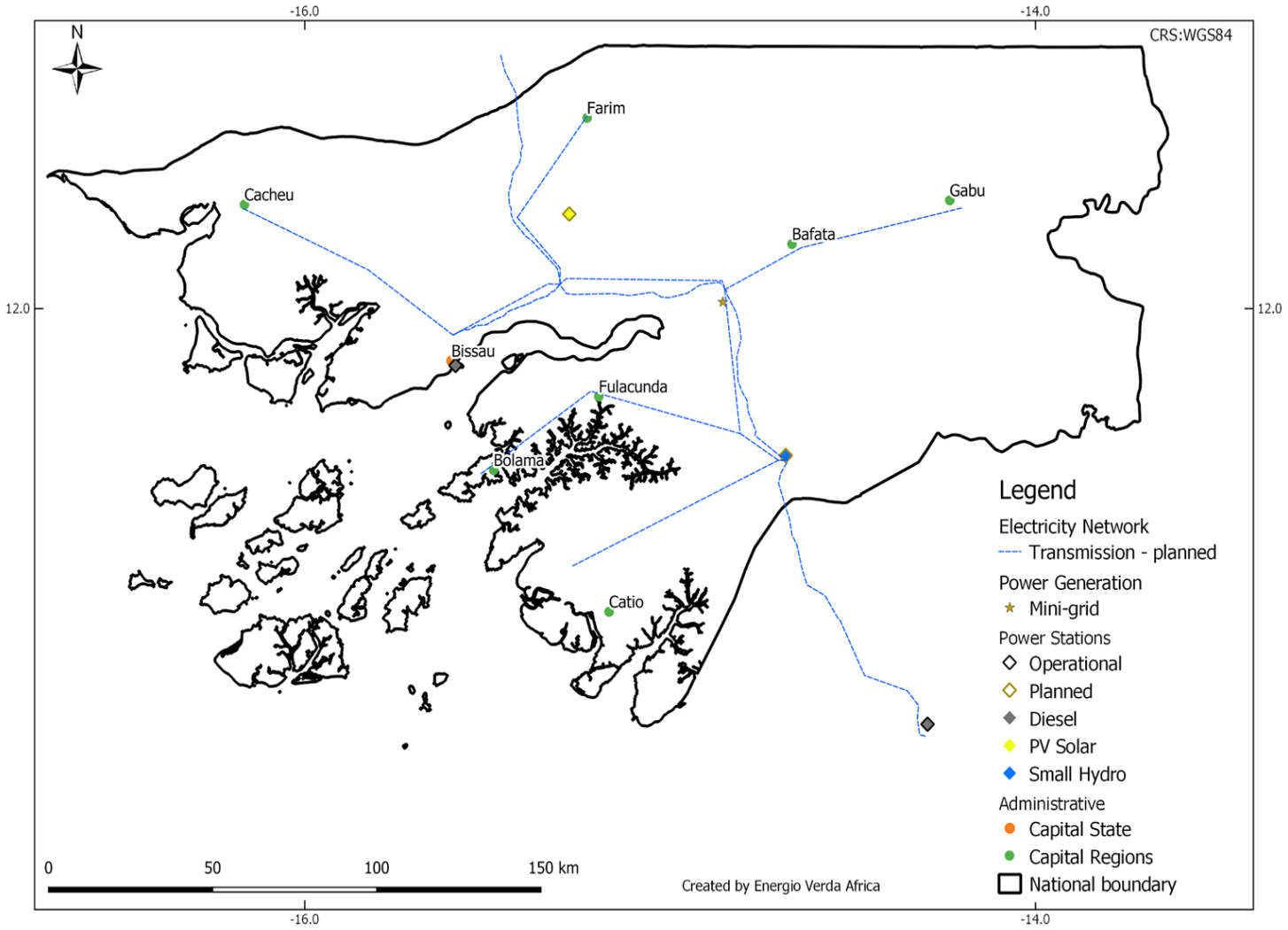
country's complex geography and widely dispersed population, which makes grid extensions challenging. Overall, a significant gap exists between the infrastructure needs of the electricity network and the availability of resources to adequately invest in maintenance and improvement of the existing grid.

Guinea-Bissau is a member of the West African Power Pool (WAPP) and therefore a part of the organization's mission to integrate the national power systems of the West African region into a regional, unified market to provide, in the medium and long-term, reliable energy at a competitive cost.

The Gambia River Development Organization (Organisation pour la Mise en Valeur du fleuve Gambie, OMVG) is also seeking to address Guinea-Bissau's transmission and distribution network barriers through the construction of an interconnection network for the evacuation of energy, comprising 1,677 km of 225 kV lines, 15 high/medium voltage transformer stations, and two load dispatch centers.[58] The OMVG network will play an important role within the WAPP system by connecting the existing Senegal River Basin Development Organization network in the north to the Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) network in the east. Some of the project's commitments include a 225 kV transmission from Gambia to Guinea-Bissau and 225 kV transmission from Guinea-Bissau to Guinea.[59] The project will also provide a main transmission line through the country to support urban and rural electrification. This project is financed by The World Bank, West African Development Bank and the AfDB.[60]

[58] Ibid.
[59] "West African Power Pool," IRENA, (2013): https://www.irena.org/documentdownloads/publications/wapp.pdf
[60] "Emergency Water and Electricity Upgrading Project," GTAI, (2017): https://www.gtai.de/GTAI/Content/DE/Trade/Fachdaten/PRO/2017/06/Anlagen/PRO201706235011.pdf?v=1

Figure 2: Electricity Transmission and Distribution Network[61]



Source: Energio Verda Africa GIS analysis

[61] See **Annex 1** for more details, including data sources.

1.2.2.4 Least-Cost Electrification Analysis

A least-cost electrification analysis has been performed to assess the potential development of electricity access in Guinea-Bissau through 2023 and through 2030 ("Scenario 2023" and "Scenario 2030").[62] The analysis identifies the scale of market opportunities for off-grid stand-alone solar electrification. A brief summary of the approach and methods used, main assumptions and key results of the analysis in Guinea-Bissau are outlined below. Additional geographic information system (GIS) information, including categorizations, key definitions, and datasets are included in **Annex 1**.

- **Methodology**

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

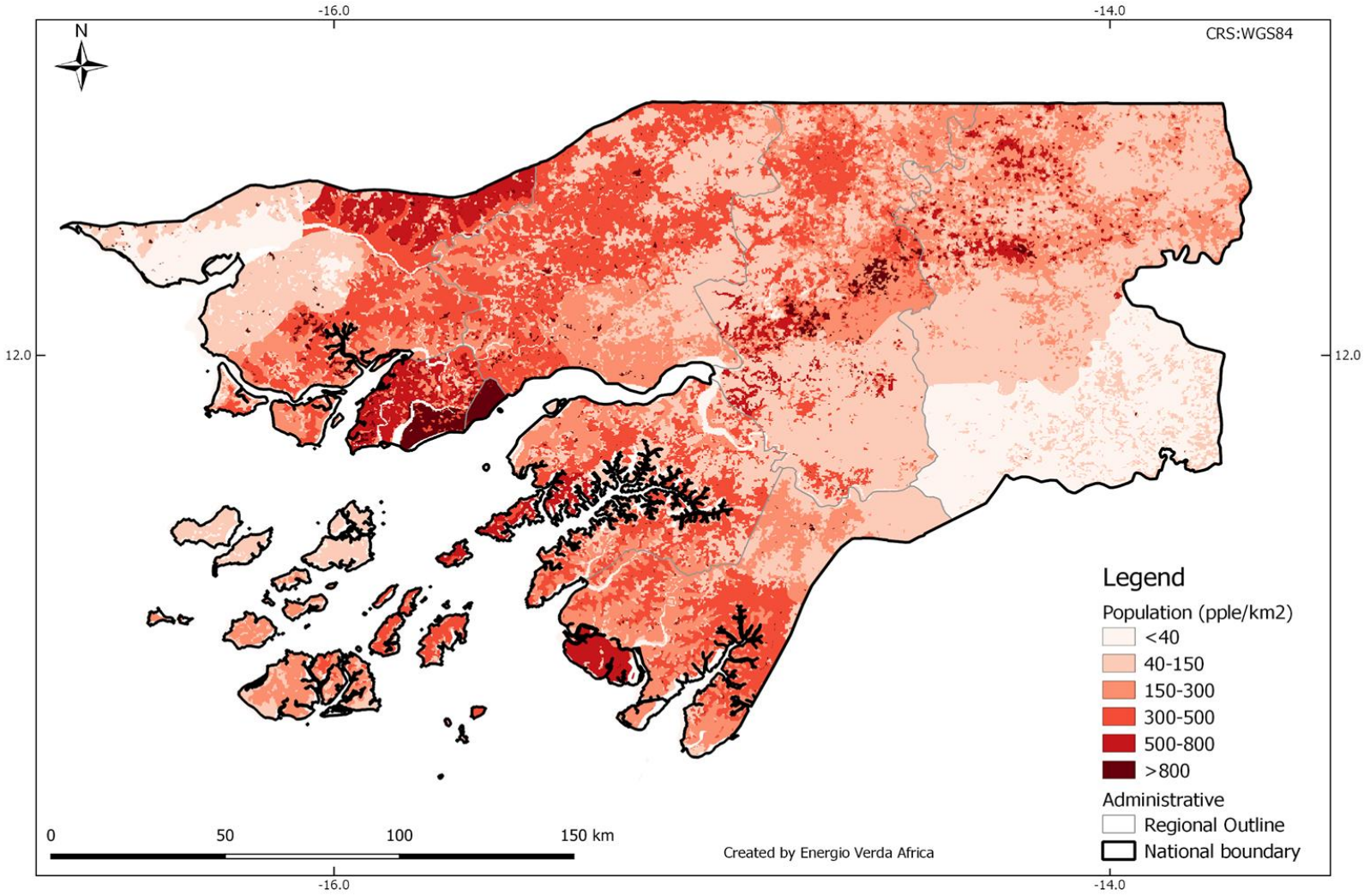
For the scenario 2023 analysis, it is assumed that widespread densification of the existing electrical grid will enable settlements within 5 km of existing grid lines and Power Stations to connect to the grid (according to WAPP densification plans). Due to the Guinea-Bissau Emergency Water and Electricity Services Upgrading Project, which aims on improving the existing electricity services, the distance around the thermal substation in the capital Bissau for densification is set to 10 km.[63] Beyond this area, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km^2) and located close to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km^2) or far from the national grid – are considered candidates for off-grid stand-alone systems.

For the scenario 2030 analysis, it is assumed that the grid and the reach of grid densification efforts will extend far beyond the existing network. Hence, settlements that are within 15 km of current lines and Power Stations (average densification distance announced by utilities across West Africa in a 10-year timeline in personal interviews) and 5 km of future planned line extensions are assumed to be connected. For mini-grids, future economic development – which will allow new settlements to grow sufficiently to become candidates for mini-grids – is assumed to occur in settlements within 1 km of mini-grid settlements (average distance of mini-grid coverage of different developers) identified in the scenario 2023 analysis, as well as within 15 km of economic growth centers – airports and urban areas. All other settlements are considered candidates for off-grid stand-alone systems.

Given the lack of low voltage distribution line data, it is necessary to approximate areas where un-electrified settlements in close proximity to the grid exist. The analysis therefore focuses on settlements that are within 5 km of the medium voltage network, but that are located beyond 15 km of areas with night-time light emissions (indicative of electrification). Settlements in areas of low population density (below 350 people/km^2) that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within scenario 2023.[64] Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 2.5%[65] was applied to the geospatial analysis to project population figures for scenario 2023 and 2030 analyses.[66] **Figure 3** shows population density across the country, which served as the basis for this analysis.

[62] NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to GoGB electrification targets for 2030
[63] Most MV- and LV-lines are concentrated within the capital. Transmission lines (HV lines) are not existing in 2018.
[64] Note that this analysis was performed for scenario 2023 but not for the scenario 2030 due to uncertainties regarding population densities being too high over such a long timeframe
[65] The World Bank: https://data.worldbank.org/indicator/SP.POP.GROW?locations=GW
[66] See **Annex 1** for the results of this analysis as well as more details on the approach and methods used

Figure 3: Population Density, 2014[67]



Source: Energio Verda Africa GIS analysis

[67] See **Annex 1** for more details, including data sources.

- **Results**

Table 3 summarizes the results of the least cost electrification analysis. **Figure 4** and **Figure 5** illustrate the distribution of settlements according to least-cost electrification options under scenarios 2023 and 2030, respectively. The number of households was estimated by using the average household size for the country (5.4 persons/household).[68]

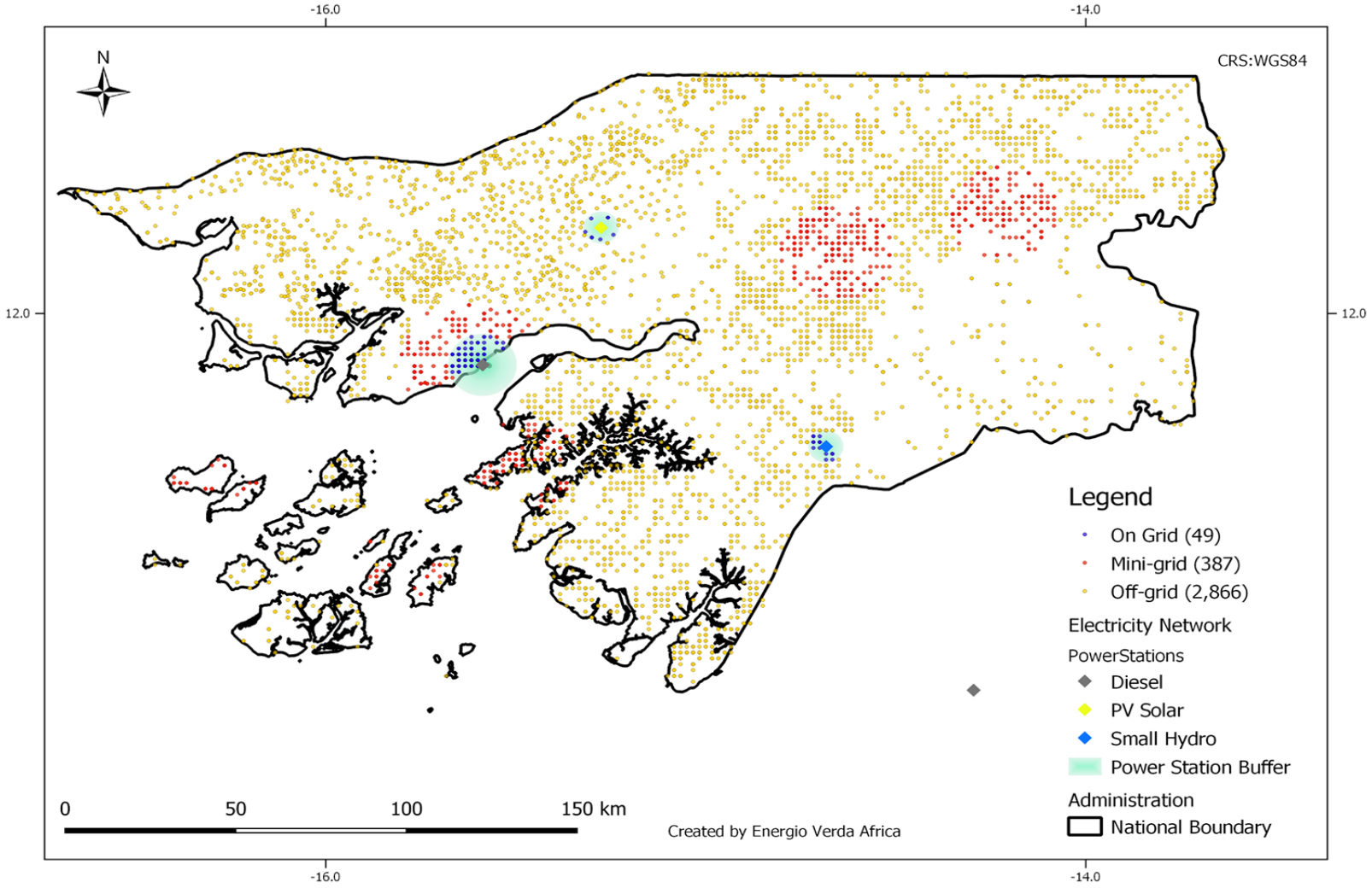
Table 3: Results of Least-Cost Electrification Analysis

Scenario	Indicator	Least-Cost Electrification Option			Grid Vicinity		
		Grid extension	Mini-grid	Off-grid stand-alone systems	Under-grid un-served	Total under-grid	Total outside grid vicinity
Scenario 2023	Number of settlements	49	387	2,866	0	49	3,253
	% of settlements	1.5%	11.7%	86.8%	0.0%	1.5%	98.5%
	Total population	566,911	297,566	1,304,328	0	566,911	1,601,894
	% of population	26.1%	13.7%	60.1%	0.0%	26.1%	73.9%
	Number of households	104,984	55,105	241,542	-	104,984	296,647
Scenario 2030	Number of settlements	771	963	1,568	Not calculated	771	2,531
	% of settlements	23.3%	29.2%	47.5%	Not calculated	23.3%	76.7%
	Total population	1,159,038	687,896	731,094	Not calculated	1,159,038	1,418,990
	% of population	45.0%	26.7%	28.4%	Not calculated	45.0%	55.0%
	Number of households	214,637	127,388	135,388	Not calculated	214,637	262,776

Source: Energio Verda Africa GIS analysis

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

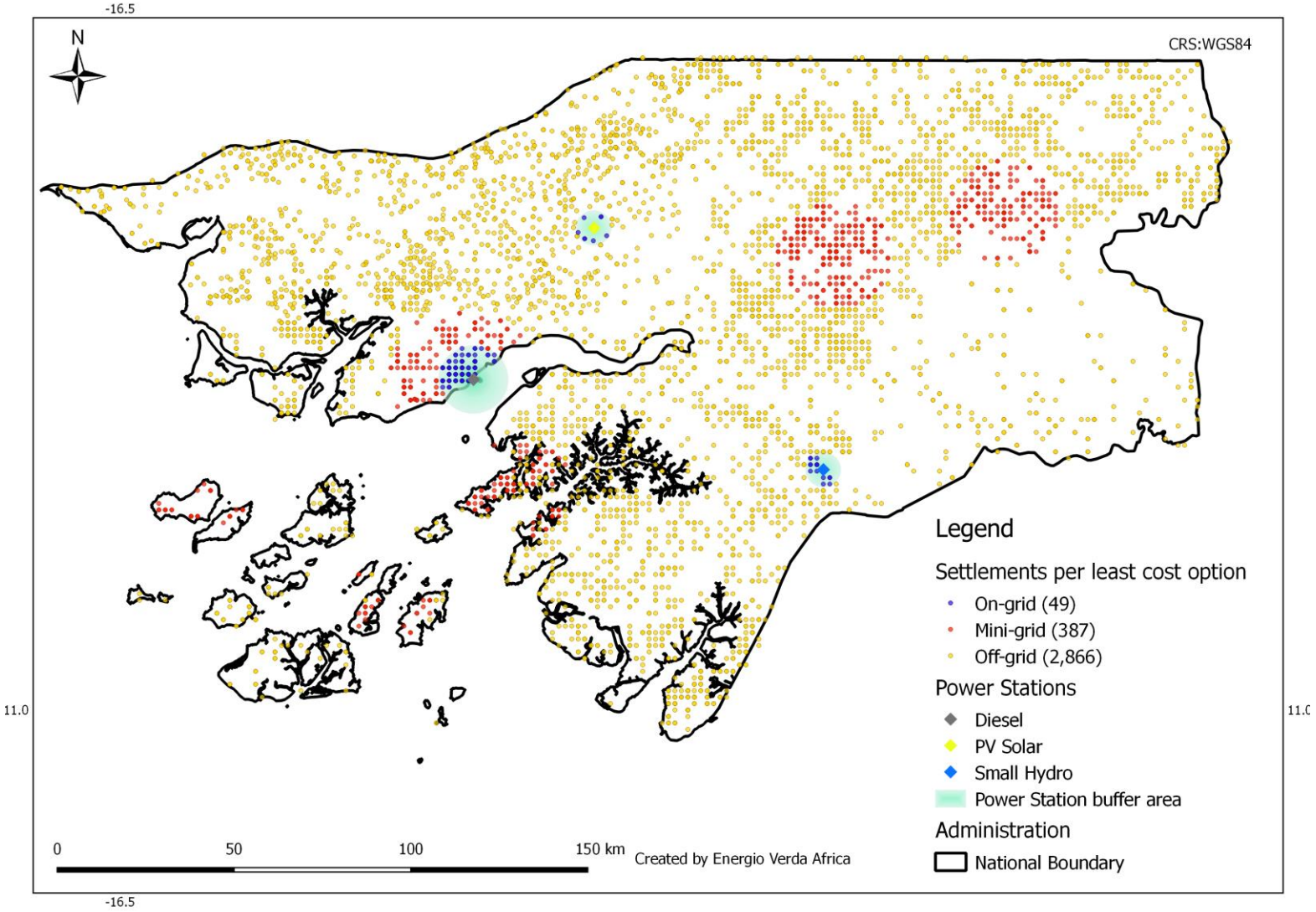
Figure 4: Distribution of Settlements by Least-Cost Electrification Option, 2023[69]



Source: Energio Verda Africa GIS analysis

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

Figure 5: Distribution of Settlements by Least-Cost Electrification Option, 2030[70]

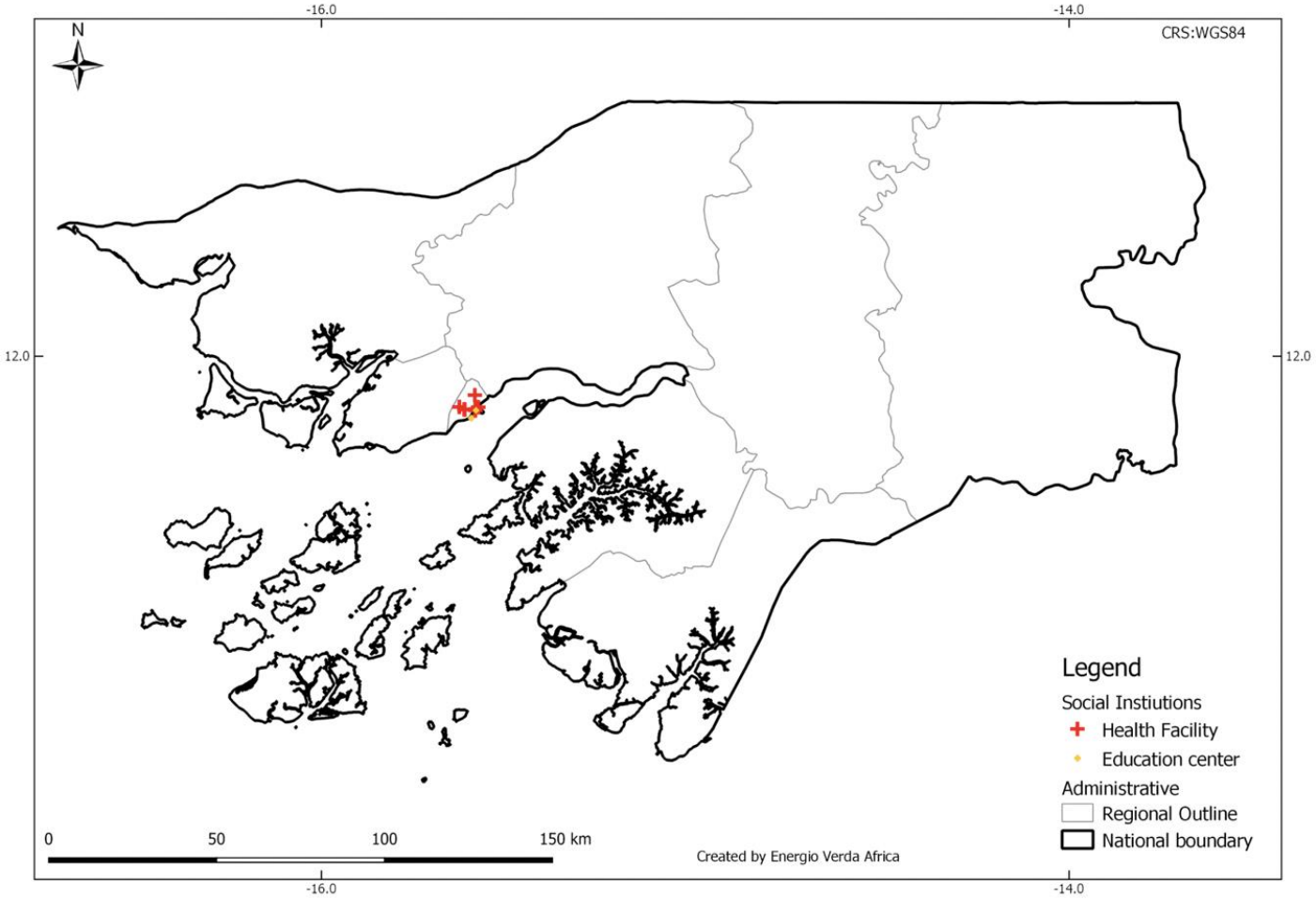


Source: Energio Verda Africa GIS analysis

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

The analysis also investigated the health facilities and education center that will remain off-grid during the analyzed timeframes. A small set of social facilities could be identified for the analysis (facilities with known coordinates). As illustrated in **Figure 6**, all of the identified facilities are located within the capital Bissau and are therefore considered to be grid-connected.

Figure 6: Distribution of Identified Social Facilities in Guinea-Bissau[71]



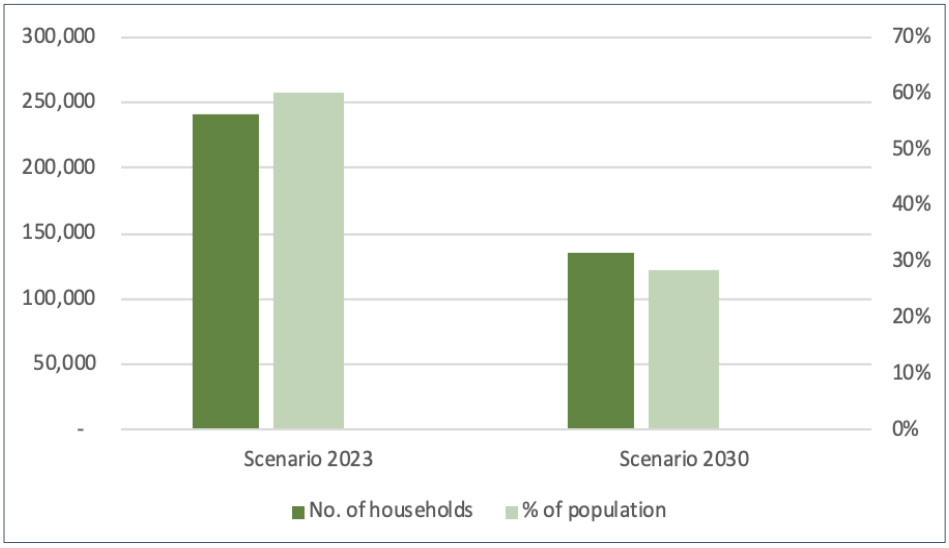
Source: Energio Verda Africa GIS analysis

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

According to the geospatial analysis (**Table 3**), by 2023, 49 settlements across Guinea-Bissau (104,984 households) will be connected to the main grid, representing 26,1% of the population. By 2030, this figure will increase to 771 settlements (214,637 households), equivalent to 45% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030.

Outside of the main grid areas, settlements with higher economic growth potential and higher population density can optimally be electrified by mini-grids. By 2023, this represents an estimated 387 settlements (55,105 households), or 13.7% of the population, increasing to 963 settlements (127,388 households), or 26.7% of the population by 2030. The remaining more dispersed settlements (further from centers of economic activity) can optimally be served by off-grid stand-alone systems. This comprises 2,866 settlements (241,542 households) and 60.1% of the population in 2023, decreasing to 1,568 settlements (135,388 households) and 28.4% of the population in 2030 (**Figure 7**).

Figure 7: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

The analysis indicates that the off-grid stand-alone market has the potential to grow significantly. The least-cost analysis estimates that more than 240,000 households in 2023 are suitable for off-grid solutions. In its SEforALL National Renewable Energy Action Plan, the GoGB envisions a relatively limited share of the population will gain electricity access through off-grid systems (**Table 4**). The findings of the least-cost analysis suggest that the Government may need to consider increasing the utilization of off-grid solutions (a combination of mini-grids and stand-alone systems) in its electrification planning in order to achieve its energy access targets, particularly in the near-term until planned grid extensions are realized.

Table 4: Estimated Share of Population Served by Off-Grid Systems[72]

Share of population with access to off-grid systems powered by renewable energy (%) *	2020 (target)	2030 (target)
	4%	9%

* Estimate includes both mini-grids and stand-alone systems

Source: SEforALL National Renewable Energy Action Plan (PANER)

[72] "Guinea-Bissau National Renewable Energy Action Plan," SEforALL/ECREEE, (2015): http://se4all.ecreee.org/sites/default/files/plano_de_acao_nacional_no_sector_das_energias_renovaveis_paner_para_a_guine-bissau.pdf

1.2.2.5 Inclusive Participation[73]

Inclusive participation in Guinea-Bissau remains an ongoing challenge. Gender inequality persists, as women are under-educated and generally have a lower socio-economic status, with inadequate access to basic social services and reduced economic opportunities compared to men. Guinea-Bissau performs poorly in the UNDP Gender Inequality Index, which measures several indicators to assess levels of gender inequality in the areas of health, access to education, economic status and empowerment.[74] While gender discrimination is widespread, these issues tend to be more pronounced in rural areas of the country.

Under the Guinea-Bissau Constitution, men and women are pronounced equal before the law. The Government has even adopted a National Gender Policy (Política Nacional para a Promoção da Igualdade e Equidade de Género 2012–2015) to promote gender equality and economic opportunities for women. The Strategic and Operational National Action Plan "Terra Ranka" within the Strategy for Poverty Reduction Document (DENARP II, 2013) also includes gender equality measures. Among other initiatives, the Government has also established an Institute for Women and Children, IMC (Instituto da Mulher e Criança), the Ministry of Women, Family and Social Cohesion, and the Peace Building Fund's "Gender Promotion Initiative." Unfortunately, gender inequality persists throughout the nation especially in rural areas where customary and religious practices tend to supersede state policies and laws.

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

1.2.3 Key Challenges

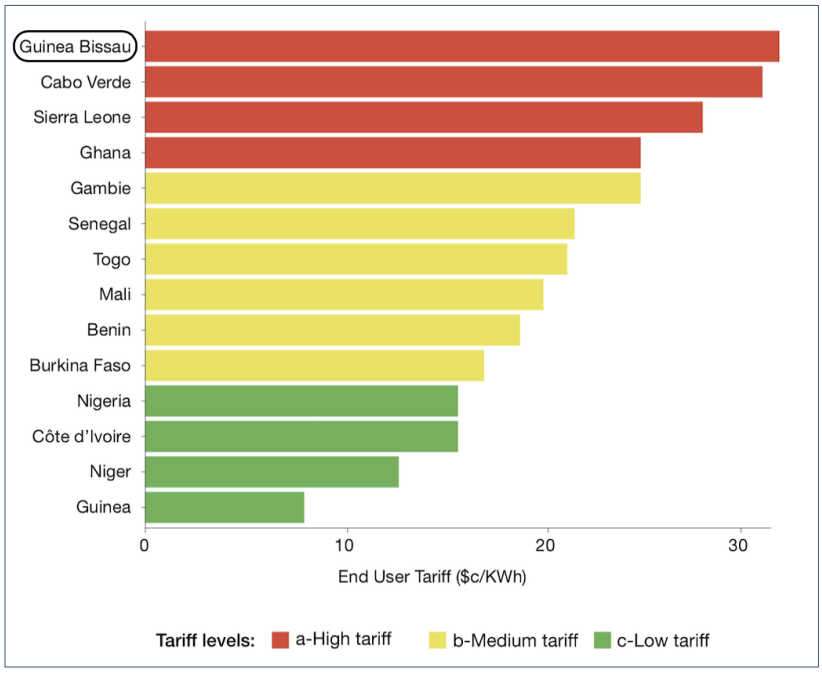
Some of the energy sector challenges facing Guinea-Bissau include (but are not limited to) the following:

- **Investment in Grid Extension and Maintenance:** Increases in electricity demand are putting pressure on power supply – a mismatch that will continue to burden the electricity transmission and distribution network that needs maintenance and investment to reduce losses and expand access.

- **Electricity Tariffs:** The average electricity tariff in Guinea-Bissau ($0.32/kWh) is the highest tariff in the ECOWAS region (**Figure 8**). This can largely be attributed to the fact that the country does not have a functional regulator in place.[75] Guinea-Bissau subsidizes electricity tariffs for low-income consumers, providing electricity to poorer households below the cost of supply with funds from the Government and the utility (EAGB) through a range of residential and commercial consumers who pay higher electricity rates. Despite this cross-subsidization scheme, electricity remains largely unaffordable for most of the population. Average households in the country spend an estimated 37% of their income on electricity compared to an average of 17% across the ECOWAS region (**Figure 9**).[76] The country's power costs serve as a significant deterrent to private business and investment and hinder economic growth.

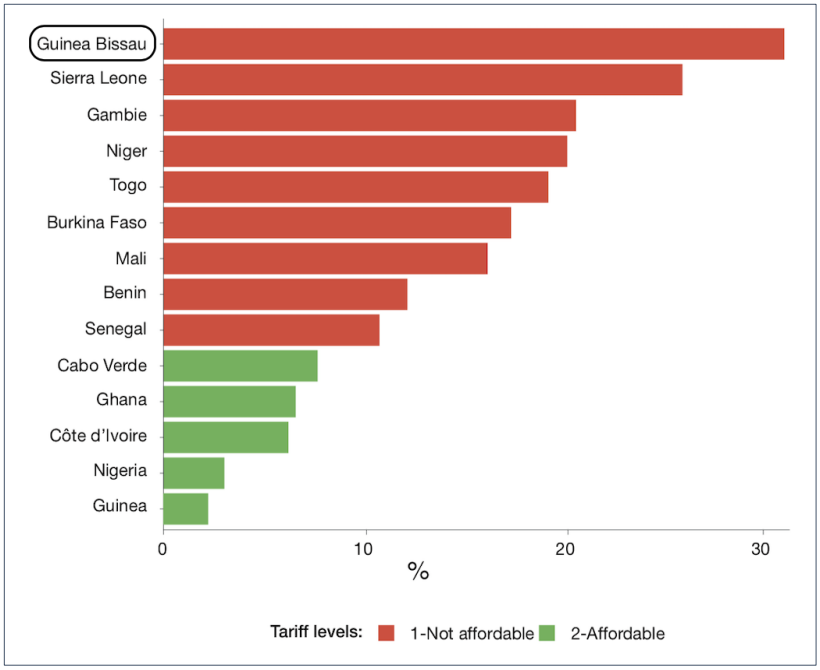
[73] Please refer to **Annex 4** for more details
[74] "Gender Inequality Index," UNDP, (2015): http://hdr.undp.org/en/composite/GII
[75] "Electricity Tariffs in ECOWAS Region," African Development Bank Group, Energy Policy, Regulation and Statistics Division, (September 2018): http://www.ecowrex.org/sites/default/files/pesr1_-_energy_statistics_bulletin_september_2018.pdf
[76] Ibid.

Figure 8: Average End-User Tariffs in ECOWAS Countries, 2018



Source: ECOWAS Regional Electricity Regulatory Authority

Figure 9: Share of Income Spent on Household Electricity in ECOWAS Countries, 2018



NOTE: Liberia is excluded from the analysis; the threshold for what is considered an affordable tariff is 10% of income spent on electricity – a household is considered energy poor if more than 10% of income is spent on energy/fuel to maintain adequate level of comfort; On average, households in the ECOWAS region spend 17% of their income on electricity.

Source (Figure 8-9): ECOWAS Regional Electricity Regulatory Authority

- **Utility Financial Performance:** Despite the country's high electricity tariff, due to mismanagement and inefficiencies, EABG does not bring in enough revenue to cover its production costs or fund grid improvements. As a result, Guinea-Bissau's electricity sector remains largely dependent upon foreign assistance, while the overall quality of electricity service remains inadequate. The utility's poor financial performance deters private investment from grid-connected energy projects, evidenced by the very few private operators present in the market despite a liberalized generation sector.

- **Imbalanced Energy Mix:** The country's power sector is overly reliant on very expensive liquid fossil fuels, which leave the country susceptible to price volatility and energy security concerns. While investment continues to support fossil fuel projects (include more recent off-shore exploration) there is little support / a lack of resources for developing untapped RE potential.

- **Off-Grid Market Development:** Guinea-Bissau does not have a policy or regulatory framework in place to support development of the off-grid sector in its electrification plans. Yet, off-grid solutions (stand-alone solar and mini-grids) have the opportunity to make a huge impact by displacing costly diesel generators. What is missing are the regulatory, technical and financial support mechanisms from the Government that are necessary to support local solar companies and the communities they serve and ultimately bolster market growth.

- **Local Financial Institutions:**[77] Local financial institutions (FIs) and microfinance institutions (MFIs) lack sufficient internal capacity and credit appetite to invest in the renewable energy/off-grid sectors. This challenge is complicated as it arises mainly from the risk perceptions of FIs, which influence whether efforts should be made to develop strategies and customize financial products to target a nascent market, where there is often limited knowledge of technologies, market characteristics and historical data on portfolio credit performance. There are also likely misperceptions about the potential size of these markets as well as doubts about the profitability of offering financial products in rural off-grid areas, where the creditworthiness of potential clients may be an issue. The renewable energy/off-grid space is particularly complicated given relatively high transaction costs and a comparatively unfavorable regulatory environment that exists in the country.[78]

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

[77] The role of FIs is examined in further detail in **Section 3.**

[78] One notable exception to this is the commercial and industrial (C&I) market segment, where systems are larger, and off-takers are often companies with large enough balance sheets to borrow. Other market segments in the country that may be suitable for off-grid solutions include hotels, cashew and cement production, and telecommunications industries – all of whom use significantly large diesel generators.

1.3 National Policy and Regulation

1.3.1 National Electricity/Electrification Policy

Guinea-Bissau's regulatory framework governing the energy sector is limited. Following the 2000 Letter of Sectorial Energy Policy and the Strategic Plan on Energy (2005-2008), which both intended to privatize EAGB but did not succeed due in part to the country's political upheaval, a Policy Letter for the Development of the Energy Sector (LPDSE) was adopted in 2010. One of the main objectives of the LPDSE is to encourage private investment in the production and distribution sector, including for the development of renewable energy.

As part of its broader electrification strategy, the GoGB intends to pursue the following objectives: (i) ensure continuity of measures to ensure the development of an energy model that is sustainable and that does not jeopardize the quality of life of citizens, (ii) ensure a substantial improvement in the country's energy efficiency through the implementation of the SEforALL Action Agenda and PANER, and (iii) strengthen coordination with support programs for energy efficiency and renewable energies and support innovation and transfer of technology. The vision and objectives of Guinea-Bissau to achieve SDG 7 (ensure access to affordable, reliable, sustainable and modern energy for all) include achieving a national electrification rate of 80% by 2030.[79]

The World Bank has also supported the GoGB by launching the Guinea-Bissau Emergency Water and Electricity Services Upgrading Project.[80] This project is ongoing and received an additional round of funding in late 2017. The initial phase of the project aimed to improve the reliability of national electricity services mainly through reforming EAGB by financing a private service operator to take over key management positions of the utility over a three-year period to improve its performance. In addition to improving EAGB technical, commercial and financial performance, the project also aims to make improvements to critical power infrastructure. A long-term Master Plan for the Development of Production and Generation electricity infrastructures has been finalized but has yet to be adopted as of mid-2018.[81]

1.3.2 Integrated National Electrification Plan

The GoGB does not have an official integrated national electrification plan in place. Given that private sector participation will be necessary for the GoGB to achieve its rural electrification targets, a comprehensive, integrated strategy urgently needs to be developed (in the form of a Master Plan for rural electrification).

1.3.3 Energy and Electricity Law

Guinea-Bissau's legal framework is very limited and includes only a few key ordinances relevant to the off-grid sector. Energy Law Decreto Lei 2/2007 (29 June 2007) and Electricity Law Decreto Lei 3/2007 (29 June 2007) introduce amendments to the VAT Code and complementary legislation. Both laws are undergoing review in an effort to adapt the sector to the LPDSE and facilitate private sector involvement in the electricity generation sector.

[79] "SEforALL Guinea-Bissau Country Action Agenda," SEforALL, (2017): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/web_agenda_de_acao_optimized.pdf
[80] "Emergency Water and Services Upgrade Project," The World Bank, (2017): http://documents.worldbank.org/curated/en/762861494852192647/pdf/GB-PP-05112017.pdf
[81] "SEforAll Action Agenda Guinea-Bissau," SEforAll-Africa, (2017): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/web_agenda_de_acao_optimized.pdf

1.3.4 Framework for Stand-alone Systems

Figure 10 is an overview of the key national policies, programs, laws, and regulations pertaining to Guinea-Bissau's framework for stand-alone systems. The gaps in this framework are addressed in **Section 1.3.5**.

Figure 10: Policy and Regulatory Framework for Stand-alone Systems

	GUINEA-BISSAU		
Policy/Regulatory Support and Financial Incentives	**Specific National Policies, Laws and Programs**		
	National electrification policy with off-grid provisions	x	
	Integrated national electrification plan	x	
	Energy/electricity law with off-grid provisions	x	
	National programs promoting off-grid market development	x	
	Specific target for rural electrification	√	80% access by 2030
	Financial Incentives		
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	√	Solar panels exempt from import duties
	Standards and Quality		
	Government-adopted international quality standards for stand-alone systems	x	
	Government-certified program for solar equipment installers	x	
	Consumer awareness/education programs	x	
	Concession Contracts and Schemes	x	
	Business Model Regulation	x	

√ = existing/implemented provisions in the current regulatory framework
X = no existing provisions

Source: Stakeholder interviews; GreenMax Capital Advisors analysis

1.3.4.1 Existence of Specific National Programs

Although the GoGB has adopted several regional initiatives that include renewable energy and rural electrification targets, there are no national programs supporting stand-alone solar development in the country.

1.3.4.2 Financial Incentives

There are limited financial incentives to promote off-grid sector development. Solar panels are exempt from import duties while other components of a solar kit are not (inverters, batteries, controllers, etc.).[82]

1.3.4.3 Standards and Quality

For the quality of off-grid solar products and systems to meet the expectations of end-users, a set of standards need to be in place to ensure equipment is reliable, adequately covered by warranties and post-sale O&M. There are currently no government-adopted standards and quality for stand-alone systems or solar equipment installers in Guinea-Bissau.

[82] "Guinea-Bissau Country Sheet," Europa EU, (2016): https://europa.eu/capacity4dev/file/30359/download?token=JF8EMVUd

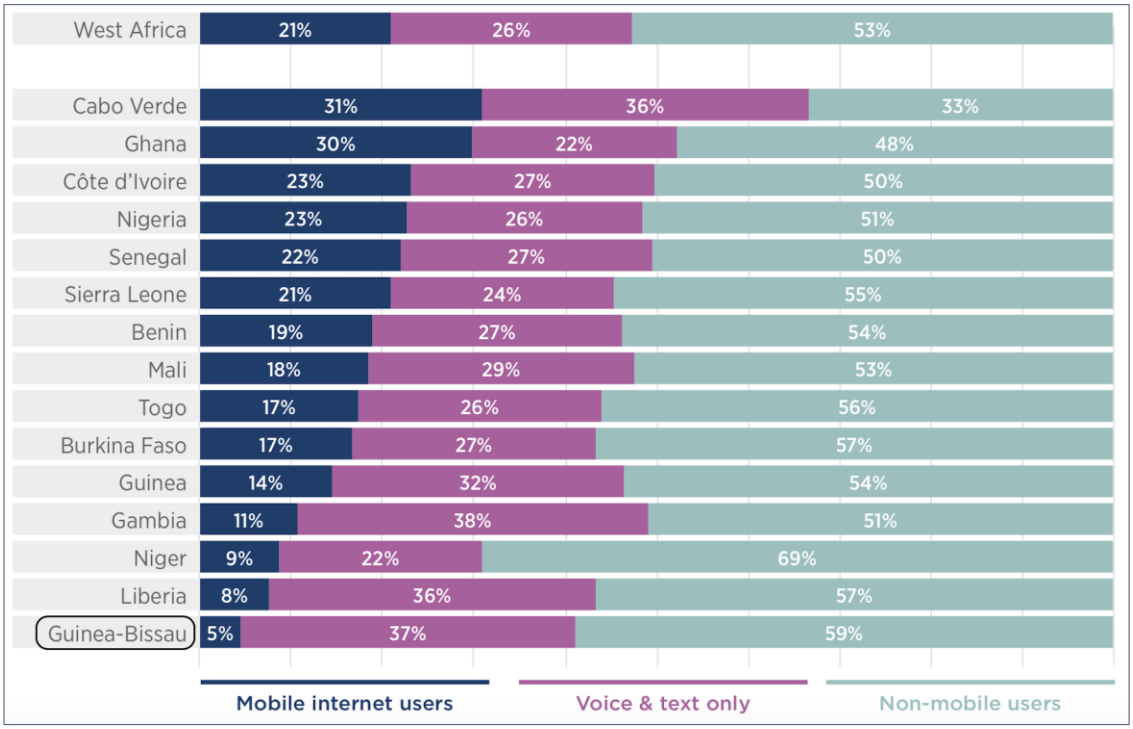
1.3.4.4 Concession Contracts and Schemes

There are no concession contracts and schemes available to promote off-grid market development. The office of the EU in Guinea-Bissau is developing a strategy for mini-grid concessions.

1.3.4.5 Specific Business Model Regulation

No specific business model regulations exist for the off-grid sector in Guinea-Bissau. As was demonstrated in East Africa in recent years, the proliferation of mobile money platforms can rapidly facilitate energy access. There is an opportunity for the Government to bring together key stakeholders in the off-grid sector (solar suppliers, technology providers, telecommunications companies etc.) to support growth of the country's mobile internet usage (**Figure 11**) and development of a PAYG business model to encourage private companies that are either already engaged in the country's off-grid market or looking to enter it.

Figure 11: West Africa Mobile Internet Penetration Rates, 2017[83]



Source: GSMA Intelligence

1.3.5 Capacity Building and Technical Assistance

To overcome the challenges surrounding rural electrification, a range of technical and financial resources from both the public and private sector must come together. At the institutional level, the DGE and EAGB, among others, will play key roles in establishing a supportive policy and regulatory framework. Additional reforms to the power sector may be required to provide the incentives necessary to increase private sector participation. Local FIs and MFIs will need incentives and support to develop and implement new financial products and administrative procedures to lend to the off-grid sector. International and local solar

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

companies will need policy and financial support. Local technical capacity of the solar sector will need to be developed to ensure long-term O&M services are available and sustainable. Above all, financing and TA will be critical for all market actors – government, financial institutions, end-users, suppliers and service providers – in order to accelerate growth.

Table 5 identifies some of the policy/regulatory challenges facing off-grid market development in Guinea-Bissau and the proposed mitigation measures/TA interventions to overcome these gaps.

Table 5: Gaps in the Off-Grid Policy and Regulatory Framework[84]

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Specific National Policies, Laws and Programs	**A. Lack of National Electricity / Electrification Policy**	
	a. No policy exists for rural electrification	a. Help Government establish a Rural Electrification Policy which encourages least cost, integrated planning for all options
	b. Main focus of policy is on national grid extension only	b. Help Government develop a comprehensive, fully integrated electrification plan with least cost planning to consider where extension is the most efficient and sustainable approach to increasing energy access vs. development of the off-grid sector – mini-grids and stand-alone systems powered by local renewable resources
	c. Government is subsidizing fossil fuel electricity production	c. Help Government analyze where fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives
	B. Lack of Integrated National Electrification Plan	
	a. No integrated plan exists	a. Help Government develop a comprehensive, least cost, integrated plan for all rural electrification options
	b. Insufficient focus on or understanding of framework to support private sector participation	b. Help Government improve policy and regulatory framework to create appropriate incentives for private sector participation to expedite off-grid solar market growth, including *inter alia* preparation of procurement schemes and financing mechanisms designed to encourage PPP engagement in the off-grid sector
	C. Lack of Energy and Electricity Law	
	a. No specific Energy or Electricity Law with off-grid provisions exists	a. Help Government develop new legal framework that is flexible and helps create appropriate incentives for private sector participation in off-grid market development (e.g. to initiate process of unbundling / electricity market liberalization)

[84] "Government" as it is used throughout this table refers to the main public institutions, officials and policymakers responsible for planning, management and regulation of the energy sector in Guinea-Bissau (**Table 2**), including the General Directorate of Energy (DGE) and the national utility, EAGB, both within the Ministry of Energy, Industry, and Natural Resources (MEIRN) among other national and local authorities.

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
	D. Lack of national policies, laws, programs and/or action plans targeting off-grid market development	
	a. No specific Off-Grid Policy, Law, or Action Plan in place	a. Help Government establish the medium-long term rural electrification strategy in the country through development and implementation of a rural electrification Master Plan
	b. No Lead Agency	b. Help Government establish a lead agency that has a clear mandate to coordinate activities with the private sector, donor community and at national and local level in order to accelerate off-grid market growth to achieve energy access objectives
	c. Insufficient understanding of framework to support private sector participation	c. Help Government improve off-grid framework to create appropriate incentives for private sector participation
2. Financial Incentives (import duties, taxes, etc.)	**A. Insufficiently supportive financial incentives / tax regime**	a. Help Government develop appropriate VAT and tariff policies covering the entire off-grid / stand-alone solar product supply chain (including batteries, inverters or other system components) that would provide necessary support to the industry[85] b. Help Government establish a Special Task Force to (i) mitigate potential difficulties in customs clearance and import logistics, and (ii) oversee implementation of tax exemptions by coordinating with all agencies and regulatory bodies involved c. Help Government introduce appropriate grant and subsidy schemes which require private funding matches and are predictable and not overly bureaucratic d. Help Government create PPP schemes to share high project development and market entry costs particularly with developers in remote areas e. Help Government analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede development of clean energy solutions
3. Standards and Quality	**A. Insufficient Market Data**	a. Help Government establish a Special Task Force responsible for collaborating with the private sector to compile and regularly update a database of critical off-grid market data (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

[85] The GoGB currently has incentives in place for solar panels only, but not for other components of a solar kit / SHS

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
	B. Unclear / lack of quality standards	a. Help Government establish 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 Government implement a legal framework that provides protections for consumers and suppliers, including *inter alia* regulations that (i) require licensing for the sale and installation of solar equipment; (ii) prohibit the sale of certain brands or models; and (iii) enable companies or public authorities to prosecute those caught distributing counterfeit / inferior products that are not up to promulgated standards
	C. Lack of capacity of local technical sector (solar PV technicians, installers, services providers etc.)	a. Support establishment of technical certification and vocational training programs through government, private sector, and/or academia for installation and maintenance of stand-alone solar systems[86] b. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through MEIRN)
	D. Insufficient attention of private companies to environmental/social standards and community engagement	a. Assist private sector and/or civil society organizations to ensure environmental/social standards are in place b. Assist in development of strategies encouraging inclusive gender participation c. Support with the implementation of a repair and recycling framework for off-grid solar systems and equipment
	E. Insufficient public awareness	a. Support Government, trade associations and civic society organizations to develop and implement consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related national programs b. Support development and implementation of programs to educate consumers, retailers and distributors on the benefits of quality certified solar products vs. counterfeits

[86] Acção para o Desenvolvimento is a local NGO that runs a technical school that provides solar PV training

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
4. Concession Contracts and Schemes	**A. Lack of clear and transparent licensing and permitting procedures** a. Unclear procedures b. Insufficient communication and streamlining	a. Help Government develop clear licensing and permitting procedures b. Help Government develop improved systems for sharing and disseminating information to project developers and key stakeholders, including establishment of a "one-stop-shop" for national level permits and approvals and expediting of local permits
	B. Lack of experience/understanding of emerging concession and energy services schemes for off-grid providers a. Need for understanding of different SHS concession schemes b. Need for understanding of emerging models for 'Integrated Private Utilities' c. Public procurement or public finance/budget laws that hamper deployment of energy services models for public facilities d. Lack of standardized contracts for energy services provided by private system operators to public facilities e. Insufficient protection for stranded investments	a. Help Government understand all options and models for possibilities of granting geographic concessions to private operators of SHS[87] b. Help Government to understand and develop approaches to facilitate pilots of 'Integrated Private Utility' schemes.[88] c. Help Government develop procurement and public finance laws that will facilitate stand-alone solar system investment for public facilities (schools, health care facilities, etc.) d. Help Government, trade associations or civic society organizations develop model bilateral PPA and Energy Services Contracts for small scale IPPs and ESCOs to sell power or deliver energy services to public facilities (i.e. schools, health care facilities) or deliver solar street lighting services to municipalities e. Help Government develop proper procedures and guidelines to protect against stranded investments from competition among all on-grid and off-grid rural electrification approaches[89]

[87] Different models used to grant geographic 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.

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

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

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
5. Business Model Regulation	A. Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers	a. Support capacity building of regulators, Government and non-Government stakeholders about different pricing schemes[90] offered by stand-alone solar system providers to improve understanding and help avoid unnecessary interventions to regulate. b. Support Government and off-grid enterprises to collaborate specifically on developing pricing schemes for productive use market segment[91] c. Support in building the capacity of and fostering linkages between telecommunications companies / mobile money providers and off-grid solar companies to help roll out PAYG technology platforms and business models

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

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

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

1.4 Development Initiatives

1.4.1 National Government Initiatives

The Government of Guinea-Bissau has not yet launched an off-grid initiative due in large part to its immediate focus on and increasing generation capacity and improving the dilapidated electricity grid. The 2010 Sector Development Policy Paper describes the Government's energy initiatives as focused primarily on increasing power generation and distribution infrastructure in Guinea-Bissau, especially in the capital city, strengthening EAGB's capacity and pursuing grid interconnection opportunities under the Rio Gambia Development Organization (OMVG). The GoGB has also prioritized replacing firewood and charcoal with clean energy, promoting energy efficiency in urban and rural buildings, and mobilizing both public and private financial investment in the energy sector to achieve a national electrification rate of 80% by 2030. In 2013, the GoGB also added the Energy Master Plan of 2013 as its energy sector policy.

1.4.2 DFI and Donor Funded Programs

There has been relatively little Development Finance Institution (DFI) and donor agency activity in Guinea-Bissau's off-grid sector. However, the AfDB is financing an electrification program in Bissau city, which will result in 10,500 new electricity connections. DFI/donor programs and initiatives supporting development of the off-grid sector are summarized in **Table 6**.

Table 6: National Government and DFI-Funded Off-Grid Development Programs

Project/Program	Sponsor / Funding Source	Timeline	Market Segment(s)	Description
Projet d' Urgence pour l´Amélioration des Secteurs d´Eau potable et d´Electricité de Bissau (PUASEE)	World Bank	2016 - present	Grid rehabilitation	• Under this program, the World Bank is financing strengthening and rehabilitation of the distribution grid in the city of Bissau. • The initial grid rehabilitation phase is expected to cost approximately USD 8.2 million.
Guinea-Bissau electrification program, Bissau city	African Development Bank and World Bank	2015 - present	Rural electrification, grid rehabilitation	• AfDB is providing €16.7 million (a €9-million loan / €7.7-million grant) towards an electrification program in Bissau. The program aims to strengthen the electricity distribution network by rehabilitating facilities of 31,000 existing subscribers, connecting 10,500 new subscribers, and improving the commercial management and governance of public utility.
Community Program for Access to Renewable Energy	ACP-EU Facility	2015 - 2017	Rural electrification, solar PV	• In Guinea-Bissau, the Community Program for Access to Renewable Energy (2011-2015) has installed a 312 kW PV hybrid power generation system in the village of Bambadinca, providing electricity to 250 clients (190 households and 60 business and 10 institutions).

1.4.3 Other Initiatives

Outside of the Government and DFI/donor initiatives mentioned above, there are also several non-governmental organization (NGO) programs and other related initiatives in Guinea-Bissau's off-grid sector. The Portugal-based NGO, TESE, has developed energy sector baseline studies in Guinea-Bissau and has been a technical implementing partner of the EU and GEF-UNIDO project. TESE has implemented several Institutional and Productive-Use solar systems in Guinea-Bissau under the EU financing scheme including the first solar mini-grid system in the country (Bambadinca). Another example is the Guinea-Bissau-based NGO Acção para o Desenvolvimento (AD). The organization owns and supports a technical school where it has been training young technicians in the solar PV Market for the last 10 years.

Foundation Rural Energy Services (FRES), present in Guinea-Bissau, Burkina Faso, and Mali, is a Netherlands-based NGO working to promote rural electrification by establishing small scale, commercial electricity companies. These small electricity companies provide households and small businesses with solar PV generated electricity and help them meet their daily energy demand. In Guinea-Bissau, FRES operates through its local affiliate, Sociedade de Serviços Descentralizados, S.A., based in the eastern regions of Bafata and Gabu, where it provides rural electricity services to over 3,500 customers. FRES has approximately 300 kWp of installed PV power through a fee-for-service business model and an investment of more than USD 2.5 million.[92]

ADPP-GB (Ajuda de Desenvolvimento de Povo para Povo) is a Danish-international NGO that has been active in Guinea-Bissau for more than 35 years. Based out of its headquarters in the city of Bissorã, ADPP-GB works primarily in the agriculture, education, health, community development, culture and economic development sectors. In January 2018, ADPP-GB renewed its support of the Vocational School of Bissorã and its efforts to modernize and improve the quality of its training in electricity and solar energy for youth.

[92] Foundation Rural Energy Services (FRES): https://www.fres.nl/fres-in-guinea-bissau/

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

This section presents the overall market assessment for stand-alone off-grid solar (OGS) energy systems in Guinea-Bissau. **Section 2.1** provides an overview of the current household off-grid energy situation and estimates potential household market demand for solar energy systems. **Section 2.2** introduces institutional off-grid energy demand and the potential of solar to supply this market. **Section 2.3** evaluates the demand for off-grid solar to serve productive use applications. **Section 2.4** examines the existing off-grid solar product supply chain in the country. **Table 7** summarizes the overall total cash market potential for OGS systems from each of the analyzed market segments. **Annex 2** provides an overview of the Task 2 methodology.

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

For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution 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 7: Indicative Total Cash Market Potential for Off-Grid Solar PV Products in Guinea-Bissau, 2018

Off-Grid Market Segment	Annualized Cash Demand (Units)	Annualized Cash Demand (kW)	Annualized Cash Market Value (USD)	Financed Market Value (USD)
Household				
Pico solar	63,766	191	$2,869,478	$0.00
Plug and play	11,489	115	$1,436,175	$5,744,701
Small SHS	0	0	$0.00	$6,376,618
Medium and Large SHS	0	0	$0.00	$4,308,525
Household Subtotal	**75,255**	**306**	**$4,305,653**	**$16,429,844**
Institutional				
Water supply	247	885	$2,211,313	-
Healthcare facilities	130	62	$155,925	-
Primary and secondary schools	56	60	$157,710	-
Public lighting	52	26	$77,400	-
Institutional Subtotal	**485**	**1,033**	**$2,602,348**	-
Productive Use				
SME applications for microenterprises	253	63	$158,125	-
Value-added applications	39,134	5,056	$26,314,030	-
Connectivity / ICT (phone charging)	698	279	$601,935	-
Productive Use Subtotal	**40,085**	**5,398**	**$27,074,090**	-
TOTAL	**115,825**	**6,737**	**$33,982,091**	

Source: African Solar Designs analysis

2.1 Demand – Households

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

2.1.1 Overview of Household Market Segment

According to the International Energy Agency (IEA), in 2016 there were 299,873 households (1.62 million people) in Guinea-Bissau without access to electricity.[93] In that year, an estimated 13% of the population had access to electricity, with the rate of access at 23% in urban areas and 1% in rural areas.

This section gives an introduction to household consumer market segments, their characteristics and size (**Table 8**). It then discusses household sources of income and geographic distribution of off-grid households, both presently and projected over time. This provides context for the next section, 2.1.2, which sizes household segment potential market demand through a series of detailed analyses.

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

Table 8: Household Consumer Market Segments[94]

Income Quintile	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	Geographic segments	Description
	2018 Scenario				2023 Scenario				2030 Scenario					
Highest 20%	50%	34,468	$9,256	Tier 3	1%	803	$10,953	Tier 3	1%	955	$13,404	Tier 3	High income rural	• Small portion of rural households using a petrol generator set • Has a demonstrated ability to pay for solar off-grid systems
													Mid to high income urban	• Professionals, business owners and salaried people are likely to be connected to the grid. • Small portion without grid access desire replacement to generator power[95]
Fourth 20%	90%	62,043	$2,987	Tier 2	11%	8,597	$3,535	Tier 3	2%	1,910	$4,326	Tier 3	Low income peri-urban / urban "under-grid"	• Low income urban population engaged in SME work or casual labor • Lives near grid but cannot afford or does not have access to connection
Third 20%	95%	65,490	$1,992	Tier 1.5	90%	72,294	$2,357	Tier 2	3%	2,864	$2,884	Tier 2		
Second 20%	100%	68,936	$1,355	Tier 1.5	99%	79,523	$1,603	Tier 1.5	36%	34,176	$1,962	Tier 1.5	Low income rural	• Engaged in farming, or SME • Lives more than 15km from the nearest grid connection.
Lowest 20%	100%	68,936	$735	Tiers 1	100%	80,326	$869	Tier 1	100%	95,483	$1,064	Tier 1		
Total Households without Access to Electricity		**299,873**			**Total**	**241,542**			**Total**	**135,388**				

Source: IEA and World Bank; African Solar Designs analysis

[94] See **Annex 1** and **Annex 2** for more details.

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

- **Off-grid household characteristics**

Guinea-Bissau has a high level of extreme poverty (households living below $1.90 a day). As shown in **Table 8**, the vast majority of the country's households are low income.

Table 9: Poverty Headcount in Guinea-Bissau, 2010

Poverty headcount ratio	% of population
Lives at or below $1.90 a day*	67.1%
Lives at or below $3.20 a day*	84.5%
Lives at or below $5.50 a day*	93.4%

*2011 PPP

Source: World Bank

According to focus group discussions, the main income-generating activities in rural areas are agriculture and telecommunications. As rural areas are concerned, payment capacity is very low and access to sources of financing is almost non-existent. Important agricultural exports include fish, cashew nuts and ground nuts.

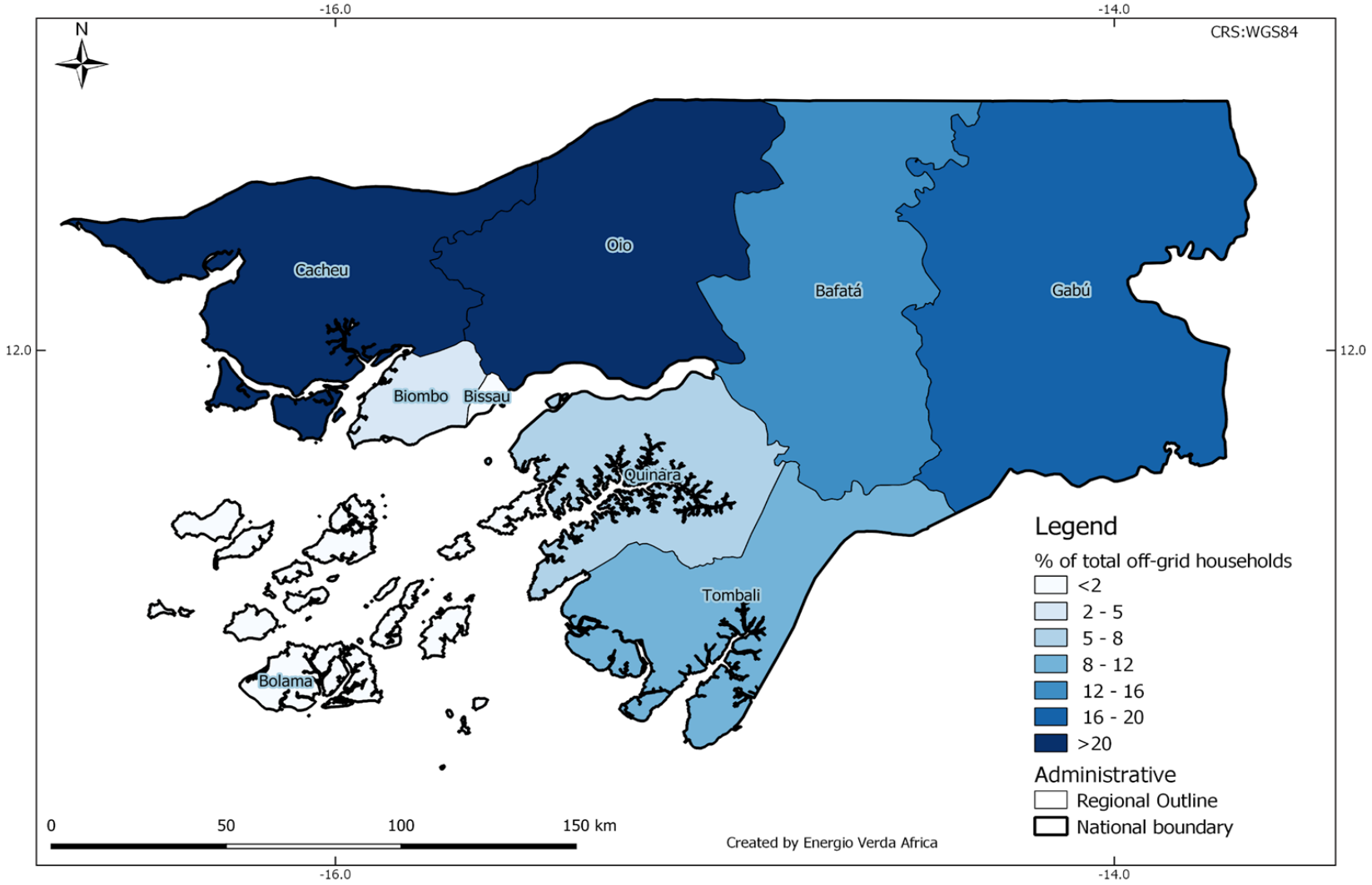
- **Geographic Components of the Solar Market**

The total number of off-grid households and their geographic distribution will change significantly over time. To analyze the potential OGS market over time, GIS maps were prepared from demographic information to present potential market areas for OGS. GIS calculations consider drivers of off-grid household market change including grid extension around current urban and peri-urban centers, mini-grid development for more densely populated rural areas, and population growth. Sources of information for the maps presented below (**Figures 12-15)** can be found in **Annex 1**.

GIS maps shown here are for 2018-2023 and 2030. Data shown for 2018-2023 includes information on existing grid lines only. The data of planned "future lines" is not broken down in enough detail to show in which year future lines will be built, so an assumption was made that all future lines would be built after 2023 but prior to 2030

As shown in the maps and chart summaries below **(Figures 12-15)**, the total size of the OGS market will decrease over time, while also becoming somewhat more concentrated in more remote districts. However, because the reach of the national grid is so limited, off-grid households will remain spread across all districts of the country, even over time.

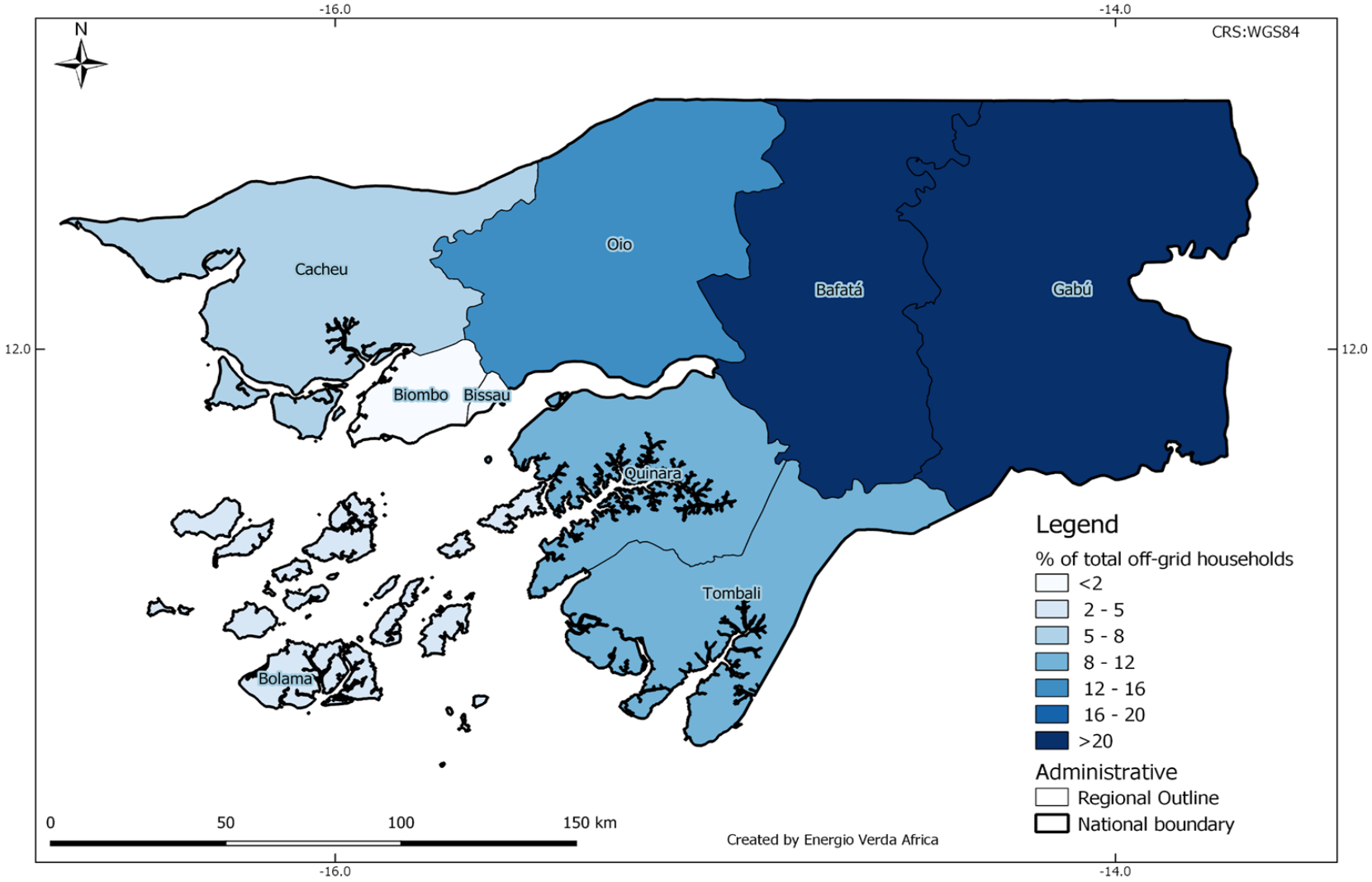
Figure 12: Distribution of Potential Off-Grid Households by Region, 2023[96]



Source: Energio Verda Africa GIS analysis

[96] See **Annex 1** for more details, including data sources.

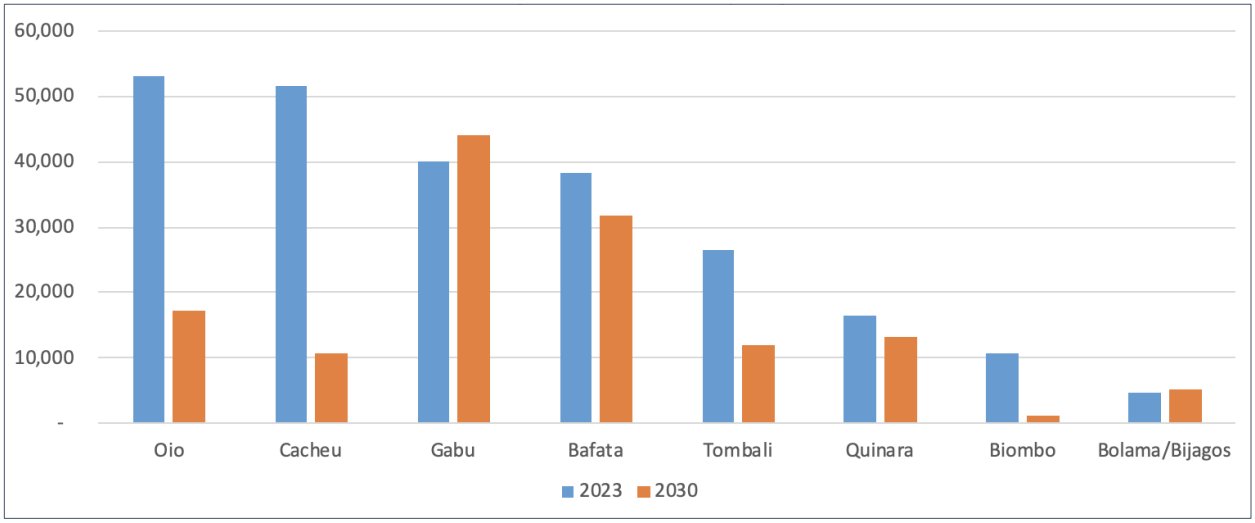
Figure 13: Distribution of Potential Off-Grid Households by Region, 2030[97]



Source: Energio Verda Africa GIS analysis

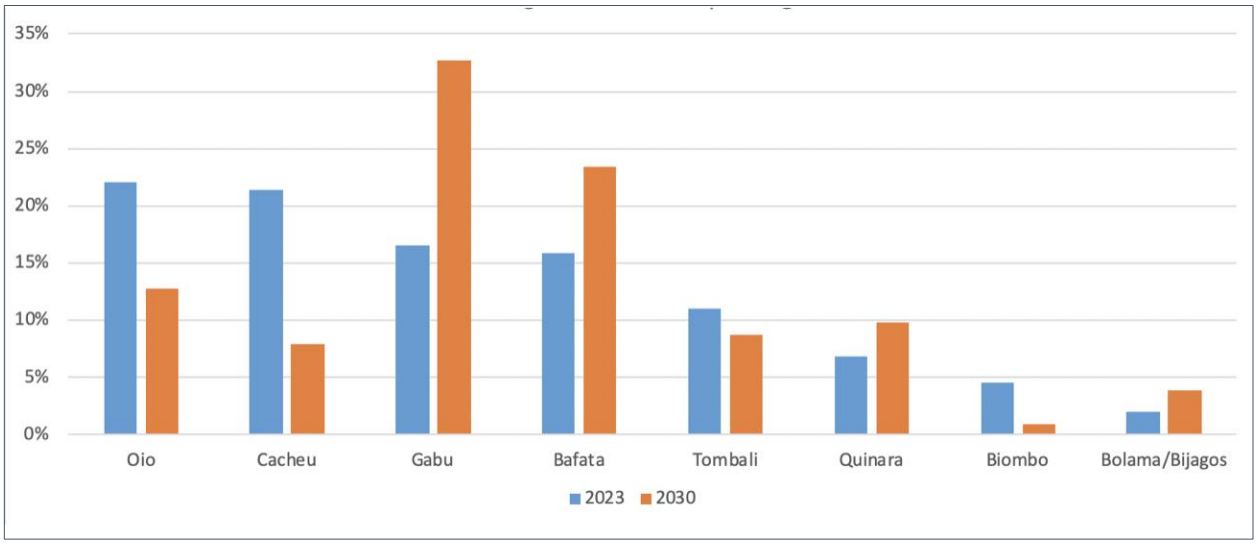
[97] See **Annex 1** for more details, including data sources.

Figure 14: Estimated Number of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

Figure 15: Estimated Percentage of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

2.1.2 Analysis of Household Market Segment Demand

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

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

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

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

According to feedback from focus group discussion (FGD) participants, in most households there is a weak demand for energy. In most cases, energy needs are for lighting (main use), refrigeration and some appliances for entertainment (audiovisual). Highlighting the use in the East and Oio regions, costs and domestic energy needs in off-grid systems are still very high for most households, if compared to traditional diesel groups and are difficult to estimate, for statistical data are not available.

Table 10 shows the typical monthly cost of using common rural energy technologies. Household use of different types and amounts of energy technologies is associated with different energy access tiers, as defined in the Multi-Tier Energy Access Framework. For example, a household using one battery powered lantern and one charged cell phone would fall under the Tier 1 level of energy access. A household using two lanterns, one cell phone and a radio would be in Tier 1.5.

These tiers are defined in **Table 11**. Establishing an average monthly household expenditure for each energy tier using common rural technologies shows how household income level aligns with energy tiers. Secondly, it provides a basis to compare these costs to solar products that can offer an equivalent level of service by energy tier. This in turn reveals potential household savings by switching to solar products, as shown in **Figure 16** and **Table 12**.

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

Table 10: Rural Energy Technology and Costs[98]

Technology	Details	Average Life (Years)	# of Units/ Month	Unit Operating Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)
					2018 Scenario		2023 Scenario		2030 Scenario	
Torch lights/Electric Lanterns	Torch lights/electric lanterns powered by D-type, AA-type or AAA-type batteries	0.5	16	$0.16	$2.00	$2.56	$2.19	$2.80	$2.69	$3.44
Cell Phone Charging	Done at a charging station	-	8	$0.17	$0.00	$1.36	$0.00	$1.49	$0.00	$1.83
Smart Phone Charging	Done at a charging station	-	16	$0.17	$0.00	$2.72	$0.00	$2.97	$0.00	$3.66
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	$0.16	$0.00	$1.28	$0.00	$1.40	$0.00	$1.72
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	$0.65	$50.00	$2.6	$54.64	$2.84	$67.2	$3.49
Small Petrol Generator	The most popular rural generator for basic use is 0.9kW generator (for phone charging, lighting, TV, fan and music system)	2	20	$1.14	$100.00	$22.80	$109.30	$24.91	$134.39	$30.64

Source: African Solar Designs analysis

[98] Data from FGDs, field surveys and various published data sources

Table 11: Typical Tier-Based Energy Costs

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Typical Monthly Cost (USD) 2018	Typical Monthly Cost (USD) 2023	Typical Monthly Cost (USD) 2030
Tier 0 No electricity	• 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
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	$3.92	$4.28	$5.27
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	$7.76	$8.48	$10.43
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	$14.36	$15.69	$19.30
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	$22.80	$24.91	$30.64

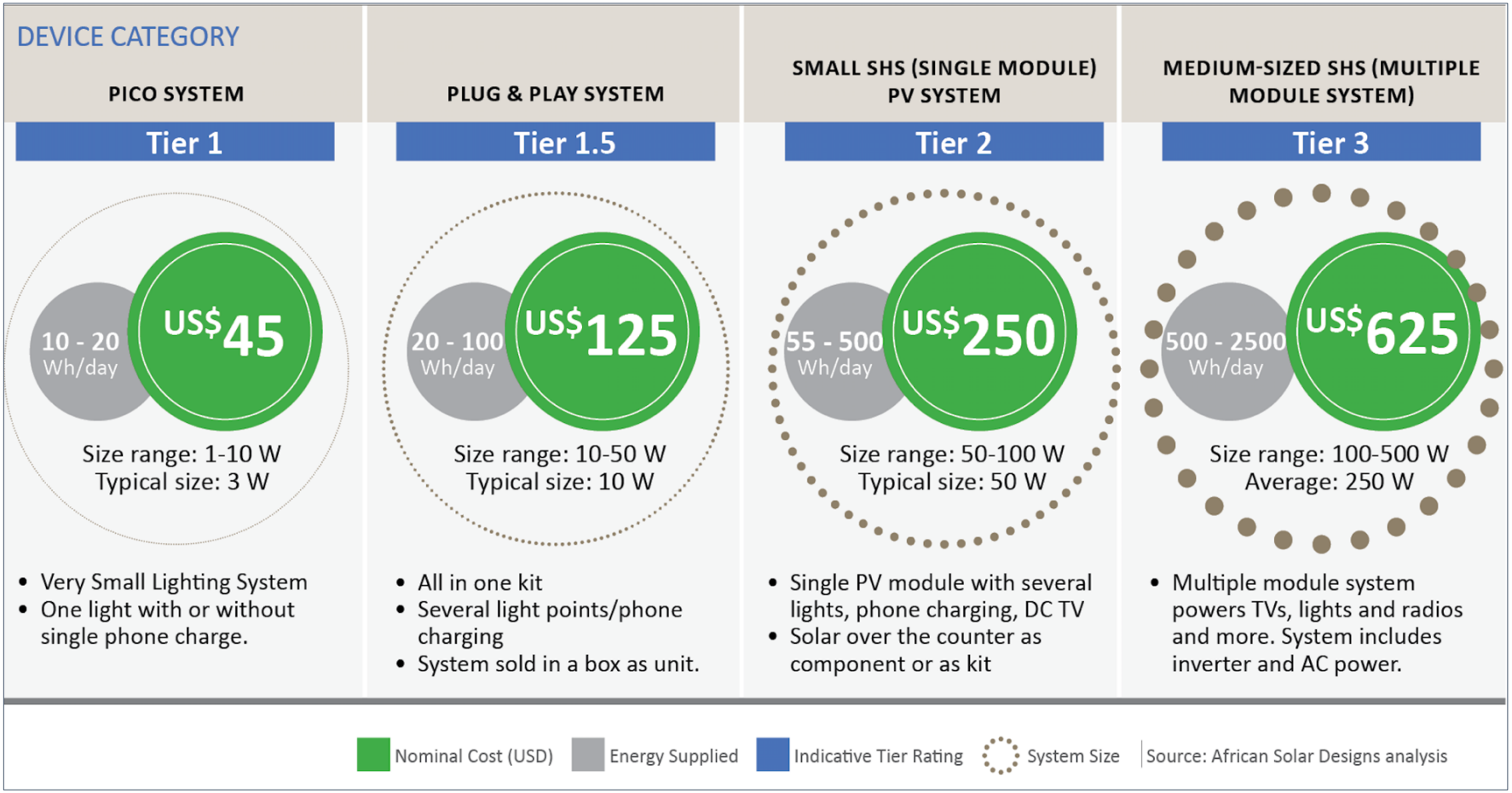
Source: African Solar Designs analysis

Per **Table 11**, it can be seen that, given the purchase price of dry cells and the cost of phone charging, the "ideal" electricity availability is extremely difficult to sustain. This is especially true where there is a high incidence of poverty in rural areas and lack of regular incomes. In reality, households often must reduce their energy consumption when cash is not available. This means that even a Tier 2 level family might drop to Tier 1 for a week each month when cash is not available to pay for phone charging or dry cell purchase.

- **Household Solar PV System Types**

Solar PV systems can provide lower cost and higher levels of service than existing dry cell, phone charging and generator options. In order to model how solar systems can meet existing energy use categories, levels of service and ability to pay, four types of household solar systems are configured to match the tier-based demands of off-grid communities. The system descriptions, energy outputs, prices, tier ratings and target consumer groups are listed in **Figure 16**.

Figure 16: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

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

Focus group discussion participants indicated that uni-modular systems (Tier 1 and 2) are widely used in rural areas in housing and small businesses. Multi-modular systems of small power (Tier 2 and 3) tend to be more common in urban and peri-urban centers. Public and private institutions and wealthier households utilize more powerful systems (Tier 4). Also noteworthy for Tier 5 are some experiments with off-grid solar micro-grids, such as Bambadinca (312 kW), Contuboel (45 kW) and Bissorã (500 kW).

FGD participants also noted that a large share of the population lacks understanding of the advantages of using solar systems and prefers traditional small diesel generators. Yet, it was suggested that the potential for the sector is significant, with brands and systems being acquired from various sources and suppliers (Victron, Solarworld, etc.). The most active geographic areas of the country utilizing off-grid solar for domestic use are the East and Oio. Participants estimated that 50% of OGS product sales in the country go to the institutional sector, while households account for 30% of the market, and productive use for 20%.

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

Looking beyond current use of off-grid solar products by households, this study analyzes potential for OGS market development by estimating potential household demand based on household income. Household income shown in **Table 12** is sourced from World Bank demographic data based on household surveys, which reports income by population quintiles. From household income, potential for energy spending is estimated as 10% of monthly income (see methodology annex). Future scenarios project higher energy budgets as household incomes rise with economic development over time. In all scenarios, the large majority of off-grid households will fall under the lowest income quintile.

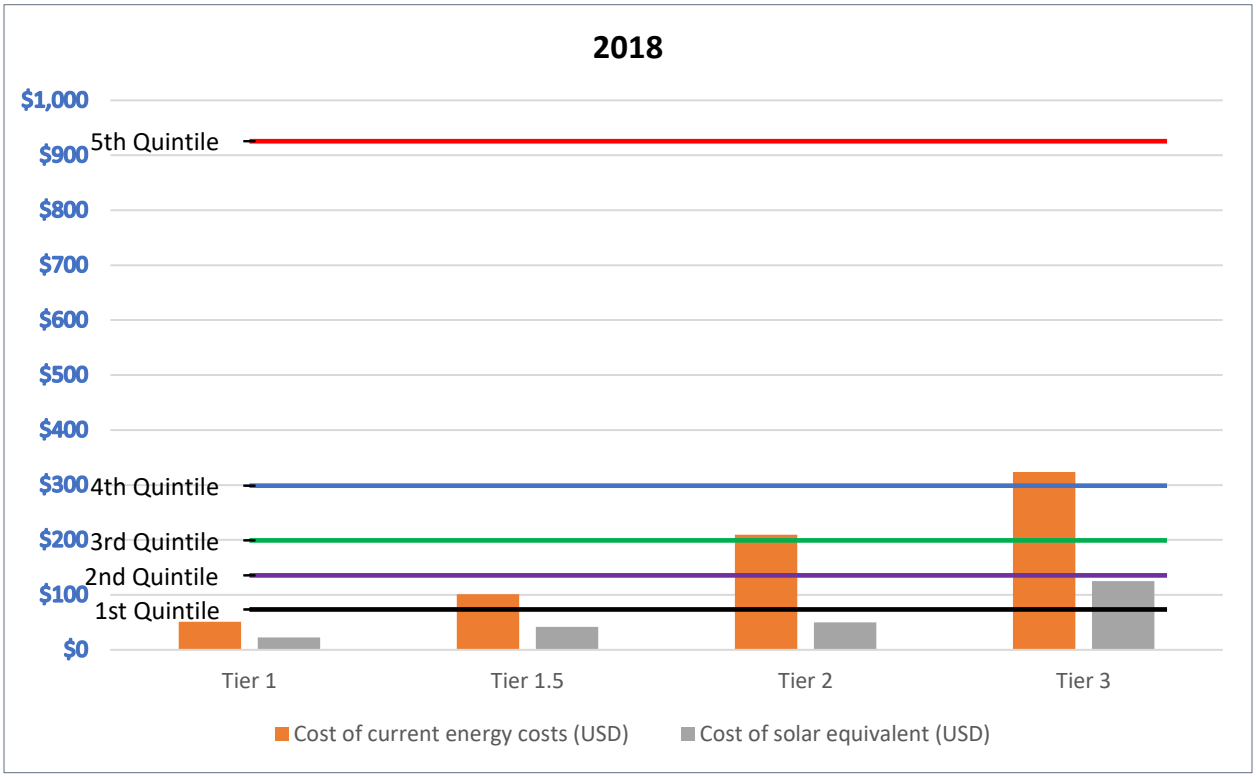
Table 12 : Energy Expenditure of Different Income Groups

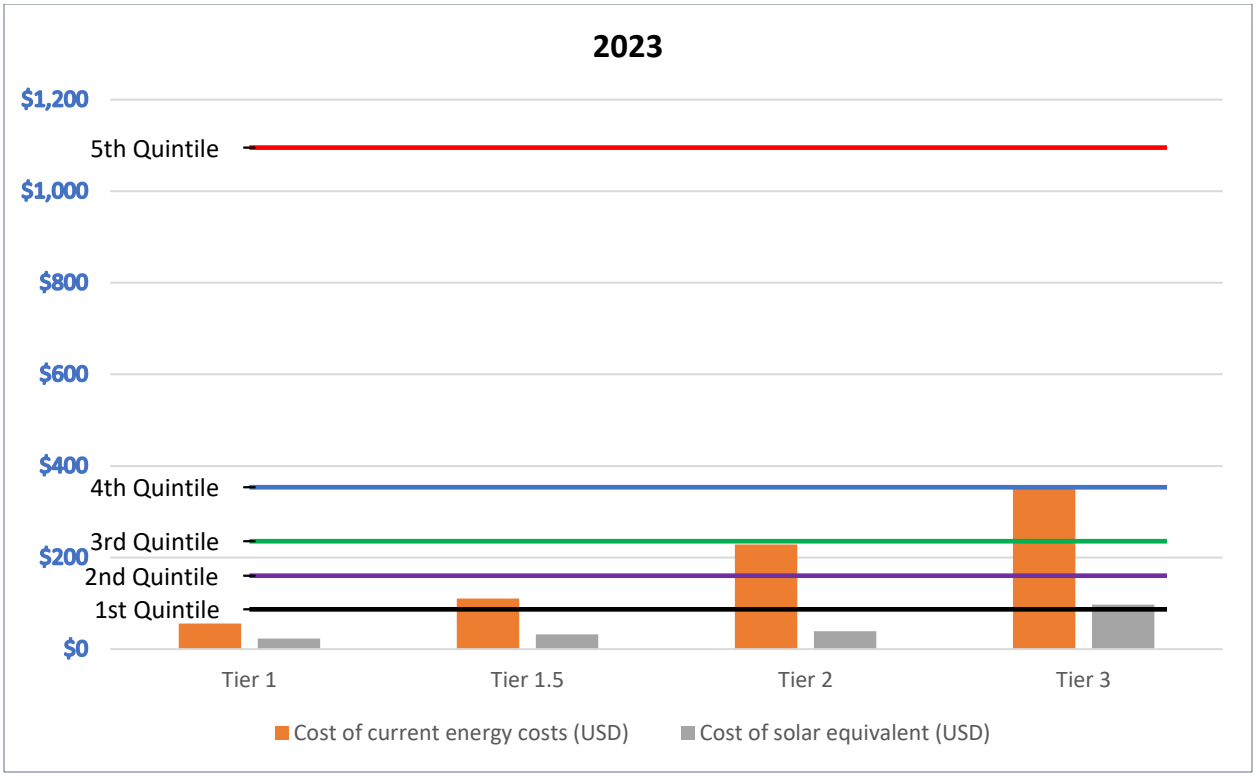
Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	$11.34	$61.22	10%	$6.12
2nd Quintile of Population	$20.91	$112.91	10%	$11.29
3rd Quintile of Population	$30.74	$165.97	10%	$16.60
4th Quintile of Population	$46.10	$248.95	10%	$24.90
Highest Quintile of Population	$142.84	$771.35	10%	$77.13
2023 Scenario				
Lowest Quintile of Population	$13.42	$72.44	10%	$7.24
2nd Quintile of Population	$24.74	$133.61	10%	$13.36
3rd Quintile of Population	$36.37	$196.40	10%	$19.64
4th Quintile of Population	$54.55	$294.60	10%	$29.46
Highest Quintile of Population	$169.03	$912.76	10%	$91.28
2030 Scenario				
Lowest Quintile of Population	$16.42	$88.65	10%	$8.87
2nd Quintile of Population	$30.28	$163.51	10%	$16.35
3rd Quintile of Population	$44.51	$240.34	10%	$24.03
4th Quintile of Population	$66.76	$360.52	10%	$36.05
Highest Quintile of Population	$206.85	$1,117.01	10%	$111.70

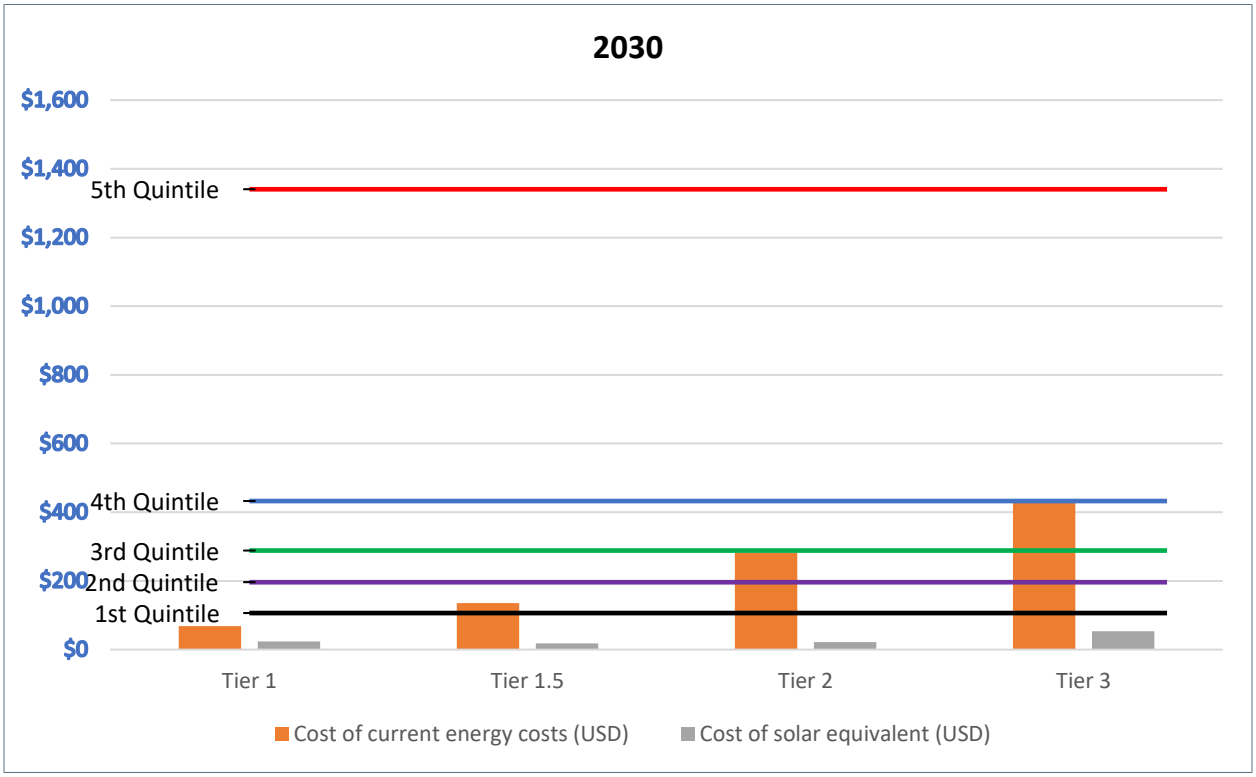
Source: African Solar Designs analysis

Figure 17 summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. Both the annual costs of current energy technologies and equivalent solar solutions consider the capital costs of the units, and the operating costs considered over the average unit life times. The data clearly shows strong potential savings for households to switch to solar products. Affordability also increases over time, as the cost of solar technology reduces, while the cost of traditional energy sources increases with inflation, and household income increases. Affordability here is shown by comparing annual income and energy costs over the life of a product. This indicates the need for short term financing, as many households still struggle to pay up front unit capital costs to achieve subsequent savings.

Figure 17: Annual Household Energy Budget by Quintile, Annual Energy Costs and Cost of Solar Equivalents







Source: African Solar Designs analysis

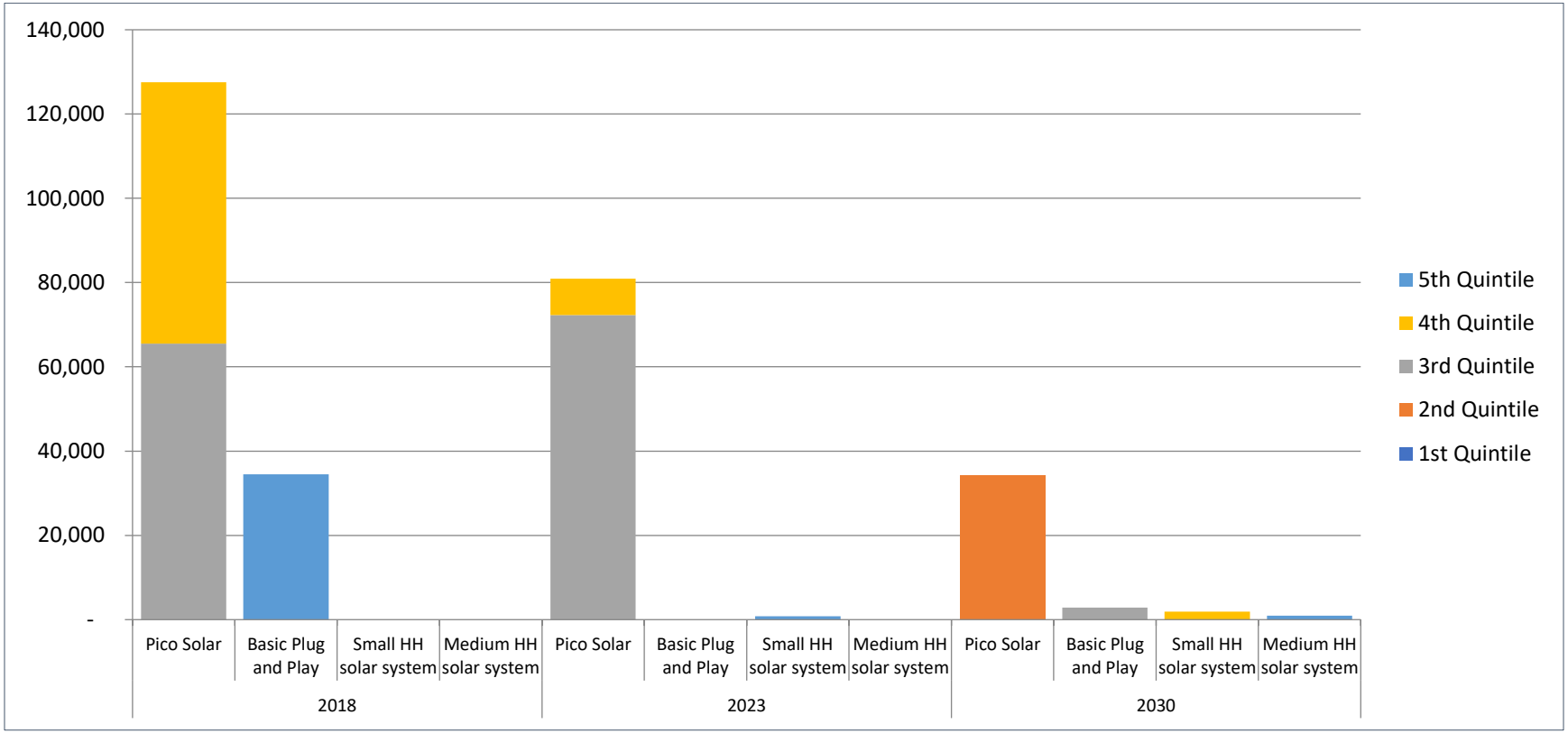
2.1.3 The Market for Household Devices without Consumer Finance

This section analyzes the cash market for various income levels and the corresponding energy services powered by OGS systems they can afford. Modelling of the viable market was based on income quintiles associated with data from the World Bank. The calculations and assumptions made are presented in **Table 12**. It was assumed that for a cash purchase a household is willing to save three months of their current energy expenditure to purchase the OGS system.

Based on the income quintiles and corresponding estimated current energy expenditure, in the 2018 scenario, only households without electricity access in the highest income quintiles (3-5) can afford an OGS product unfinanced. Affordability increases significantly over time, as only households in the lowest income quintile are unable to afford an OGS system unfinanced by 2030. However, the need for financing solutions for almost all income quintiles is clear.

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

Figure 18: Estimated Number of Households Able to Afford Cash Purchase of OGS Systems by Income Group



Source: African Solar Designs analysis

Table 13 presents the estimated annualized cash market potential for off-grid solar product sales in the country's household sector.

Table 13: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	63,766	191	$2,869,478
Basic Plug and Play	11,489	115	$1,436,175
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**75,255**	**306**	**$4,305,653**
2023 Scenario			
Pico Solar	40,445	121	$1,851,281
Basic Plug and Play	0	0	$0.00
Small HH solar system	161	8	$31,190
Medium HH solar system	0	0	$0.00
Total	**40,606**	**129**	**$1,882,471**
2030 Scenario			
Pico Solar	17,088	51	$813,876
Basic Plug and Play	955	10	$51,381
Small HH solar system	382	19	$41,105
Medium HH solar system	191	48	$51,381
Total	**18,616**	**128**	**$957,743**

Source: African Solar Designs analysis

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

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

2.1.4 The Financed Market for Off-Grid Solutions

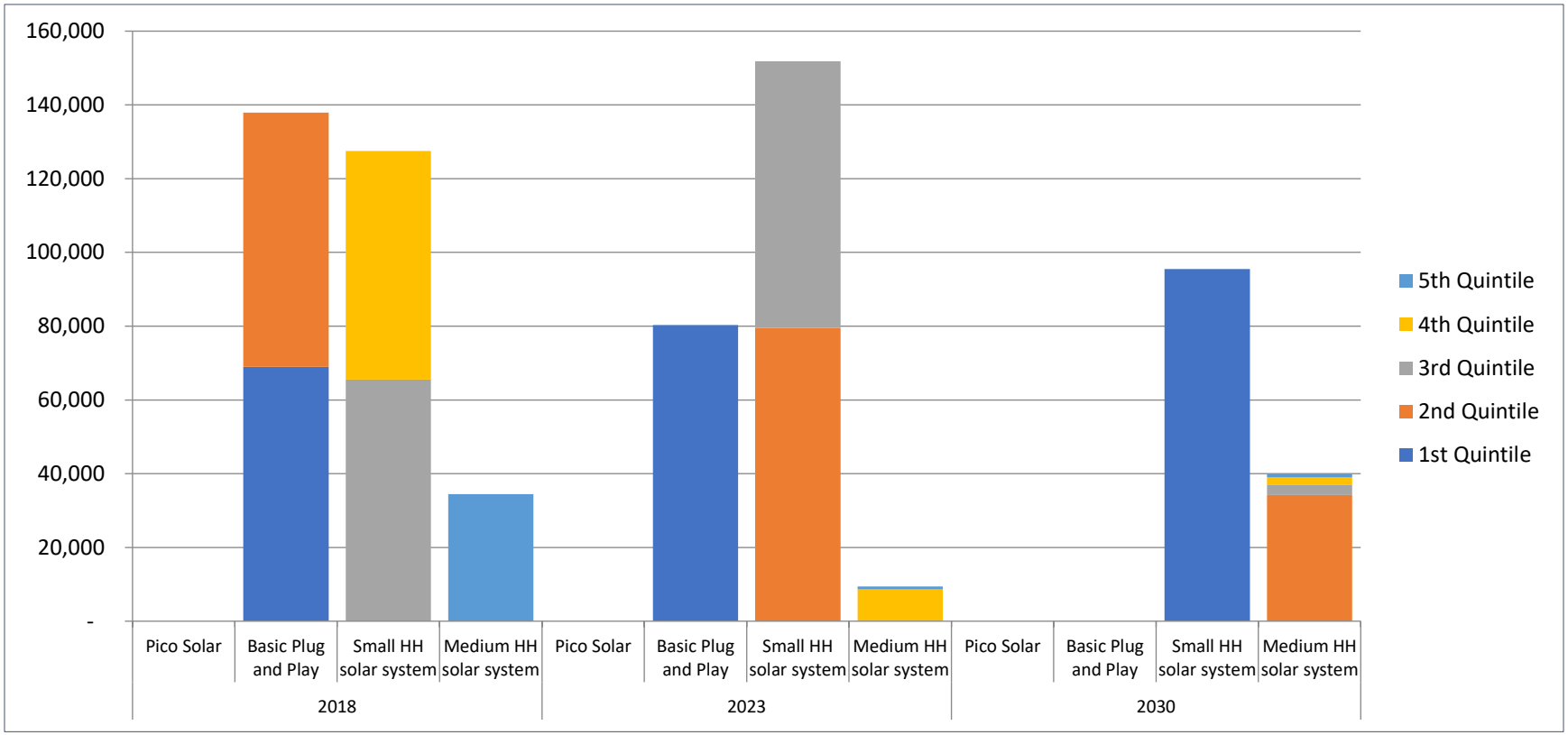
- **Financial Model**

In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with a 24% p.a. interest rate[99] and a 24-month term. The financial model assumes that the households would be willing to save for three months of their current energy expenditure to cover a small upfront deposit of 10% of the system and their current energy expenditure would be used to pay the monthly installments.

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

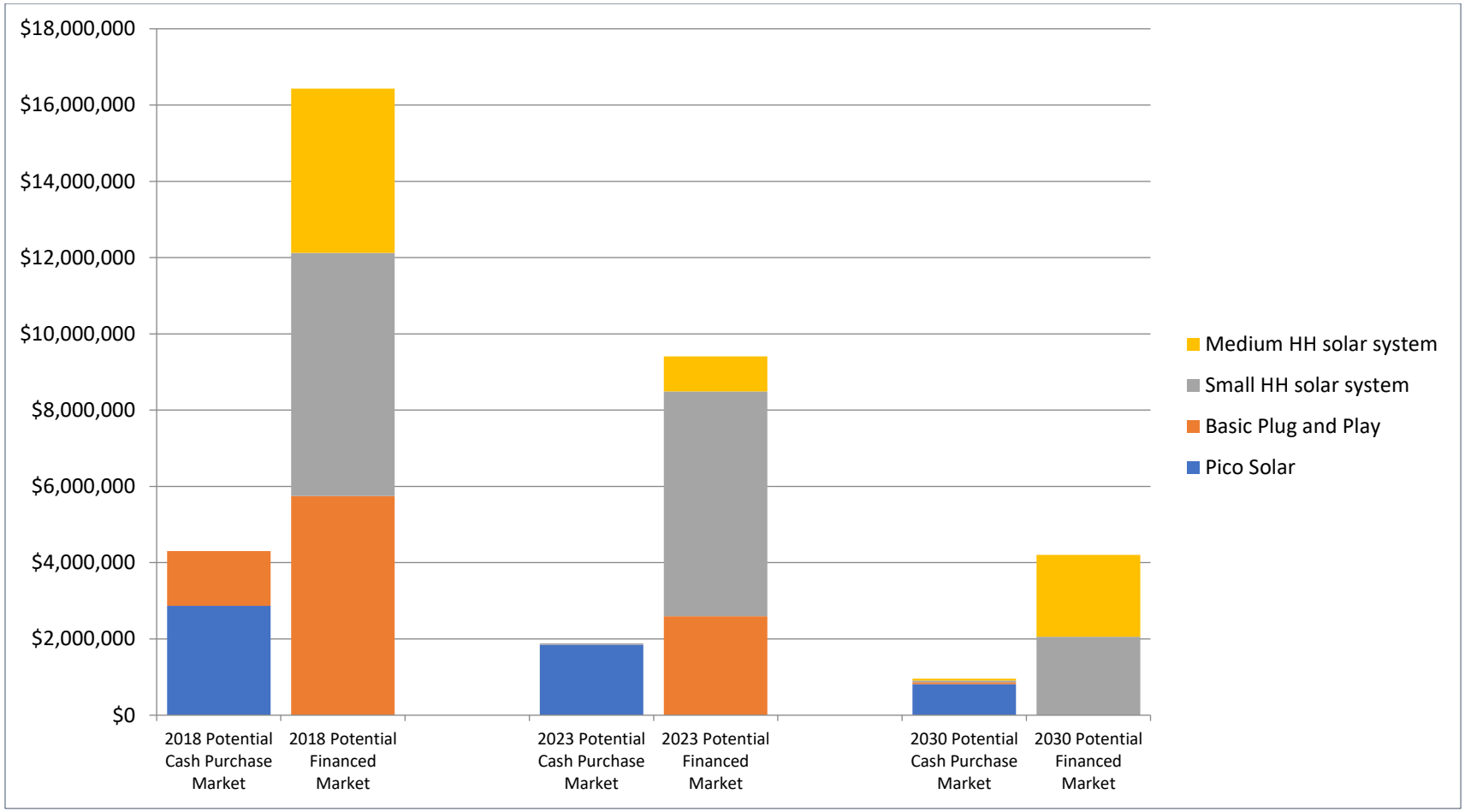
[99] Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf

Figure 19: Estimated Number of Households Able to Afford Financed OGS Systems by Income Group



Source: African Solar Designs analysis

Figure 20: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

In 2018, without financing, 162,001 households (54% of the households without electricity access) could afford an OGS system. However, with financing, 299,873 households (100% of the households without electricity access) could afford an OGS system as the 137,873 households without electricity access in the two lowest income quintiles are enabled to acquire at least one OGS system. Consequently, the annualized potential market size increases from USD 4,305,653 to USD 16,429,844 (**Figure 20**).

The least-cost electrification 2023 scenario calculates that 241,542 households could be electrified by stand-alone systems. Under this scenario, with financing, the number of households with the ability to acquire at least one OGS system increases from 81,693 (33.8% of the households without electricity access) to 241,542 (100% of all the households without electricity access) as the 159,849 households without electricity access in the two lowest income quintiles are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 1,882,471 to USD 9,406,579 (**Figure 20**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems would drop to 135,388 (according to the least-cost electrification analysis). Under this scenario, with financing, the number of households with the ability to acquire at least one OGS system increases from 39,905 (29.5% of the households without electricity access) to 135,388 (100% of all the households without electricity access) as the 95,483 households without electricity access in the lowest income quintile are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 957,742 to USD 4,202,614 (**Figure 20**).

Table 14 presents the estimated annualized financed market potential for off-grid solar product sales in the country's household sector.

Table 14: Estimated Financed Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	45,958	460	$5,744,701
Small HH solar system	25,506	1,275	$6,376,618
Medium HH solar system	6,894	1,723	$4,308,525
Total	**78,358**	**3,458**	**$16,429,844**
2023 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	26,775	268	$2,599,177
Small HH solar system	30,363	1,518	$5,894,934
Medium HH solar system	1,880	470	$912,467
Total	**59,018**	**2,256**	**$9,406,578**
2030 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	0	0	$0.00
Small HH solar system	19,097	955	$2,055,236
Medium HH solar system	7,981	1,995	$2,147,378
Total	**27,078**	**2,950**	**$4,202,614**

Source: African Solar Designs analysis

2.1.5 Consumer Perceptions, Interest and Awareness

- **Purchasers of solar are "early adopters" who tend to buy from system integrators as well as hardware traders**

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

- **Consumers have a general awareness that solar can economically replace generators and batteries, but they are still largely uninformed about solar electric specifics**

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

- **Perceptions of households vary according to experience they have had with solar**

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

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

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

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

2.2 Demand – Institutional

2.2.1 Overview of Institutional Market Segment

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

2.2.2 Analysis of Institutional Market Segment Demand

Table 15 shows the estimated annualized cash market potential for institutional users in Guinea-Bissau. This estimation is calculated using available GIS data, secondary research, and primary source field data. The analysis is based on available information from planned expansion of the sectors and typical usage patterns and costs of existing systems in the country. There was insufficient GIS data available to properly estimate the market size; as a result, per capita comparisons were made with similar countries to analyze certain sectors, as described below.[100]

Table 15: Indicative Total Cash Market Potential for Institutional Sector[101]

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	123	185	$461,183
	Medium power pumping system	89	355	$887,000
	High power pumping system	35	345	$862,500
	Subtotal	247	885	$2,211,313
Healthcare	Health post (HC1)	113	28	$70,500
	Basic healthcare facility (HC2)	14	21	$52,875
	Enhanced healthcare facility (HC3)	3	13	$32,550
	Subtotal	130	62	$155,925
Education	Primary schools	33	16	$48,750
	Secondary schools	23	44	$108,960
	Subtotal	56	60	$157,710
Public lighting	Public lighting (excluding street lighting)	52	26	$77,400
TOTAL		**485**	**1,033**	**$2,602,348**

Source: African Solar Designs analysis

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

- **Water Supply**

Table 16: Key Assumptions for Water Supply Sector Analysis

Sector	System Sizes	Key Assumptions
Water supply	• Low Power (1,500 W) • Medium Power (4,000 W) • High Power (10,000 W)	The type of pump selected is dependent on depth, yield, community need and other factors. System sizes depend on the common pump sizes used for rural applications: • Low power pumps are used for low/medium head applications. They replace hand pumps for shallow wells • Medium power pumps have high volume low head and medium volume medium head applications • High power pumps are used for high volume or high head applications such as deep wells and boreholes

The water supply sector analysis considered the electricity needs for water supply for communities in off-grid areas. Energy is only one component of this sector – a variety of factors (water quality, number of users, yields of well, delivery system etc.) need to be considered when planning for off-grid water supply. The supply of solar powered pumping systems for village water supply requires additional planning and study to identify the most viable sites.

Available GIS data identified off-grid water points such as boreholes and wells that could be electrified by stand-alone systems. Based on the analysis, the estimated annualized cash market potential for the water supply sector is presented in **Table 17**.[102] The distribution of potential off-grid water points is shown in **Figures 21-23**.

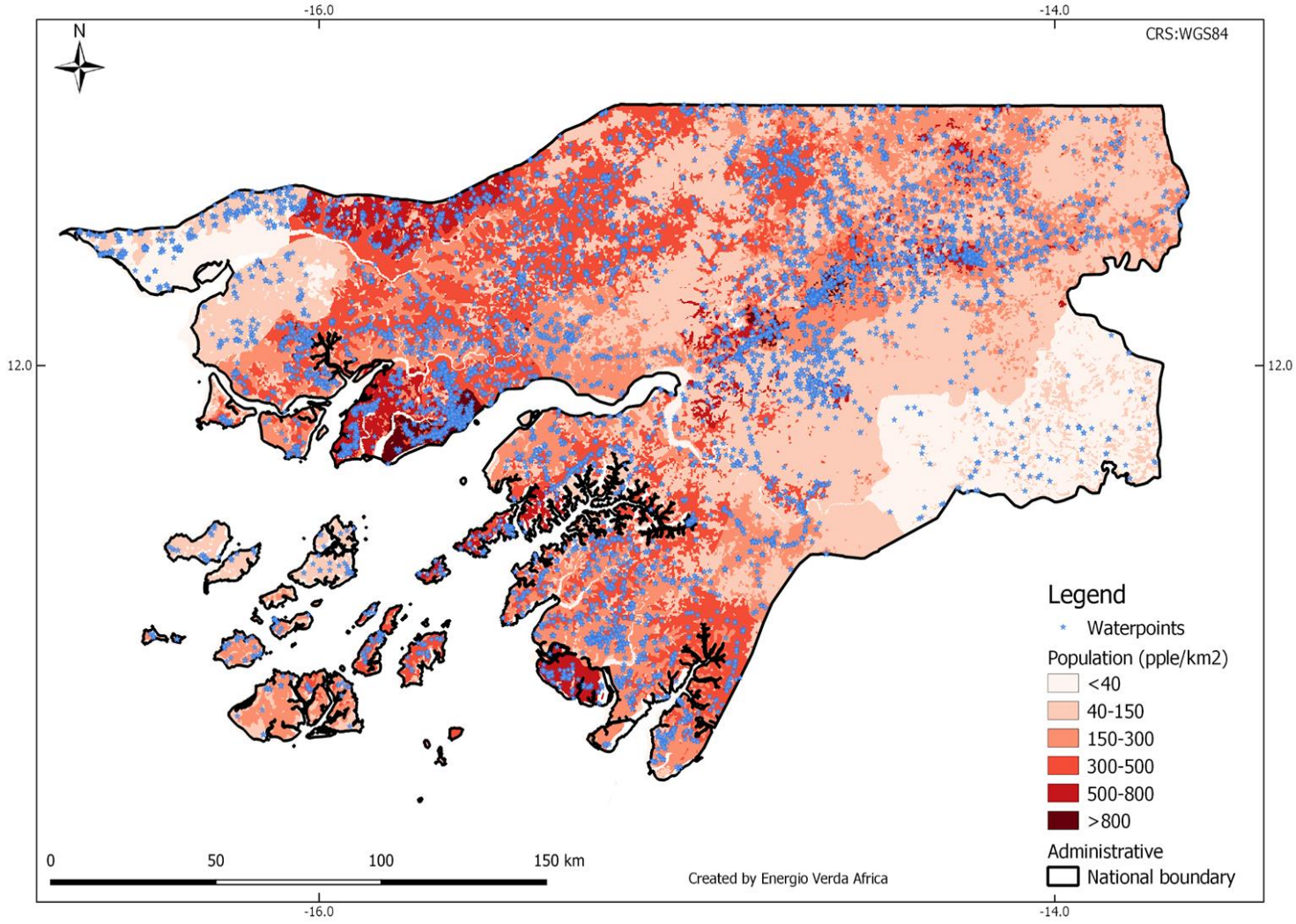
Table 17: Estimated Cash Market Potential for Water Supply[103]

Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	123	185	$461,183
Medium power	89	355	$887,000
High power	35	345	$862,500
Total	**247**	**885**	**$2,211,313**

Source: African Solar Designs analysis

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

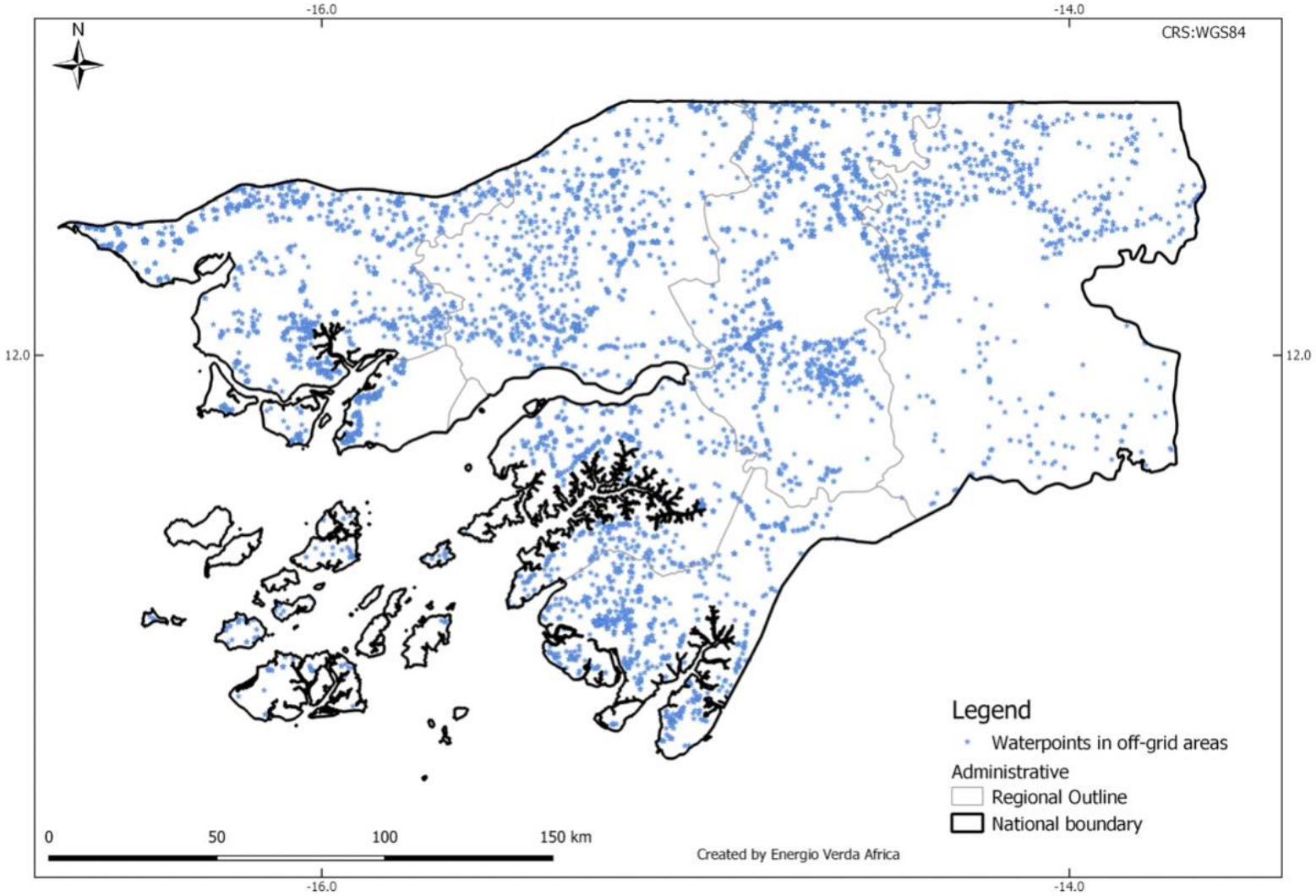
Figure 21: Distribution of Water Points and Population Density[104]



Source: Energio Verda Africa GIS analysis

[104] See **Annex 1** for more details, including data sources.

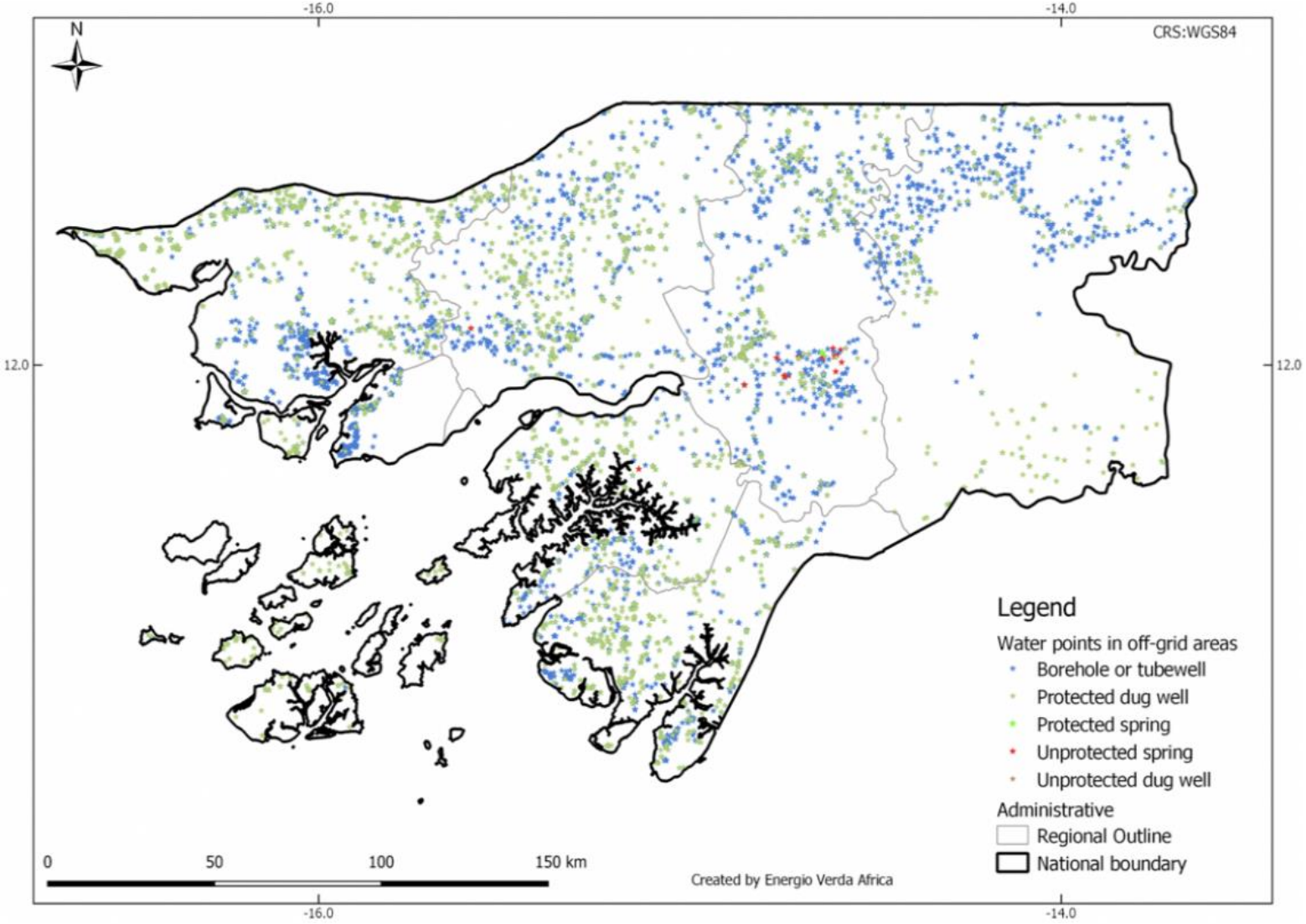
Figure 22: Distribution of Water Points in Off-Grid Areas[105]



Source: Energio Verda Africa GIS analysis

[105] See **Annex 1** for more details, including data sources.

Figure 23: Distribution of Water Points in Off-Grid Areas by Category[106]



Source: Energio Verda Africa GIS analysis

[106] See **Annex 1** for more details, including data sources.

- **Healthcare**

Table 18: Key Assumptions for Healthcare Sector Analysis

Sector	System Sizes	Key Assumptions
Healthcare	• HC1: Dispensary health post (300 W) • HC2: Basic health facility (1,500 W) • HC3: Enhanced health facility (4,200 W)	A per capita comparison identified a total of 908 off-grid healthcare facilities that could be electrified by stand-alone systems

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

As GIS data was not available to conduct the analysis, a per capita comparison made using data from Guinea[107] identified off-grid health facilities categorized according to their size (HC1, HC2, and HC3) that could be electrified by stand-alone systems.[108] To establish electricity demand, an assessment of equipment found within each category of healthcare facility was undertaken, with the daily demand of each used to calculate the system size required to cater to the load of the facility (**Table 19**). The assumptions of system size below are based on the services offered at each of these facilities.

Table 19: Healthcare Facility Categorization and Electricity Demand[109]

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

Source: GIZ; African Solar Designs analysis

[107] Guinea was in the same category as Guinea-Bissau; See **Annex 2** for more details.
[108] NOTE: This represents a small subset of the overall health infrastructure in the country; See **Annex 1** for more details.
[109] "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ__2016__Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

Based on these assumptions, the estimated annualized cash market potential for health facilities is presented in **Table 20**.

Table 20: Estimated Cash Market Potential for Healthcare Facilities[110]

Type of Facility	Units	kW Equivalent	Cash value (USD)
Health post (HC1)	113	28	$70,500
Basic healthcare facility (HC2)	14	21	$52,875
Enhanced healthcare facility (HC3)	3	13	$32,550
Total	**130**	**62**	**$155,925**

Source: African Solar Designs analysis

- **Education**

Table 21: Key Assumptions for Education Sector Analysis[111]

Sector	System Sizes	Key Assumptions
Education	• Elementary schools (500 W) • Secondary schools (1920 W)	A per capita comparison identified a total of 650 off-grid primary schools and 454 off-grid secondary schools that could be electrified by stand-alone systems

The education sector analysis considered the electricity needs of off-grid primary and secondary schools.[112] These include lighting, ICT (computers etc.), laboratories and staff housing. The size of a school and number of students determines the amount of energy it requires. As GIS data was not available to conduct the analysis, a per capita comparison made using data from Guinea[113] identified primary and secondary schools that could be electrified by stand-alone systems. To establish electricity demand, an assessment of equipment found within each type of school was undertaken, with the daily demand of each used to calculate the system size required to cater to the load of the school (**Table 22**).

Table 22: Education Center Categorization and Electricity Demand[114]

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

Source: GIZ; African Solar Designs analysis

[110] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[111] NOTE: While the GIS analysis in **Section 1.2.2.4** covers all education centers (including nursery, pre-primary, primary, secondary, technical-vocational, universities etc.), this analysis only examines primary and secondary schools (see **Annex 1** and **Annex 2**).
[112] 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.
[113] Guinea was in the same category as Guinea-Bissau; See **Annex 2** for more details.
[114] "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ__2016__Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

Based on these assumptions, the estimated annualized cash market potential for primary and secondary schools is presented in **Table 23**.

Table 23: Estimated Cash Market Potential for Primary and Secondary Schools[115]

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	33	16	$48,750
Secondary school	23	44	$108,960
Total	**56**	**60**	**$157,710**

Source: African Solar Designs analysis

- **Public Lighting**

Table 24: Key Assumptions for Public Lighting Sector Analysis[116]

Sector	System Sizes	Key Assumptions
Public lighting	Standard system (200 W)	• District population figures were used to determine the number of market centers per district, assuming 5,000 people per market center • Each market center was assumed to have two public lighting points

Analysis of the public lighting sector considered the public lighting needs for off-grid villages and market centers. It did not assess public street lighting, which would generally be included in road infrastructure projects. Based on these assumptions, the estimated annualized cash market potential for the public lighting sector is presented in **Table 25**.

Table 25: Estimated Cash Market Potential for Public Lighting[117]

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	52	26	$77,400

Source: African Solar Designs analysis

2.2.3 Ability to Pay and Access to Finance

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

Institutional users that rely on government or donor funds for the purchase and O&M of solar systems may be constrained by limited funds and/or competing budget priorities. Thus, local communities benefiting from solar electrification would also have to bear some long-term costs for the maintenance of systems and

[115] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[116] Population figures used in this analysis were obtained from: https://www.citypopulation.de/Guinea.html
[117] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

replacement of parts. In the event that public or donor funding is made available to cover the initial capital expenditure, funds can be raised by local communities through a minimal tariff to customers of the health facilities, water pumping stations etc. for long-term O&M. A market standard of 5-10% of the capital expenditure is accepted as a rate for annual maintenance of systems.[118]

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

[118] Grundfos: https://www.grundfos.com/service-support/encyclopedia-search/maintenance-and-repaircostscm.html

2.3 Demand – Productive Use

2.3.1 Overview of Productive Use Market Segment

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

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

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

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

Guinea-Bissau's economy is largely informal and relies heavily on agriculture and fisheries, which is largely practiced for subsistence purposes. The agricultural sector contributes to 49% of GDP and employs about 80% of the population, who rely on agriculture for their livelihood.[119] Rice and cashew nuts, produced for domestic consumption and exports, respectively, dominate the sector. An over-reliance on cashew exports, the impacts of climate change (diminishing rainfall, higher temperatures), political instability and volatile food prices put Guinea-Bissau at risk of food insecurity. The remaining labor force not participating in agriculture is mainly engaged in the services sector, particularly in commerce and transport. However, poor electricity infrastructure, especially in rural areas, has forced households and businesses to rely on self-generated electricity.[120] Given the importance of consistent energy access to the profitability of most enterprises, business owners are often forced to utilize off-grid solutions, usually fossil-fuel powered generators. Off-grid solar applications could play a significant role in helping these businesses and in turn supporting GoGB economic and poverty reduction goals.

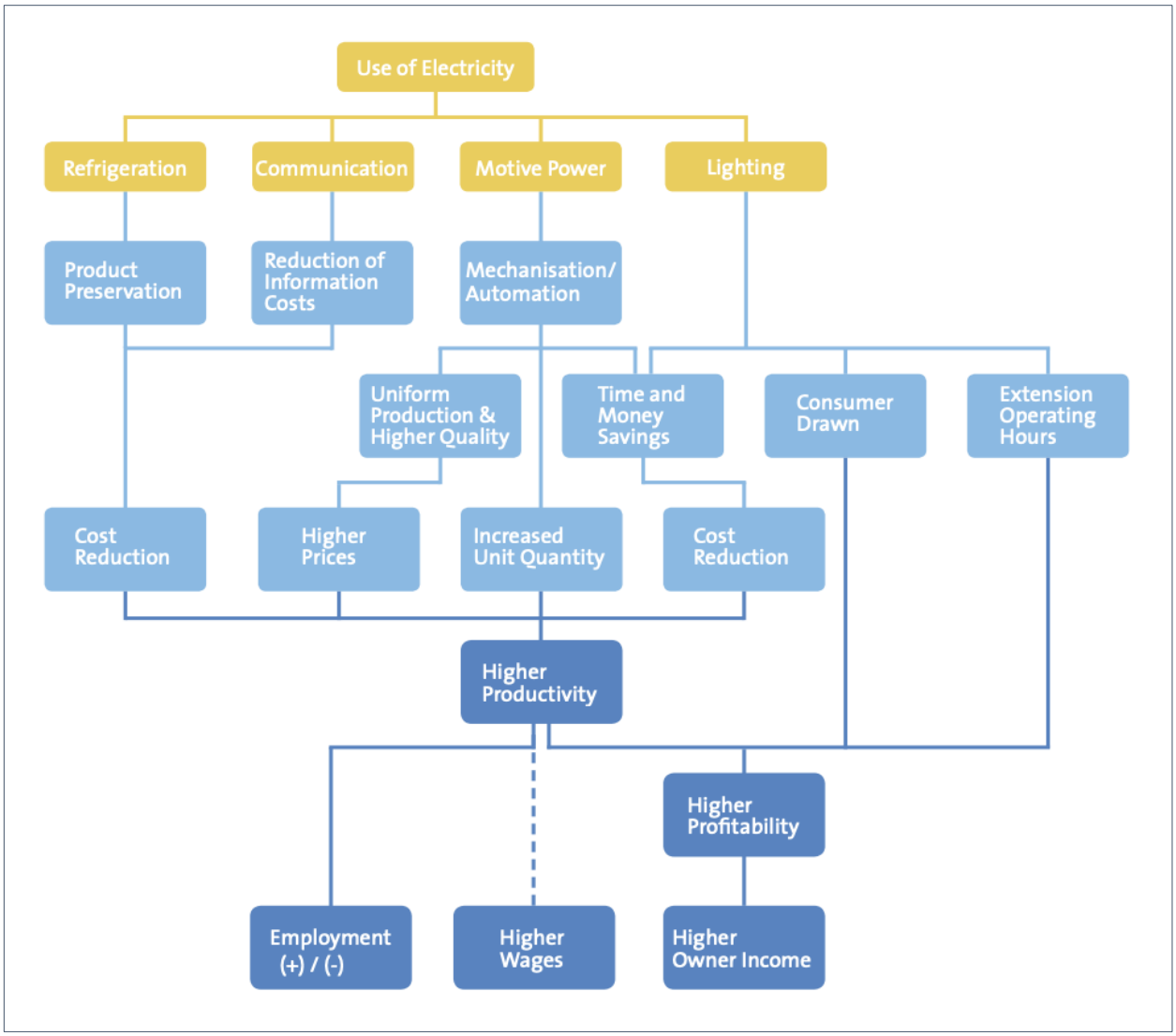
The impact of electricity use on SMEs depends on a variety of external and internal factors, especially access to markets, the location of the firm, supply of inputs and financial capability. Therefore, the extent

[119] "Agribusiness solutions to reduce youth migration," Food and Agricultural Organization (FAO) of the United Nations: http://www.fao.org/partnerships/resource-partners/stories/story/en/c/1160692/

[120] It takes on average 455 days for businesses to get connected to the grid in Guinea-Bissau, almost three times longer than the regional average: http://documents.worldbank.org/curated/en/100721467968248103/pdf/106725-CSD-P155168-IDA-SecM2016-0127-IFC-SecM2016-0078-MIGA-SecM2016-0076-Box396273B-PUBLIC-disclosed-7-5-16.pdf

to which firms can afford to invest in off-grid solar solutions is determined largely by increases in productivity, profitability, and employment/wages from investment in the off-grid appliance (**Figure 24**).

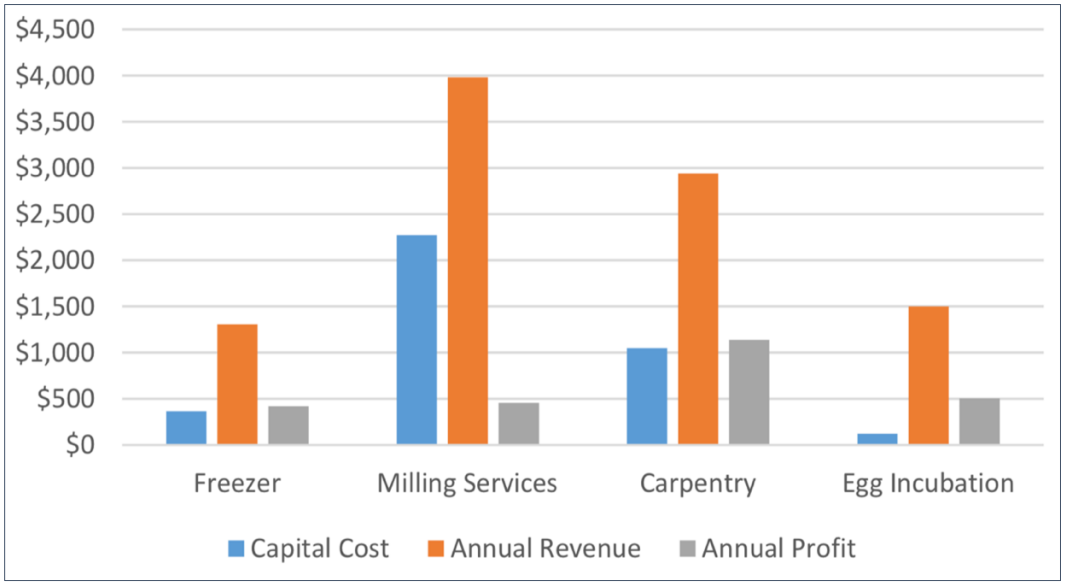
Figure 24: Pathways from Electricity to Income Generation[121]



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

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

Figure 25: Analysis of Cost, Revenue and Profit for Various Off-Grid Productive Use Applications[122]



NOTE: Annual profit does not include recovery of cost capital

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

In order to organize and simplify this analysis and to deliver meaningful insights on country-level market sizing, productive solar applications have been divided into three main groups (**Table 26**).

Table 26: Overview of Productive Use Applications

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

Source: African Solar Designs

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

- **Geographic Locations**

Most PUE sector activities will take place in rural off-grid towns in the East and Quinhamel and in Bissora in the Oio region. There are already some existing forms of solar powered productive use aimed at enhancing community livelihoods in Bissora and surrounding communities supported by Ajuda de Desenvolvimento de Povo para Povo (ADPP Guinea-Bissau) and the European Union's, African Caribbean Pacific (ACP-EU) Energy Facility. Between 2013 and 2016, this initiative equipped 24 villages with 39 solar powered water pumps and drip irrigation systems and opened community processing centers with machines for processing cereals.[123] As a result of this program, average yields per farmer increased 71% during this period. The communities charge a small fee for the use of the water pumps to improve living standards and local economic conditions.

2.3.2 Analysis of Productive Use Market Segment Demand

Data from the World Bank, Food and Agriculture Organization of the UN (FAO) and GSMA was used to conduct the PUE market study. In order to conduct the analysis, several key assumptions were made about PUE applications, which are presented in the sections below and in **Annex 2** in greater detail. **Table 27** presents the estimated annualized cash market potential for off-grid solar productive use applications.

Table 27: Indicative Total Cash Market Potential for Productive Use Sector[124]

Productive Use Sector		Units	kW Equivalent	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	253	63	$158,125
Value-added Applications	Irrigation	39,069	4,688	$25,395,139
	Milling	13	84	$209,391
	Refrigeration	52	284	$709,500
	Subtotal	39,134	5,056	$26,314,030
Connectivity Applications	Phone Charging	698	279	$601,935
TOTAL		**40,085**	**5,398**	**$27,074,090**

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

- **SME Applications for Village Businesses**

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

With the exception of replacing diesel gensets, the estimation of the available market for off-grid solar appliances for SMEs is not as closely correlated with economic indicators. Nonetheless, some widely

[123] "Renewable Energy for Local Development in Bissora," EU and ADPP Guinea-Bissau, (2017): http://www.adpp-gb.org/wp-content/uploads/2017/08/Energy-Facility-Case-Study-022017.pdf

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

marketed solar powered appliances are more centrally related to the revenue generation of SMEs. Investments in such appliances in off-grid and low-income settings are more likely to be sustainable. This study analyzed barbering and tailoring appliances (i.e. hair clippers and sewing machines designed or marketed for off-grid solar powered settings) with respect to microenterprises that face difficulty in accessing outside capital, as the two appliances would provide an economic opportunity for such entrepreneurs that are demographically most likely to be in off-grid communities. A study undertaken in West Africa that found little correlation between electricity access and a firm's profitability did, however, find that tailors do consistently benefit from electricity access.[125]

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.

According to the analysis, estimated annualized off-grid solar cash market potential for barbers and tailors is USD 158,125 (**Table 28**).

Table 28: Estimated Cash Market Potential for SMEs – Barbers and Tailors[126]

No. of SMEs with Constrained Access to Finance[127]	Units	kW Equivalent	Cash Value (USD)
1,265	253	63	$158,125

Source: World Bank; African Solar Designs Analysis

- **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 where these products contribute to export revenues.

In Guinea-Bissau, the agricultural sector is the main source of income for nearly 80% of the population. However, low crop productivity, climate impacts and over-reliance on cashews for export – which are susceptible to international price fluctuations – have combined to hinder economic growth. Despite extensive cultivation of cashews, smallholder farmers in the country benefit little from cashew production and trade and would benefit from developing value chains in fisheries, rice and other agricultural crops less vulnerable to external shocks.[128]

[125] 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

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

[127] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap

[128] "Guinea-Bissau: Turning Challenges into Opportunities for Poverty Reduction and Inclusive Growth," Systematic Country Diagnostic (SCD), Report No. 106725-GB, World Bank, (2016): http://documents.worldbank.org/curated/en/100721467968248103/pdf/106725-CSD-P155168-IDA-SecM2016-0127-IFC-SecM2016-0078-MIGA-SecM2016-0076-Box396273B-PUBLIC-disclosed-7-5-16.pdf

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

Solar Powered Irrigation:

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

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.[129] GIS analysis demonstrated that access to the water table and surface water is not a major determinant of the costing of applicable solar irrigation systems, as most farming settlements in Guinea-Bissau are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 26**).

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 29** presents the estimated annualized off-grid solar cash market potential for smallholder value-added solar irrigation applications in Guinea-Bissau, which has an estimated cash value of USD 25.3M (see **Annex 2** for more details).

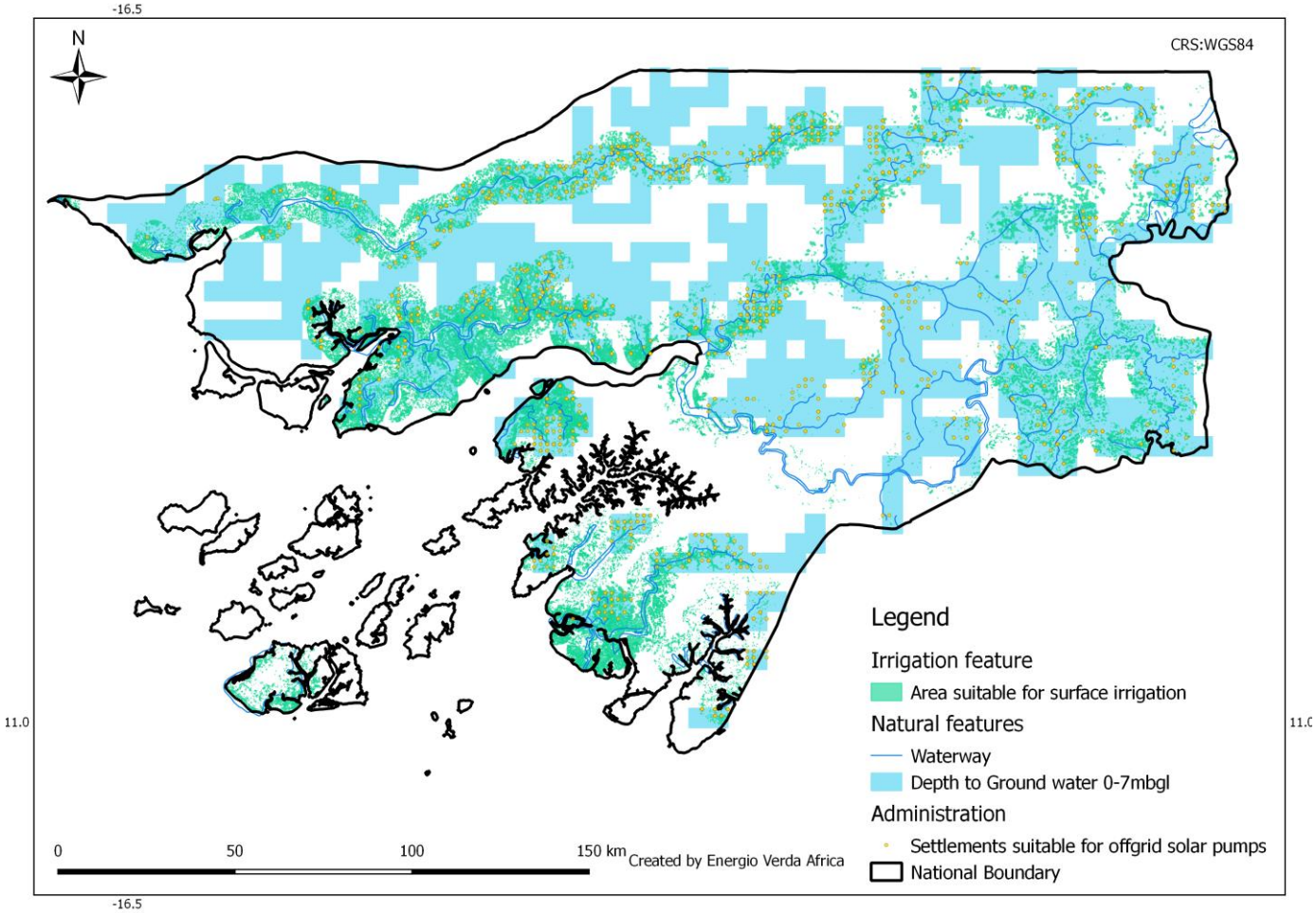
Table 29: Estimated Cash Market Potential for Value-Added Applications – Irrigation[130]

Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation	Units	kW Equivalent	Cash Value (USD)
234,417	39,069	4,688	$25,395,139

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

[129] *See* GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS
[130] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

Figure 26: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps[131]



Source: British Geological Survey, British Geological Survey; ESA Climate Change Initiative; Humanitarian Data Exchange; Energio Verda Africa GIS analysis

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

Solar Powered Milling:

Cereal crops like maize, sorghum, millet, and rice provide an opportunity for value addition through hulling or milling. Off-grid communities use maize or rice milling equipment that is typically powered by diesel generators. Discussions with off-grid community groups revealed that although many are aware of the long-term cost savings associated with solar powered mills, the up-front cost of purchasing equipment was viewed as too high.

Table 30 presents the estimated annualized off-grid solar market potential for smallholder value-added solar grain milling applications in Guinea-Bissau, which has an estimated cash value of USD 209K (see **Annex 2** for more details).

Table 30: Estimated Cash Market Potential for Value-Added Applications – Milling[132]

Estimated No. of Solar Mills	Units	kW Equivalent	Cash Value (USD)
258	13	84	$209,391

Source: Food and Agriculture Organization; African Solar Designs analysis

Solar Powered Refrigeration:

Solar-powered refrigerators and freezers in rural areas serve multiple purposes, including to store milk, fish, meat and vegetables to extend the life of produce and reduce losses. In addition to storing produce, ice-makers can increase the income of rural SMEs by providing ice to businesses that require cold storage (stores, restaurants etc.). **Table 31** presents the estimated annualized off-grid solar market potential for smallholder value-added solar refrigeration applications in Guinea-Bissau, which has an estimated cash value of USD 709,500 (see **Annex 2** for more details).

Table 31: Estimated Cash Market Potential for Value-Added Applications – Refrigeration[133]

Off-Grid Market Centers	Units	kW Equivalent	Cash Value (USD)
1,032	52	284	$709,500

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

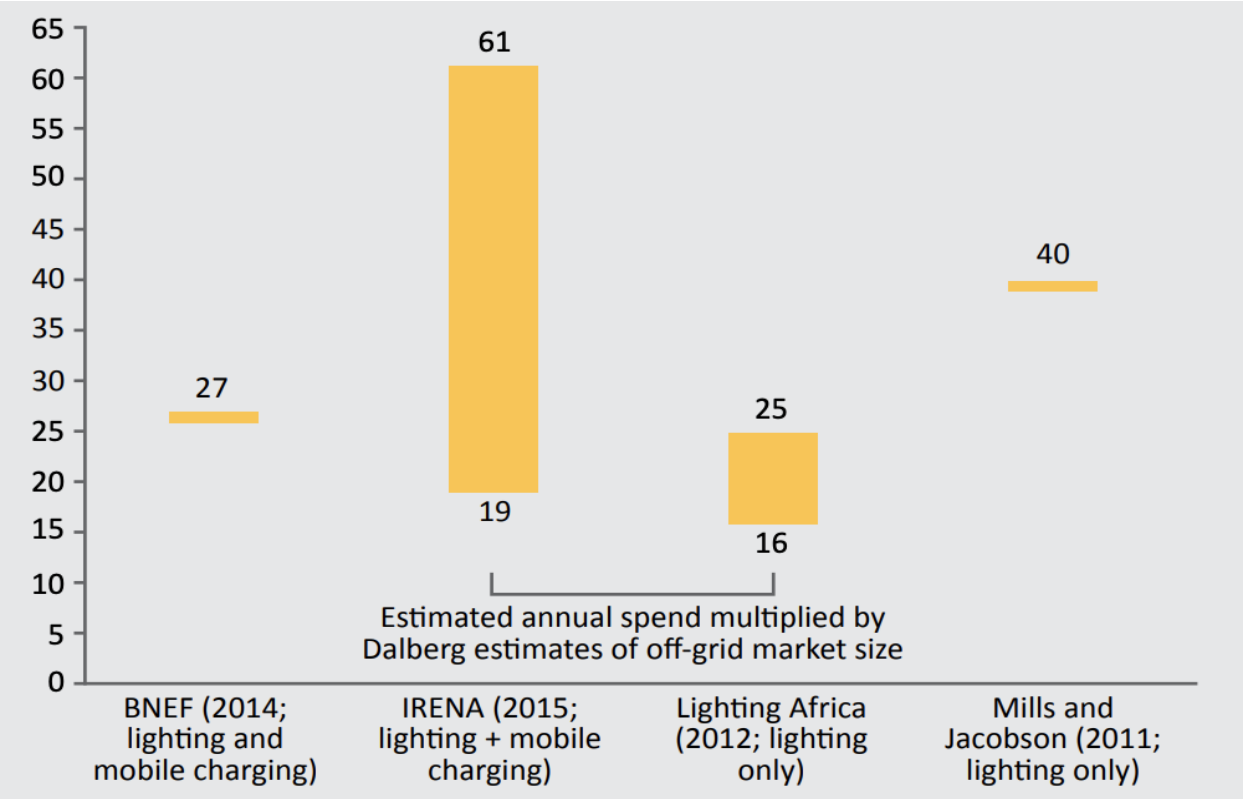
Ultimately, the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry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

- **Connectivity/ICT Applications**

Mobile phone charging stations/kiosks make up a critical segment of off-grid solar demand, as the market for solar phone charging is expected to grow significantly in the near-term. Household rates of mobile phone ownership often greatly exceed rates of electricity access, while households spend a significant share of income on lighting and phone charging (**Figure 27**). Increasingly, off-grid solar devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

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

Figure 27: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging[134]



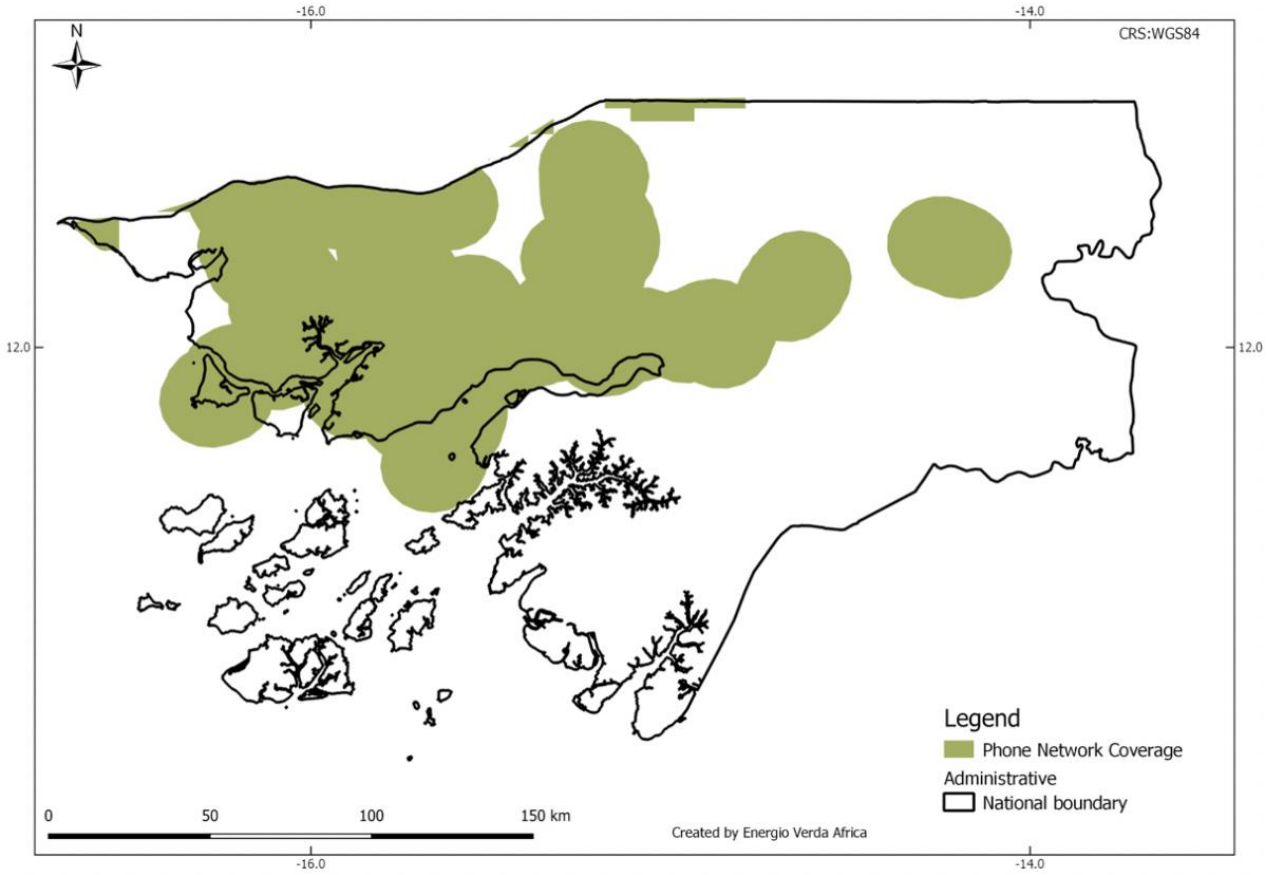
NOTE: Figures in Billion USD

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

Figure 28 shows the relatively broad geographic coverage of cellular signals across the region. Cellular connectivity is essential for solar PV markets. In many African countries, mobile phone charging provides a primary productive use application for off-grid solar. Mobile phone access – and more importantly connectivity – helps drive commerce and employment in rural areas. The penetration of mobile money services is also critical, as it drives greater financial inclusion, expands consumer financing options and further increases demand for phone charging enterprises. Above all, mobile phones and connectivity are a necessary precursor to PAYG solutions in the OGS sector. Countries with expanding mobile phone coverage and especially broadband internet users are more attractive to PAYG solar companies (**Figure 11)**

[134] "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 28: Mobile Phone Network Geographic Coverage[135]



Source: GSMA

The analysis of the potential solar-powered phone charging market was based on the country's mobile phone penetration rate, rural population rate, and the average costs of OGS phone charging appliances. **Table 32** presents the estimated annualized cash market potential for off-grid solar mobile phone charging enterprises in Guinea-Bissau, which has an estimated cash value of USD 601,935 (see **Annex 2** for more details).

Table 32: Estimated Market Potential for Mobile Phone Charging Enterprises[136]

Mobile Subscribers[137]	Rural Population (%)[138]	Units	kW Equivalent	Cash Value (USD)
700,000	50%	698	279	$601,935

Source: GSMA and World Bank

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

2.3.3 Ability to Pay and Access to Finance

The above analysis illustrates that there is a sizeable off-grid solar cash market for productive use applications in Guinea-Bissau. 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, barbers and tailoring). Providing solar-kits through subsidized micro-credit schemes can lead to productive uses and boost household income.

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Guinea-Bissau, including an overview of key actors, solar products and services, business models, and sales volumes. The section also analyzes the role of informal market players and the impact of uncertified products. The section concludes with an assessment of local capacity and the needs of the supplier market segment. The data presented in this section was obtained through desk research, interviews with local officials and industry stakeholders, focus group discussions and surveys of international and local solar companies (see **Annex 2** for more details). The tier system used to classify solar companies throughout this section is described in **Table 33**.

Table 33: 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

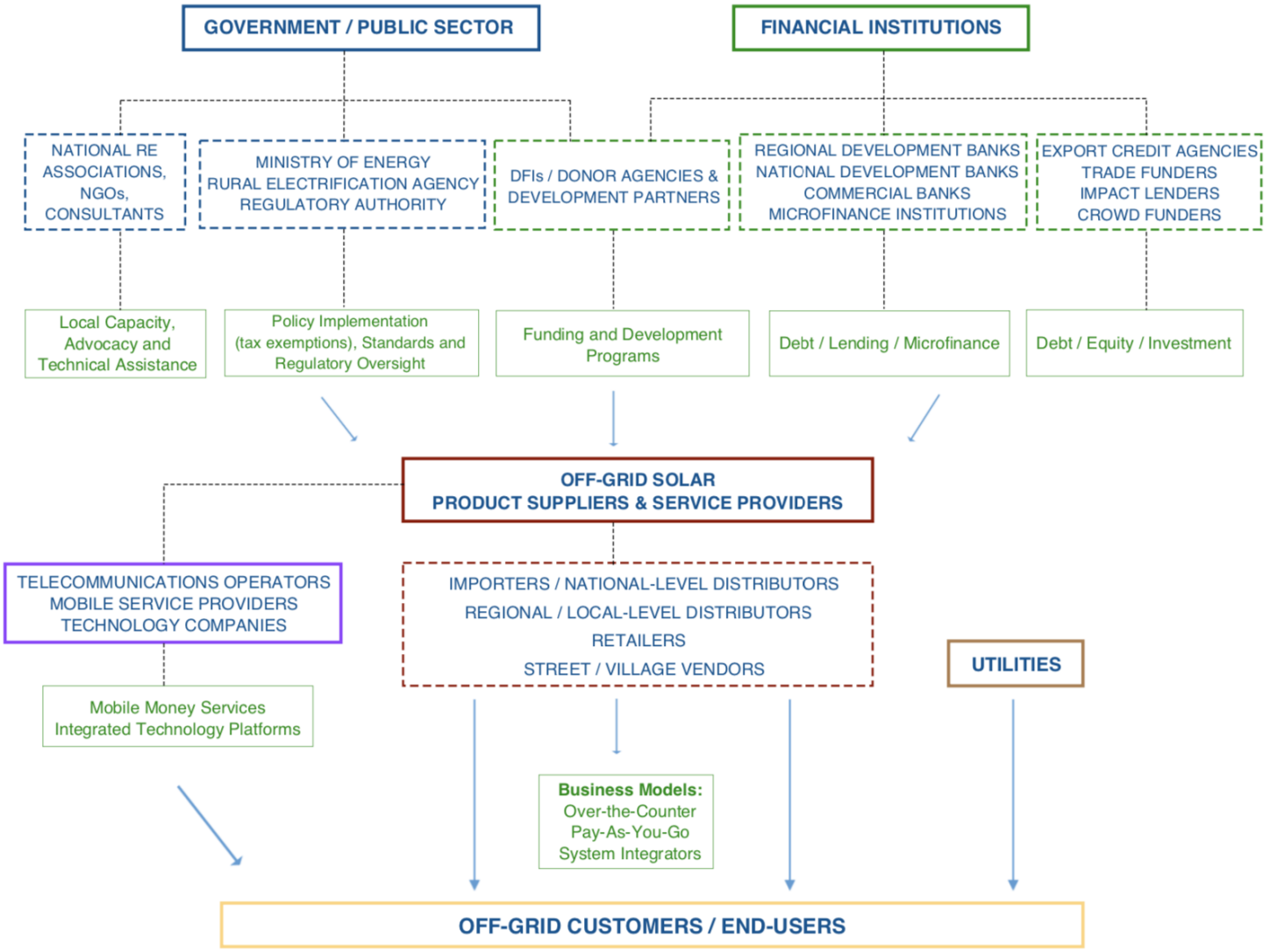
2.4.1 Overview of Commercial Market for Solar PV Equipment

The off-grid solar supply chain in Guinea-Bissau is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 29**). Guinea-Bissau is among the smaller off-grid solar markets in the region, with demand for solar products (e.g. for lighting and water pumping) gradually increasing. The overall market environment, however, has not been particularly conducive to the sector's development.

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

Based on feedback from local experts, a rough estimate of demand and market share by segment indicated that the institutional segment (especially water pumping) was the largest (about 50% of the market), followed by households (30%) and the productive use segment (20%). The main business model deployed by local solar companies is cash/over-the-counter sales, while only one company has started to utilize PAYG sales. While large companies selling certified products play a central role in the market, the informal sector remains a key factor. Surveys of local industry stakeholders and focus group discussions noted that a regulatory framework was necessary to address the widespread sale of low-quality, uncertified products, which is hindering development of the country's OGS market.

Figure 29: Off-Grid Solar Market and Supply Chain Overview



Source: GreenMax Capital Advisors

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

The African off-grid solar market has experienced rapid growth over the last five years. This growth can largely be attributed to the emergence of a progressively diverse, global pool of manufacturers and distributors, decreased system costs and an increase in three major product categories – pico solar, Plug-and-Play SHS, and component-based systems.[139] 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.

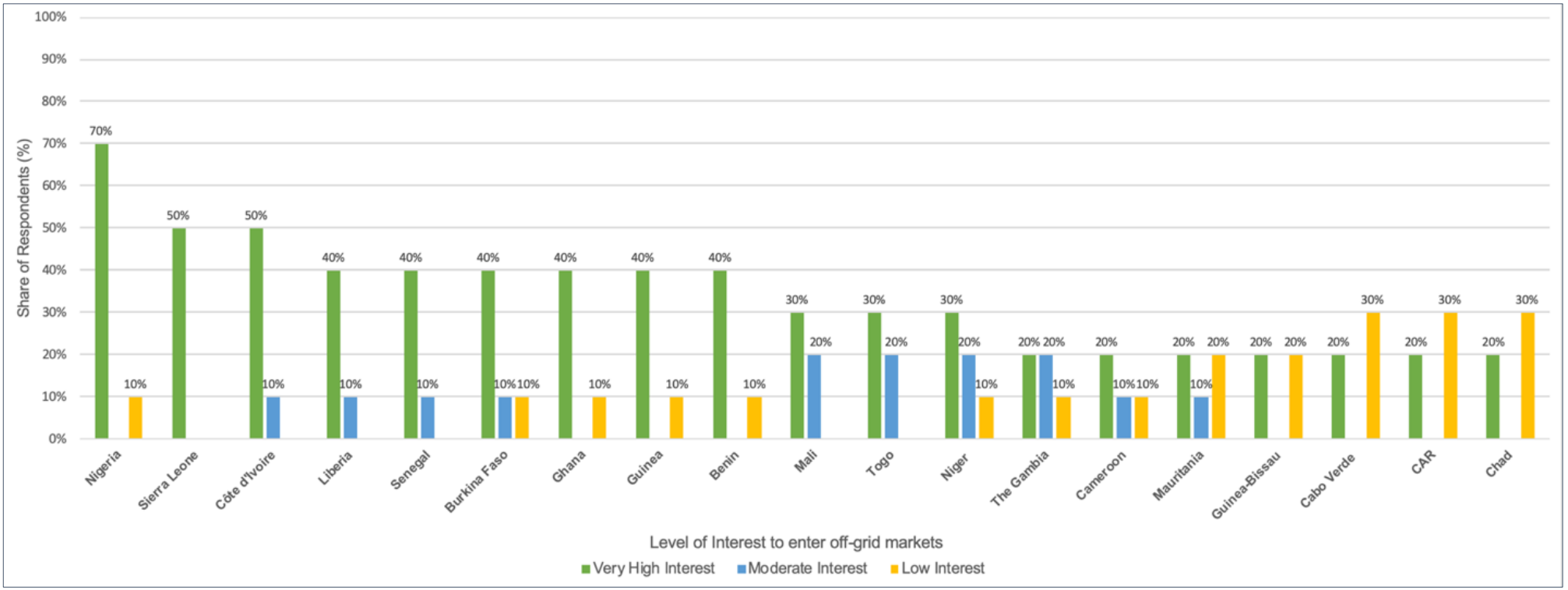
Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money 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.[140]

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.[141]

A survey of large international solar companies that assessed *inter alia* their level of interest in entering the off-grid markets in West Africa and the Sahel is presented in **Figure 30**. 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.

[139] "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
[140] Ibid.
[141] "Insights from Interviews with Off-Grid Energy Companies," ECREEE, (June 2018).

Figure 30: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[142]



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

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

2.4.3 Solar Market, Products and Companies in Guinea-Bissau

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

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

Guinea-Bissau has a small number of experienced companies operating in the solar sector, providing a wide range of quality solar products and professional services to consumers in all market segments throughout the country. In addition to local firms, the formal market also includes international players that enter the market to win tenders to install systems for donor-funded projects. Surveyed stakeholders indicated that suppliers tend to specialize in multiple modular systems and very large solar systems, while pico lanterns are mostly sold by smaller retailers. One solar company sells solar lanterns and plug and play systems. As of 2018 there were no formally identified large Tier 3 companies in the market.

Most companies are well established local or international Tier 1 companies (nearly 20) and Impar is the only Tier 2 company in the country to date. There are no local manufacturers, manufacturer representatives or wholesalers in the market, which consists almost exclusively of retailers who buy from a variety of sources, mainly from international component manufacturers (e.g. Victron, Solar World, Suntech, Canadian Solar etc.). Very few companies have formed necessary partnerships with IT and telecommunications companies to develop and implement PAYG consumer financing (FRET is the only supplier that offers PAYG and fee-for-a-service payment schemes).[143]

Most solar companies use a cash/over-the-counter transaction model, while public procurement is common (for social/institutional clients). Consumer finance and PAYG options are still rare, offered only by very few companies, while external sources of finance are also available to their customers (e.g. through MFI loans). These companies typically also offer installation and O&M services for the products they sell to customers, including repairs under warrantee. Stakeholder interviews also indicate that there are challenges associated with the cost and time it takes to import products into the country and an overall lack of local technical capacity to install, operate and maintain systems. Most companies are largely self-financed, with the exception of a few who also have access to bank financing.

While formal companies play an important role in the development of Guinea-Bissau's solar industry, the informal sector still accounts for a significant share of the overall market. Surveys of local stakeholders and focus group discussions emphasized the urgent need for a comprehensive regulatory framework to address the issue of low-quality, uncertified products flooding the market. Awareness raising was also cited as another key area where additional support was needed for the market to grow.

- **Sales Volumes and Revenue**

Focus group participants indicated that it is challenging to assess the size of the current market due to a lack of standardization in pricing from one company to another and a shortage of sound statistical data. During surveys and FGDs, companies were reluctant to share confidential data on sales volumes and market shares. With support from the EU, Foundation Rural Energy Services (FRES), which operates in the in the region of Gabú, has sold 3,000 solar lighting kits to date. The company expects to install an estimated 4,700 SHS by the end of 2018.[144]

[143] Stakeholder interviews, 2018.
[144] Foundation Rural Energy Services (FRES): https://www.fres.nl/fres-in-guinea-bissau/

➢ Main Solar Products and Components

Table 34 lists the brands of common solar products and components in Guinea-Bissau. The list does not include non-certified brands that are also common in the country's grey market.[145]

Table 34: Off-Grid Solar Products and Components in Guinea-Bissau

Systems	Companies
Distributors of Pico solar Lanterns	FRES, Electro Djudan N'Gjudau, Cidade Solar
Single Module distributors	FRES, Heliotropic, Electro Djudan N'Gjudau, PP-Energy, Cidade Solar, Prosolia, PP-Energy
Multi module system distributors	Heliotropic, Cidade Solar, JRL Energia Solar, Guinersol, Elmi Guiné, Dura Energy, PP-Energy, GB Energy Solutions, Teditronic, Electro Djudan N'Gjudau
Very large system supplier	Ímpar, Cidade Solar, Prosolia, JRL Energia Solar, Guinersol, Elmi Guiné, Dura Energy, PP-Energy, GB Energy Solutions, Teditronic, Electro Djudan N'Gjudau
Product Systems	**Brands**
Plug & Play, Pico Solar	Victron
Solar modules	Solar World, Suntech, Trunsun, Canadian Solar, Kyocera, Isofoton, Jiawei
Lead Acid battery	Victron, Hoppecke, Rolls, Ecote di, EnerSys, Andel
Inverters	Studer/Victron, SMA, Outback, Su-kam

Source: Stakeholder interviews

➢ Market Prices

Table 35 presents average prices for off-grid systems and components in Guinea-Bissau's solar market. Prices for certified solar equipment remain higher compared to more mature solar markets.

Table 35: Estimated Prices of Solar Systems and Components in Guinea-Bissau

Off-Grid System / Component	Price range (USD / per unit)
Pico solar	$26-$43
SHS (average)	$1,600
Small SHS	$430
Medium SHS	$780
Very Large SHS	$3,450
Solar Module (250Wp-320Wp)	$275-$345
Inverter (0.82kVA-1.5kVA)	$465-$3,800
Lead Acid Battery (150-3,500Ah)	$300-$1,350

Source: Stakeholder interviews

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

➢ **Importation Clearance Processes**

Two government ministries are involved in the importation of solar products into Guinea-Bissau – the Ministry of Finance and Economy and the Ministry of Commerce, through their respective Director General of Customs and Director General of Commerce. These agencies are responsible for registering, monitoring an evaluating all activities related to the importation/exportation and commercialization of goods and equipment. For goods and equipment imported within the framework of projects financed by donors or development agencies, the DG of Planning through the Public Investment Department must supervise the process and justify any tax exemptions for the public investment. According to Law No. 16/97 under the Internal Revenue Tax (IGV) any product (good or equipment) to be commercialized in the internal market is subject to the payment of a tax to the Government. This tax is 10% and is calculated ad-valorem.

It usually takes between five and six weeks to import solar PV products into the country. It takes about 10 to 15 days for cargo to reach the country. Then it can take another two weeks for the imported product to be cleared by the Ministry of Finance/DG of Planning, and an estimated three weeks to recover merchandise from the port. There are no existing national bodies in a position to make this process more efficient and to ensure the quality of products entering the market.

2.4.4 Overview of Business Models

➢ **Company Approach to Market**

Solar companies in Guinea-Bissau have developed as vertically integrated companies, based on in-house design of solar systems, outsourcing of manufacturing and the use of equity and grants for growth and development. Most of the local surveyed companies have been involved in the sector for more than five years. Yet, many of these companies are struggling to grow their business due to a lack of finance while the sector also fails to attract large international players.

While some companies sell a wide range of products, many have started to specialize in order to focus on specific consumer segments. For most formal solar companies, large institutional clients tend to be their most important clients, followed by the household and productive use sectors. Most companies utilize cash/over-the-counter transactions model, with limited deployment of PAYG and other consumer financing options to date.

➢ **Business Models**

There are five primary business models used in Guinea-Bissau (**Table 36**), although in reality solar companies utilize a number of business models to reach a variety of clients:

- **Over-the-counter cash sales** include both formal and informal retailers. Many traders simply offer solar products over-the-counter. Formal sector solar companies also stock modules, batteries and balance of system and offer them over-the-counter to do-it-yourselfers and agents.
- **System integrators** handle large systems and projects. They design, procure and install systems which range from high-end residential sites, to institutional power to mini-grids. Local integrators represent international solar, inverter and battery brands with whom they partner with on projects.
- **Plug and play and pico solar suppliers** cooperate with many of the major OGS brands to distribute products in the country (products are usually sold in a cash transaction or financed through PAYG).
- **The PAYG sector** is currently in its early stages of development in Guinea-Bissau. Stakeholder interviews revealed that only FRES offers PAYG consumer financing as an option to customers. Margins are made from subscriptions of consumers who buy systems through created accounts. The

task of installation and after sales services is undertaken by agents. Common products sold include plug and play systems that are fully designed.

- **The fee-for-service model** is being launched in its pilot phase in Guinea-Bissau by FRES. While SHS remains the property of the solar company, customers pay a monthly fee to use the system and have it installed, maintained and repaired. This model has the advantage of removing the initial investment cost, which is usually a major challenge for low income population.

Table 36: Overview of Off-Grid Solar Business Models

Business Model	Strategy and Customer Base	Typical State of Market Development
Over-the-counter solar market	**Formal:** Retailers in Guinea-Bissau are almost exclusively small-scale suppliers and distributors. They sell lighting/electrical products, including solar, pico systems and also large panels for urban customers. **Informal:** Kiosks, street vendors form a key pico-product retailer segment (that has not been fully explored). They sell low-priced products which are often short-lived. They have been seen as the entry points for black market low quality solar products to the country.	Mature commercial market Early stage commercial development
System integrator	Integrators operate out of central offices with small specialized staff. They do not typically carry stock for sale over-the-counter. Instead, they deal directly with consumers and institutional clients and provide as per orders. Integrators target the NGO/donor market and participate in procurement tenders for supply and installation of larger systems.	Mature commercial market
Plug and Play system supplier	These suppliers distribute equipment to retailer projects, rural agents, community groups and over-the-counter. Traders of plug and play often sell these devices as part of other businesses.	Early stage commercial development
PAYG Sales	PAYG companies seek to implement the rent-to-own payment-based models used successfully in other countries. The business model is data-driven and relies on mobile money services and a network of agents to meet last-mile customers. Innovative OGS PAYG collaborations between shop-owners, mobile-operators and other larger local businesses are being tested.	Early stage commercial development
Fee-for-service model	The fee-for-service model is new, not only in Guinea-Bissau but also in the region and in Sub-Saharan Africa. While this concept also offers consumer finance to bottom-of-the-pyramid customers, they do not pay to own the SHS/solar products but rather simply to access the energy as a service. The solar operator owns the equipment and manages installation, maintenance, and any repairs using monthly-fee paid by customers.	Early stage commercial development

Source: Stakeholder interviews; African Solar Designs analysis

➢ Company Financing

Solar companies have difficulty to finance their operations and grow their business in Guinea-Bissau. Suppliers require significant working capital to purchase equipment, pay taxes on this equipment, conduct marketing campaigns, and cover field costs. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited. A majority of firms surveyed in Guinea-Bissau are self-financed, with cash flow covered by shareholders and founders and from on-going business transaction, while some have access to donor funding/grants. Very few local players are supported by FI/MFI loans, and these resources are limited for most.

As most players are local companies in Guinea-Bissau, they 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. In Guinea-Bissau, very few companies offer credit to consumers. Surveyed stakeholders indicated that purchasing power is particularly low in rural areas of the Est and Oio regions. Thus, potential customers are rarely households but typically small associations or income generating groups.

- **Evolving Business Models**

Despite challenges with the country's regulatory environment, Guinea-Bissau presents a fertile ground for new business model innovations and is one of the few countries where the fee-for-service model has been introduced. New models will require partnerships between developers, solar distributors, telco companies, commercial finance and the retail sector. One of the results of the FGD was a list of potential partnerships that can be explored to enhance existing and new business models (**Table 37**).

Table 37: Evolving Off-Grid Solar Business Models

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 Guinea-Bissau 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 GoGB 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

2.4.5 The Role of Non-Standard Players in the Market

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 the GoGB or formal projects.

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

2.4.6 Equipment Quality and the Impact of Uncertified Equipment

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

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 high 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.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

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

The synergy with formal training institutions has yet to be fully explored and most of the players in the industry are not adequately equipped with the skills needed to design and assess policies, understand and deploy technologies, grasp electricity user needs and ability to pay, and operate and maintain systems. Some of the other areas where TA and capacity building is needed to support growth of the solar market include:

- Provision of TA and training to public and private partners on the development of OGS power projects.
- Support in development of vocational training curricula for solar technicians by working with education institutions to adopt the curricula and implement training programs. This support could include development of community training materials to raise community awareness about the importance of

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

2.4.8 Capacity Building Needs of the Supplier Market Segment

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

- High taxes on solar products and lengthy importation procedures are perceived as one of the most significant barriers facing the industry.
- Local financing is largely not available (or affordable) to support the sector's development; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations.
- 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.
- Knowledge, technical capacity and expertise is possessed by 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.
- An improved regulatory framework is necessary to ensure product quality. The lack of control of product quality and import process has led to an increase in low-quality equipment, which negatively impacts perceptions of solar.

Table 38 presents various areas of support and associated capacity building for the OGS supply chain in Guinea-Bissau. Attention should be given to the following:

- **Importers**: Reducing the cost of financing for importing solar PV products by reducing VAT and other taxes for the solar product supply chain
- **Technical Capacity Building**: 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 stakeholders.
- **Consumers**: Deal with sociotechnical barriers: Although PV technology has advanced tremendously in the last decades, there are still several sociotechnical barriers to adoption, including the local conditions of end-users and the political and financial arrangements of the market. Like most countries in the region, various counterfeit solar PV products have infiltrated the market. Implementation of the regulations and quality/standards to ensure product quality could significantly boost market growth.

Table 38: Capacity Building and Technical Assistance for the OGS Supply Chain in Guinea-Bissau[146]

Area of Support	Description	Rationale
Tax exemptions on solar technology	• Implementation of VAT and import duty exemption on all solar products	• Costs of solar products are inflated by import duties; costs are passed on to customers, making solar less affordable.
Quality control/certification agency	• Ensure that imported products are suitable/relevant to the local context in Guinea-Bissau	• Ensure the quality of products on the market and address 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 and effect loss sharing agreements to cover irrecoverable inventory loans	• De-risking encourages private sector lending to solar sector • Initial security until the proof case of 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 • Incubation and acceleration of early-stage businesses • 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 suppliers in rural areas • Capacity building for local FIs	• 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; Stakeholder interviews; African Solar Designs analysis

[146] 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.

2.5 Key Market Characteristics

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

2.5.1 Barriers to Off-Grid Solar Market Growth

Table 39 examines the key barriers to OGS market growth from the perspective of both the demand and supply side of the market. See **Section 1.3.5** for an overview of the gaps in the country's off-grid policy and regulatory framework.

Table 39: Key Barriers to Off-Grid Solar Market Growth in Guinea-Bissau

Market Barrier	Description
Demand[147]	
Consumers are unable to afford solar systems	• Low-income consumers, particularly in rural areas, lack of access to finance • Purchasing solar products of all varieties among end-consumers remains relatively low.
Lack of initial funding by HHs, businesses and institutions for the initial capital investment	• Relatively high costs of OGS systems (compared to more mature markets in the region) • Consumers rather choose cheaper one-off solutions – like generators and fuel – rather than more expensive up-front solutions that will be cheaper long-term (especially with incremental payments, e.g. PAYG)
A lack of understanding of and trust in solar solutions among consumers impedes development of the market	• There is still lack of general awareness about solar solutions • There is an inability to distinguish between solar products or product quality • Consumers lack information about the most suitable design options, funding options, PAYG benefits and options, points of sales and support, etc. • Products are still not widely available in rural areas, so consumers are unfamiliar with them • Any poor history / track record with OGS will deter consumers from taking expensive risks
Informal sector competition and market spoilage	• The non-standard / unlicensed market still accounts for a majority of OGS product sales • Consumers need to understand the quality and value issues of quality solar products vis-a-vis inferior over-the-counter lighting products and generators. Educated consumers drive markets.
Lack of experience in maintaining the systems and sourcing qualified technicians	• A sustainable approach to O&M is critical for long-term success
Supply	
Technical capacity	• Technical skills lack through the supply chain within the sector, affecting both the upstream, midstream and downstream, thus adversely affecting the ability of the sector to pick up and grow. Majority of the firms decry lack of adequate number of technicians to support the downstream side of the market
Transportation costs	• High transportation costs of inventory deter new entrants; devices and equipment are shipped either from China or from Europe, creating long delivery lead times of up to three months and long inventory holding times once products have arrived in country • Typical supplier payment terms are 30% upon placement of the production order and the remaining 70% upon shipment before any cargo has even left its port of origin. • Transport by container would reduce the costs dramatically; however, this requires purchases in bulk, which local solar distributors aren't able to make without financing

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

Poor sales and performance history of the sector	• A lack of investment into the sector prevents growth; this is due to perceived high risks resulting primarily from lack of track record of sales • Solar distributors have limited alternative financing options. Solar suppliers are unwilling to provide trade financing while commercial financiers in Guinea-Bissau, including banks and MFIs, are currently not positioned to service the financing requirements of solar distributors.
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 quite easy to obtain debt financing and other loans once the solar companies have sufficiently grown and reached the "level of interest" of the larger funds; however, until the number of customers and sales volumes are reached, they need some equity investors to share higher risks with the original founders of the companies
Informal sector competition and market spoilage	• Several informal entrepreneurs have taken advantage of high import duties by illegally importing low-quality solar products ranging from solar lanterns to larger home installations • Black-market traders are able to significantly undercut the prices of registered businesses who are still subject to high taxes and import duties • These products are largely low-grade, failure-prone counterfeits with short lifespans • Damaged perceptions of solar systems durability and reliability hinders market uptake
Lack of data	• No clear figures on the actual needs, actual usage or experience of consumers • The data for the private market players on the available opportunities is very limited and not concise due to fragmented data
High 'transaction costs' for solar installations	• Cash-flow and bureaucratic hurdles for the local suppliers • Sales and O&M services in remote areas can be costly, especially for small businesses

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

2.5.2 Drivers of Off-Grid Solar Market Growth

Table 40 is a summary of the key drivers of OGS market growth in the country.

Table 40: Key Drivers of Off-Grid Solar Market Growth in Guinea-Bissau

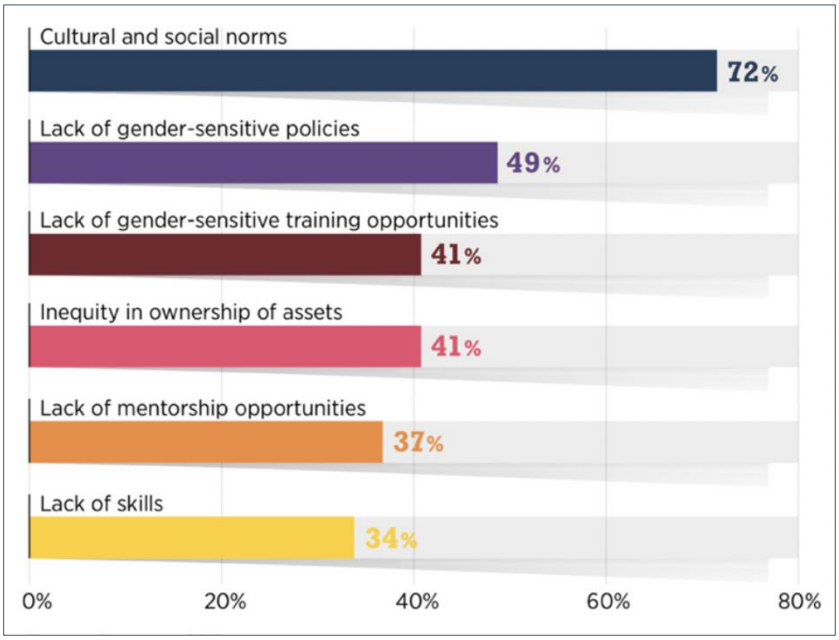
Market Driver	Description
Strong off-grid electricity demand	• Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	• The Government is viewed by sector players as forward-leaning and action-oriented, creating and supporting momentum and positive attention for the solar sector, which helps attract substantial and sustained investment to the market
Increased utilization of PAYG	• OGS service providers in Guinea-Bissau should look to start utilizing PAYG financing solutions, as this model has the ability to leverage increasing rates of mobile phone ownership and mobile internet usage in rural areas and grown rapidly
Engaged and open-minded private sector	• Local OGS suppliers are actively engaged in efforts to improve / reform the sector, accept new business models and strategies and take measures to attract external investment
Strong donor/NGO presence	• The presence and wide range of donor-funded activities in the country's off-grid sector provides confidence that the market will continue to receive financial and policy support to develop

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

2.5.3 Inclusive Participation[148]

Given that the off-grid market is only beginning to emerge in Guinea-Bissau women are not yet highly engaged in the sector. The overall lack of inclusive participation in the off-grid space is attributable to a wide range of factors. In a 2018 survey that assessed barriers to women's participation in expanding energy access, nearly three-quarters of respondents cited cultural and social norms as the most common barrier, which reflects the need for gender mainstreaming (**Figure 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.[149]

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



Source: International Renewable Energy Agency

As a starting point, electrification (whether grid-connected or off-grid) increases access to information, which can help challenge gender norms and increase the autonomy of women.[150] Access to electricity can save women time and/or enable them to complete domestic activities in the evening, thus allowing them to participate in paid work during the day. Many opportunities also exist for women in the productive use of energy, including solar-powered machinery that can support productive applications, particularly in the agricultural sector in the areas of irrigation, water pumping, and milling/food processing.[151]

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

[148] See **Annex 4** for more details
[149] "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
[150] "Productive Use of Energy in African Micro-Grids: Technical and Business Considerations," USAID-NREL and Energy 4 Impact, (August 2018): https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf
[151] "Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development," UN Women, (2018): http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2018/sdg-report-fact-sheet-sub-saharan-africa-en.pdf?la=en&vs=3558

technicians, and part time and full-time employees and entrepreneurs.[152] Women also have unique social networks that typically offer greater access to rural households, which can be important to deploying energy access solutions.

Despite these opportunities, women are typically not part of key decision-making processes at nearly all levels of society. Women tend to have limited access to land and capital, as these are often determined by traditional and religious customs that remain deeply rooted in patriarchal traditions. Women also have more difficulty accessing finance due in part to lack of collateral required to guarantee payment and often resort to obtaining loans from money lenders who charge exorbitant interest rates.[153]

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

- Women lack access to skills, technical capacity, and education/training
- Women broadly lack access to capital, asset ownership, collateral and credit (e.g. to start a business)[154]
- Extensive household responsibilities reduce their ability to generate income and service credit
- Financial literacy among women remains low and there is a lack of education and information available to women on access to financial resources

One key initiative that seeks to address some of these challenges and help improve the rate of participation among women in Guinea-Bissau's energy and off-grid sectors was launched by ECREEE and the AfDB in 2018. These two agencies joined to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of inclusion of women in the energy value chain – only 2% of energy sector entrepreneurs in West Africa today are women. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Guinea-Bissau.[155]

[152] "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

[153] See **Section 3.2** for more details.

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

[155] "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/

III. ANALYSIS OF THE ROLE OF FINANCIAL INSTITUTIONS

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

3.1 Introduction to Financial Products for the Off-Grid Sector

A wide range of financial products can be utilized to support development of the stand-alone solar sector in West Africa and the Sahel. These may include instruments such as matching grants, contingent loans, results-based financing (grants reimbursing cost after completion of work), equity investment (seed capital and later stages), concessional debt (subsidized interest or forgiveness of a portion of principal repayment), short-term commercial credits for inventory purchases and working capital, trade finance solutions (from export credit agencies or private trade funders) and medium-term loans secured on assets or receivables from a portfolio of installed projects. This "financial supply chain" consists of capital delivered at different stages of 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.

3.1.1 Financial Products for End-Users

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

- **Households**

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

- **Public Institutions**

The main public institutional facilities that require funding for off-grid electrification are directly linked to national, provincial or local administrations and budgets, including schools, health facilities, and other public buildings/lighting systems. Sustainable energy finance for community facilities is typically provided through a ministry, department or agency if the facility falls under the purview of the national or provincial

budget. The challenge is that budget resources are severely limited and constantly face competing priorities; as a result, many public community facilities are left without access to energy.

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

- **Productive Use**

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

- **Commercial and Industrial**

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

3.1.2 Financial Products for Suppliers/Service Providers

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

- **Working Capital**

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

- **Inventory and Trade Finance**

To fulfill orders, solar system providers need inventory on hand. Equipment suppliers to the off-grid sector in West Africa and the Sahel are usually unwilling or unable to offer generous terms, often requiring down payments with balance due in full at cash-on-delivery (COD). Therefore, these businesses are in dire need of short-term loans of 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.[156]

- **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.[157]

[156] 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 2020.

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

3.2 Financial Market Overview

3.2.1 Market Structure

As a member of the West African Economic and Monetary Union (WAEMU, or Union Économique et Monétaire Ouest Africaine, UEMOA), Guinea-Bissau shares a currency with seven other countries in the economic community, the West African CFA Franc, which is pegged to the euro. FIs in Guinea-Bissau are regulated by the Central Bank of West African States (Banque Centrale des États de l'Afrique de l'Ouest, BCEAO) and supervised by the WAEMU Banking Commission. Within this macroeconomic environment, Guinea-Bissau has experienced relatively low rates of inflation and low interest rates, especially compared to non-WAEMU countries. 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%.[158]

The financial system in Guinea-Bissau is still developing is mostly limited to the banking sector, which is comprised of only five commercial banks, namely: Banco Da África Ocidental (BAO), Banco Da União (BDU), Ecobank-Guinea-Bissau, Orabank Guinea-Bissau, and Banque Atlantique Guinea-Bissau.[159] The country also has a small microfinance sector made up of 18 licensed institutions, with only five of these operational as of 2015. Private insurance companies and a semiautonomous public pension fund - the National Institute of Social Security, account for most of the rest of the formal financial system in Guinea-Bissau.[160] Guinea-Bissau joined the West African Economic and Monetary Union (WAEMU) in 1997.

The five commercial banks in the country dominate the financial sector in terms of total assets, deposits and credit, however, their size relative to the economy remain small. As of 2014, the banking sector accounted for 94% of the total assets of the country's financial sector, although this represented only 12.8% of GDP and less than 1% of the total assets in the WAEMU banking sector. As of 2016, foreign investors, mostly from WAEMU countries, held 94% of shares in the Bissau Guinean banking system, with the local private sector owning the remaining 6%. The Government of Guinea-Bissau holds no banking shares.[161]

- **Banking Industry Financial Soundness Indicators**

Asset-Based Indicators: In 2015, two of the four commercial banks accounted for over half of the banking system assets. During the same year these banks were considered insolvent and required substantial capital injections due to a high level of non-performing loans (NPLs). The then-Government bailed out the banks at a cost of approximately 5.5% of GDP. As a result, the ratio of gross NPLs to total gross credit fell sharply from 39.4% at the end of 2014 to 8.2% at the end of 2015 (**Table 41**). Following complaints about the bailout, which were carried out without any cabinet or Parliamentary scrutiny, a successor Government declared it null and void in October 2016.[162] However, legal uncertainty continues over the issue. In late 2017, a lower court ruled itself not competent to try the civil case, considering among others an arbitration clause in the contract. The Government has since appealed this decision to a higher court yet reaching a final court ruling could be a protracted process.

[158] "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

[159] Banco Da África Ocidental (BAO), Banco Da União (BDU), Ecobank-Guinea-Bissau are subsidiaries of regional banking groups and Orabank Côte D'Ivoire, and Banque Atlantique Côte D'Ivoire are branches.

[160] "Guinea-Bissau Country Profile," Making Finance Work for Africa (MFW4A), (2016): https://www.mfw4a.org/fileadmin/data_storage/documents/MFW4A-documents/Country_FSP_GUINEA_BISSEAU__.pdf

[161] MFW4A, 2016.

[162] "Republic of Guinea-Bissau: Report No. 114815-GW," World Bank, (May 15, 2017): http://documents.worldbank.org/curated/en/905591497578455518/pdf/Guinea-Bissau-CPF-Board-version-May-15-gt-ks-05192017.pdf

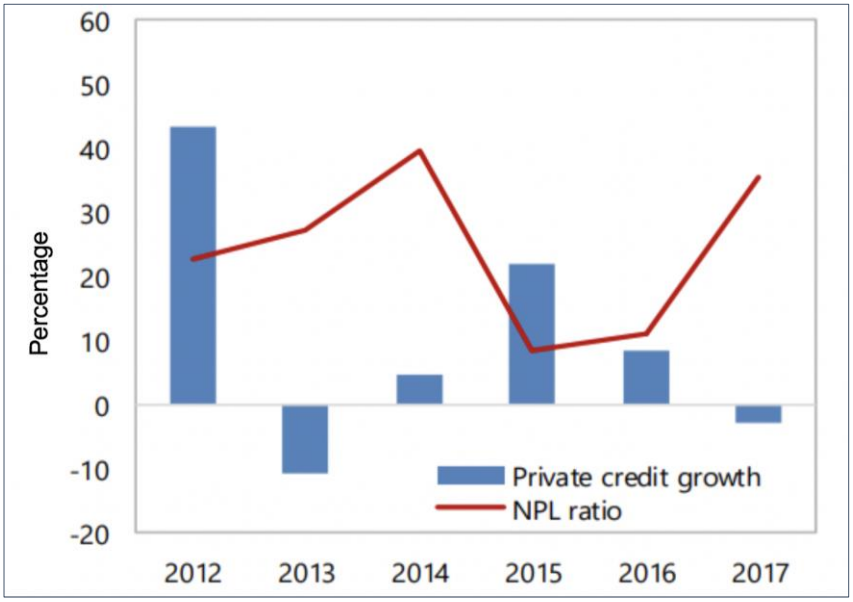
Table 41: Banking Sector Asset-Based Indicators (%)[163]

Indicator	2011	2012	2013	2014	2015	2016	2017
Asset Quality							
Non-performing loans (gross) to total credit	6.7	22.6	27.0	39.4	8.2	10.8	35.3
Non-performing loans (net) to total credit	2.9	14.4	16.3	22.6	6.0	7.9	15.6
Non-performing loans (net) to capital	35.6	195.3	110.5	115.1	28.2	23.7	24.7
Provisions to gross non-performing loans	51.8	31.2	39.1	46.2	46.7	45.5	64.3
Provisions to gross loans	2.7	6.1	9.4	15.7	4.8	6.2	21.9
Liquidity							
Liquid assets to total assets	72.3	58.1	58.2	62.2	68.3	57.3	58.9
Liquid assets to short term assets	104.0	84.0	74.0	75.5	87.5	70.5	68.4
Ratio of deposits to assets	86.3	77.1	76.5	75.0	69.0	55.7	55.9
Ratio of loans to deposits	69.0	94.5	86.0	85.2	93.1	96.6	90.1

Source: International Monetary Fund

As shown in **Figure 32**, the voiding of the bailout has led to a return to a high NPL ratio in the banking sector with NPLs gross of provisioning amounting to 35.3% by the end of 2017. However, net NPLs only rose to 15.6% by the end of 2017 due to significant provisions made in early 2017 by banks affected by the voided 2015 bailout. The provisions were made in accordance with recommendations by the WAEMU Banking Commission.

Figure 32: Private Credit and Non-Performing Loans[164]



Source: International Monetary Fund

In order to address the high level of NPLs in the banking system, the Government, in consultation with commercial banks, is developing measures to help the banks clean up their balance sheets. These measures

[163] Ibid.

[164] "Guinea-Bissau: IMF Country Report No. 18/147," International Monetary Fund, (June 2018): https://www.imf.org/en/Publications/CR/Issues/2018/06/06/Guinea-Bissau-Fifth-Review-Under-the-Extended-Credit-Facility-Arrangement-Request-for-45942

include encouraging banks to engage more actively in debt restructuring that is affordable to borrowers and facilitating collection of collateral.

Capital-Based Indicators: As of December 2017, the banking sector average capital adequacy ratio (CAR) remained low at 5.5% (**Table 42**). Consequently, the WAEMU Banking Commission issued instructions to the two undercapitalized banks involved in the voided bank bailout, requiring them to meet the minimum capital requirement by June 2018. The banks were at the same time barred from distributing dividends and required to report monthly on actions taken. As of June 2018, one of the banks had complied with the regulations, while efforts were underway to recapitalize the other bank, which remained significantly undercapitalized.

Table 42: Banking Sector Capital-Based Indicators (%)[165]

Indicator	2011	2012	2013	2014	2015	2016	2017
Capital to risk-weighted assets	17.4	21.0	17.3	25.8	28.9	4.8	5.5
Capital to total assets	4.3	5.2	9.5	11.5	8.8	3.5	28.9

Source: International Monetary Fund

Income and Expense-Based Indicators: As shown in **Table 43**, the banking sector's earnings and profitability remain low, with return on assets (ROA) of 0.9% in 2017. This has also contributed to weak financial intermediation in the country. In the past years, ROA and return on equity (ROE) of banks in Guinea-Bissau have moved erratically, perhaps due to the country's political and economic environment. Also, data on the ROA and ROE of banks in the WAEMU region show that banks are commonly less profitable in Guinea-Bissau than in other WAEMU countries.[166]

Table 43: Banking Sector Profitability Indicators (%)[167]

Indicator	2011	2012	2013	2014	2015	2016	2017
Net income to average assets (ROA)	2.5	0.1	-3.2	-1.4	0.2	1.0	0.9
Net income to average equity (ROE)	17.7	0.6	-21.2	-13.6	2.0	8.4	6.3

Source: International Monetary Fund

- **Distribution of Credit by Sector**

Commercial bank credit to the private sector (gross of provisions and including all five banks) expanded by 8.2% in 2016 but fell by 2.9% (year-on-year) in 2017 despite the country's robust economic growth. Also, credit net of provisions declined by 25.3% in 2017, reflecting the large provisions mandated by the WAEMU Banking Commission in early 2017. Financial intermediation in Guinea-Bissau remains weak due to high non-performing loans (NPLs) and low profitability, as the banking sector tends to invest in WAEMU bonds.[168]

In terms of distribution of private sector credit, the commerce sector continues to receive the largest share of total bank lending, accounting for 64% in 2017 (**Table 44**). By contrast, the share of total bank lending

[165] IMF Country Report No. 18/147, 2018.
[166] MFW4A, 2016.
[167] IMF Country Report No. 18/147, 2018.
[168] "Republic of Guinea-Bissau: Report No. 114815-GW," World Bank, (May 15, 2017): http://documents.worldbank.org/curated/en/905591497578455518/pdf/Guinea-Bissau-CPF-Board-version-May-15-gt-ks-05192017.pdf

to agriculture and fishing is relatively small at 1.6%, despite the fact that the sector constitutes the main source of income for more than two thirds of households and virtually all small family farms.[169]

Table 44: Distribution of Credit by Sector (%)[170]

Sector	2011	2012	2013	2014	2015	2016	2017
Agriculture and fishing	2.1	3.0	1.9	1.0	0.3	2.1	1.6
Extractive industries	-	-	-	-	-	-	0.7
Manufacturing industries	1.4	1.5	1.3	1.0	1.3	1.0	1.4
Electricity, gas and water	3.5	3.6	3.1	3.2	0.2	2.3	3.0
Building and construction	4.0	3.2	2.3	1.7	1.3	3.3	6.0
Commerce	52.9	52.3	53.8	54.2	58.0	54.3	64.0
Transport and communication	0.1	0.1	0.1	-	0.1	1.1	1.7
Insurance and enterprise services	0.6	0.5	0.3	-	-	2.5	3.1
Other activities	35.4	35.9	37.2	38.8	38.8	33.4	18.5

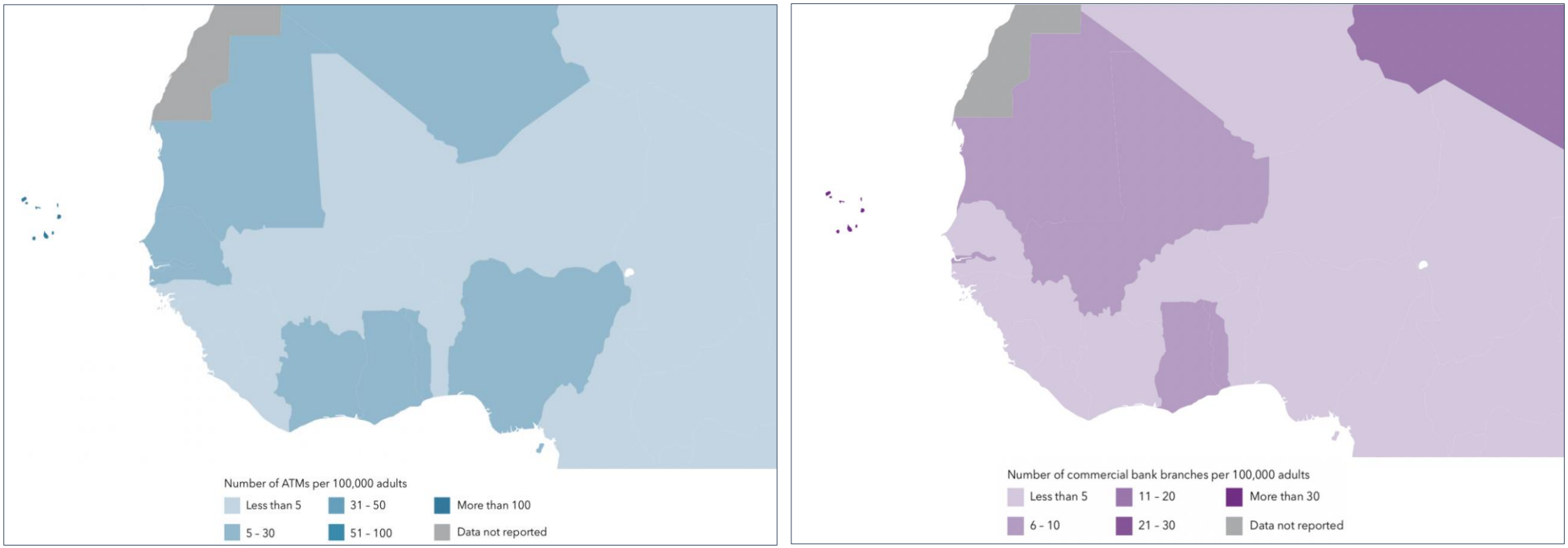
Source: International Monetary Fund

3.2.2 Financial Inclusion

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 33**).[171] 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%.[172] Many countries across the region have also seen a sharp increase in mobile money account ownership (**Figure 34**) and transaction volume (**Figure 35**).

[169] Ibid.
[170] IMF Country Report No. 18/147, 2018.
[171] "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
[172] 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 33: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017[173]

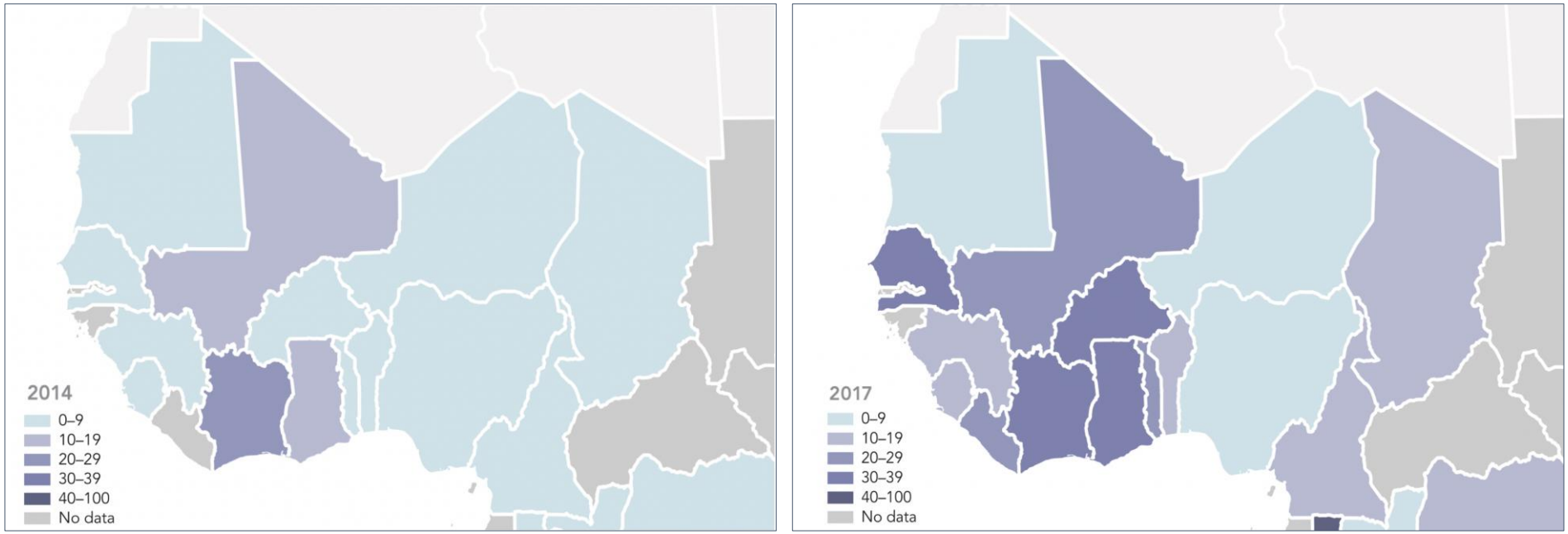


Source: International Monetary Fund

Figure 33 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.

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

Figure 34: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[174]



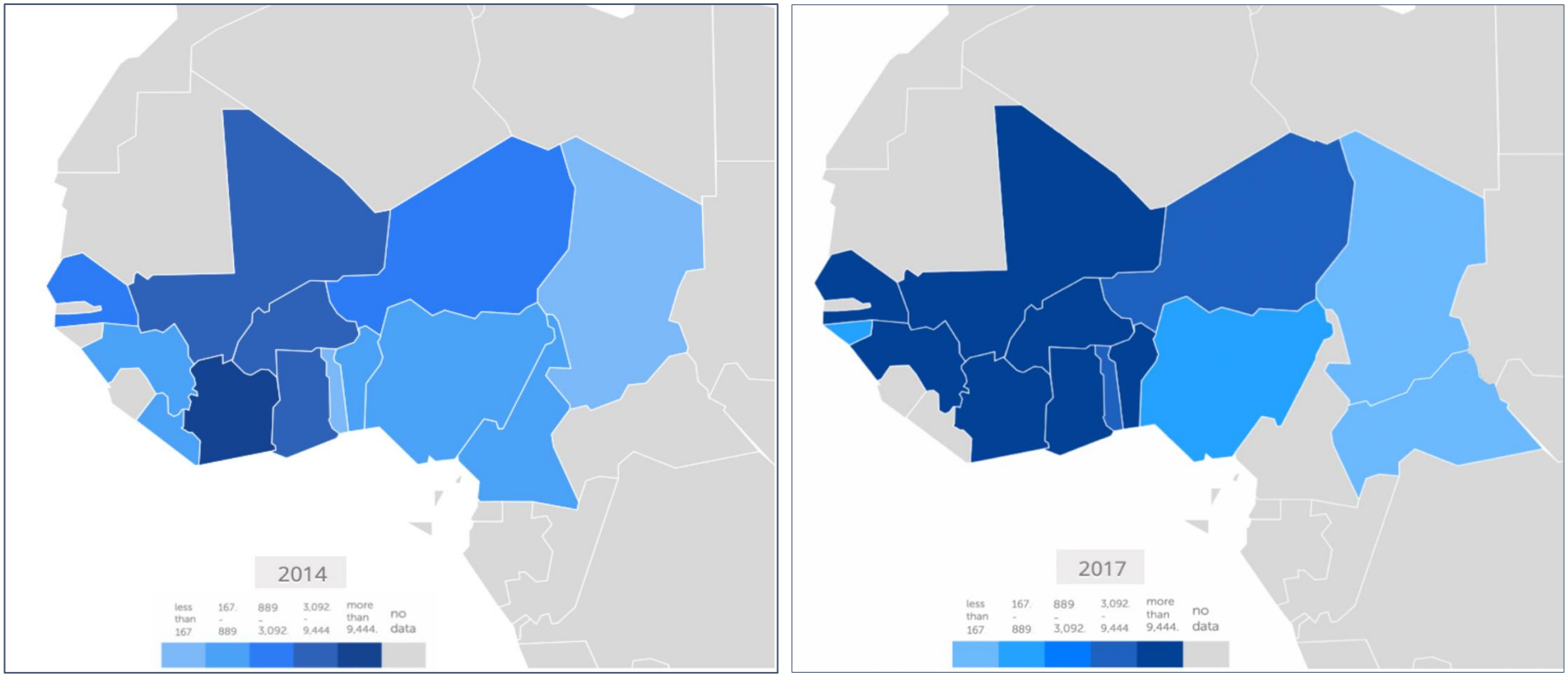
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 34 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.

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

Figure 35: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[175]



NOTE: Maps exclude Cabo Verde (no data)

Source: International Monetary Fund

Figure 35 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.

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

Access to financial services remains an ongoing challenge in Guinea-Bissau. The number of branches of commercial banks (**Figure 33**) and adults with a deposit account in a commercial bank (**Table 45**) are both low. Despite these trends, the mobile money sector is growing quickly, with mobile money account ownership more than doubling between 2015 and 2017 (**Table 45**).

Table 45: Access to Finance Indicators[176]

Indicator	2011	2012	2013	2014	2015	2016	2017
Automated Teller Machines (ATMs) per 100,000 adults	1.41	2.00	3.90	4.19	4.07	4.81	N/A
Branches of commercial banks per 100,000 adults	2.28	2.43	2.67	2.59	3.20	3.11	3.03
Depositors with commercial banks per 1,000 adults	60.88	73.37	61.61	76.23	94.29	91.59	114.35
Mobile money accounts: active per 1,000 adults	N/A	N/A	N/A	N/A	18.23	24.14	38.52
Mobile money accounts: registered per 1,000 adults	N/A	N/A	N/A	N/A	122.91	232.57	345.14
Mobile money agent outlets: active per 100,000 adults	N/A	N/A	N/A	N/A	20.92	15.28	81.55
Mobile money agent outlets: registered per 100,000 adults	N/A	N/A	N/A	N/A	43.40	31.13	163.65
Mobile money transactions: number per 1,000 adults	N/A	N/A	N/A	N/A	257.17	286.78	569.02
Mobile money transactions: value (% of GDP)	N/A	N/A	N/A	N/A	0.08	0.08	0.40
Outstanding deposits with commercial banks (% of GDP)	20.10	17.79	18.29	20.72	18.89	17.32	17.55
Outstanding loans with commercial banks (% of GDP)	13.36	15.33	13.92	13.71	17.10	15.47	12.46

Source: International Monetary Fund

With assistance from WAEMU authorities and development partners, the Government is updating a plan for financial inclusion that incorporates support for the SME sector, including measures that support (i) re-financing of BCEAO claims for eligible SMEs, and; (ii) providing regulated credit incentives to banks such as reducing weighting of claims and adjusting compliance requirements for prudential ratios.[177] The Government's plans for financial inclusion follow rapidly expanding mobile phone penetration and as a result mobile financial services are expanding, especially for rural and previously unbanked populations. Two mobile financial service providers are active in the country – MTN and Orange – but there is a need to expand coverage as only an estimated 30% of the population has access to mobile network services.[178]

3.2.3 Commercial Lending Environment

- **Maturity Structure of Bank Deposits and Credit**

Bank credits to the economy are mostly short- or medium-term and closely linked to the cashew nut harvest seasons. In 2015, private sector credit totaled CFA 62.6 billion (USD 106 million); 99% of these loans were short- or medium-term, with just CFA 646 million (USD 1.1 million) categorized as being long-term.[179]

- **Interest Rates**

Interest rates in the WAEMU zone have been capped since 1997. The caps are set as absolute limits with different levels applied to banks and non-bank financial institutions, mainly MFIs. In 2014, the levels of

[176] IMF – Financial Access Survey: https://www.imf.org/en/News/Articles/2018/09/28/pr18366-imf-releases-the-2018-financial-access-survey
[177] IMF Country Report No. 18/147, 2018.
[178] "Energias Renováveis e Eficiência Energética na Eelatório Nacional de Ponto de Situação," UNDP, Renewables and Energy Efficiency in Guinea-Bissau and Lusophone Renewable Energy Association (ALER), (December 2018): http://aler-renovaveis.org/contents/files/aler_relatorio_gb_2018.pdf
[179] "Guinea-Bissau: 2015-2019 Country Strategy Paper," African Development Bank, (January 2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Guinea-Bissau__-_2015-2019_Country_Strategy_Paper.pdf

the caps were revised downwards by the BCEAO. For banks, ceilings went from 18% to 15% and from 27% to 24% for microfinance institutions.[180] **Table 46** shows the movements in banks' deposit and lending rates between 2012 and 2017. Since 2014, average deposit rates have been on a decline while lending rates have increased; consequently, the spread between the deposit rates and the lending rates has widened.

Table 46: Interest Rates (%)

Indicator	2012	2013	2014	2015	2016	2017
Deposit rate (average)	4.6	4.7	4.6	4.5	4.2	4.0
Prime Lending rate	10.1	9.5	9.4	10.7	10.8	10.2

Source: International Monetary Fund

- **Foreign Exchange Market**

As a member state of WAEMU, Guinea-Bissau's currency, the CFA franc, is pegged to the euro. The BCEAO therefore follows the monetary policy of the European Central Bank, which effectively sets interest rates for the CFA franc zone. This pegged exchange rate system limits the ability of member states to quickly respond to shocks. At the same time, 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.[181] In general, the CFA franc monetary zone consistently outperforms other Sub-Saharan countries in terms of inflation rate and overall macroeconomic stability.

The CFA franc is backed by a guarantee from the French treasury for the convertibility of the CFA franc into euros at the fixed exchange rate at the Paris Stock Exchange.[182] This provides stability and credibility to the currency. The common currency also expedites trade by removing foreign exchange between member states. This includes the eight members of WAEMU as well as the six countries in the Economic and Monetary Community of Central Africa (Communauté Economique et Monétaire de l'Afrique Centrale, CEMAC). On a regional level, there are plans to implement a single currency across all of West Africa by 2020, although there are many hurdles to overcome before this degree of macroeconomic convergence can be achieved.[183]

Table 47 shows the official exchange rate of CFA to USD between 2013 to 2018.

Table 47: Official Exchange Rate (CFA-USD)

Exchange Rate	2013	2014	2015	2016	2017	2018
End of Period	475.64	540.28	602.51	622.29	546.95	572.89
Period Average	494.04	494.41	591.45	593.01	582.09	555.72

Source: International Monetary Fund

[180] Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf
[181] 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/
[182] Hallet, M., "European Economy: The role of the Euro in Sub-Saharan Africa and in the CFA franc zone," European Commission Directorate-General for Economic and Financial Affairs, (2008): http://ec.europa.eu/economy_finance/publications/pages/publication13478_en.pdf
[183] Liedong, T., "Could West Africa introduce a single currency?" CNN, (August 8, 2017): https://www.cnn.com/2017/08/08/africa/single-currency-west-africa/index.html

- **Collateral Requirements**

A common problem in the West African Economic and Monetary Union is poor judicial processes regarding collateral registry and recovery, as well as a lack of available credit information about the borrower. Hence, most commercial banks require high amounts of collateral in order to mitigate consumer credit risk. As a result, a majority of firms in the country are unable to obtain loans due to high costs of credit, insufficient funds offered, the short maturity of the loans, and/or the amount of required collateral. In an effort to address this, the Government has developed a credit registry to aid in the financing decisions of banks and to enhance access to credit.[184]

- **Banking Supervision**

The corporate financial regulatory framework is determined by legislation issued by WAEMU and the Organization for the Harmonization of Business Law in Africa (L'Organisation pour l'Harmonisation en Afrique du Droit des Affaires, OHADA). In 2016, the WAEMU Council of Ministers adopted measures to implement the Basel II and Basel III rules into the monetary union, designed to further preserve resilience in the banking sector by increasing capital requirements and controlling risk profiles. In addition, BCEAO adopted regulations to establish Credit Information Bureaus (Bureaux d'Information sur le Crédit, BICs) within the monetary union, which were designed to reduce asymmetric information between customers and banks by providing economic and financial information to customers.

The central bank also implemented regulations to improve its ability to enforce existing regulations. The instructions focused on how to set up internal audit systems, compliance audit systems and provisional administration for BICs. The provisions also defined the sanctions applicable to BICs and established the amounts required to set up a special reserve to ensure their long-term viability. Reporting systems and procedures were also put in place to ensure that financial statements of credit institutions were reliable and also prepared in a timely manner.[185]

3.2.4 Lending to the Off-Grid Solar Sector

While there are several donor and DFI-funded programs and initiatives that have provided financing to support development of Guinea-Bissau's off-grid solar market, these funds have not been channeled through local commercial banks or MFIs. ROGEP is therefore a pioneering initiative in the country, as it endeavors to boost OGS lending via engagement with local financial partners. Local FIs are increasingly becoming more aware of the opportunities in the off-grid space, and interviews FIs revealed a willingness to participate in providing financing to the sector.

3.2.4.1 Programs Supporting Financial Institutions in Off-Grid Solar Lending

- **AFD Sustainable Use of Natural Resources and Energy Finance (SUNREF)**

SUNREF is a credit line provided by AFD for financial institutions and their clients that aim to fund clean energy projects. SUNREF includes TA and credit facilities to provide banks with the necessary long-term financing to overcome financial barriers met by project sponsors. The program is open to companies seeking to obtain easier access to green finance and banks seeking to develop their green finance portfolios. In 2014, Orabank, Société Générale and AFD signed a partnership agreement to launch SUNREF's West

[184] IMF Country Report No. 18/147, 2018.
[185] "2016 Annual Report," Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO), (2016): https://www.bceao.int/sites/default/files/2017-12/2016_annual_report_2.pdf

Africa program, which makes a EUR 30 million (CFA 19.6 billion) credit line available to banks in the WAEMU (Benin, Burkina Faso, Côte d'Ivoire, **Guinea-Bissau**, Mali, Niger, Senegal and Togo).[186]

3.2.4.2 Key Barriers to Off-Grid Solar Lending

- **Unfamiliarity with the Off-Grid Solar Sector**

Much like other African markets, local FIs in Guinea-Bissau are unfamiliar with lending to off-grid solar projects and companies and have a limited understanding of the nascent sector. During stakeholder interviews, many of the FIs noted a lack of expertise in assessing OGS risks and in structuring/developing customized products for the sector. While programs such as SUNREF have supported participating FIs, there remains a significant gap in overall local capacity. Nearly all of the interviewed FIs stressed that technical assistance would be necessary to facilitate off-grid solar lending.

- **Low Private Sector Credit**

Commercial bank credit to the private sector remains weak and continues to constrain development of the off-grid solar sector. Access to finance remains a key barrier for businesses in the country; the 2019 World Bank Doing Business Report ranks Guinea-Bissau ranks 144th out of 190 countries in getting credit, as the country's financial system is characterized by low levels of financial intermediation.[187] The use of bank loans for working capital and investment is extremely low in Guinea-Bissau. This hinders solar companies from investing in the growth of their business and expansion of their operations.

- **Maturity Structure of Bank's Funding**

The sizable share of short-term deposits limits the ability of banks to offer longer-tenor consumer financing products, which are necessary to accelerate off-grid solar market growth. In more mature off-grid solar markets, Lease-to-Own and Pay-As-You-Go (PAYG) payment models reduce entry barriers for consumers by allowing for small, incremental payments for electricity which are more affordable, rather than demanding a high up-front cost for installation and service.

- **High Interest Rates and Short Loan Tenors**

Due to the banking sector's high rate of NPLs, banks typically offer loans at interest rates of around 15%, significantly higher than in other WAEMU countries. This constrains capital investment and limits new business development in the country. The country's political instability also makes it difficult for banks to provide loans with long re-payment periods.[188]

[186] SUNREF: https://www.sunref.org/en/sunref-elue-meilleure-solution-financiere-pour-lenergie-durable-en-afrique-de-louest/
[187] "Guinea-Bissau: Doing Business Report," World Bank, (2019): http://www.doingbusiness.org/content/dam/doingBusiness/country/g/guinea-bissau/GNB.pdf
[188] "Housing Finance Africa, 2018 – Guinea-Bissau" Housing Finance Africa (2018): http://housingfinanceafrica.org/countries/guinea

3.3 Financial Institutions[189]

3.3.1 Development Finance Institutions

Several DFIs are active in Guinea-Bissau, including AfDB, IFC, and the European Investment Bank (EIB) among others. According to a Global Impact Investing Network (GIIN) report, between January 2005 and July 2015, DFIs deployed a total of USD 3 million under three direct investments in the country.[190] Most DFI engagements in the country have provided support to large-scale infrastructure and energy projects, with little to no activity in Guinea-Bissau's off-grid solar sector.[191]

On a regional scale, the African Development Bank has two key off-grid focused programs – the Sustainable Energy Fund for Africa and 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.[192]

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 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.[193] The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[194]

IFC has been active in strengthening the country's private sector and improving access to finance for SMEs. In 2015, IFC launched a leasing program in Guinea-Bissau as part of the second phase of its Africa Leasing Facility (ALF II) program, which aims to promote and establish a leasing industry in the country to enable SMEs that lack sufficient collateral or credit history to access conventional financing tools.[195]

3.3.2 Microfinance Institutions

Guinea-Bissau has a small microfinance sector with 18 licensed institutions as of 2015. However, only a few of these MFIs are operational, providing limited financial services mainly in the urban centers of Bissau and Gabú. Guinea-Bissau's microfinance sector is substantially smaller than microfinance sectors in other

[189] Excluding commercial banks, which are reviewed in detail in **Section 3.2**.
[190] "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
[191] "Energias Renováveis e Eficiência Energética na Eelatório Nacional de Ponto de Situação," UNDP, Renewables and Energy Efficiency in Guinea-Bissau and Lusophone Renewable Energy Association (ALER), (December 2018): http://aler-renovaveis.org/contents/files/aler_relatorio_gb_2018.pdf
[192] "Sustainable Energy Fund for Africa," African Development Bank, (2018): https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/
[193] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com
[194] "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/
[195] "IFC signs a Cooperation Agreement with the Government of Guinea-Bissau to promote SMEs," IFC, World Bank, (April 28, 2015): https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/FE74F975674E1D5242257E350033E5C1?OpenDocument

UEMOA member countries in terms of outstanding loans, customers and number of points of service.[196] The MFIs in Guinea-Bissau target small merchants, women's cooperatives, local associations and projects related to agriculture and trade. These small institutions, which are regulated by the BCEAO, provide micro-credits especially to women who carry out or intend to carry out income generating activities, and who present their income as a security.[197] As of March 2016, the formal microfinance sector in Guinea-Bissau recorded CFA 71 million (USD129 318) in outstanding loans and CFA 265 million (USD 482 668) in deposits.[198]

In 2014, Plan International started to roll out Village Savings and Loans Associations (VSLAs) in the least developed areas of Guinea-Bissau including the Bafata and Gabu regions.[199] VSLAs are groups of local people who save together and take out small loans (with interest) from these savings. The purpose of these groups is to provide simple savings and loan facilities in communities that have no access to formal financial services.[200]

Catholic Relief Services (CRS) is implementing a Savings and Internal Lending Communities (SILC) project in disadvantaged communities in Guinea-Bissau, including the Bafatà and Gabú regions.[201] The objective is to create economic opportunities, help rural community members to form groups, pool their savings and provide loans, much like a VSLA.[202]

3.3.3 Informal Financial Institutions

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.[203] 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 (ROSCAs).[204]

Much like other African states, informal financial services are widely available in Guinea-Bissau. Data from this sector remains limited, largely due to the informal nature of these institutions, which does not facilitate access to information on their practices, cost standards and transaction levels. The overall lack of geographic coverage by FIs in rural areas of the country means that a significant portion of the rural population either relies exclusively on informal sources of finance at the community level or utilizes a combination of informal and formal credit and savings methods.

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[196] "Housing Finance Africa, 2018 – Guinea-Bissau" Housing Finance Africa (2018): http://housingfinanceafrica.org/countries/guinea
[197] ALER, 2018.
[198] "Guinea-Bissau: Third Review Under the Extended Credit Facility Arrangement, Request for a Waiver of Nonobservance of Performance Criterion, and Financing Assurances Review-Press Release and Staff Report," IMF, (July 20, 2017): https://www.imf.org/en/Publications/CR/Issues/2017/07/20/Guinea-Bissau-Third-Review-Under-the-Extended-Credit-Facility-Arrangement-Request-for-a-45109
[199] Plan International: www.plan.ie
[200] "Local Savings Group Clubs Together to Upgrade School in Guinea-Bissau," Plan International, (February 16, 2015): https://www.plan.ie/news/local-savings-group-clubs-together-upgrade-school-guinea-bissau/
[201] Catholic Relief Services (CRS) is an international non-governmental organization supporting relief and development work in over 100 countries around the world.
[202] Catholic Relief Services: https://www.crs.org/our-work-overseas/where-we-work/guinea-bissau
[203] "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
[204] 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

Informal financial structures cater mostly to rural households and small entrepreneurs. The most common of these informal financial institutions are ROSCAs, locally known as "Abota" groups. Abota groups are largely comprised of women engaged in the informal economy. Group members tend to be from the same socioeconomic group and often the same age group. These groups are member-managed and operate as an informal instrument of social protection, as the savings gathered by the groups are regularly used to pay for domestic expenses, such as medical expenses and school tuitions. However, due to the low and often irregular contributions of the members, funds are often minimal.

Other informal safety nets take the form of organized wage-sharing groups among male day workers (Surni groups) and social clubs (Mandjuandades), which provide not only recreational but also limited income opportunities for its members. There is a dearth of data on the size and volume of these activities and informal institutions in Guinea-Bissau.[205]

[205] "Self-help women organizations in Guinea-Bissau: analyzing economic and social impacts," The Council for the Development of Social Science Research in Africa, (June 2015): https://repositorio.iscte-iul.pt/handle/10071/9067

3.4 Summary of Findings

- **Opportunity for ROGEP Credit Lines**: The banking sector in Guinea-Bissau is characterized by low levels of financial intermediation and poor asset quality, which depresses profitability. Consequently, local banks have high margins in order to boost their net interest income, 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 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 FX risk. This risk is somewhat mitigated in Guinea-Bissau, however, 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, as the all-in cost of capital to local FIs is manageable to provide competitive offers to borrowers.

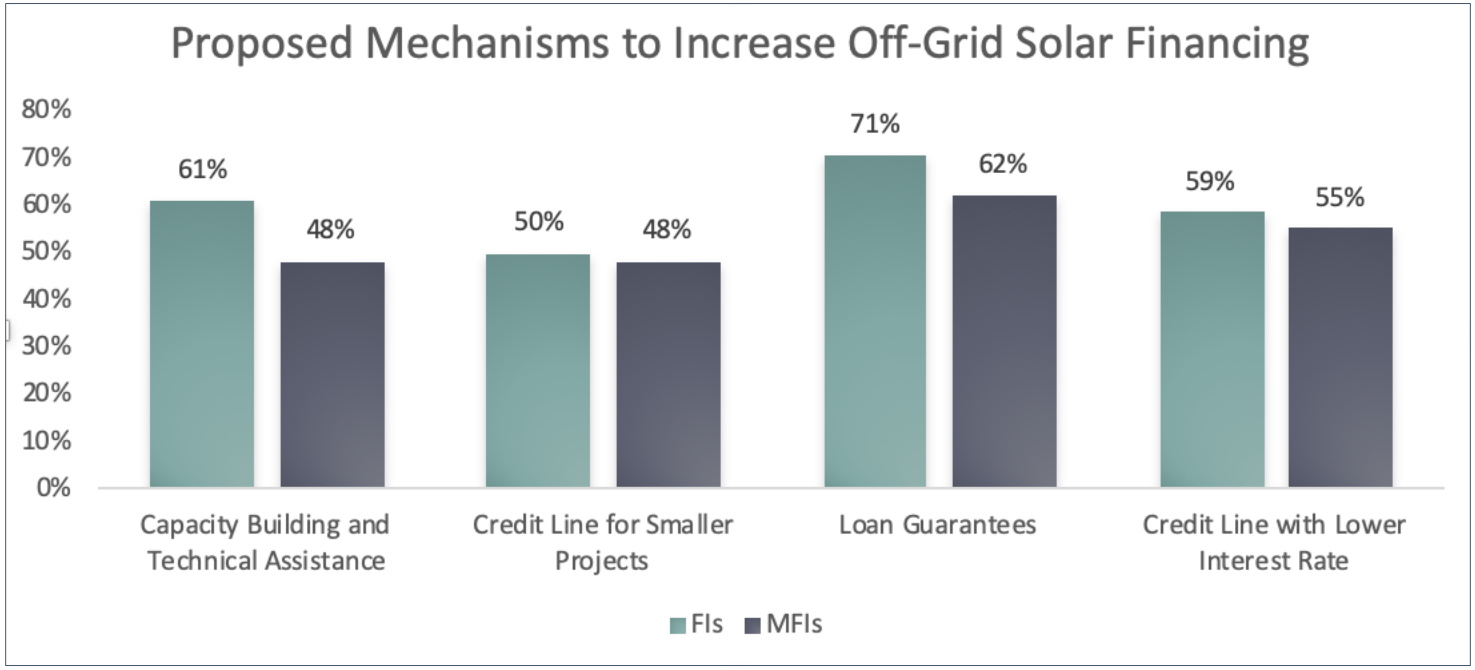
- **Collateral Requirements**: The collateral requirements of commercial banks in Guinea-Bissau are extremely high, particularly for small firms. Moreover, lenders already in the space are deeply constrained from originating loans where the borrower cannot meet these requirements. Hence, the use of third-party *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.

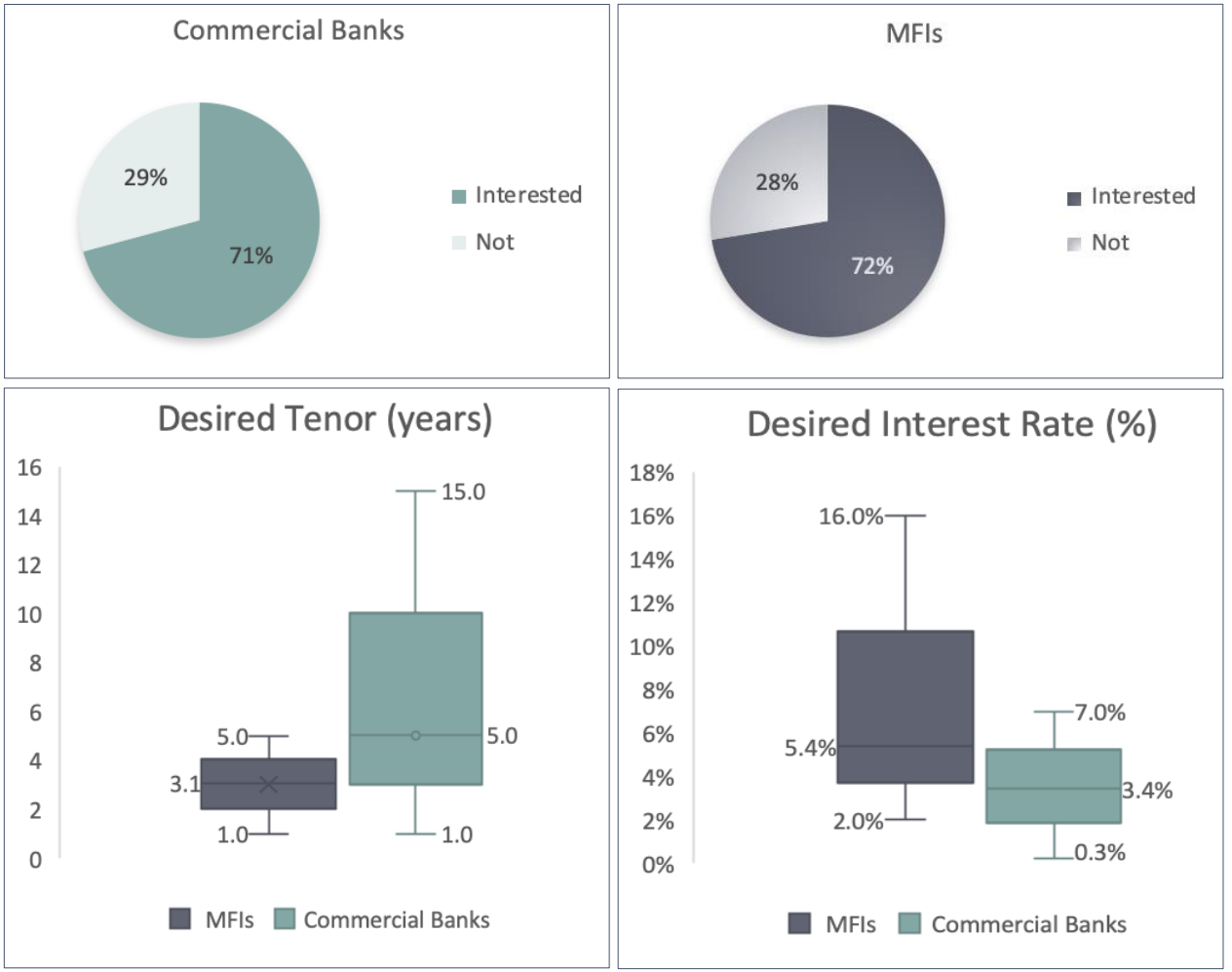
- **Technical Assistance**: A well designed TA intervention is critical to accelerating OGS lending in the country. Stakeholder interviews revealed the following key areas of support: training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of stand-alone solar firms and projects; extensive due diligence support to qualify products and approve vendors; and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. Special attention should also be paid to offering advisory services on the side of the stand-alone solar enterprises. Lenders opine that these entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

- **Digital Financial Services**: The advent of digital financial services and mobile money is one of the most important developments in off-grid solar market development to date, as it has allowed new and innovative business models to emerge that are now driving unprecedented growth in the sector. Mobile communication technology facilitates payments for solar products and systems (lease-to-own, pay-as-you-go) and/or for electricity usage (energy-as-a-service) and enables monitoring for operations and maintenance of equipment. Expanding access to mobile money services also creates new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. The Government should take steps to support capacity building of and foster linkages between off-grid solar companies operating in the market and key stakeholders from various sectors, including energy access policymakers and regulators, financial and telecommunications companies, mobile network operators, financial service providers (commercial banks and microfinance institutions), mobile money service providers, international organizations, NGOs and civil society groups involved in financial inclusion etc.

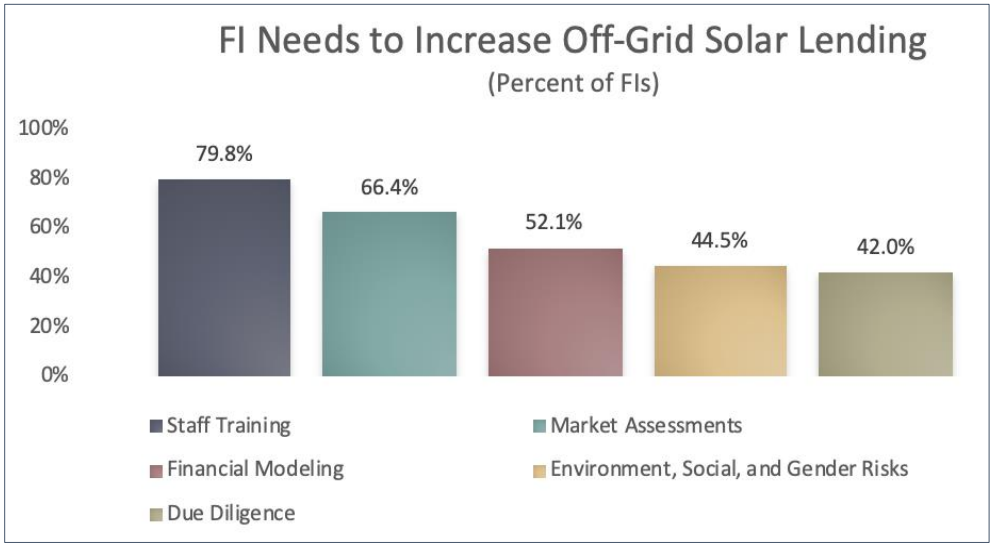
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from commercial banks and MFIs, which together account for 92% of all respondents. See **Annex 3** for more details.



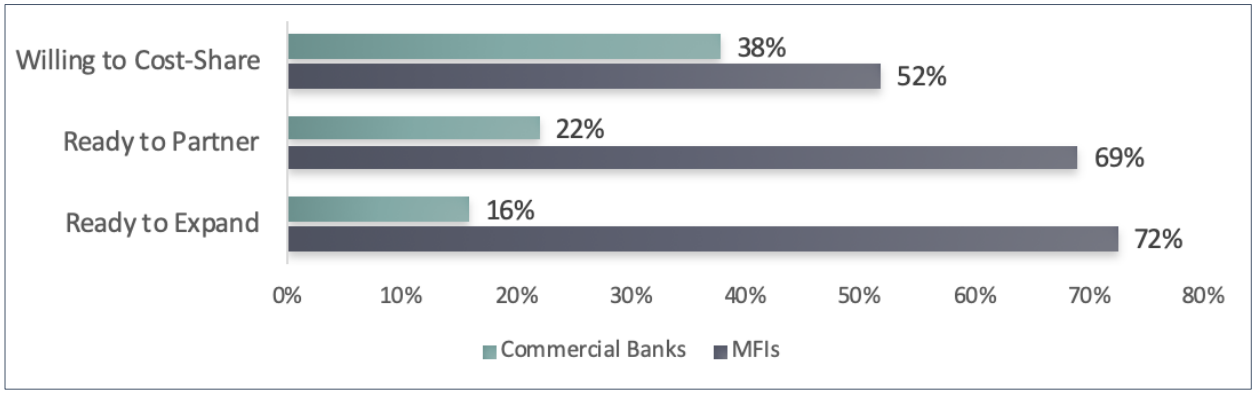
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy sector. Most of the surveyed institutions also identified clear interest in credit lines.



More than 70% of surveyed commercial banks and MFIs are interested in a credit line to finance off-grid solar projects. Commercial banks want tenors of 1-15 years and interest rates from 0.25-7%. MFIs are seeking tenors of 1-5 years with interest rates from 2-16%. On average, commercial banks want a credit line with a 5-year tenor and 3.4 % interest rate, and MFIs want a 3.1-year tenor with 5.4% interest rate.



In addition to their clear interest in credit lines and loan guarantees to finance off-grid projects, surveyed financial institutions (commercial banks and MFIs) in ROGEP countries also identified several areas of internal capacity that require improvement in order to lend (or increase lending) to the off-grid solar sector.



Compared to commercial banks, MFIs reported a greater willingness to cost-share capacity building activities and a higher level of readiness to partner with solar companies and expand operations to serve rural and off-grid areas.

ANNEX 1: TASK 1 METHODOLOGY

STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

Data presented in this section was collated from a range of public documents and reports as well as primary source documents either provided by ECREEE or obtained through supplemental market research (desk research and interviews with local public officials and industry stakeholders). These findings were subsequently corroborated by attendees of national validation workshops held in each country at the conclusion of the market assessment. Information obtained from the Task 2 focus group discussions and surveys of industry stakeholders (see **Annex 2**) was also used to support the Task 1 analysis.

GIS DATA ANALYSIS APPROACH / METHODOLOGY

1. Categorizations, key definitions and datasets for geospatial least-cost analysis

The main steps of the GIS analysis are as follows:
(i) Categorization/definition of settlements: scenario 2023;
(ii) Categorization/definition of settlements: scenario 2030;
(iii) Definition of un-electrified settlements within grid areas; and
(iv) Determination of population per settlement

1.1. Categorization/definition of settlements: Scenario 2023

1.1.1. *Electrification by grid extension* – settlements which are located within 5 km of the current electrical grid network[206] (according to WAPP densification plans).

1.1.2. *Electrification by mini-grid* – settlements that:
- Are located within 15 km of areas that have a high night-lights value (above 50/225 on grayscale raster)[207] and outside the buffer area established for the electrification by grid extension
- Are located within areas that have a population density of more than 350 people per km^2 (as defined by Eurostat for rural areas)[208], plus an additional 50 people per km^2 for greater feasibility of mini-grids[209] and are within 1 km[210] of a social facility (education center or health facility) and existing mini-grids of 2018.

1.1.3. *Electrification by off-grid stand-alone systems* – settlements that do not fall into the above categories

1.2. Categorization/definition of settlements: Scenario 2030

1.2.1. *Electrification by grid extension* – settlements which are located within 5 km of planned future line extensions and Power Stations.[211]

[206] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[207] 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
[208] http://ec.europa.eu/eurostat/web/rural-development/methodology
[209] Identified in discussions with different international mini-grid developer.
[210] Preferred maximum distance for mini-grids from discussions with different international developer.
[211] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

1.2.2. *Electrification by mini-grid* – settlements that:
- Were defined as mini-grid settlements in the 2023 scenario
- Are located within 1 km of the above mini-grid settlements, which is the preferred distance of mini-grid developers for their grid according to discussions with several international developers.
- Are located within 15 km of economic growth centers – airports and urban areas; average worker distance in Africa is 10 km, a distance of 5 km is added to include the growth of businesses in the periphery of the growth centers.[212]

1.2.3. *Electrification by off-grid stand-alone systems* – settlements that do not fall into the above categories

1.3. Definition of un-electrified settlements within grid areas

To identify settlements that are located close to the national electrical grid but are not served by it, the following criteria were used:

- Within the main grid line zones (see buffer zones for *electrification by grid extension* above)
- Outside 15 km night-lights of buffered areas to capture the densification within 5 years
- Within areas of low population density (less than 350 people per km^2)

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." [213]

A Voronoi polygon analysis[214] was used to create boundaries for each settlement. These boundaries were then used in combination with a population density layer to estimate total settlement population of the given year. The current annual national population growth rate of 2.5%[215] was applied to the geospatial analysis to project populations for scenario 2023 and 2030 analyses.

[212] 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.
[213] https://www.worldpop.org
[214] To learn more about Voronoi polygons, see wikidot: http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons
[215] The World Bank: https://data.worldbank.org/indicator/SP.POP.GROW?locations=GW

2. Summary of Key Datasets

The table below summarizes the key datasets used for scenarios 2023 and 2030 as well as the criteria applied and sources used.

Overview of Key Datasets of the Least-Cost Electrification Analysis								
Dataset	Description	Criteria used by technology						Source and Year
		Scenario 2023			Scenario 2030			
		On-grid	Mini-grid	Off-grid	On-grid	Mini-grid	Off-grid	
Electricity grid network (current)	Current MV and LV lines not available; HV lines not existing	--	--	--	--	--	--	--
Electricity grid network (planned)	Future network planned to be built (HV lines); MV and LV lines not available	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	ECOWREX, 2018[216]
Power Stations	Existing and planned power stations. Buffer zone around the stations indicates connection via LV and MV lines.	≤10km distance of thermal station in Bissau and ≤ 5km distance of other stations	≥ 10km distance of thermal station in Bissau and ≥ 5km distance of other stations	≥ 10km distance of thermal station in Bissau and ≥ 5km distance of other stations	≤10km distance of thermal station in Bissau and ≤ 5km distance of other stations	≥ 10km distance of thermal station in Bissau and ≥ 5km distance of other stations	≥ 10km distance of thermal station in Bissau and ≥ 5km distance of other stations	ECOWREX, 2018
Mini-grids	Existing mini-grids in 2018	Not considered	≤ 1km distance	≥ 1km distance	Not considered	≤ 1km distance from all identified mini-grids in Scenario 2023	≥ 1km distance from all identified mini-grids in Scenario 2023	ECOWREX, 2018
Night-lights	Night-time light emissions used to identify electrified areas	Not considered	≤ 15km distance	≥ 15km distance	Not considered	Not considered	Not considered	NASA Earth Observatory, 2016
Population density	Population distribution in people per km^2.	≥ 350 people per km^2 [217]	≥ 350 people per km^2	≤ 350 people per km^2	Not considered	Not considered	Not considered	WorldPop, 2014

[216] http://www.ecowrex.org/mapView/index.php?lang=eng

[217] 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

Settlements	Settlement layer giving location of settlements across Guinea-Bissau (cities, towns, villages, hamlets)	Used	Used	Used	Used	Used	Used	Humanitarian Data Exchange (HDX), 2018
Social facility: education centers	Two schools within Bissau only were available for the analysis.	Not considered	≤ 1km distance[218]	≥ 1km distance	Not considered	Not considered	Not considered	OpenStreetMap, 2018
Social facility: health centers	Hospitals and clinics; data extracted from the Global Health sites Mapping Project; Indicator of active local economy	Not considered	≤ 1km distance[219]	≥ 1km distance	Not considered	Not considered	Not considered	HDX, 2018
Growth center: airport, urban areas	Economic growth centers for the analysis up to 2030 - defined for mini-grid areas; Urban areas as defined by Electricity Demand	Not used	Not used	Not used	Not considered	≤ 15km distance	≥ 15km distance	airports: HDX, 2017 urban areas: ECOWREX website, 2015[220]

[218] Preferred maximum distance for mini-grids from discussions with different international developer.
[219] Preferred maximum distance for mini-grids from discussions with different international developer.
[220] http://www.ecowrex.org/mapView/index.php?lang=eng

ANNEX 2: TASK 2 METHODOLOGY

OFF-GRID SOLAR PV MARKET ASSESSMENT METHODOLOGY

Focus Group Discussions (FGDs) were held in Bissau in June 2018 with key stakeholders from each of the four off-grid market segments analyzed under Task 2: (i) household, (ii) institutional, (iii) productive use, and (iv) supplier. Focus group participants included representatives from government, the donor community, NGOs, solar companies, business and industry associations, academia, community groups, and women's groups. Each market segment had its own dedicated meeting, although some stakeholders attended more than one discussion. Each FGD lasted approximately 90 minutes and covered a range of topics related to demand for off-grid solar vis-à-vis each market segment.

In addition to the FGDs, three additional survey activities were undertaken to support the Task 2 analysis: (i) a survey of large-scale international solar companies to gauge their level of interest in the country and wider region; (ii) a survey of local small-scale retail suppliers of solar equipment; and (iii) an assessment of an off-grid village to better understand how solar was being utilized for productive uses. The FGDs and surveys largely yielded qualitative inputs to supplement the quantitative analysis that was undertaken.

The methodology and assumptions utilized to assess each market segment under Task 2 is presented below.

1. HOUSEHOLD DEMAND

1.1 Household market segments

1.1.1 Total population without access to electricity was calculated using World Bank total population figures,[221] multiplied by electricity access rates from the International Energy Agency (IEA),[222] and translated to households using World Bank open data average household size. This method is used to align population data throughout the report, with IEA seen as an overarching source for energy access data and the World Bank providing important population and household income data. See **Annex 1** for more details.

1.1.2 Based on the country demographic and income data, the household solar market was broken down into segments by income quintile, as shown in **Section 2.1.1**. For the purpose of this analysis, income quintiles were aligned with energy tiers, as indicated by the Multi-Tier Energy Access Framework, which is roughly determined by household ability to pay for tier levels of energy. Quintiles were also aligned roughly with geographic segments.

1.1.3 World Bank demographic data used does not provide household income data broken down by rural, urban, on-grid or off-grid. For example, the data shows the total population falling under a certain poverty line, shows the total population that does not have access to electricity, and shows the total population that is rural, but does not cross reference any of these indicators to e.g. show the total rural population without access to electricity living under the poverty line. For this reason, assumptions were made regarding the number of households per income quintile that are off-grid (detailed in section 1.3.1 of these assumptions). It was assumed that the majority of off-grid households are rural. The data gap prevents the presentation of an overlapping map of the traditional poverty line income pyramid with electricity access.

[221] World Bank Open Data, 2017: https://data.worldbank.org/
[222] IEA Energy Access Outlook, 2017: https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

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 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 TV	-	-	1	-
Small Generator	-	-	-	1

- Numbers of units of torch lights/lanterns, cell phones, dc radio, dc TV 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 Guinea-Bissau, the number of off-grid households by income quintile was derived. For this, a percentage of off-grid households by quintile was assumed, as follows:

Quintile	% Off-Grid
Highest 20%	50%
Fourth 20%	90%
Third 20%	95%
Second 20%	100%
Lowest 20%	100%

It was assumed that there is a general correlation between income and access to electricity. The highest quintile has the highest percentage of population that are both urban and connected to the grid. Evidence indicates that the vast majority of households connected to the grid are from the top two quintiles Similarly, it was assumed that virtually all people in the bottom two quintiles are off-grid.

1.3.2 From this, average household energy expenditure was determined based on income, with the assumption that all households spend an average of 10% of their income on energy.

Average rural household expenditure on energy varies considerably. A study from Sierra Leone found that the "cost of lighting, on average, occupied between 10-15% of household incomes. Households using generators were found to spend a greater proportion of their income (upward of 20%) on lighting."[223] Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.[224] For the purpose of this research, we have assumed that households can allocate 10% of their income on average to energy.

1.3.3 The monthly energy budget for each household per quintile was calculated by multiplying monthly Household income by the assumed 10% of Household income spent on energy. Monthly Household income per month was calculated by multiplying per capita income per month by the avg. # of persons/household. Per capita income per month for each quintile is calculated by dividing the Share of the country GDP for each quintile by the population of each quintile, which is one-fifth of the country population. The share of the country GDP for each quintile is based on World Bank, World Development Indicators demographic data.

1.3.4 A simple model was used to evaluate the market using the World Bank income quintile data and average energy expenditures as input data.

1.3.5 In determining the monthly energy expenditure related to each tier, the following assumptions were made with guidance from the FGDs output:

[223] 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).
[224] 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 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.
- **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 DC TV powered by lead acid battery recharged once per week.
- **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 Guinea-Bissau, as shown in 2.2.5).

1.3.7 In determining the **number of off-grid households per quintile that will be willing to pay for each solar tier**, the key assumption of the model is that each off-grid household purchases only one system and that they will opt for the highest solar system tier they can afford.

- For cash purchases, the assumption was that they will be willing to save (set aside) up to 3 months (number of months can be adjusted on the 'HH Assumptions' tab) of their monthly energy budget to purchase the system.
- For PAYG/financed, the assumption was that they will be willing if their monthly energy budget is less than or equal to the monthly PAYG payment AND if the PAYG upfront payment is less than or equal to 3 months of their monthly energy budget.

1.3.8 The interest rate for consumer finance was conservatively estimated to be 24% p.a., based on the interest rate cap for Microfinance Institutions in WAEMU countries.[225]

<u>2023 and 2030 Household Demand Scenario: Assumptions</u>

1. The GIS analysis[226] estimated that by 2023, 15.9% of the population will be grid connected, 24.0% will be connected by mini-grids while 60.1% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 38.3% of the population will be grid connected, 33.3% will be connected by mini-grids while only 28.4% of the population will be connected by off-grid stand-alone solutions. Based on these dynamics in the demographic patterns, coupled with the existing government plans, the following assumptions regarding the off-grid population based on the quintiles were made:

[225] Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf
[226] See **Annex 1** for GIS methodology

- In the 2023 scenario, it was assumed that as the grid gets extended and mini-grids are deployed (based on GIS data), the households in the quintiles with the highest income will be given priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest quintile was assumed to have only 1% off-grid households, while the second highest quintile was assumed to have 11% off-grid households. The percentages of off-grid households in the bottom three quintiles remain unchanged. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2023 estimate.
- Similarly, in the 2030 scenario, it was assumed that the higher income quintiles will be prioritized for electrification, based on economic considerations, above the lower quintiles. Hence, the highest four quintiles were assumed to have only 1%, 2%, 3%, and 36% off-grid households respectively, while the lowest quintile was assumed to have 100% off-grid households. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2030 estimate.

Quintile	% Off-Grid (2023)	% Off-Grid (2030)
Highest 20%	1%	1%
Fourth 20%	11%	2%
Third 20%	90%	3%
Second 20%	99%	36%
Lowest 20%	100%	100%

2. Inflation rates for Guinea-Bissau: According to the IMF World Economic Outlook data, inflation in Guinea-Bissau is estimated to be at 3% in 2023. It was assumed that the rate will remain the same through 2030. Based on this assumption, the expected prices of the current household energy technologies and the solar alternatives were estimated using an annual price escalation factor of 1.03.

3. Based on a 2.5% population growth rate from the World Bank[227] and the population density dataset used in the study, the estimated total population will be 2,168,805 in 2023 and 2,578,028 in 2030.

4. The least-cost electrification analysis found that the share of the population with access to electricity via the national grid and mini-grids will be 39.9% in 2023 and 71.6% in 2030.

5. To estimate GDP, it was assumed that the current annual GDP growth rate of 5.5% will be maintained through 2023 and 2030:

Parameter	2023	2030
Population	2,168,805 (GIS estimate)	2,578,028 (GIS estimate)
GDP (constant 2010 USD)	$1,551,718,513	$2,257,252,585

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,[228] 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).

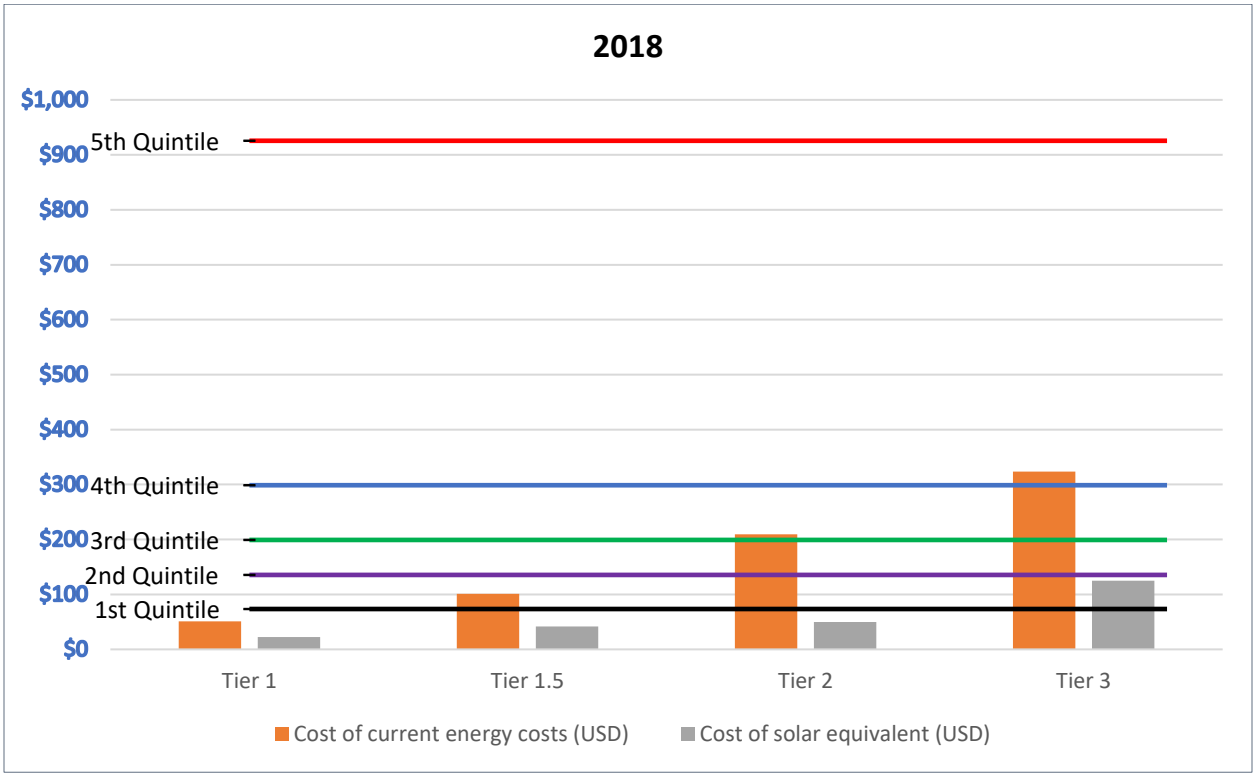
[227] https://data.worldbank.org/indicator/SP.POP.GROW?locations=BJ
[228] "Off-Grid Solar Market Trends Report 2018," Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

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 Guinea-Bissau will stagnate at the current rate of 24% or possibly decline.

Household Cost Savings and Affordability Calculation

Annual Household Energy Budget by Quintile, Annual Energy Costs and Annual Costs of Solar Equivalents



- This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. The 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.

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:

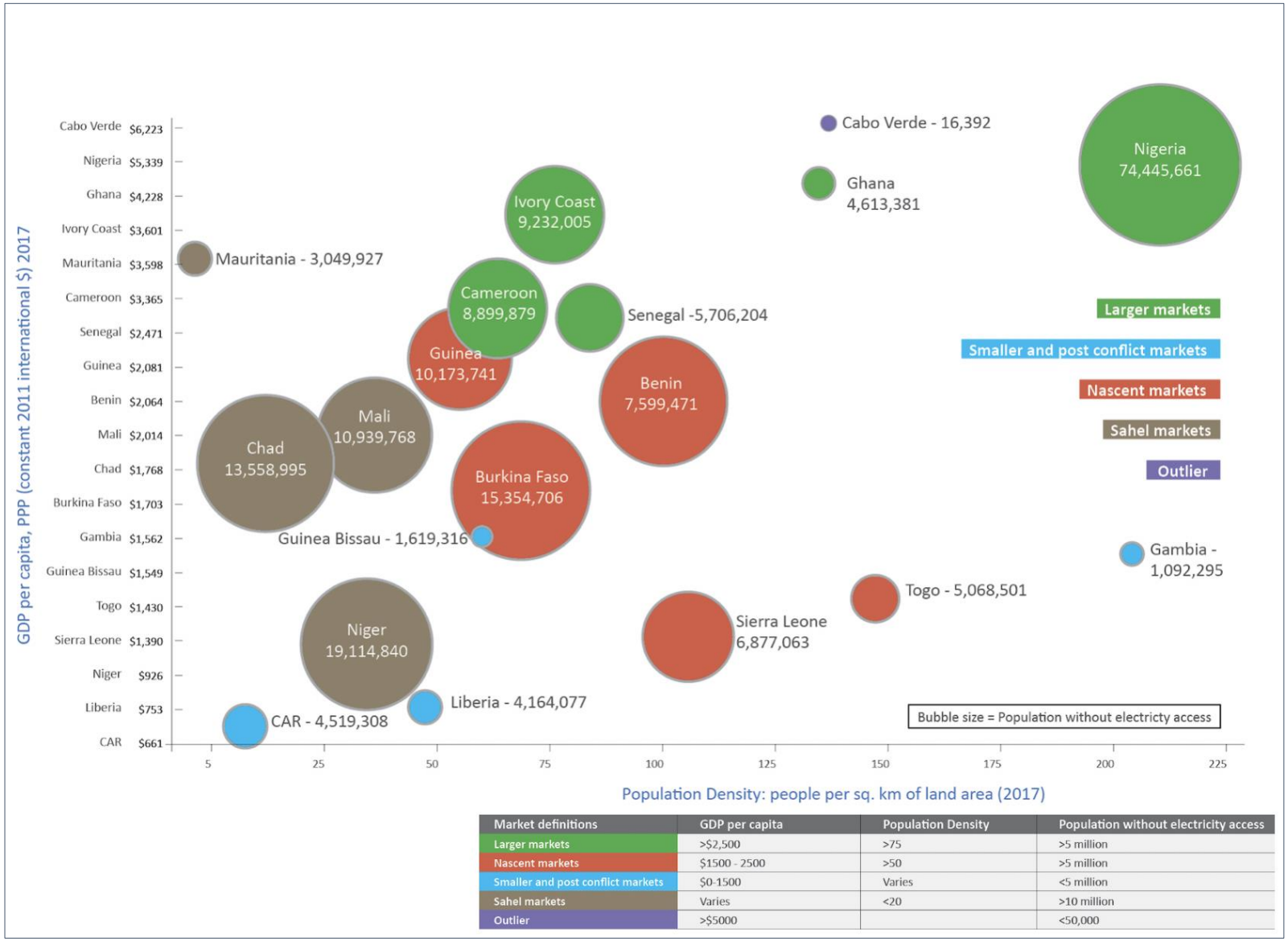
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	**Category 2:** Low-income / high population density	**Category 3:** High-income/ low population density	**Category 4:** High-income / high population density
Niger Burkina Faso Chad Mali Guinea 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.[229] The solar PV sizing factor is based on the peak sun hours available across most of Africa.

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

Energy Needs Assumptions:

Water Supply: Power requirements (low, medium, high) are based on the type of water point:

- Borehole: 40% low power pumps; 40% medium power; 20% high power
- Protected dug well: 80% no pump; 10% low power pumps; 10% medium power; no high-power
- Unprotected dug well: No pump
- Protected spring: No pump
- Unprotected spring: No pump
- Public tap/standpipe (stand-alone or water kiosk): No pump
- Sand/Sub-surface dam (with well or standpipe): No pump
- Piped water into dwelling/plot/yard: No pump
- Rainwater harvesting: No pump

Healthcare: The size of the healthcare facility (HC1, HC2, HC3) determines the amount of energy each facility requires.

Education: The size of the school and number of students determines the amount of energy each school requires.

Public lighting: It was assumed that two [2] public lighting points would be required to meet the energy needs of a town/market center.

2.3 Institutional Market Sizing Calculations

Household systems, cost and price per watt:

System Type	Tier Rating	USD/Watt[230]	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

Institutional Sector Market Sizing Calculations:

[230] 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

NOTE: Prices cover only solar components (except for the HC1 tier 3 system, which comes with lighting)

Water Supply						
# of water pumps	X	Size of solar system (watts) (low, medium, high power)	X	Cost per watt for pumping ($2.50) divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Water Supply Sector

Healthcare						
# of healthcare facilities						
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						
# of off-grid market centers	X	Size of solar system in Watts (500W)	X	Cost per watt ($3) divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Public Lighting Sector

2.4 Data Collection Approach by Institutional Market Segment

GUINEA-BISSAU			
Water Supply	**Healthcare**	**Education**	**Public Lighting**
GIS data	Per capita assumption	Per capita assumption	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Guinea-Bissau from a combination of available GIS data, input from local experts, stakeholder interviews and desk research. Where there were gaps in available data, per capita assumptions were made, as explained in **Section 2.2**.

Assumptions:

Water Supply: Of the identified potable water points, it was assumed that 50% would be equipped with a solar-powered water pump. Of the equipped water sources, the division of pumps between low, medium and high-powered pumps was: 50%, 35% and 15%, respectively. The lower cost of the low power pumps is the driving factor for this assumption. Where this information was not available, a per capita comparison was made with a country in the same category.

Healthcare: Wherever possible, specific data on the number of off-grid healthcare facilities by size was used (i.e. HC1, HC2, HC3). Where this information was not available, a per capita comparison was made with a country in the same category.

Education: Wherever possible, specific data on the number of off-grid primary and secondary schools was used. Primary schools encompass both primary and nursery schools. Vocational schools and universities were not considered because they tend to be in cities, which are often grid-electrified. Where this information was not available, a per capita comparison was made with a country in the same category. The following per-capita assumptions were made:[231]

- 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.

[231] 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[232]	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 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**.

3.2.1 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)[233]	X 25%	=	Smallholder Irrigation Potential (hectare)[234]	Divided by 0.3[235]	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	$650 (cost of solar pumping kit)[236]	Divided by 6 year (life of system)	=	Estimated Annualized Off-Grid Solar Market Potential for irrigation

Methodology for identifying areas suitable for irrigation activities on farms:

The areas for potential irrigation activities were calculated using the visible cropland[237] adjacent to permanent surface water sources. As identified by experts in a study in Zambia[238] and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure 26** is a map of the cropland within a 5 km distance from permanent surface water.

[232] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap
[233] AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
[234] 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
[235] 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/
[236] 120W solar pumping kit: https://futurepump.com/futures-bright-farmers-kenya/
[237] "Prototype Land Cover Map over Africa at 20m Released," Esa, (February 2018): https://www.esa-landcover-cci.org/?q=node/187
[238] "Zambia Electrification Geospatial Model," USAID and Power Africa, (April 2018): https://pdf.usaid.gov/pdf_docs/PA00T2JC.pdf

3.2.2 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 provide an opportunity for value addition through hulling or milling.

Value-Added PUE Applications – Solar Milling												
Cereals, roots tuber crops (tons)[239]	X	70% [240]	X	50%[241]	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor[242]	=	Estimated No. of Solar Mills	X	6,500 W x $2.50 per watt Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Milling

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

3.2.3 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[243]	X	5,500 W[244]	X	$2.50 per watt	Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Refrigeration

3.3 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[245]	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

[239] Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
[240] Assumption that 70% of crops are milled
[241] Assumption that 50% of milled crops are processed at smallholder farmer level
[242] 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/
[243] https://www.citypopulation.de
[244] 5.5kW solar powered refrigeration system – *See*: https://www.deutschland.de/en/solar-powered-coldhubs-nigeria
[245] "The Mobile Economy, Sub-Saharan Africa," GSMA Intelligence, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download

* Indicative Costs for Phone Charging Appliances[246]

Charging Stations	Cost (USD)	Manufacturer
Charging ECOBOXX Qube (sizes - 50) 5Wp panel	$83	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Charging ECOBOXX Qube (sizes - 90) 10Wp panel	$205	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Charging ECOBOXX Qube (sizes - 160) 2*10Wp panel	$209	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station ECOBOXX 300	$681	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station ECOBOXX 600	$965	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable Charging Station ECOBOXX 1500	$1,532	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station BOSS Kit Portable	$3,025	Phaesun GmbH
Charging Sundaya Charging Station	$193	Sundaya
Average Cost	**$862**	

Source: GIZ and African Solar Designs analysis

Identifying areas of phone network coverage

The mobile phone network geographic coverage was mapped across each country (**Figure 28)**. The source for this data is GSMA, which gives a radius ranging between 2-30 km. The radius is affected by a number of variables including tower height, power output, frequencies in use, and antenna type. Since this does not indicate the quality of network, the data was compared with data from OpenSignal, which tracks the signal from users registered on the platform.

Green: Strong Signal (>-85dBm)
Red: Weak Signal (<-99dBm)
Source: Open Data Signal

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

4. SUPPLY CHAIN ANALYSIS

The Task 2 supply chain analysis was based on the following key sources of data:

- Supplier focus group discussions held in Bissau in June 2018
- Survey of 10 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- 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 Guinea-Bissau is included below:

1	CAMPAP Solar
2	Cidade Solar
3	DuraEnergy
4	Eco Progresso
5	Electro Djudan N'Djudau
6	Elmi Guiné
7	FRES GB
8	GB Energy Solutions
9	GreenLink
10	Guinersol
11	Heliotropic
12	Impar
13	JRL Energia Solar
14	Noba Sabi Safim
15	PP-Energy Sarl
16	Prosolia
17	Teditronic

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT

Data collection under Task 3 included a combination of desk research, collaboration with local experts, and extensive stakeholder engagement with key officials and representatives from local and regional commercial banks, microfinance institutions and other development banks and agencies in Guinea-Bissau. 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.[247]

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.[248] The results of the survey are summarized in **Section 3.4**.

- Has the bank provided any loans to any segment of the off-grid sector? If so, please describe.
- Has the bank received any inquiries from any segment of the off-grid sector? How many inquiries?
- Did the bank engage in serious discussions or dismiss the inquiry(ies) as not within the bank's area of lending or not interesting as a new business line? If dismissed, please provide the bank's reasons.
- If the bank engaged in serious review/discussions and rejected the opportunity, please describe the bank's due diligence approach and reasons for rejection.
- Is the bank interested to pursue lending to any segment of the off-grid sector? Which segment and which of the bank's departments and existing products apply?
- Describe the bank's current loan products and lending activity for the SME, Corporate, Consumer and Agri markets. Please provide rough figures on volumes in number of loans and value in each category. For each category please provide average margins, pricing, loan tenors to borrowers, collateral requirements.
- Does the bank have a structured finance department? Has the bank provided financing to any IPPs? If so, please provide details on the transactions (location, technology, size, maturity, portion of bank engagement in the total financing)
- Does the bank have a trade finance department? What are standard terms and conditions? What are the volumes in number of loans and values?
- Does the bank operate nationwide or only in certain regions? Does the bank have a presence in rural areas and is rural consumer and SME and Agri lending a key business focus?
- Does the bank have experience with managing DFI credit lines? In which sectors/departments? Which DFIs? What volumes? Were the lines fully committed and disbursed? What was the bank's overall experience with these credit lines?
- Has the bank had dealings with the ECOWAS Bank for Investment and Development (EBID)? What type of relationship? Credit lines? Co-lending? Credit enhancement? Have the experiences been positive?
- What is the bank's view on accepting hard currency credit lines and on-lending in hard currency? Would the bank hedge hard currency credit lines and on-lend in local currency?
- Is the bank interested to explore a credit line with ROGEP? What size of credit line would the bank be

[247] The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.
[248] The survey was adapted based on the type of FI that was being interviewed (commercial banks, MFIs, Regional Development Banks)

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?

ANNEX 4: GENDER ASSESSMENT

1. Context and Purpose of the Gender Analysis

Within the context of this assignment, a gender-focused analysis was undertaken to assess the level of participation of women in each country's off-grid energy sector. This analysis is critical to the overall market assessment given the clear linkages between energy and gender, namely different rates of access and use as well as the impacts of energy sources and appliances in the home, community and wider society. Energy sector studies often fail to obtain gender-disaggregated data, which is necessary to inform policymakers and better understand the needs and priorities of women in the context of sustainable development.

Women in energy-poor households are at substantially higher risk of illness attributable to indoor air pollution and solid fuel (biomass) use.[249] Moreover, the significant time burdens that women and girls face in collecting fuel and water, cooking and processing food often keep girls from attending school; there is evidence that electrified milling equipment and water pumps can significantly reduce this burden. Lack of access to electricity also means that women do not have access to information and communication technologies that could improve their lives.[250]

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.[251] To address these challenges, governments across the region have adopted a range of policies to improve gender equality and promote gender mainstreaming. Member states of ECOWAS have adopted a Policy for Gender Mainstreaming in Energy Access, an initiative committed to promoting favorable policies and frameworks and mobilizing resources to more fully engage women in all areas of energy access, including as energy suppliers, planners, financiers, educators and customers.[252] ECREEE, the agency that is administering this policy throughout the region, is supporting implementation of regulatory and institutional measures that aim to improve inclusive energy access in each country by 2030. ECREEE has also partnered with AfDB to launch a separate regional initiative to advance the participation of women entrepreneurs in the renewable energy sector.[253]

Outside of ECOWAS, Cameroon, Chad and Central African Republic are pursuing gender mainstreaming at a regional level through the Economic Community of Central African States (ECCAS) Regional Policy for universal access to modern energy services and economic and social development (2014-2030).[254] Mauritania is also implementing a national policy to address this issue – the National Strategy of Institutionalization of Gender (la Stratégie Nationale d'institutionalisation du genre).

[249] "The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa," UNDP and World Health Organization, (2009): http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Sustainable%20Energy/energy-access-situation-in-developing-countries.pdf

[250] Rewald, R., "Energy and Women and Girls: Analyzing the needs, uses, and impacts of energy on women and girls in the developing world," Oxfam, (2017): https://www.oxfamamerica.org/static/media/files/energy-women-girls.pdf

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

[252] Ibid.

[253] "Feasibility study promotes women's participation in energy transition," ESI Africa, (May 7, 2018): https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/

[254] "Central Africa Regional Integration Strategy Paper," African Development Bank, (2011-2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/RISP%20CENTRAL%20AFRICA-ECCAS%20English%20FINAL.pdf

- **Description of Approach / Methodology**

While the data collection for this assignment was not sex dis-aggregated (which was beyond the scope of work), a gender-focused perspective was applied to the overall analysis. The methodology adopted to carry out this exercise included a combination of desk research, literature review, focus group discussions (FGDs) and face-to-face interviews with key gender "focal points" identified by ECREEE in each country. Representatives from women's groups, female-led businesses and energy sector organizations attended the focus group meetings that were held in Bissau in June 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Guinea-Bissau to assess the main barriers/constraints for inclusive participation in the country. The survey examined a number of key gender issues, including *inter alia* access to credit, access to education and information, entrepreneurial and income-generating activities for women (including productive use of energy), representation of women in leadership positions in business and government.

- **Gender Questionnaire**

The following questionnaire was administered to key stakeholders in each country. Respondents were asked to reply Yes/No to each question and elaborate as needed.

HOUSEHOLD

Are women generally involved in influencing decisions on household energy use/services?
Are off-grid solar solutions (E.g. solar lanterns, solar home systems) largely accessible/made available to the household sector, particularly women-headed households?
Are there any related programs and initiatives (donor, government, private sector, NGO etc.) that are specifically targeting energy access for women in the household sector?
Are off-grid solar products and services generally affordable for households headed by women? If not, are Microfinance Institutions or other organizations in the country providing credit/financing (grants/loans) to the household sector, particularly women-headed households to increase energy access?
Are women aware of the health impact of unclean energy (e.g. fuel-wood for cookstoves) and the solutions (i.e. solar) to address it?

COMMUNITY/INSTITUTIONAL

Are women represented in any high-level energy sector positions? Please provide names/examples, if available, of women in senior management positions in government, committees, boards etc.
Is the mobility and safety of women constrained due to poor energy services (e.g., unavailability of streetlights due to unreliable electricity supply)?

PRODUCTIVE USE

What kind of productive use activities do women engage in and what women-led productive use activities can be supported by off-grid solar solutions?

- Agriculture (irrigation, water pumping etc.)
- Shops (retail, artisanal/handicrafts, grocery, salons etc.)
- Restaurants (bar, cafe etc.)
- Kiosks (e.g. mobile money etc.)
- Tourism
- Other

SUPPLIER

Please describe the level of engagement that women have in in the off-grid energy services sector. Are women highly employed in this area (e.g. is there data collected on the number of women-owned businesses/SMEs)?
Are there any related programs and initiatives (donor, government, private sector, NGO etc.) that provide training for women to manage or be employed by energy-related enterprises?

ADDITIONAL:
What are the main barriers women face to access information?
What are the main barriers/constraints for women entrepreneurs to have access to credit?
Do women have equal access to capacity building and training services (e.g. vocational training/technical education) or do they experience discrimination in access to these services?
What policy, regulatory and institutional framework(s) exist, if any, to address gender mainstreaming[255] (e.g. national gender action plans/related policies etc.)?
Are gender-related issues taken into consideration in energy policy provisions and/or are energy-related issues reflected in gender policies (e.g. existence of 'gender units' within public sector agencies and/or 'gender audits' in energy sector)?

2. Gender Profile

2.1 The State of Gender Equality in Guinea-Bissau

Structural inequalities and gender discrimination against women and girls persist in Guinea-Bissau, as inclusive participation remains an ongoing challenge. The gender assessment found that while there have been modest improvements in recent years to certain social indicators, gender disparities still exist across the economy, particularly in access to resources, higher education, land ownership, and inheritance systems, political power and decision-making. These findings are supported by the UNDP Human Development Index (HDI) on Gender Inequality, where Guinea-Bissau performs extremely poorly, ranking 177 out of 189 countries in the index.[256]

2.2 Gender and Poverty

Poverty remains widespread in Guinea-Bissau. About half of the overall population and almost 70% of the rural population lives in poverty. According to UNDP statistics, 78.2% of the labor force is considered working poor at PPP USD 3.10/day.[257] Income levels are comparatively much lower for women, who constitute a disproportionate share of the country's poor and extremely poor population.

2.3 Gender, Human Capital and Economic Empowerment

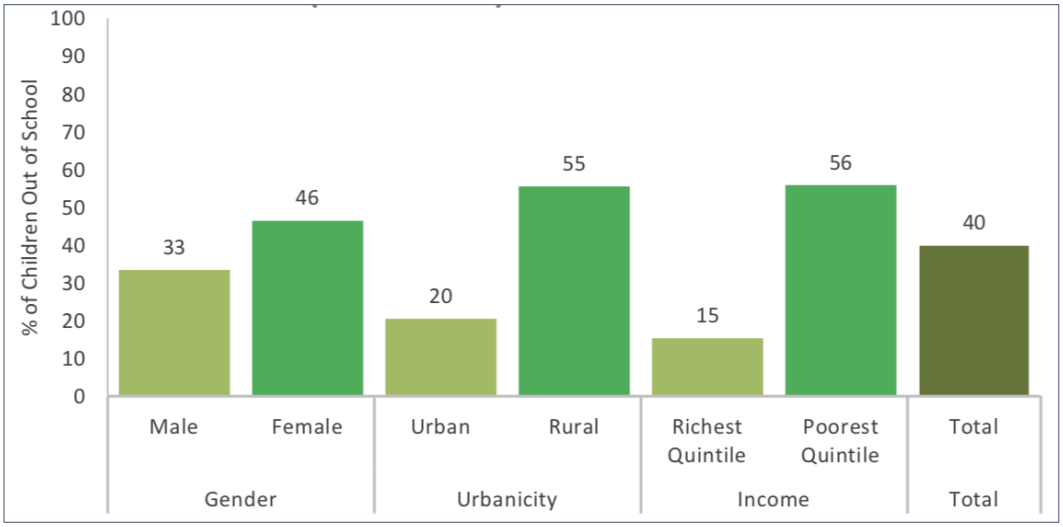
2.3.1 Education, Skills Development and Training

While Guinea-Bissau has made improvements in gender parity in rates of access to primary education, there are many troubling signs in the primary and secondary education sector and gaps still persist between men and women in higher education and literacy rates. An estimated 33% of boys of secondary school age are out of school compared to 46% of girls of the same age, while overall male rates of enrollment in secondary school are twice as high as female rates of enrollment.[258] Across the entire sector, there are huge disparities between the poorest and the richest youth in terms of access to education.[259] This trend remains consistent

[255] **Gender mainstreaming**: The process of ensuring that women and men have equal access to and control over resources, development benefits and decision-making, at all stages of development process, projects, programs or policy.
[256] "UN Human Development Reports: Gender Inequality Index (GII)," UN Development Programme, (2018): http://hdr.undp.org/en/composite/GII
[257] "UN Human Development Indicators: Guinea-Bissau," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/GNB
[258] "Guinea-Bissau: National Education Profile, 2014 Update," Education Policy and Data Center, (2014): https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Guinea-Bissau.pdf
[259] Ibid.

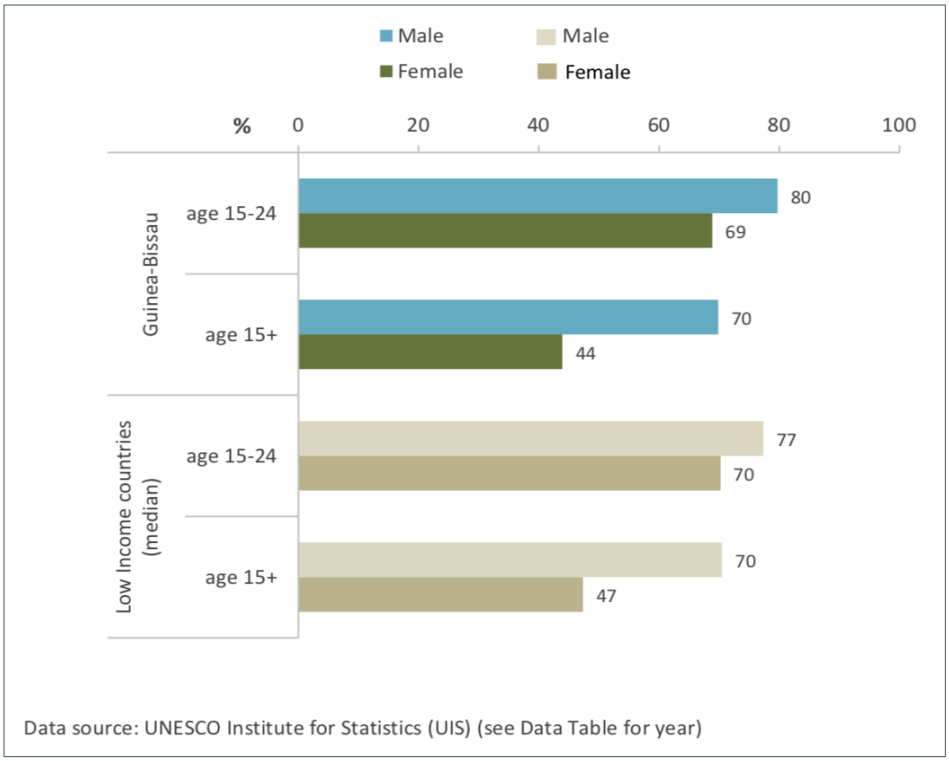
in literacy rates among Guinea-Bissau's youth and adult populations, as just 44% of the country's female adult population is literate, compared to 70% of the adult male population.[260]

Percentage of Children of Secondary School Age (13-17) Out of School



Source: UNESCO Institute for Statistics

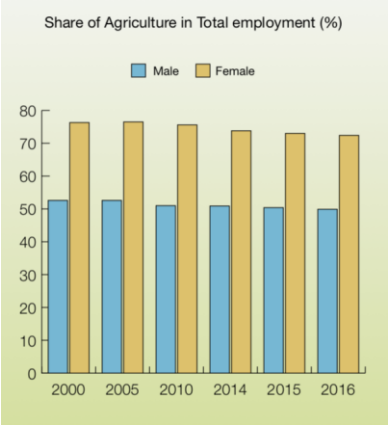
Literacy Rates Among Youth and Adult Populations



Source: UNESCO Institute for Statistics

[260] Ibid.

Women in Guinea-Bissau face elevated levels of poverty and low or irregular sources of income, especially given the relatively high percentage of women that are engaged in the informal sector – especially subsistence agriculture, which still employs a disproportionate number of women.[261]



Source: African Development Bank

2.3.2 Fertility Rates and Reproductive Health

As of 2017, the fertility rate in Guinea-Bissau remained high, at about five children per woman. The country also has a high maternal mortality rate; for every 100,000 live births, 549 women die from pregnancy related causes. An estimated 22.3% of women have an unmet need for family planning.[262]

2.3.3 Participation and Decision-Making

Socio-cultural perspectives in Guinea-Bissau remain male-dominated, as conventional gender roles continue to hold women back. This is reflected in household decision-making, which often plays a role in restricting the rights and empowerment of women. These dynamics are also present in the rates of representation of women in the labor market as well as in leadership positions in business and government.

Although women's level of participation in the economy is growing, they still lag behind men, with an adult labor force participation rate of 65.6% compared to 78.1% for men.[263] As of 2017, women held only 13.7% of the country's seats in parliament.[264]

In the new government, there are 16 Ministers including five women who head the Ministries of Defense, Education, Public Health, Family and Social Cohesion. Of the 15 Secretaries of States, one is a woman. The Justice Minister announced the appointment of a women as head of the judicial police and two of the nine recently appointed regional governors are women. In 2014, a new position of Assistant to the President for Human Rights and Gender was a milestone.

[261] "Indicators on Gender, Poverty the Environment and Progress toward the Sustainable Development Goals in African Countries," African Development Bank, (2017): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/GENDER_Poverty_and_Environmental_Indicators_on_African_Countries-2017.pdf

[262] "Human Development Indices and Indicators: 2018 Statistical Update," UN Development Programme, (2018): http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf

[263] "UN Human Development Indicators: Guinea-Bissau," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/GNB

[264] Ibid.

2.4 Gender Policy, Institutional and Legal Framework in Guinea-Bissau

2.4.1 Gender Mainstreaming Initiatives by the Government

With a new democratically elected government, strong civil society women's organizations, and a national gender plan of action – the national gender policy (PNIEG) – there is potential for significant advances to be made in gender equality in Guinea-Bissau.

The GoGB has adopted several policies to promote gender equality and has signed on to key international and regional framework agreements protecting women's rights. At the international level, Guinea-Bissau has ratified the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) and is also signatory to the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa,[265] the Solemn Declaration on Gender Equality in Africa and the Beijing Platform for Action, among others.

The country's 1984 Constitution guarantees gender equality under the law. To date, the Government has enacted a number of laws to ensure the protection of the rights of women to create an enabling environment to ensure inclusive participation in the country's development. These include the National Gender Policy (Política Nacional para a Promoção da Igualdade e Equidade de Género 2012–2015) and its Gender Action Plan (2015), which were implemented under the Strategic and Operational National Action Plan in 2011. The Ministry of Women, Family and Social Cohesion (*Ministério da Mulher, Família, e Coesão Social*) is another agency mandated to formulate gender-responsive policies and to coordinate and monitor their implementation within different sectors of the society.

2.4.2 Gaps in the Gender Policy/Legal Framework

Despite the Government's policy initiatives and legislative reforms, gender inequality remains an ongoing challenge across the country's political, economic and socio-cultural landscape, as women still face many barriers to inclusive participation. In general, there are significant gender gaps in the areas of education, literacy, access to information and decision-making. There is also still a lack of sex-disaggregated data across all sector of the economy, which is critical to inform policy decision and promote gender mainstreaming.

2.5 Summary of Recommendations

Given the increased attention that gender inclusion has received in development planning, there are a number of tools that are now available to policymakers that can be utilized to support gender mainstreaming and encourage women's participation in the energy sector. Despite encouraging progress in the discourse on gender and energy access, substantial efforts are still needed, especially in enabling women's participation in the sector in different roles, including as energy entrepreneurs and in leadership positions.[266]

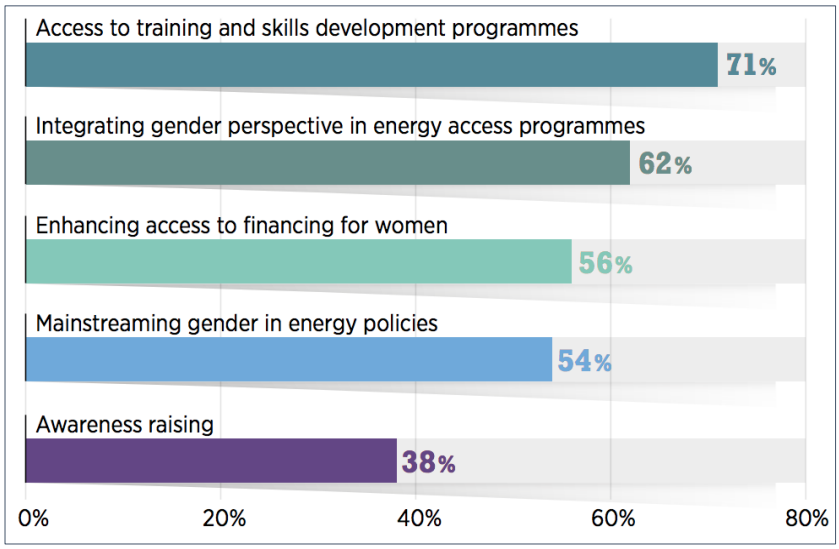
In seeking solutions to improve women's engagement in energy access, a 2018 IRENA survey found that access to necessary technical, business or leadership skills development programs was the single most important measure that could be taken. Over half of survey respondents also highlighted the need to integrate gender perspectives in energy access programs as well as enhanced access to finance.[267]

[265] Protocole to the African Charter on Human and People's rights on the Rights of Women in Africa: http://www.achpr.org/instruments/women-protocol/ratification/

[266] "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

[267] Ibid.

Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

In addition to the measures highlighted in the figure above, below is a list of additional policy recommendations that could further improve gender equality in Guinea-Bissau's energy sector:[268]

- Revise the 1996 sector policy letter which is outdated and does not include gender provisions.
- Take measures to close the gender gap in access to education, particularly in higher levels of education
- Implement a quota system to increase the number of women employed in government's energy ministry and ensure that women are part of decision-making processes in the energy sector
- Implement policy and budgetary measures to support programs that aim to raise awareness and promote opportunities for women as energy customers, suppliers, financiers, and educators
- Commission studies to collect, synthesize and publish gender-specific/sex-disaggregated data on women's energy access and usage to inform (i) public policy development to improve rates of access for women; and (ii) private sector on potential customer needs (e.g. clean cooking technologies, productive use of energy applications etc.)
- Undertake a "gender audit" of the sector and develop a plan to inform long-term policy objectives targeting gaps in the existing framework and promoting inclusive participation (e.g. by adding gender categories to energy policies and projects and accounting for gender impacts in strategic planning.
- Establish a Gender Focal Point or Unit within key national and local institutions in order to administer targeted gender policies and programs
- Raise awareness / provide training and technical support to private sector businesses / SMEs on (i) the benefits of gender inclusion and in viewing business decisions through a gender lens; (ii) the value of gender-disaggregated data; and (iii) how to develop and implement gender strategies to encourage inclusive participation.[269]

[268] NOTE: This is not an exhaustive list of recommendations as it is only intended to address inclusive participation in the energy sector; there are many gender-related challenges that warrant further study and attention within the context of the country's complex economic and social structures that are beyond the scope of this analysis

[269] "ECOWAS-CTCN Project on Mainstreaming Gender for a Climate Resilient Energy System in ECOWAS Countries: Final Report," ECREEE and CTCN, (May 2018): https://www.ctc-n.org/system/files/dossier/3b/180627_final_report-uk.pdf

ROGEP focus group discussions in Bissau, Guinea-Bissau, in June 2018.

A retail market for off-grid solar products in Bissau, Guinea-Bissau.

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