WORLD BANK GROUP

ECREEE

TOWARDS SUSTAINABLE ENERGY

REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

LIBERIA REPORT

JULY 2019

GreenMax Capital Advisors

Energio Verda
Renewable Energy for Development

ASD

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS & ACRONYMS

AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ASD	African Solar Design
BIVAC	Bureau Veritas Liberia
BTG	Beyond the Grid Program
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAR	Capital Adequacy Ratio
CBL	Central Bank of Liberia
CEADIR	Climate Economic Analysis for Development, Investment and Resilience
COD	Cash-on-Delivery
CRS	Credit Reference System
CSET	Center for Sustainable Energy Technology
DFI	Development Finance Institution
DfID	Department for International Development
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
ERB	Energy Regulatory Board
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
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
FX	Foreign Exchange
FSDIP	Financial Sector Development Implementation Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information Systems
GIZ	German Corporation for International Cooperation
GNI	Gross National Income
GOGLA	Global Off-Grid Lighting Association
GoL	Government of Liberia
GSMA	Groupe Spéciale Mobile Association (Global System for Mobile Communications)
HC	Health Center
HDI	Human Development Index
HFO	Heavy Fuel Oil
HH	Household
ICT	Information and Communications Technology

IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
IPRE	Investment Plan for Renewable Energy
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
JICA	Japan International Cooperation Agency
LACEEP	Liberia Accelerated Electricity Expansion Project
LBDI	Liberian Bank for Development and Investment
LCUNA	Liberia Credit Union National Association
LEAP	Liberia Energy Access Practitioner
LEC	Liberia Electricity Corporation
LEDFC	Liberian Enterprise Development Finance Company
LEN	Liberia Energy Network
LERC	Liberian Electricity Regulatory Commission
LIRENAP	Liberia Renewable Energy Access Project
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LRD	Liberian Dollar
LTO	Lease-to-Own
MCC	Millennium Challenge Corporation
MFI	Microfinance Institution
MFT	Multi-Tier Energy Access Framework
MME	Ministry Mines and Energy
MOCI	Ministry of Commerce and Industry
MNCU	Multi-National Credit Union
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NEMIL	Network of Microfinance Institutions in Liberia
NEPL	National Energy Policy of Liberia
NGO	Non-Governmental Organization
NPL	Non-Performing Loan
NREAP	National Renewable Energy Action Plan
NSFI	National Strategy for Financial Inclusion
O&M	Operations and Maintenance
OGS	Off-Grid Solar
OPIC	Overseas Private Investment Corporation
PAYG	Pay-As-You-Go
PCU	Primary Credit Union
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PUE	Productive Use of Energy
PV	Photovoltaic
RCFI	Rural Community Finance Institution
RCFP	Rural Community Finance Project
RCUs	Regional Credit Unions

RE	Renewable Energy
REFUND	Rural Energy Fund
RESMP	Rural Energy Strategy Master Plan
RISE	Regulatory Indicators for Sustainable Energy
ROA	Return on Assets
ROE	Return on Equity
ROGEP	Regional Off-Grid Electricity Project
RREA	Rural and Renewable Energy Agency
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SHS	Solar Home System
SME	Small and Medium Enterprise
SPV	Special Purpose Vehicle
SSA	Sub-Saharan Africa
TA	Technical Assistance
TSCU	Trust Savings Credit Union
UN	United Nations
UNDP	United Nations Development Programme
UNMIL	United Nations Mission in Liberia
UPSCU	United Savings Progressive Savings Union
USAID	United States Agency for International Development
USCU	Unity Savings Credit Union
USD	United States Dollar
VAT	Value Added Tax
VSLA	Village Savings and Loan Association
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
WOCCU	World Council of Credit Unions
Wp	Watt peak

ACKNOWLEDGEMENTS

The consortium of GreenMax Capital Advisors (GreenMax), African Solar Designs (ASD) and Energio Verda Africa (EVA) would like to thank the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE), including Mahama Kappiah, Executive Director, ECREEE; Festus William Lartey Amoyaw, ROGEP Project Coordinator; and the entire ROGEP Expert and Technical Specialist team: Hamadou Tchiemogo, Kwabena Adom-Opare, Nouhou Amadou Seini, Daniel Paco, Ermelinda Tavares Lima, Sire Abdoul Diallo and Collins Osae for their leadership and guidance. We would also like to thank Nicola Bugatti and Yuri Handem for their support.

In addition, we would like to acknowledge the following individuals and organizations in Liberia for their assistance:

Ministry of Mines and Energy, Ministry of Education, Ministry of Agriculture. Ministry of Public Works, Ministry of Health, World Bank, European Union, Rural and Renewable Energy Agency (RREA), Liberia Electricity Corporation (LEC), Liberia Institute of Statistics and Geo-Information Services (LISGIS), Environmental Protection Agency, Booker Washington Institute, Mercy Corps, Africa Electric, Jerrut Enterprise, Universal Empowerment Group, Lib.solar, EnDEV, Center for Sustainable Energy Technology (CSET) and JC-EMCS; and all focus group and survey participants in the country. This report would not have been possible without their support.

We would especially like to thank Nathan F. Reeves for his significant contributions to this research effort.

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

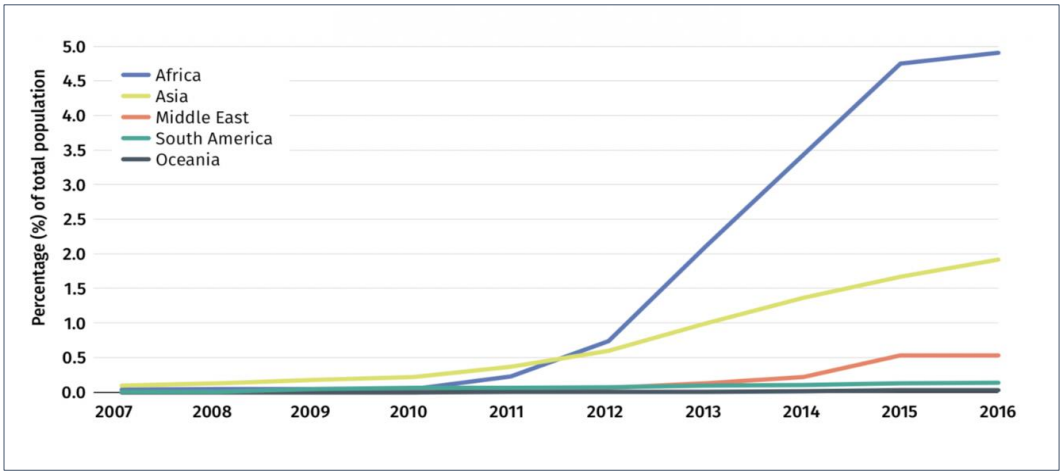
The term "West Africa and the Sahel" as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina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

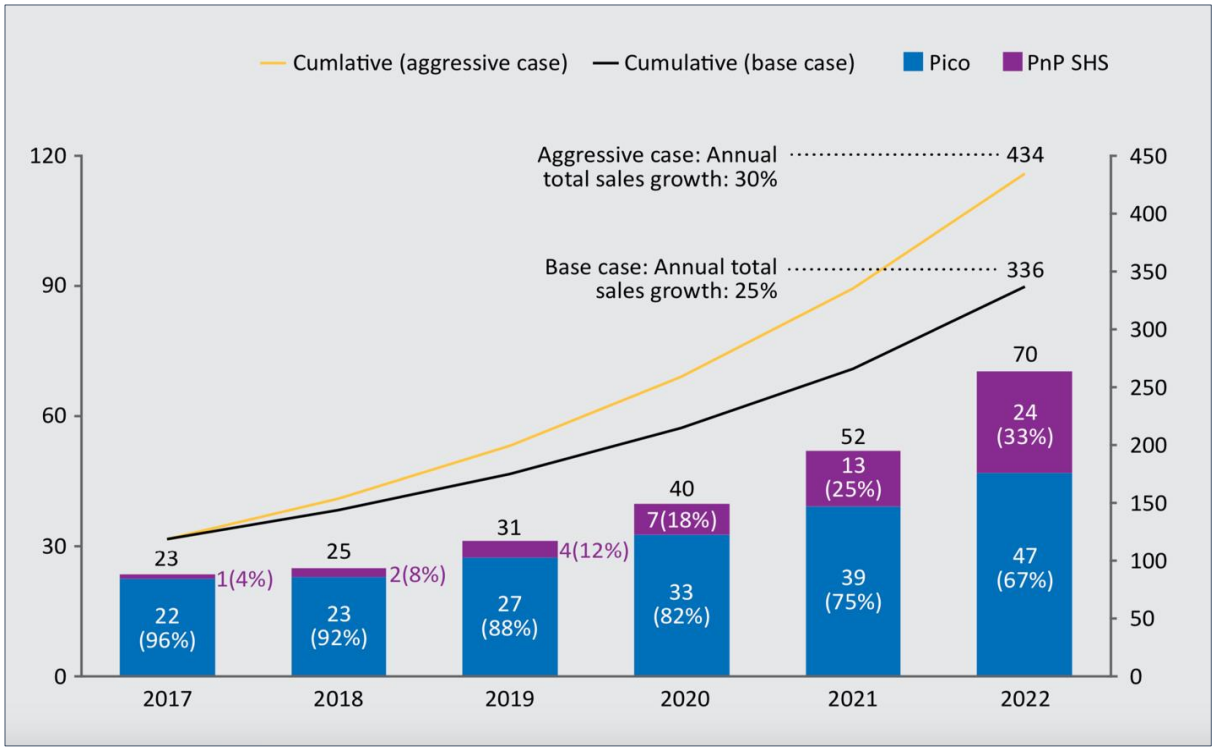
Until recently, diesel generators largely served as the expensive alternative both for rural electrification and for urban and peri-urban "bad grid" areas, where electricity was unreliable or only available for part of the day. However, the advent of decentralized renewable energy technologies, particularly 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.

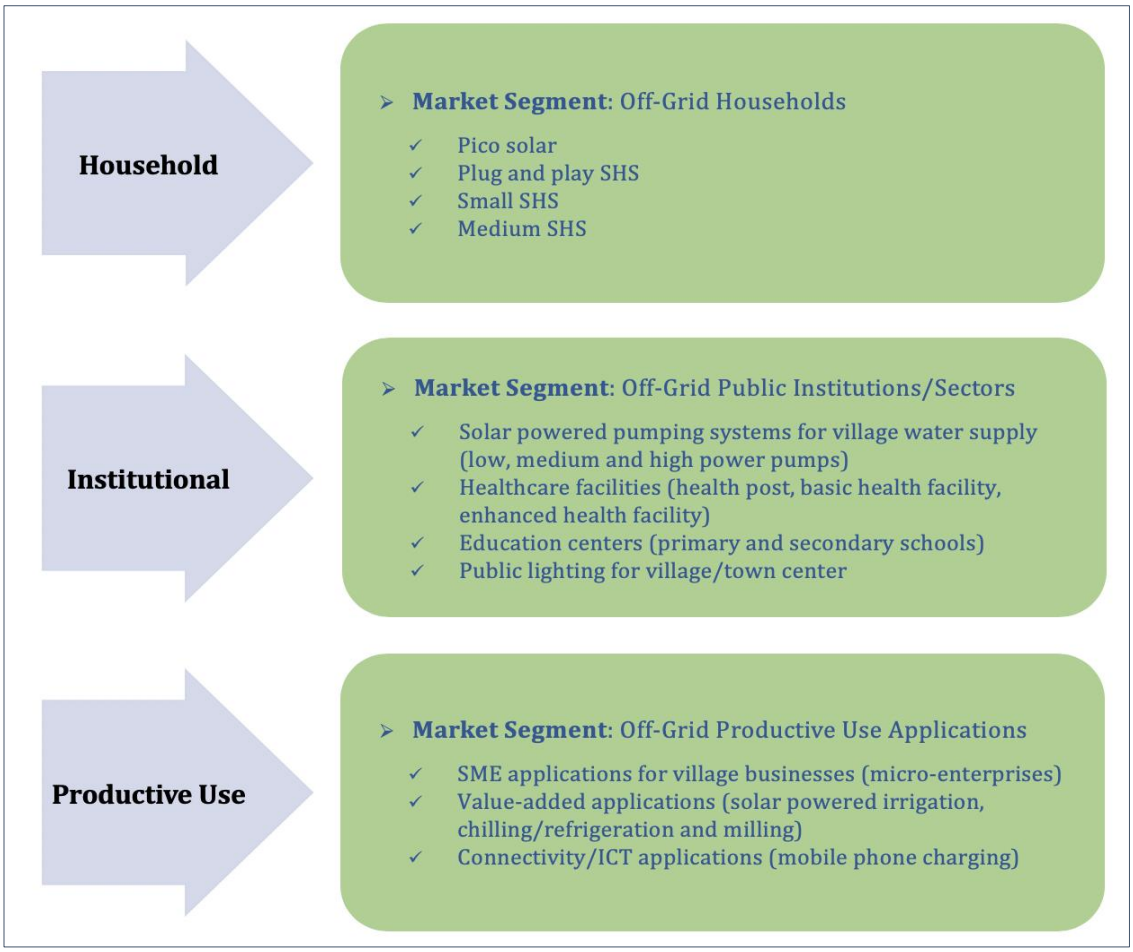
The institutional sector analysis combines available GIS data with secondary research to estimate potential demand based on assumptions about the electricity needs, usage patterns and associated costs of solar electrification of four public/institutional markets – water supply for off-grid communities, 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

The Liberian economy, which was destroyed by the country's long civil war, began to slowly recover following the installation of a democratic government in 2006. In 2014-2015, economic growth stagnated due to low commodity prices and the Ebola outbreak, which caused massive disruptions to the country's development efforts. Driven by exports of mineral resources, economic growth has since rebounded and is projected to continue to improve in the near-term. Liberia's macroeconomic gains have not translated into improvements for the majority of the population, as rates of poverty remain high, particularly in rural areas. While the extractive industry and services sector account for nearly two-thirds of GDP, 70% of the labor force remains in agriculture. The country's economy continues to be highly dependent upon foreign aid.

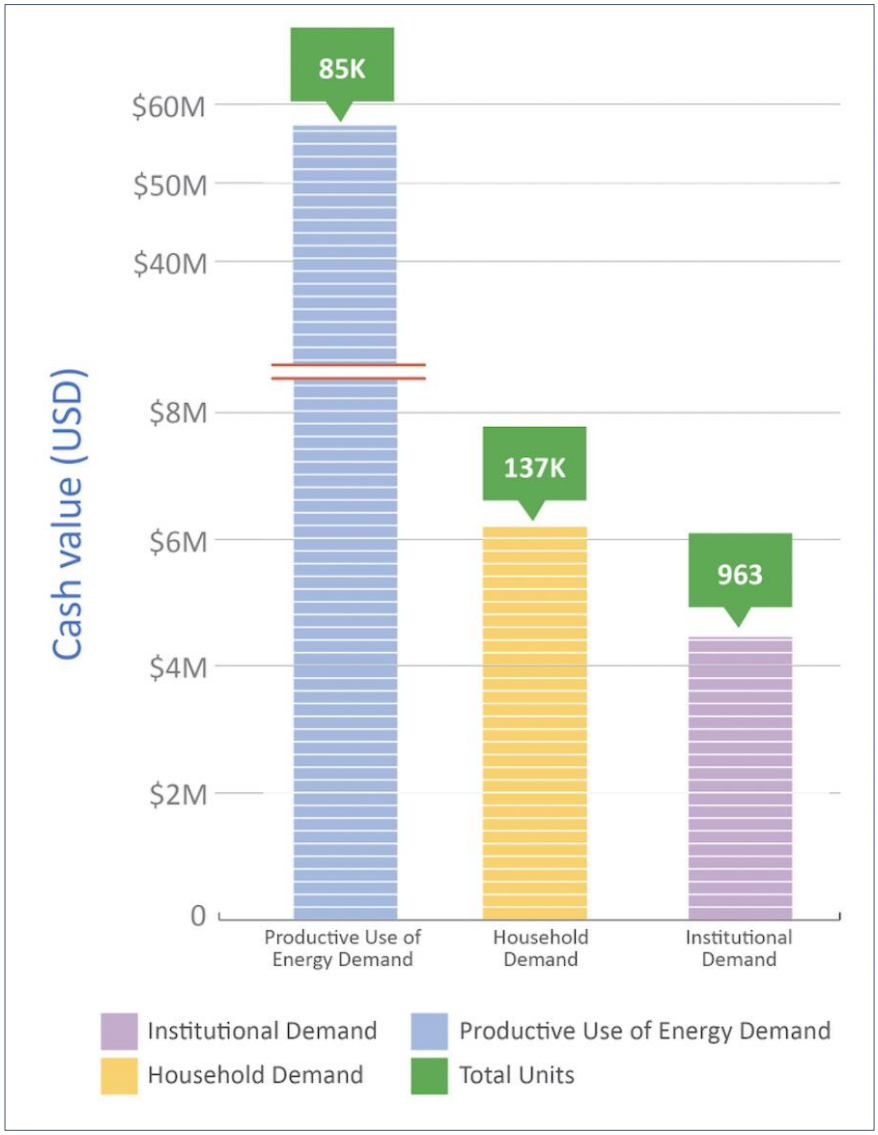
Access to electricity remains an ongoing challenge. In 2016, an estimated 88% of the population – an estimated 4 million people – did not have access to electricity, with a significant disparity in rates of access between urban (16%) and rural (3%) areas.[24] Even where grid connections exist, power supply is often unreliable, as roughly half of firms and fewer than one-third of households reported reliable access to electricity when surveyed.[25] Off-grid electrification is a policy priority for the Government of Liberia (GoL), which has set a target of increasing electrification rates to 70% in the capital Monrovia and 35% of rural areas by 2025 and universal electricity access nationwide by 2030.[26] To date, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing slowly, as evidenced by the country's relatively low energy access score in the World Bank Regulatory Indicators for Sustainable Energy (RISE) evaluation.[27]

Several off-grid programs are in various stages of implementation by the GoL, with funding and support from development partners. With support from ECREEE, the Government has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan (NREAP). In 2016, the World Bank provided USD 27 million for the Liberia Renewable Energy Access Project (LIRENAP), which includes provisions for 100,000 people nationwide to gain electricity access through stand-alone solar systems and lanterns.[28] The GoL recently adopted a Rural Energy Strategy and Master Plan (RESMP), which includes a "Beyond the Grid" (BTG) program that will utilize a combination of grid extensions and off-grid renewable energy technologies to electrify rural areas. The BTG initiative includes a range of measures to be implemented by the Rural and Renewable Energy Agency (RREA) to support off-grid electrification. The Government also plans to establish an Off-Grid Power and Renewable Energy Unit within RREA and to utilize a Rural Energy Fund to provide financing for off-grid project planning and development.

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 Liberia (**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 67.8 million. The productive use sector (USD 57.2M) makes up the majority of estimated demand, followed by the household (USD 6.2M) and institutional (USD 4.4M) sectors.

[24] IEA Energy Access Outlook, 2017.
[25] Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019): https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y
[26] "Liberia National Renewable Energy Action Plan," SEforALL and ECREEE, (2015): http://se4all.ecreee.org/sites/default/files/national_renewable_energy_action_plans_nreap_-_liberia.pdf
[27] "Policy Matters: Regulatory Indicators for Sustainable Energy," World Bank ESMAP, (2018): http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf
[28] "New Energy Project Targets 150,000 Liberians for Increased Access to Affordable and Reliable Electricity," World Bank, (January 11, 2016): http://www.worldbank.org/en/news/press-release/2016/01/11/new-energy-project-targets-150000-liberians-for-increased-access-to-affordable-and-reliable-electricity

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

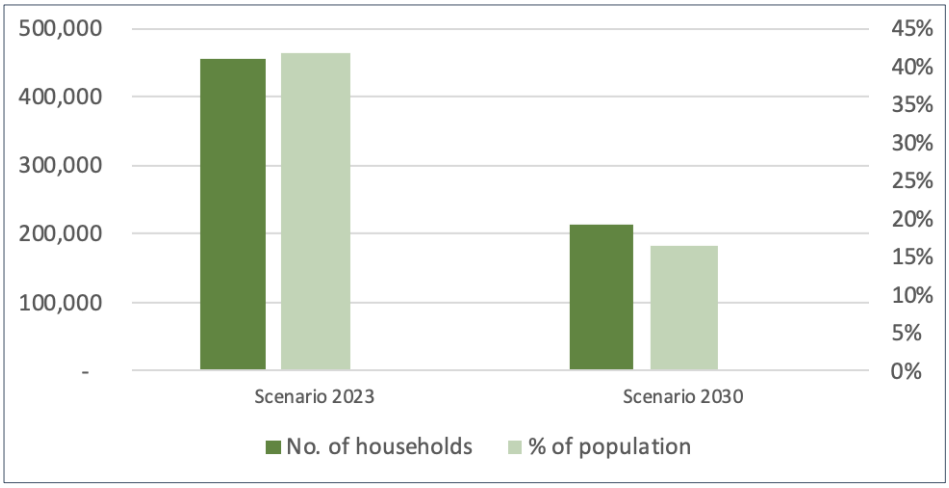


Source: African Solar Designs analysis

The least-cost electrification analysis found that by 2023, 942 settlements across Liberia (301,418 households) will be connected to the main grid, representing 27.6% of the population. By 2030, this figure will increase to 6,887 settlements (959,165 households), equivalent to 73.9% 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 9,159 settlements (456,807 households), representing 41.8% of the population in 2023, as suitable for stand-alone systems, decreasing to 3,713 settlements (214,505 households) and 16.5% of the population in 2030 (**Figure ES-5**). While the total size of the OGS market for households will decrease over time, given the relatively limited reach of the national grid, off-grid households will remain spread across all districts of the country. In both the 2023 and 2030 scenarios, the district of Bong is projected to retain the largest number and percentage of off-grid households in the country. Bong is the third most populated district in Liberia and known for its mining industry.

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



Source: Energio Verda Africa GIS analysis

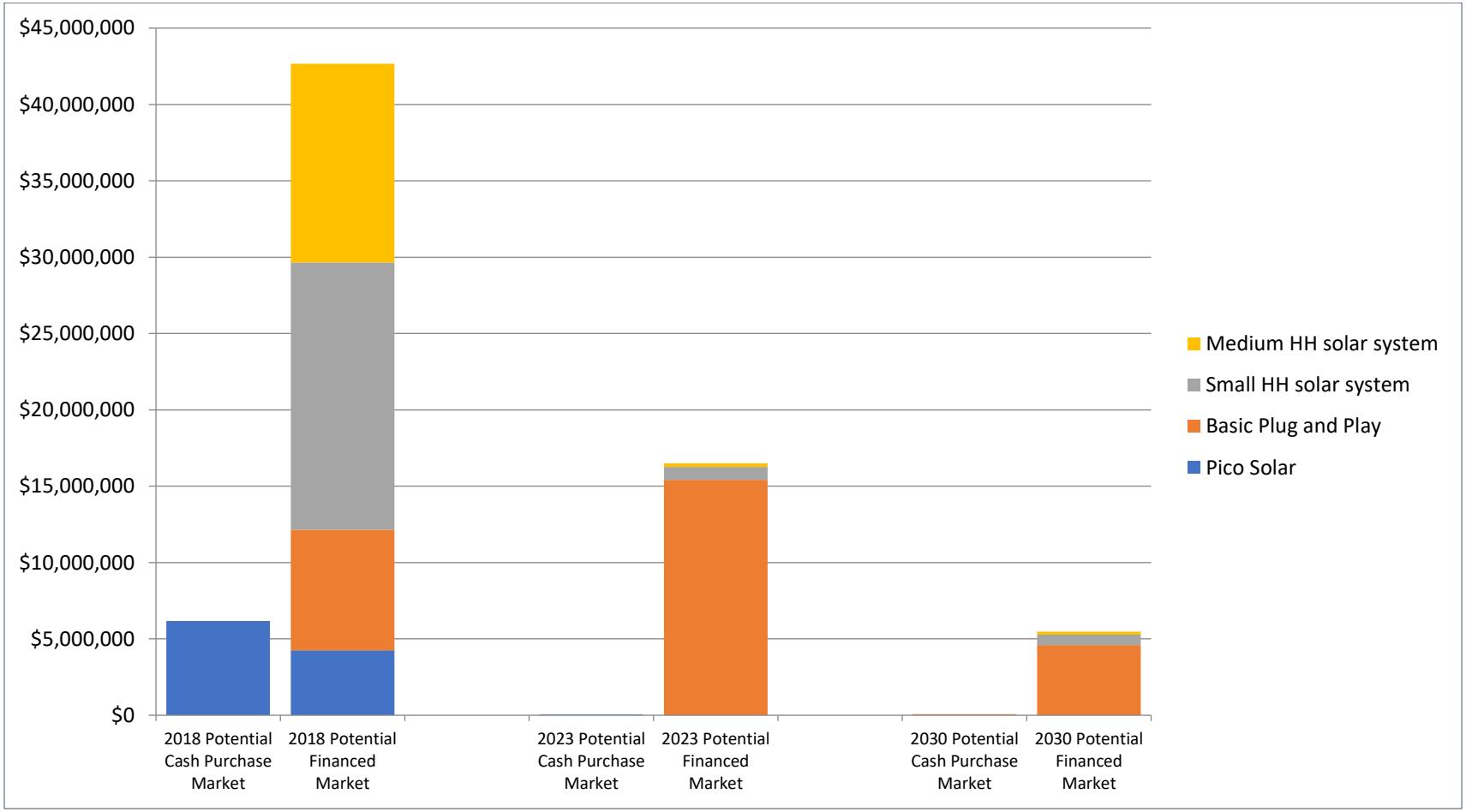
According to the analysis, the annualized off-grid solar cash market potential for the household sector in 2018 is USD 6.2 million, with the estimated market value growing nearly *sevenfold* to USD 42.7 million with the addition of consumer financing (**Figure ES-6**). Consumer financing allows the poorest 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 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

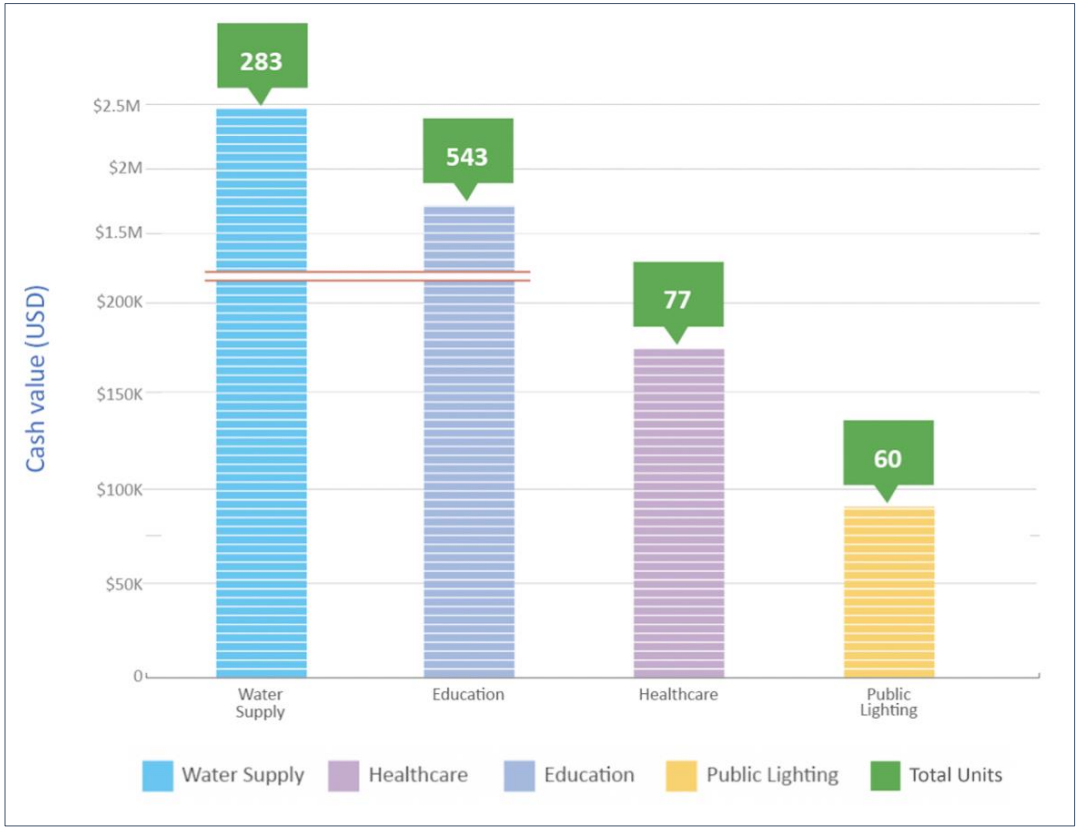
Source: African Solar Designs analysis

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

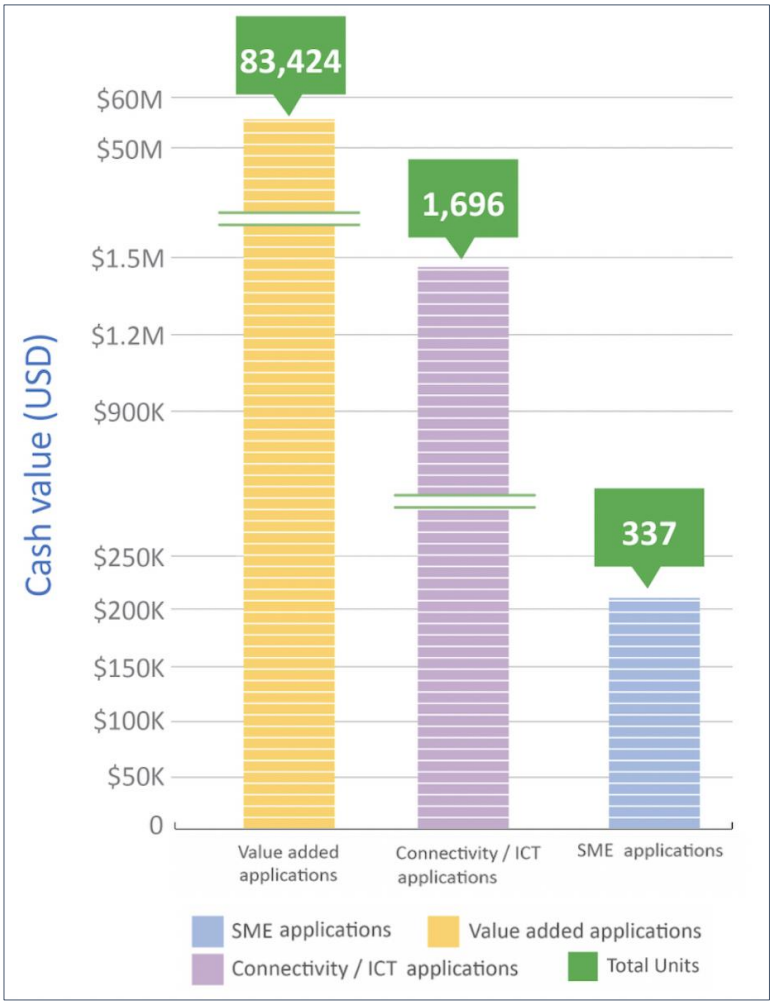


Source: African Solar Designs analysis

The estimated annualized cash market potential for Liberia's public/institutional sector in 2018 is USD 4.4 million (**Figure ES-8**). The institutional market segment with the largest potential is water supply (USD 2.4M), followed by education (USD 1.7M), healthcare (USD 174K) and public lighting (USD 89K). 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 57.1 million (**Figure ES-9**). The estimated demand from value-added applications represents most of the PUE market potential (USD 55.4M), followed by applications for connectivity (USD 1.4M) and SMEs (USD 210K).

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.

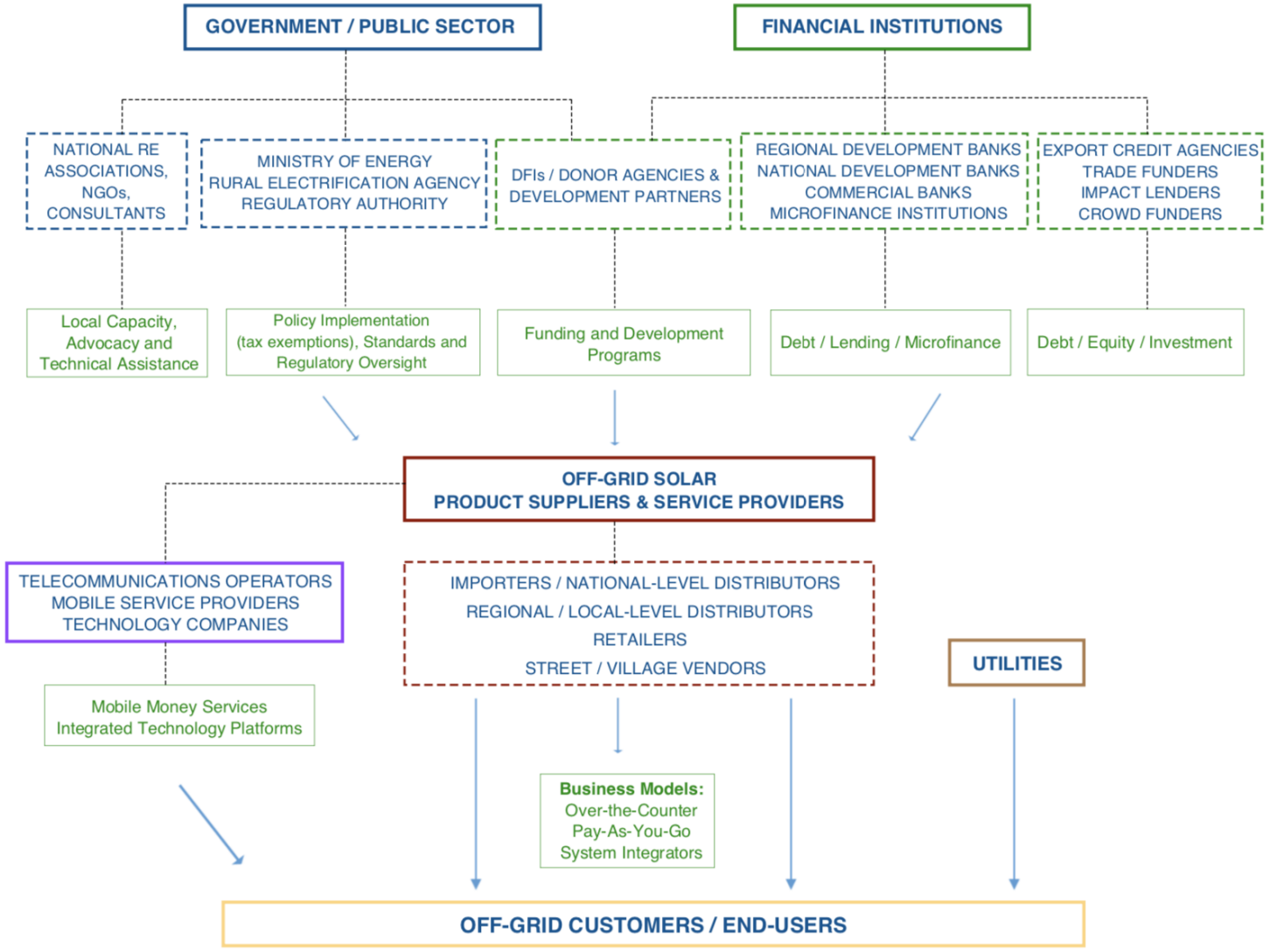
For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realties, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely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

Liberia'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 Liberia:

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 Liberia and throughout the region to support development of the OGS sector. In addition to commercial banks and microfinance institutions, impact investors and crowd funders are also active in several markets across the region.

In Liberia, financial inclusion has improved considerably in recent years, driven primarily by the proliferation of mobile money services. In 2017, 36% of the country's adult population had an account at a financial institution or with a mobile money service provider, up from 19% in 2011 and slightly above the West Africa and Sahel region's average of 33%. Despite this improvement, there is still a significant gender gap in rates of access to financial services, as Liberia's financial inclusion gender gap doubled from 8% in 2011 to 16% in 2017.[29]

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.

Given the importance of the mobile money sector, the GoL has made it the focus of its financial inclusion strategy. In 2014, the CBL launched the National Strategy for Financial Inclusion (NSFI) and subsequently in 2016, the Financial Sector Development Implementation Plan (FSDIP).[30] Under these initiatives, the

[29] 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

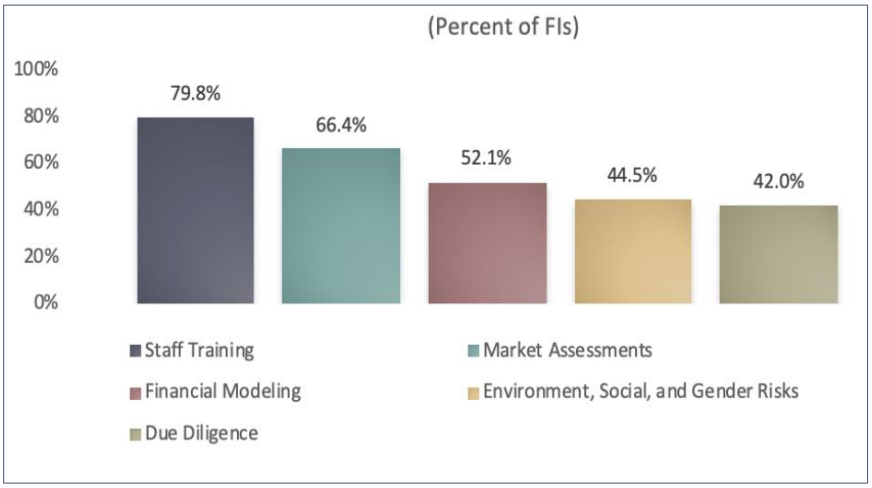
[30] "Increasing Responsible Financial Inclusion in Liberia," First Initiative, https://www.firstinitiative.org/projects/increasing-responsible-financial-inclusion-liberia

CBL amended its mobile money regulations to allow other institutions other than banks to provide mobile money services in the country. In addition, the Liberian Bank for Development and Investment (LBDI) and GN Bank Liberia were given approval to collaborate with mobile service providers to roll out mobile money platforms. In 2018, mobile money activities continued to increase in usage and transaction volume. However, the spread of more sophisticated mobile banking services remains limited due to weaknesses in connectivity, liquidity management challenges, and other economic constraints.[31]

While several donor-funded programs and initiatives have provided financing to support development of the country's OGS market, none of these funds have 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 sector opportunities thanks to initiatives such as the recently completed USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR) program.

According to the Task 3 survey of financial institutions in Liberia and across the region,[32] there is strong interest to provide financing to the off-grid solar sector. Respondents identified loan guarantees and credit lines as the most important measures to reduce market entry risks for lenders and stimulate FI engagement in the sector. Surveyed FIs also identified several areas of internal capacity that require improvement in order to lend (or increase lending) to the OGS sector (**Figure ES-11**). The most common need among FIs was training for bank staff, which includes *inter alia* assistance to originate deals and appropriately assess the credit risk of off-grid solar firms and projects, due diligence support to qualify products and approve vendors, and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. Technical assistance for solar enterprises (as is envisioned under Component 1B of ROGEP) will also be necessary, as entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

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



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

[31] "Republic of Liberia – From Growth to Development: Priorities for Sustainably Reducing Poverty and Achieving Middle-Income Status by 2030," World Bank, (May 2018): http://documents.worldbank.org/curated/en/585371528125859387/pdf/LBR-SCD-draft-10-06012018.pdf

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

Gender inclusiveness is also a key component of this market assessment, and the key findings of the gender analysis are presented throughout this report. Given that the off-grid market is only beginning to emerge in Liberia, 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.[33]

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**).[34]

[33] "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
[34] Ibid.

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

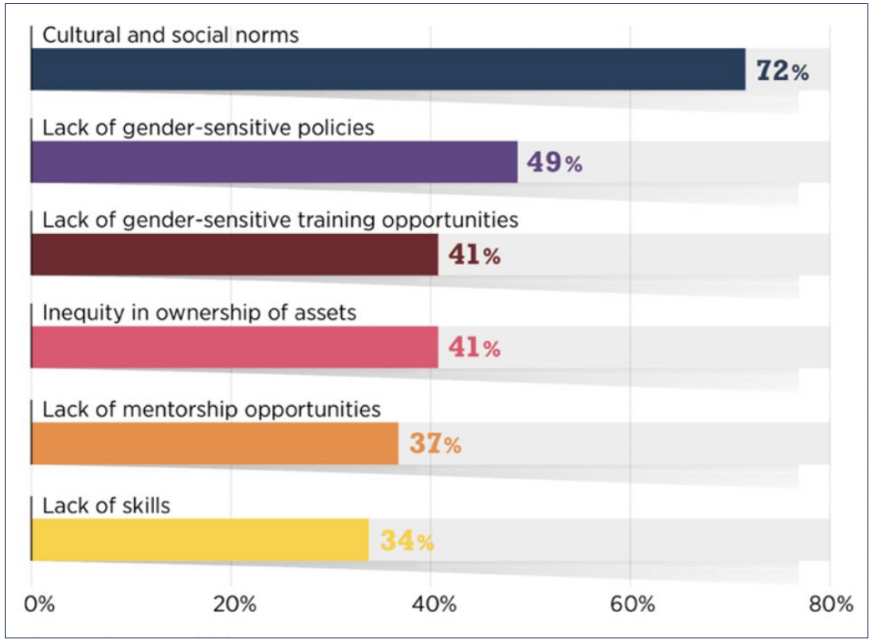
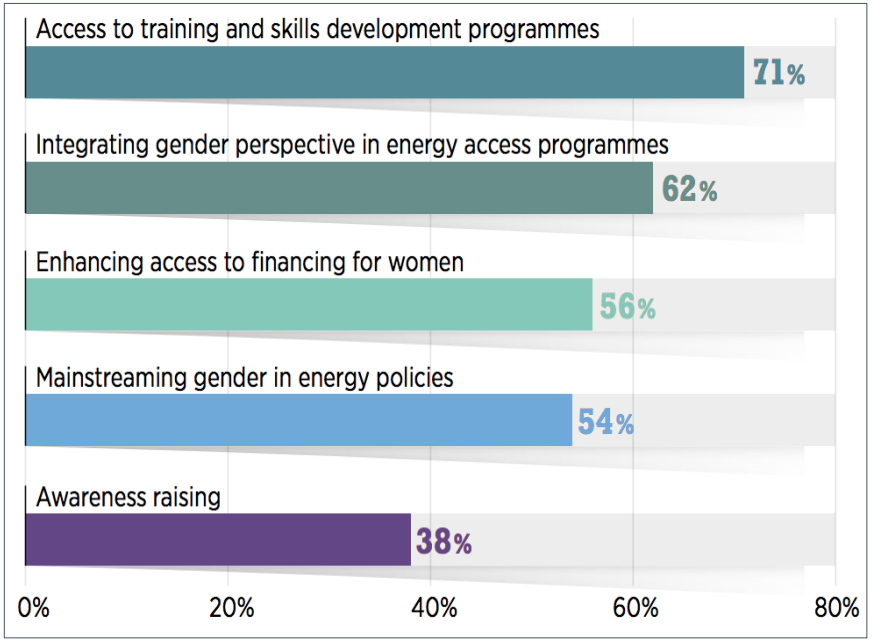


Figure ES-13: Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in Liberia 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 Liberia.[35]

[35] "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 Liberia (**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[36] in Liberia 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

The Liberian economy, which was destroyed by the country's long civil war, began to slowly recover following the installation of a democratic government in 2006. In 2014-2015, economic growth stagnated due to low commodity prices and the Ebola outbreak, which caused massive disruptions to the country's development efforts. Driven by exports of its rich mineral resources, growth was listed at 2.6% in 2017 and is projected to reach 3.9% in 2018 and 5% in 2019.[37] The country's macroeconomic gains have not translated into improvements for the majority of the population, as education and healthcare services are inadequate, and rates of unemployment and poverty remain high, particularly in rural areas. While the extractive industry and services sector account for nearly two-thirds of GDP, 70% of the labor force remains in agriculture. The country's economy continues to be highly dependent upon foreign aid.

Table 1: Macroeconomic and Social Indicators

Population	4.73 million[38]
Urban Population	50% of total
GDP	USD 3.2 billion
GDP growth rate	2.5%
GNI per capita*	USD 620
Unemployment rate	2.39%
Poverty rate	63.8% (2016)[39]
Urban	55.1%
Rural	67.7%
Currency	Liberian Dollar (LRD)
Official language	English
Natural resources	Agricultural (cocoa, palm oil); ores (iron ore, gold, timber, diamonds, rubber)

* World Bank Atlas method (current USD)[40]

All figures from 2017 unless otherwise indicated
Source: AfDB, World Bank and Liberia Institute for Statistics and Geo-Information Services

[36] 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
[37] "Liberia Economic Outlook," African Development Bank, (2018): https://www.afdb.org/en/countries/west-africa/liberia/
[38] 50.3% male / 49.7% female
[39] Liberia Household Income and Expenditure Survey 2016: http://microdata.worldbank.org/index.php/catalog/2986
[40] "World Bank Open Data: Liberia," World Bank, (2017): https://data.worldbank.org/country/liberia

1.2 Energy Market

1.2.1 Energy Sector Overview

The Liberia Electricity Corporation (LEC) is the country's public utility that has a monopoly over generation, transmission, and distribution of power. The Ministry of Mines and Energy (MME) is responsible for energy policy formulation and works with the Rural and Renewable Energy Agency (RREA) to improve rural electrification. The Liberia Electricity Regulatory Commission (LERC), through the Energy Regulatory Board (ERB) acts as the energy sector's regulatory authority. The Government of Liberia (GoL or "the Government") is in the process of implementing regulatory measures to increase private sector participation in off-grid development, including opening the off-grid sector to private operators to distribute stand-alone solar products and systems.

Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Ministry of Lands, Mines and Energy (MME)	Ministry responsible for overseeing the energy sector in Liberia. MME develops and implements national energy policies enforces electricity laws.
Department of Energy (DOE)	Department within the MME responsible for overseeing all energy-related activities.
Liberia Electricity Corporation (LEC)	State-owned utility responsible for improving and expanding electricity services to meet demand and ensure that efficient, reliable and affordable power is available to serve as a catalyst for socio-economic development
Liberia Electricity Regulatory Commission (LERC); Energy Regulatory Board (ERB)	Independent regulatory authority responsible for monitoring all electricity policies, agreements, contracts, and standards that MME, DOE, and other Liberian agencies engage in via the Energy Regulatory Board (ERB)
Rural and Renewable Energy Agency (RREA)	Independent agency, established under the MME, is responsible for facilitating and accelerating the economic transformation of rural Liberia by promoting the commercial development and supply of modern energy products and services to rural areas through the private sector and community initiatives with an emphasis on locally available renewable resources. The RREA is also responsible for managing the Rural Energy Fund (REFUND). RREA is an independent agency of the GoL with a Board of Directors appointed by the President.
Liberia Energy Network (LEN)	One of several entities responsible for distribution of solar lamps; LEN purchases lamps from RREA at affordable prices and sells them to rural communities at affordable costs. (RREA does not pay custom duties and other charges on the products, thus importing them below market value).

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

1.2.2 Electricity Access: *Grid and Off-grid*

Energy access in Liberia represents a significant challenge, as the country has one of the lowest electrification rates in the world. In 2016, an estimated 88% of the population – over four million people – did not have access to electricity, with a significant disparity in rates of access between urban (16% access) and rural (3% access) areas.[41] The GoL has set a target of increasing electrification rates to 70% in the capital Monrovia and 35% of rural areas by 2025 and universal electricity access nationwide by 2030.[42]

[41] "Energy Access Outlook, 2017: From Poverty to Prosperity," International Energy Agency, (2017): https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf
[42] "Liberia National Renewable Energy Action Plan," SEforALL/ECREEE, (2015): http://se4all.ecreee.org/sites/default/files/national_renewable_energy_action_plans_nreap_-_liberia.pdf

1.2.2.1 Off-Grid Market Overview

The Liberian power sector remains largely underdeveloped, with limited transmission infrastructure outside of Monrovia. Off-grid electrification has been a policy priority, as the GoL is implementing a range of measures through the RREA to extend transmission and distribution lines, develop renewable energy sources and provide a framework for off-grid electrification to meet its long-term development objectives. The ECOWAS Energy Protocol has established a foundation for Liberia's national energy policy to support development of the off-grid sector. Under this framework, the Government plans to establish an Off-Grid Power and Renewable Energy Unit within the RREA and to utilize the Rural Energy Fund (REFUND) to support off-grid project planning and development.

The main sector policy is the 2009 National Energy Policy, while the Rural Energy Strategy and Master Plan (RESMP) has put in place ambitious electrification targets through 2030, including a "Beyond the Grid" (BTG) program that will utilize a combination of grid extension and off-grid RE technologies to electrify rural areas (**Figure 1**). Beyond the Grid has three main initiatives:[43]

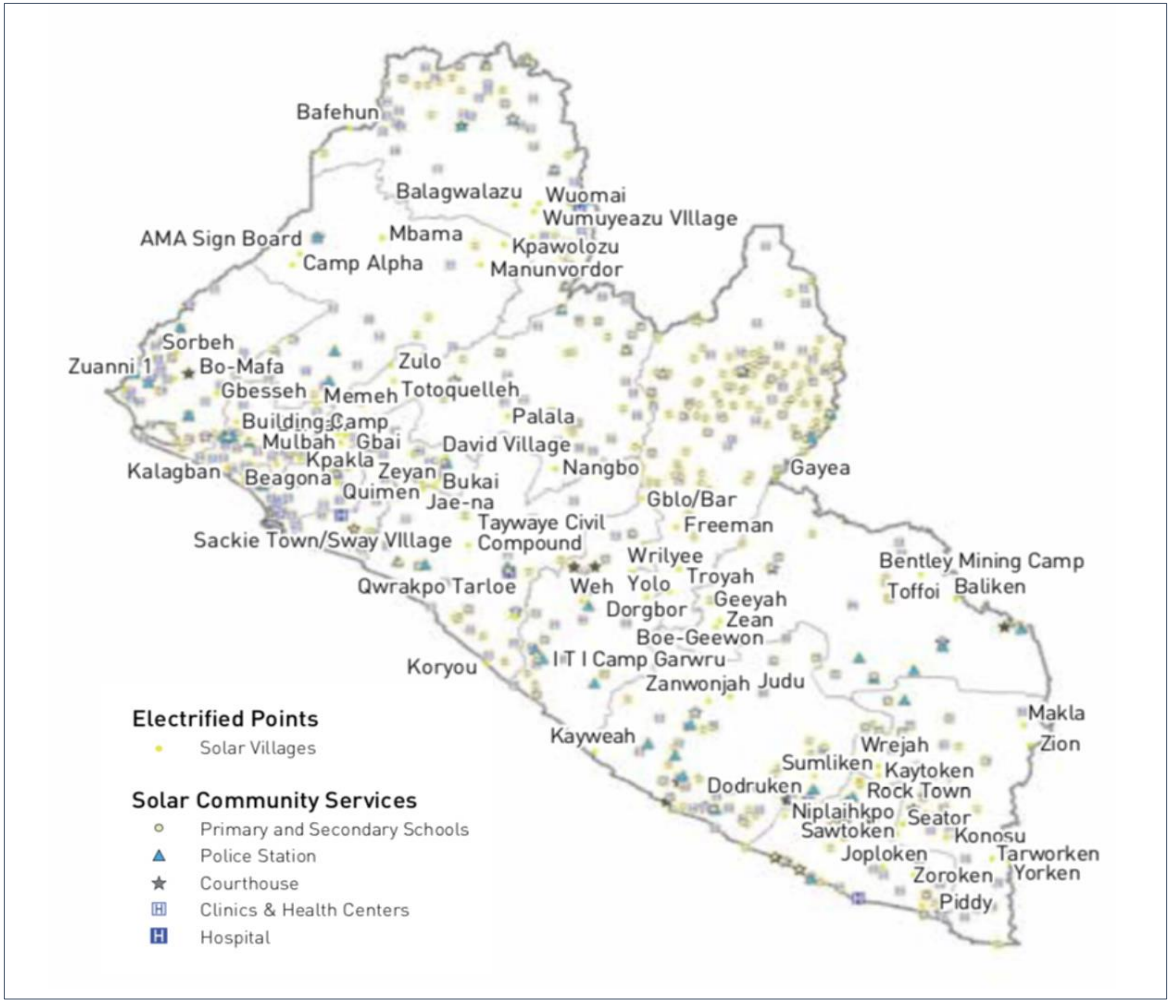
- **Solar Villages and Home Systems:** This initiative aims to provide solar to small rural communities with low levels of consumption and, due to their significant distance to electricity grids, are not viable for grid connection in the long-term. The RREA estimates that five communities in each county will be connected with these systems, totaling 75 solar systems nationwide through 2030.
- **Solar Community Services**: This initiative consists of installing solar systems in non-electrified community / institutional centers (government, healthcare, education, security etc.). The initiative will be implemented over several phases through 2030.
- **Solar Portable Lamps**: This initiative will build upon and reinforce the existing Solar Portable Lamp initiative through the creation of Rural Services Units, responsible for managing the import and distribution of solar lamps, while RREA will maintain responsibility for procurement and for communication/information campaign.

The Liberian SEforALL Action Agenda envisages universal access to electricity via a highly decentralized model that if developed could serve 68% of the population with a combination of mini-grids and stand-alone systems. Plans formulated by RREA, with support from the U.S. Agency for International Development (USAID) envision a nationwide effort to electrify the country using primarily off-grid renewable resources. The RREA has prioritized development of a range of small hydro, biomass and solar off-grid renewable energy projects throughout the country to date.[44] There are also a number of donor-funded initiatives in the off-grid solar sector. In 2016, the World Bank provided USD 27 million for the Liberia Renewable Energy Access Project (LIRENAP), which includes provisions for 100,000 people nationwide to gain electricity access through stand-alone solar systems and lanterns.[45] The EU and USAID have funded similar programs promoting off-grid solar development in Lofa county (**Table 9**).

In addition to these public initiatives, several private companies are expanding their operations in the country's off-grid space, providing pico solar, solar home systems (SHS) and larger stand-alone solar solutions utilizing Pay-As-You-Go (PAYG) and Rent-To-Own business models (see **Section 2.4**). As shown in **Figure 2**, installations have been installed mainly in clinics, health centers and schools throughout the country. As of 2018, a total of 15 clean energy mini-grids were operational in the country.

[43] "Rural Energy Strategy and Master Plan for Liberia, 2030," Rural and Renewable Energy Agency, Developed by Gesto Energy Consulting, (2016): http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf
[44] "Liberia," ClimateScope, Bloomberg New Energy Finance, (2017): http://global-climatescope.org/en/country/liberia/#/enabling-framework
[45] "New Energy Project Targets 150,000 Liberians for Increased Access to Affordable and Reliable Electricity," World Bank, (January 11, 2016): http://www.worldbank.org/en/news/press-release/2016/01/11/new-energy-project-targets-150000-liberians-for-increased-access-to-affordable-and-reliable-electricity

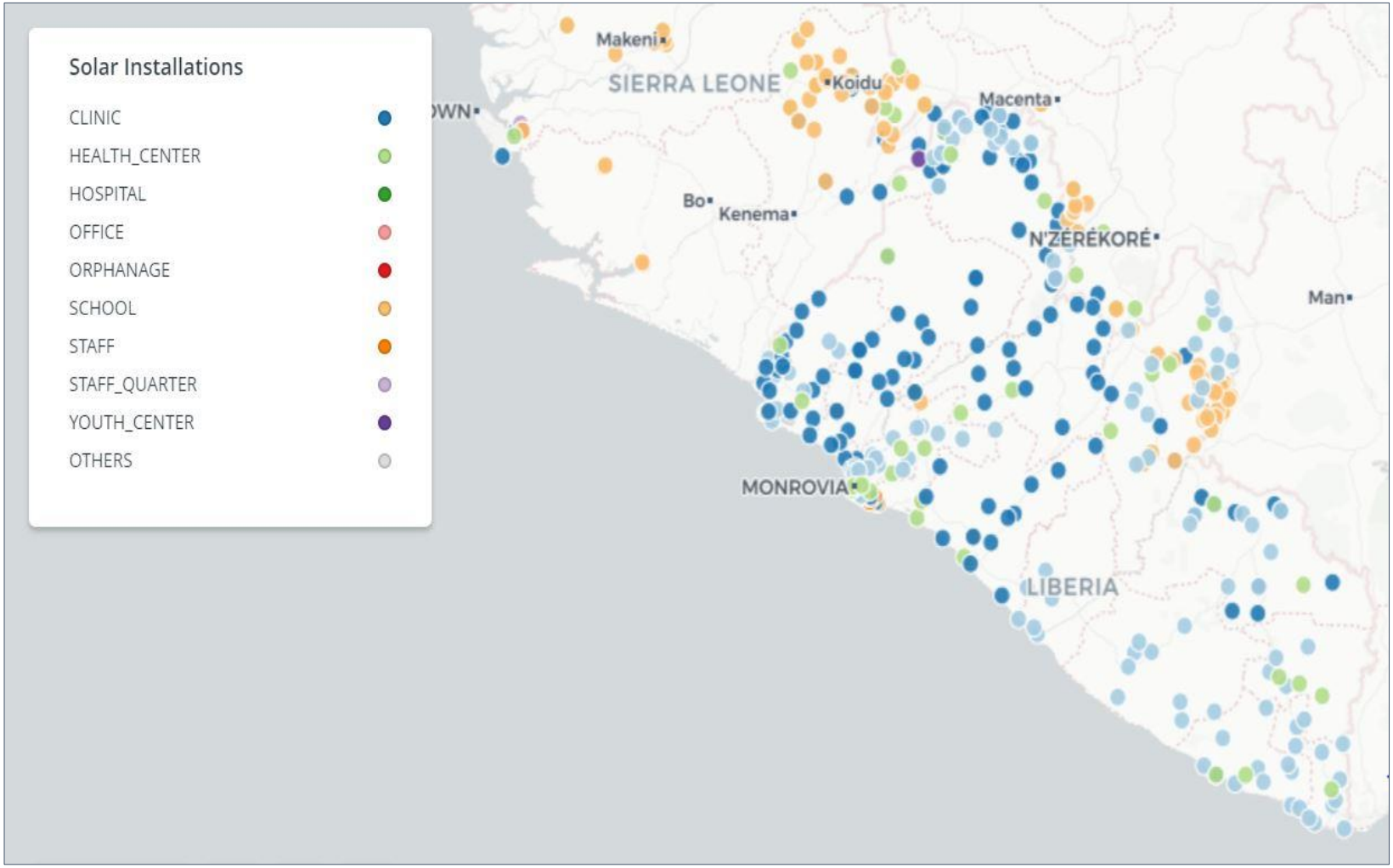
Figure 1: Rural Energy Master Plan – Beyond-the-Grid Program[46]



Source: Rural and Renewable Energy Agency

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

Figure 2: Solar Installations by Type of Facility



Source: Renewables Salone

1.2.2.2 Demand and Supply/Generation Mix

The Liberian electricity grid reached 126 MW of installed capacity – 88 MW of hydropower, and 38 MW of diesel and heavy fuel oil (HFO) capacity – with the addition of the Mt. Coffee Hydroelectric dam in 2017.[48] The installed capacity is operated by the LEC, although it struggles to provide reliable service due to insufficient transmission and distribution infrastructure. The majority of Liberians use biomass for heating and cooking and private small-scale diesel generators for electricity. Higher-income households in urban areas have access to electricity from the grid and also use liquid petroleum gas as a fuel source.

Table 3: Electricity Sector Indicators, 2017[47]

Installed Capacity	126 MW
Thermal	38 MW
Hydropower	88 MW
Renewable (non-hydro)	-
National electrification rate (2016) Urban electrification rate Rural electrification rate	12% 16% 3%
Population without access	4 million
Households without access	800,000
Electrification target	Universal access by 2030

Source: MME, IEA and World Bank

Table 4: Current and Planned Installed Capacity[49]

Installed Capacity (MW)	2017	2020 (planned)	2025 (planned)	2030 (planned)
Thermal (Diesel & HFO)	38	38	41	54
Hydro	88	231	456	456
Solar	-	20	52	60
Biomass	-	251	504	504
Total Installed Capacity (MW)	**126**	**546**	**1,053**	**1,066**
Total thermal	38	38	41	54
Total renewable energy	88	508	1,012	1,012

Source: SEforALL National Renewable Energy Action Plan

As energy demand grows, increasing available supply will be critical to meeting the country's development objectives and increasing rates of energy access. To achieve this, Liberia plans to tap into an estimated potential of more than 1 GW of hydropower, with supplemental contributions from biomass, wind (relatively low potential)[50], solar and thermal capacity (**Table 4**). Although the country also has a strong solar resource, there is still no grid-connected solar in the national grid of LEC.

As Liberia's goals for overall supply growth focus on utility-scale projects serving population centers and grid-connected areas, stand-alone solar and mini-grid solutions will be critical to meet national targets and to provide electricity to the country's massive rural population.[51] In 2018, with a view to accelerate access to electricity through both grid and off-grid options, the GoL, with World Bank support, has embarked on a study to develop a National Electrification Strategy through the help of geospatial planning tool.

[47] See **Section 2.1** for more details on households/population without access to electricity
[48] "Power Africa Liberia Fact Sheet," USAID, https://www.usaid.gov/powerafrica/liberia
[49] "Liberia National Renewable Energy Action Plan," SEforALL/ECREEE, (2015): http://se4all.ecreee.org/sites/default/files/national_renewable_energy_action_plans_nreap_-_liberia.pdf
[50] "Energy Profile Liberia," United Nations Environment Programme: https://wedocs.unep.org/bitstream/handle/20.500.11822/20504/Energy_profile_Liberia.pdf?sequence=1&isAllowed=y
[51] "SEforALL Africa Hub – Liberia," SEforALL, https://www.SEforALL-africa.org/seforall-in-africa/country-data/liberia/

1.2.2.3 Transmission and Distribution Network

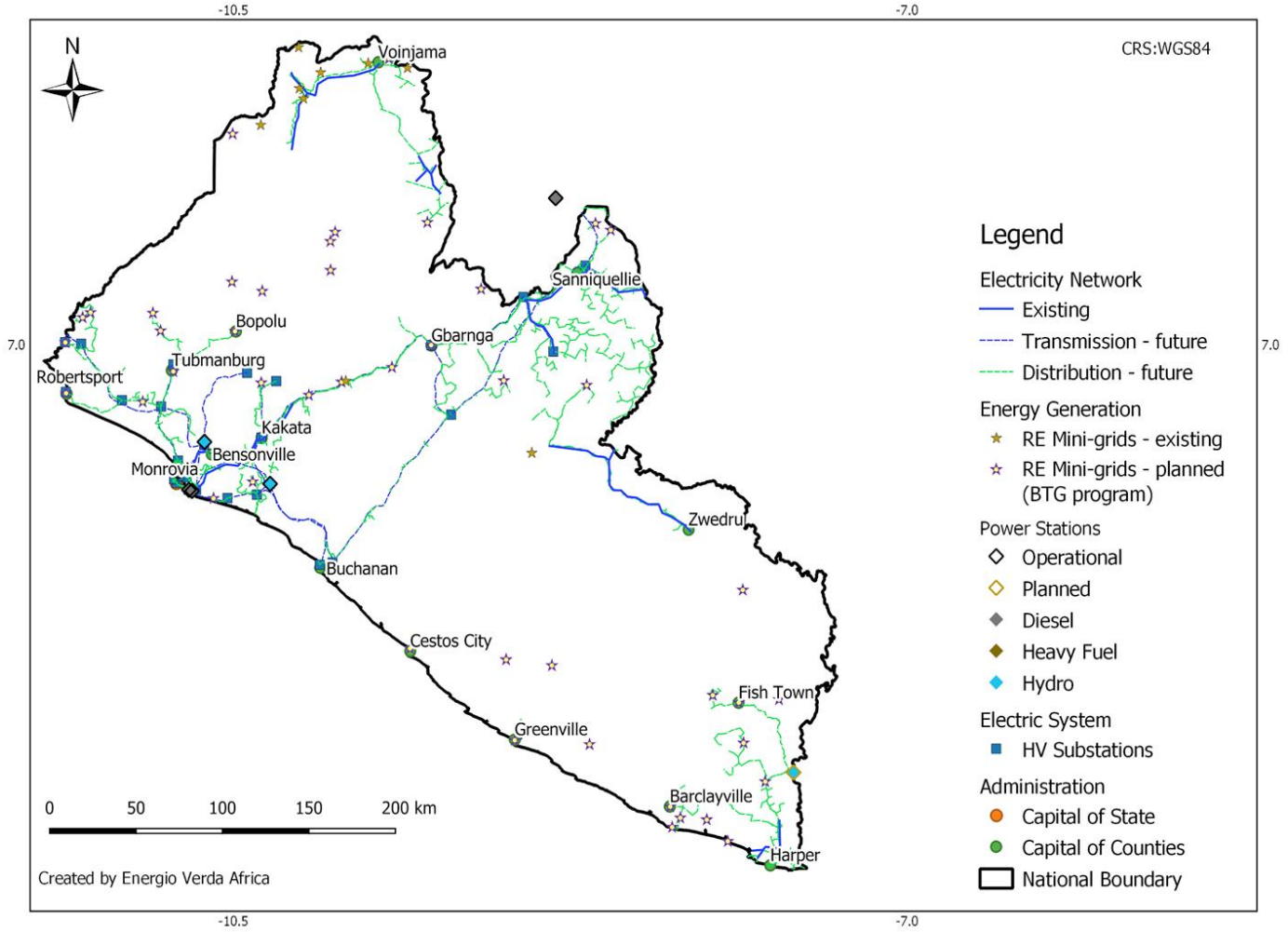
Nearly three-quarters of Liberia's electricity network was destroyed during the country's civil war. The country is still dealing with the impact of this today, with one of the lowest electrification rates in the world. Prior to the war, nearly 200 MW of installed capacity existed on the grid. Since the war's end in 2003, the grid has been slowly recovering. Yet, a significant gap still exists between the infrastructure needs of the power sector and the availability of resources to invest in grid maintenance and extension to rural areas.

The Liberian transmission and distribution network (**Figure 3**) is administered by the LEC, which currently provides service to an estimated 52,000 consumers (about 25,000 active connections), all concentrated in the Greater Monrovia area, while an estimated four million homes lack access to the electricity grid.[52] Despite having one the world's highest electricity tariffs (~USD 0.38/kWh),[53] electricity service remains largely unreliable (**Figure 4** and **Figure 5**). The LEC uses funds from various bilateral and multilateral donors and development partners to contract supply and installation companies to expand and rehabilitate its electricity network.[54]

Liberia is also part of the West African Power Pool (WAPP), with grid extension lines currently under construction to connect the country to the regional network. Through the WAPP, Liberia intends to import an estimated 27 MW of electricity from Côte d'Ivoire. The WAPP-CLSG System Redevelopment Sub-program – a regional transmission project that will connect Côte d'Ivoire, Liberia, Sierra Leone and Guinea (CLSG) – includes plans to electrify rural communities along the HV lines with step down low-voltage lines.[55]

[52] "Liberian Government and World Bank Sign West Africa Power Pool Agreement," MOFA, (2012): http://mofa.gov.lr/public2/2press.php?news_id=659&related=7&pg=sp
[53] "RISE Liberia Retail Tariffs," World Bank, (2018): http://rise.worldbank.org/country/liberia
[54] "Liberia Sustainable Energy for All," SEforALL, (2015): http://SEforALL.ecreee.org/sites/default/files/sustainable_energy_for_all_SEforALL_action_agenda_report_2015_-_liberia.pdf
[55] "West African Power Pool: CLSG Power System Redevelopment Sub-Program," World Bank: http://siteresources.worldbank.org/INTENERGY2/Resources/exercise.pdf

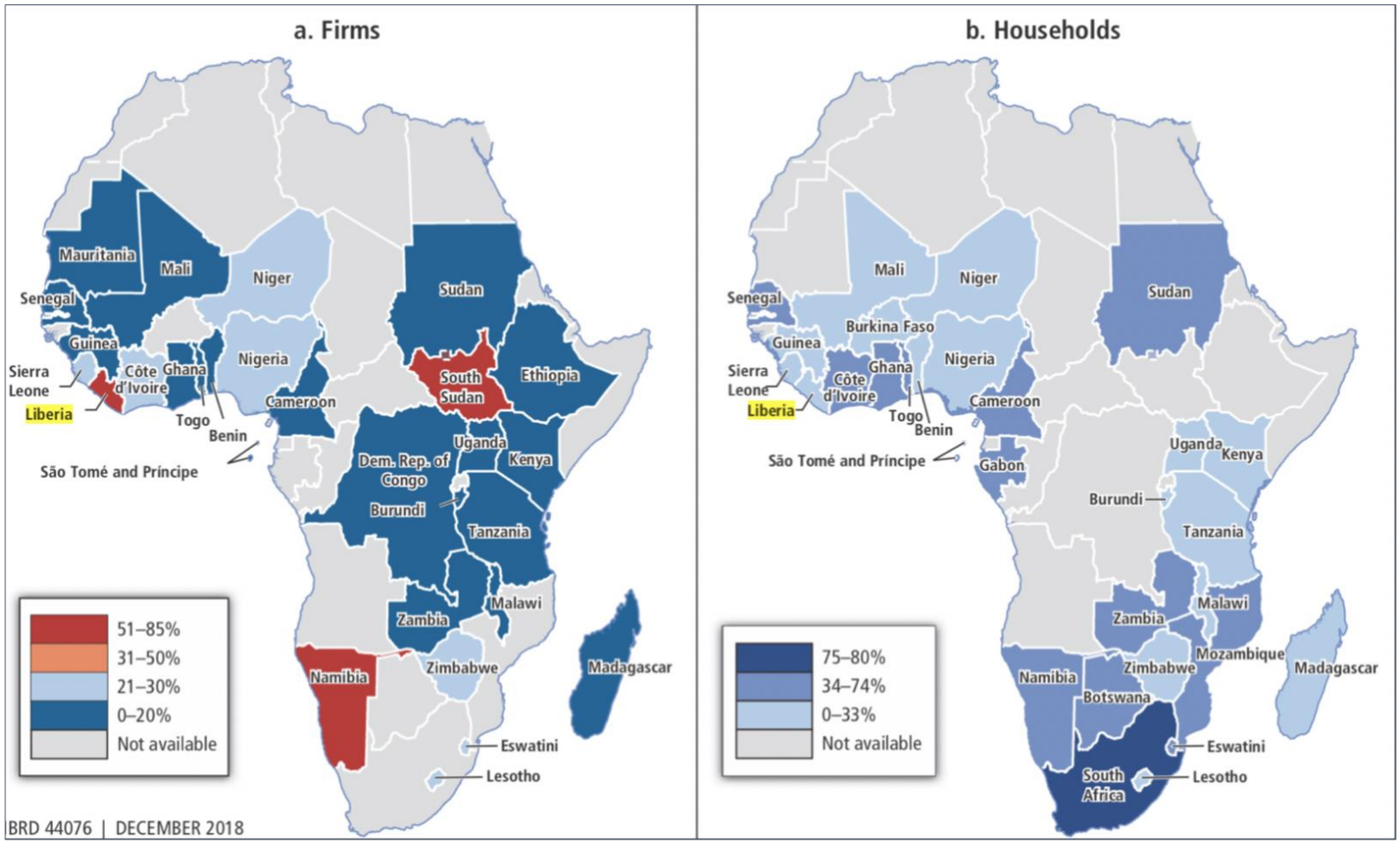
Figure 3: Electricity Transmission and Distribution Network[56]



Source: Energio Verda Africa GIS analysis

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

Figure 4: Access to Reliable Electricity by Firms and Households in Africa[57]

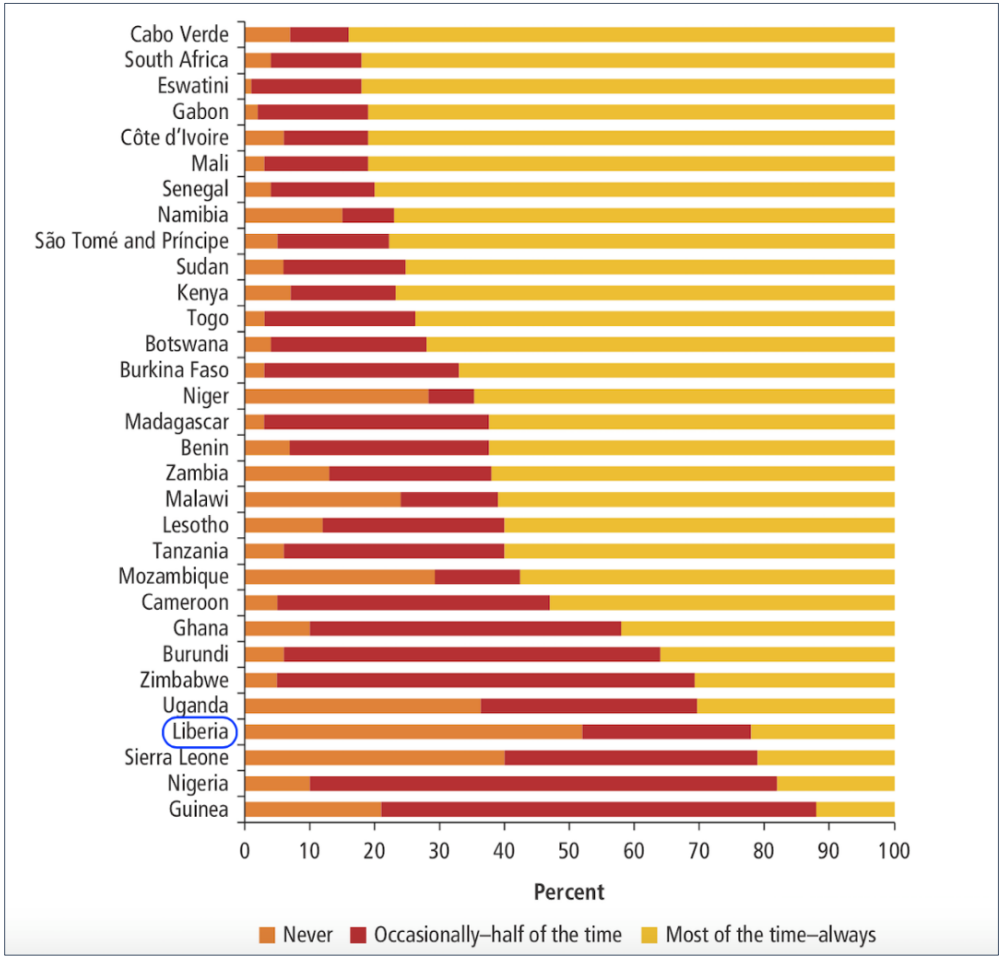


Source: World Bank Enterprise Surveys, 2013-2017 and Afrobarometer Household Surveys, 2014-2015

The maps in **Figure 4** illustrate the share of firms (Panel a) and households (Panel b) reporting access to a reliable supply of electricity across Africa. In Liberia, about half of surveyed firms and fewer than one-third of surveyed households reported having reliable access to electricity.

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

Figure 5: Reliability of Grid Electricity in Connected Households in Africa[58]



Source: Afrobarometer Household Surveys, 2014-2015

Figure 5 shows the variation in the reliability of grid electricity for connected households across Africa. In Liberia, fewer than 20% of households reported receiving electricity supply at least most of the time, while about one-third of surveyed households indicated having electricity only occasionally.

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

1.2.2.4 Least-Cost Electrification Analysis

A least-cost electrification analysis has been performed to assess the potential development of electricity access in Liberia through 2023 and through 2030 ("Scenario 2023" and "Scenario 2030").[59] 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 Liberia 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 Liberia based on their proximity to electrical infrastructure, population density or nodes of economic growth.

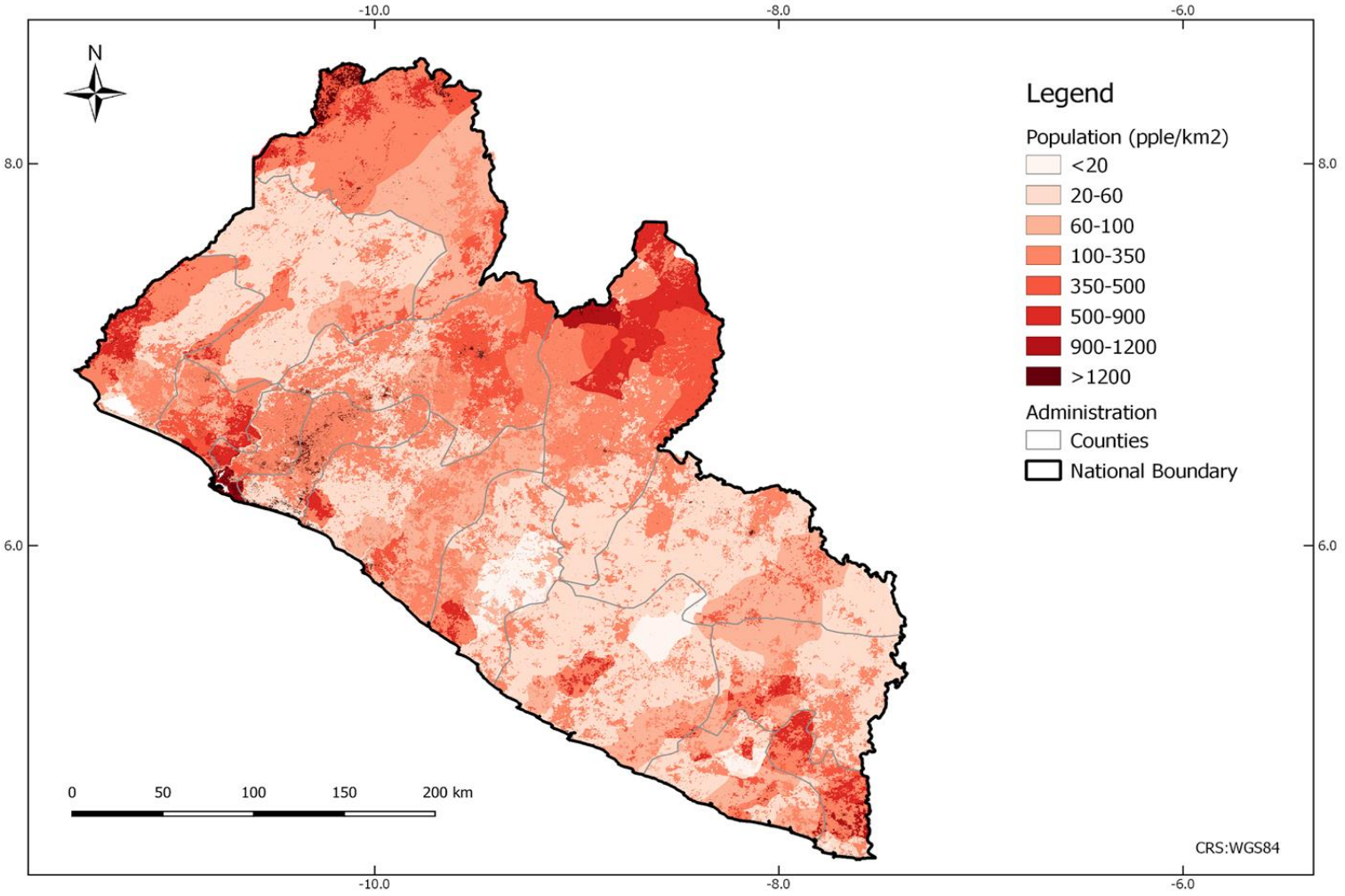
For the scenario 2023 analysis, it is assumed that widespread densification of the existing electrical grid will enable settlements within 5 km of existing grid lines and Power Stations to connect to the grid (according to LEC).[60] Beyond this area, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km^2) and have active local economies, evidenced by the presence of social facilities and by their proximity to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km^2) or far from the national grid – are defined as 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 (according to LEC) and 5 km of future planned line extensions are assumed to be connected. The electricity lines used in the analysis are following the 'Accelerated Electrification through decentralized grids alongside grid extension plans,' set out as Scenario 1B in the Liberia Rural Energy Strategy and Master Plan.[61] 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, mines and urban areas. All other settlements are defined as 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 high and medium voltage network, but that are located beyond 15 km of areas with night-time light emissions (indicative of electrification). Settlements in areas of low population density (below 350 people/km^2) that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within the scenario 2023.[62] Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 2.5%[63] was applied to the geospatial analysis to project population figures for scenario 2023 and 2030 analyses.[64] **Figure 6** shows population density across the country, which served as the basis for this analysis.

[59] NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to GoL electrification targets for 2030
[60] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[61] "Rural Energy Strategy and Master Plan for Liberia until 2030," Gesto Energy Consulting, (2016).
[62] Note that this analysis was performed for scenario 2023 but not for scenario 2030 due to uncertainties regarding population densities being too high over such a long timeframe
[63] https://data.worldbank.org/indicator/SP.POP.GROW?locations=LR
[64] Please refer to **Annex 1** for the results of this analysis as well as more details on the approach and methods used

Figure 6: Population Density, 2014[65]



Source: Energio Verda Africa GIS analysis

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

- **Results**

Table 5 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 (5.0 persons per household).[66]

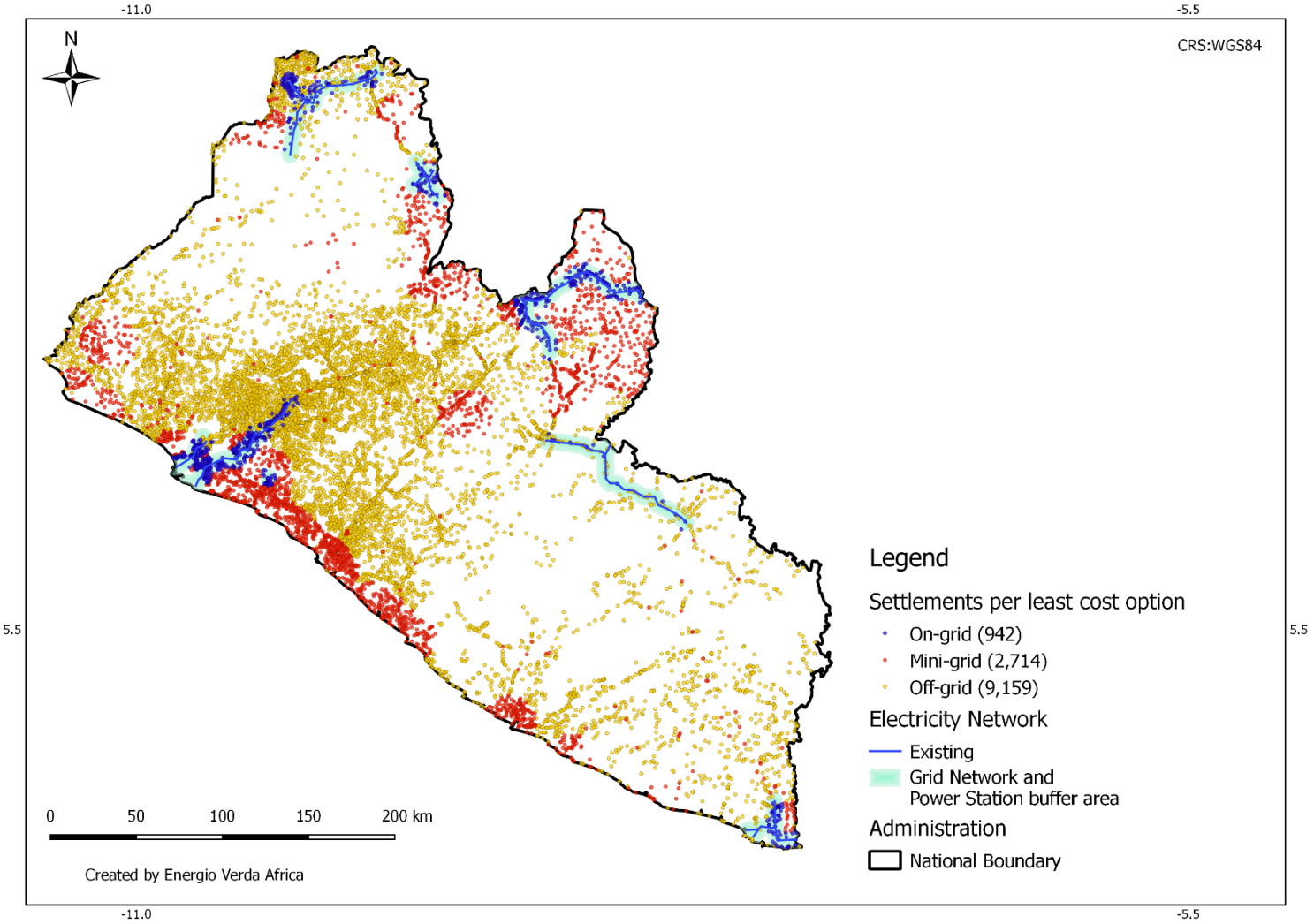
Table 5: Results of Least-Cost Electrification Analysis

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	942	2,714	9,159	443	1,385	11,430
	% of settlements	7.4%	21.2%	71.5%	32.0%	10.8%	89.2%
	Total population	1,507,090	1,670,154	2,284,033	142,039	1,649,129	3,812,147
	% of population	27.6%	30.6%	41.8%	8.6%	30.2%	69.8%
	Number of households	301,418	334,031	456,807	28,408	329,826	762,429
Scenario 2030	Number of settlements	6,887	2,215	3,713	Not calculated	6,887	5,928
	% of settlements	53.7%	17.3%	29.0%	Not calculated	53.7%	46.3%
	Total population	4,795,826	623,391	1,072,524	Not calculated	4,795,826	1,695,916
	% of population	73.9%	9.6%	16.5%	Not calculated	73.9%	26.1%
	Number of households	959,165	124,678	214,505	Not calculated	959,165	339,183

Source: Energio Verda Africa GIS analysis

[66] "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

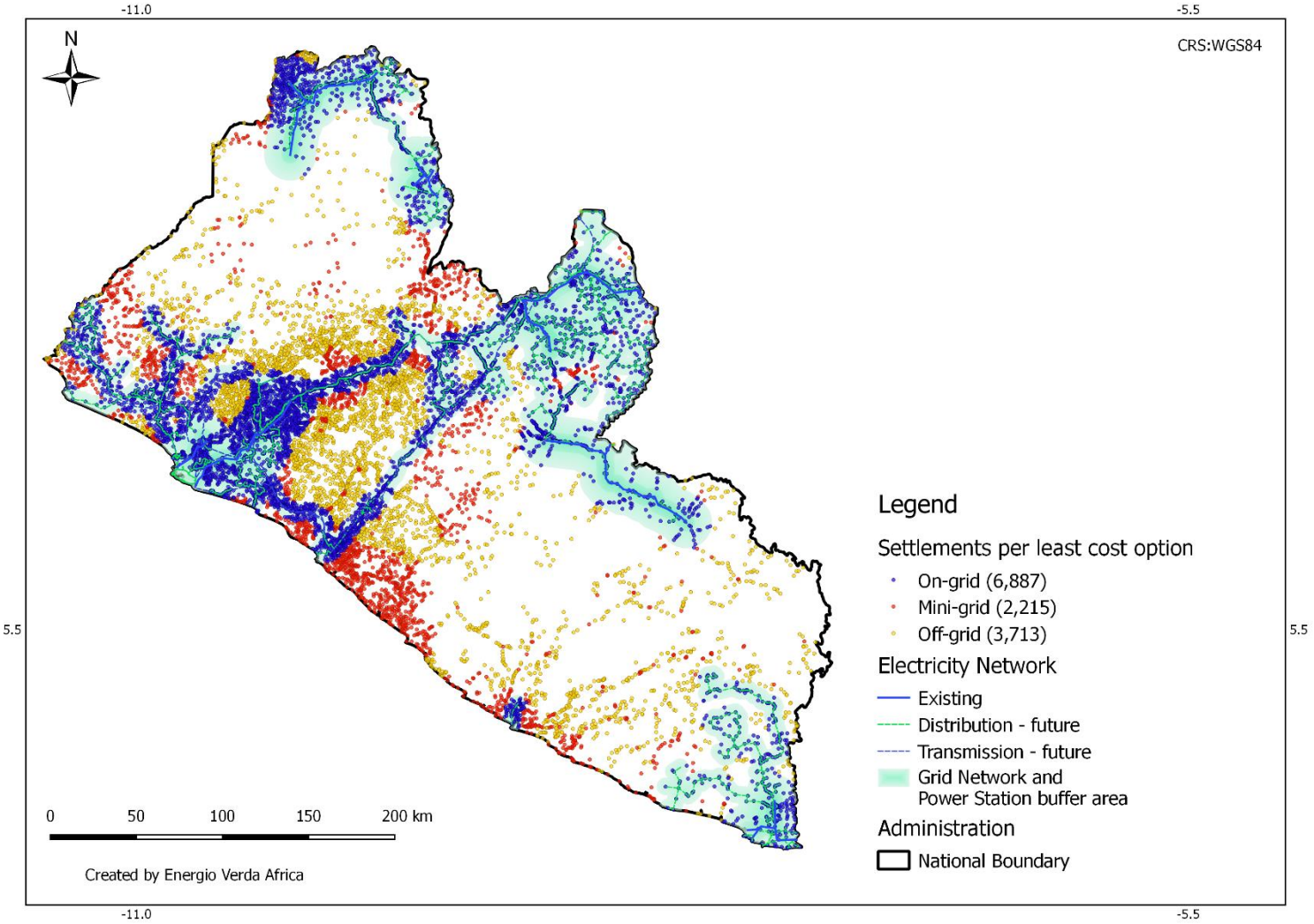
Figure 7: Distribution of Settlements by Least-Cost Electrification Option, 2023[67]



Source: Energio Verda Africa GIS analysis

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

Figure 8: Distribution of Settlements by Least-Cost Electrification Option, 2030[68]



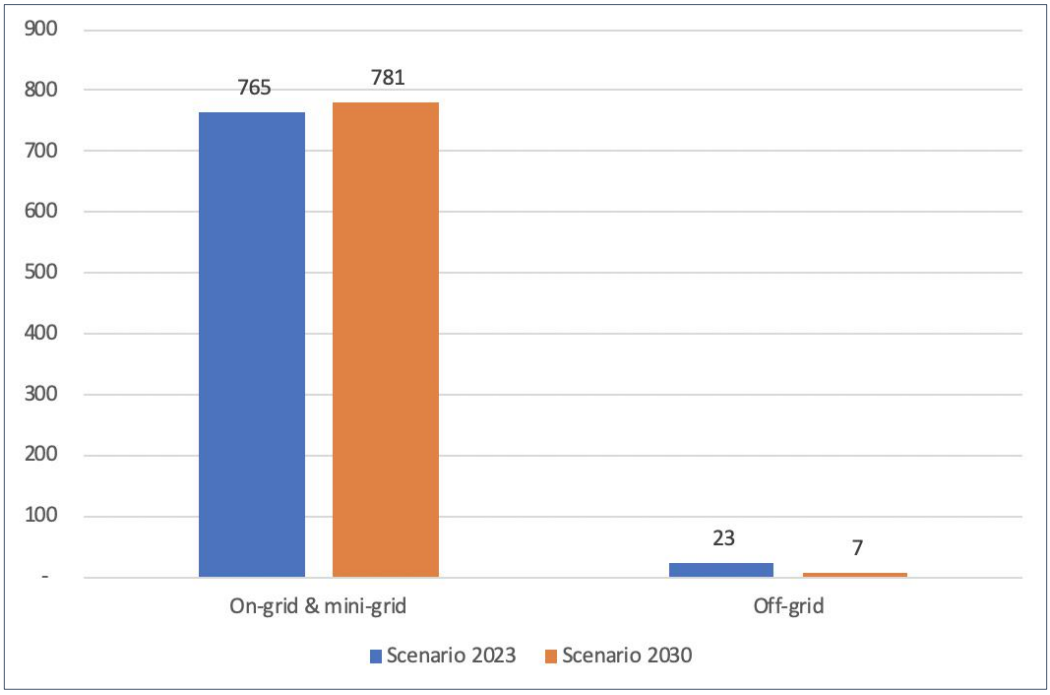
Source: Energio Verda Africa GIS analysis

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

The analysis also covered the health facilities that will remain off-grid during the analyzed timeframes.[69] The number of health facilities cannot be seen as comprehensive as not all were available for the geospatial analysis (facilities with known coordinates); a total of 788 health facilities were analyzed.

Figure 6 summarizes the number of health facilities that will be electrified (on-grid and mini-grid) or suitable for off-grid stand-alone solutions in scenarios 2023 and 2030. **Figure 7** illustrates the distribution of potential off-grid facilities across the country under the two scenarios.

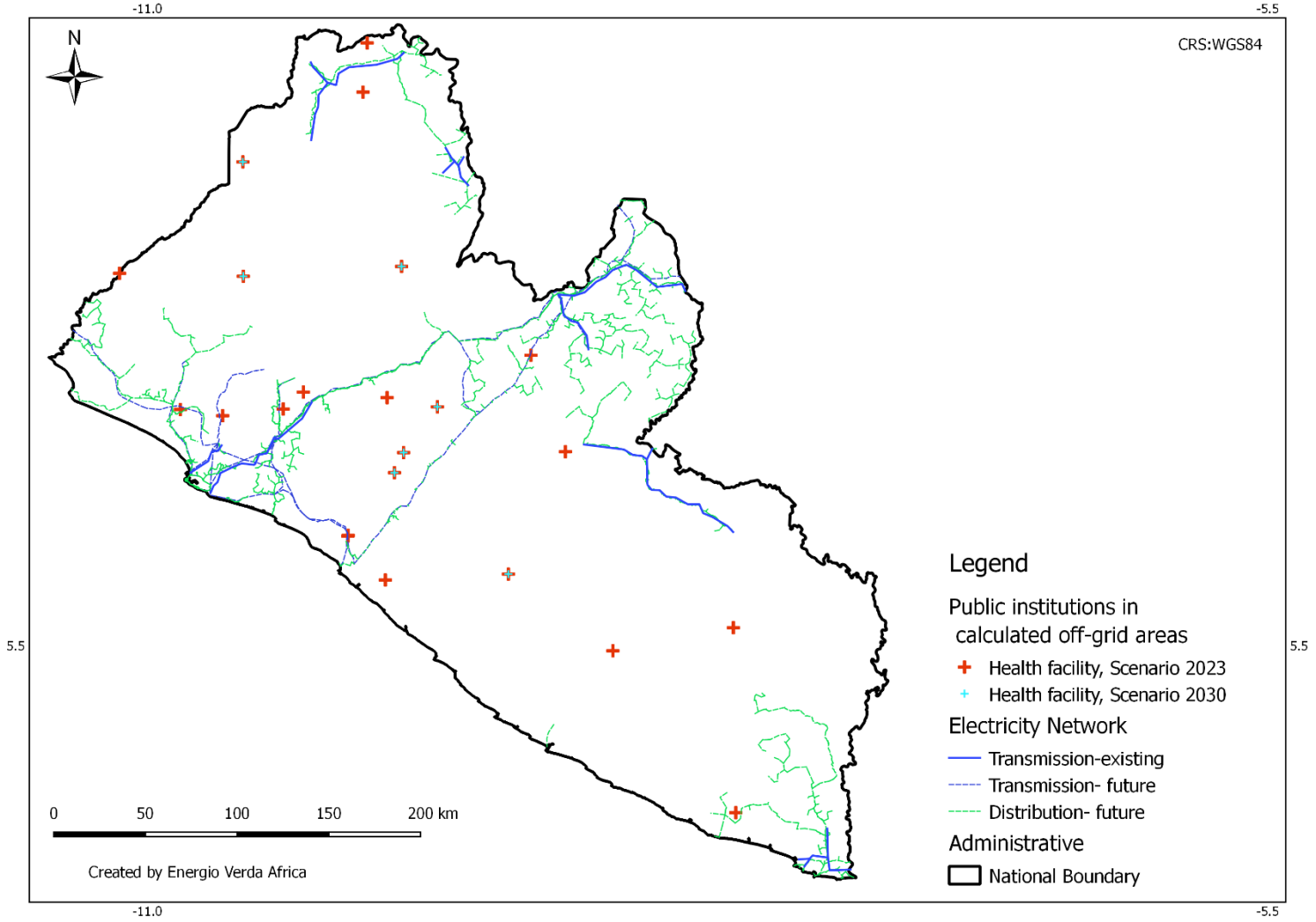
Figure 9: Identified Health Facilities for On-Grid, Mini-Grid and Stand-Alone Solutions, 2023 and 2030



Source: Energio Verda Africa GIS analysis

[69] Note: The analysis also targeted to cover the education centers that will remain off-grid, but this data was not available for the analysis (education centers with known coordinates).

Figure 10: Distribution of Potential Off-Grid Health Facilities, 2023 and 2030[70]



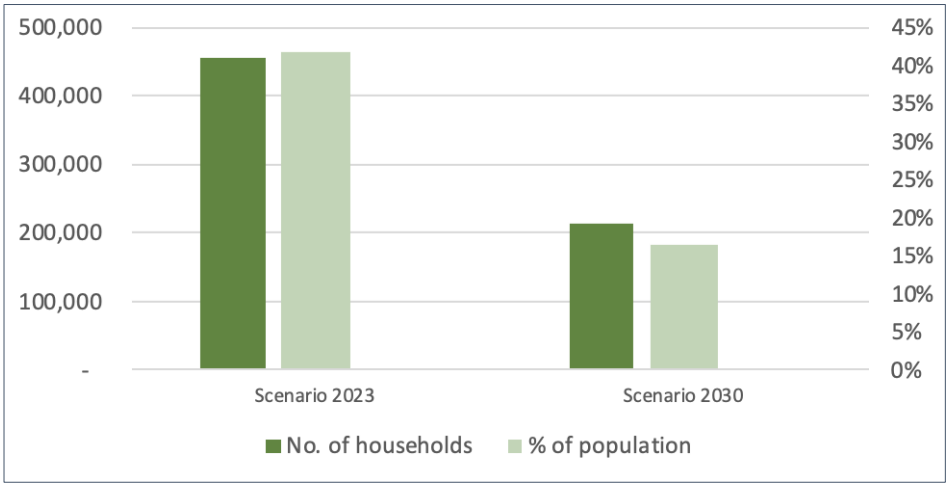
Source: Energio Verda Africa GIS analysis

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

According to the geospatial analysis (**Table 5**), by 2023, 942 settlements across Liberia (301,418 households) will be connected to the main grid, representing 27.6% of the population. By 2030, this figure will increase to 6,887 settlements (959,165 households), equivalent to 73.9% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030. Not all settlements in close proximity to electricity lines will connect to the main grid, largely due to the low density of these areas (dispersed settlements with a density below 350 people/km^2). By 2023, an estimated 443 settlements located under the grid will meet these criteria (or 32.0% of the settlements located within 5 km of the grid).

Outside of the main grid areas, settlements with higher economic growth potential and higher population density can optimally be electrified by mini-grids. By 2023, this represents an estimated 2,714 settlements (334,031 households), or 30.6% of the population, decreasing to 2,215 settlements (124,678 households), or 9.6% 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 9,159 settlements (456,807 households) and 41.8% of the population in 2023, decreasing to 3,713 settlements (214,505 households) and 16.5% of the population in 2030 (**Figure 11**).

Figure 11: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

The off-grid stand-alone solar market has the potential to grow significantly. According to figures published by the Global Off-Grid Lighting Association (GOGLA),[71] an estimated 29,340 off-grid stand-alone solar PV products (pico solar and SHS) have been sold in Liberia as of the end of 2017 (see **Section 2.4.3**). The least-cost analysis estimates that more than 450,000 households in 2023 are suitable for off-grid stand-alone solutions.

[71] "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

In its SEforALL Action Agenda, the GoL envisioned that 34.5% of the country's rural population would gain electricity access through off-grid systems by 2030 (**Table 6**). In the RESMP, the RREA included several scenarios to achieve its 2030 electrification targets through a combination of grid extension, mini-grids and individual stand-alone off-grid systems. The Master Plan envisioned electrifying 66% of the population through grid extension, 33% of customers through decentralized mini-grids, and the remaining 1% of the population – an estimated 18,900 people – through stand-alone systems (**Figure 12**).

The findings of the least-cost analysis suggest that the Liberia Electricity Corporation could connect a higher percentage of the overall population to the grid by 2030 (about 75% of the population), which would leave the remaining balance (about 25% of the population) as suitable for a combination of decentralized mini-grids and off-grid stand-alone solutions.

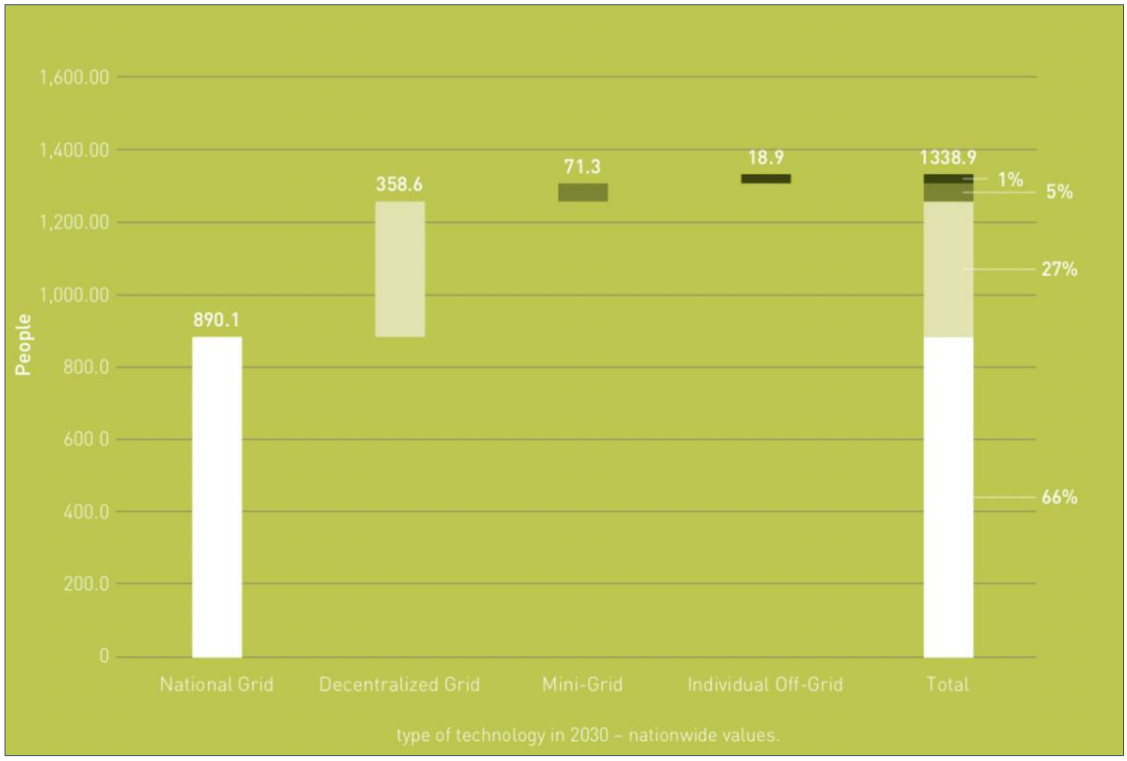
Table 6: Estimated Share of Population Served by Off-Grid Systems[72]

Share of population with access to off-grid systems powered by renewable energy (%) *	**2030 (target)**
	34.5%

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

Source: SEforALL Action Agenda

Figure 12: Estimated Number of People Electrified by Electrification Approach, 2030[73]



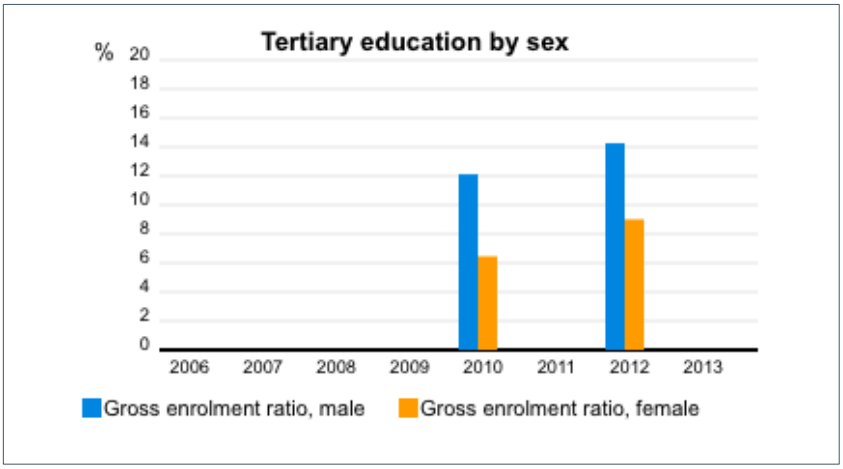
Source: Rural and Renewable Energy Agency

[72] "Liberia SEforALL Action Agenda," SEforALL, (2015): http://se4all.ecreee.org/sites/default/files/sustainable_energy_for_all_se4all_action_agenda_report_2015_-_liberia.pdf
[73] "Rural Energy Strategy and Master Plan for Liberia, 2030," Rural and Renewable Energy Agency, Developed by Gesto Energy Consulting, (2016): http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf

1.2.2.5 Inclusive Participation[74]

Inclusive participation in Liberia 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. While gender discrimination is widespread, these issues tend to be more pronounced in rural areas of the country. Liberia 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.[75] Female participation in education, particularly higher education, remains disproportionately low (**Figure 13**).[76] By age 18 (the typical age when secondary school is complete), 53% of girls are out of school, compared to just 22% of boys the same age.[77]

Figure 13: Rates of Enrollment in Tertiary Education



Source: UNESCO Institute for Statistics

The Government has adopted several policies and action plans to promote gender equality and has signed on to key international and regional framework agreements protecting women's rights. In 2009, the Liberian Ministry of Gender and Development issued the National Gender Policy, which recognizes the importance of advocacy to raise awareness about the critical nexus that exists between energy access and women's empowerment. The Government has also established the National Gender Forum and also included gender equality as a specific crosscutting issue in its Poverty Reduction Strategy.

In the energy sector, efforts have been made to implement measures under the regional framework, ECOWAS Policy for Gender Mainstreaming in Energy Access, as well as 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 GoL has established a gender focal point at the Ministry of Energy to promote inclusive participation for women in the energy sector by integrating gender into energy policies programs and conducting gender audits of the sector.

[74] Please refer to **Annex 4** for more details
[75] "Gender Inequality Index," United Nations Development Programme, (2015): http://hdr.undp.org/en/composite/GII
[76] "Liberia Participation in Education," UNESCO Institute for Statistics, (2018): http://uis.unesco.org/en/country/bf?theme=education-and-literacy
[77] "Liberia: Out of School Profile," Education Policy and Data Center, (2014): https://www.epdc.org/sites/default/files/documents/Liberia_OOSC_Profile.pdf

1.2.3 Key Challenges

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

- **Investment in Grid Maintenance:** Economic growth and corresponding increases in electricity demand are putting pressure on power supply – a mismatch that will continue to burden the transmission and distribution network that needs maintenance and investment to reduce losses and expand access. Yet, LEC lacks the funds to invest in the network and depends upon foreign assistance for this purpose.
- **Electricity Tariffs:** Electricity tariffs in Liberia are much higher than other countries in the region and are among the highest in the world, ranging between USD 0.38/kWh and USD 0.45/kWh. Electricity services are unaffordable to most of the population and overall quality of service remains inadequate.
- **Utility Financial Performance:** The financial performance of LEC is extremely poor, with system losses in the range of 60%. LEC lacks the ability to invest sufficiently in grid extensions or in the maintenance of infrastructure. While efforts are underway to expand and rehabilitate the transmission and distribution network, the grid will remain confined to greater Monrovia in the near future.
- **Imbalanced Energy Mix:** The country's power supply mix relies on a combination of large hydropower and liquid fuels (diesel and heavy fuel oil) for thermal power. During the wet season, the country has abundant supply of hydropower; thermal is needed for the dry season when hydropower availability is low. Hydropower will be increasingly susceptible to the impacts of climate change, while thermal fuels are subject to price volatility and are environmentally unsustainable. While power sector planning **(Table 4**) continues to support these technologies, there is comparatively little investment in small-scale and off-grid RE to electrify dispersed settlements beyond Monrovia, which could be more economically served by mini-grids or stand-alone systems rather than by the national grid.
- **Local Financial Institutions:** 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.

[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. This has been one of the stand-alone market segments where there has been some lending to date in Africa (e.g. AFD's Sunref program)

1.3 National Policy and Regulation

1.3.1 National Electricity/Electrification Policy

The 2009 National Energy Policy of Liberia (NEPL) provides a policy roadmap for "universal access to modern energy services in an affordable, sustainable and environmentally-friendly manner in order to foster the economic, political, and social development of Liberia." The GoL has defined an electrification target of 35% nationally by 2030 and intends to provide access to modern energy services (including lighting, cooking, communication and small productive use activities) to 40% of the overall urban and peri-urban population and 25% of all schools, clinics and community centers in rural areas by 2030. The policy also aims to increase grid-connected RE electricity production to 30% of total production and 10% of overall consumption by 2030. The Government, via the LEC, has also planned to implement the Growing the National Grid (GTG) program with the goals of electrifying (outside of Monrovia) more than 65, 000 customers by 2020, 140,000 by 2025, and 265,000 by 2035.[79]

As a member state of ECOWAS, the GoL is also committed to the ECOWAS Regional Renewable Energy Policy (July 2013)[80] for the period 2015-2030, which seeks to: (i) set national RE targets, (ii) create a harmonized regulatory framework as well as common tax and duties policies and standards, (iii) develop technology knowledge and capacity building, and (iv) promote a regional RE market. For the electricity sector, the objective is to increase total generation from RE sources as well as the overall population served by mini-grid and stand-alone systems by 2030.

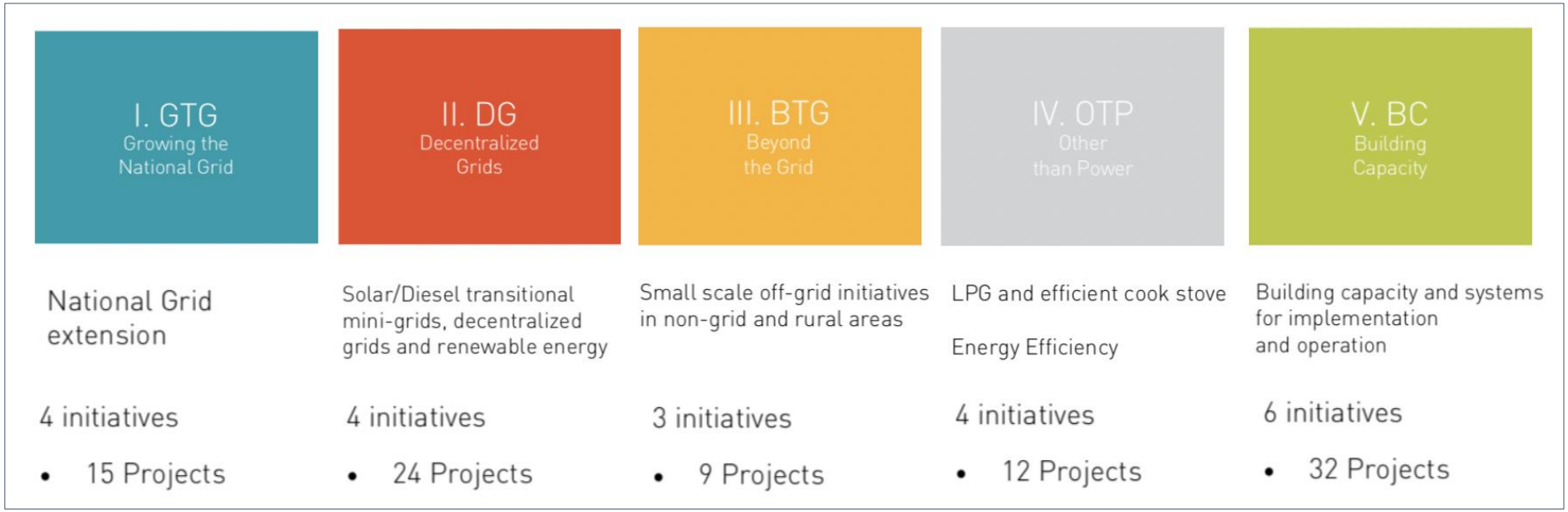
1.3.2 Integrated National Electrification Plan

The Government's rural electrification strategy can be summarized into four strategic phases: (i) network expansion and interconnections, (ii) increase the connected generation capacity, (iii) develop mini-grids, and eventually (iv) integrate mini-grids with the network.[81] The Rural Energy Strategy and Master Plan (RESMP), developed with the support of the EU and the World Bank, was adopted in 2016 and is the key plan governing the expansion of off-grid energy resources in rural Liberia. The plan expands rural electrification outside of Monrovia to 10% by 2020, 20% in 2025, and 35% in 2030.

The RESMP aims to have at least 150 MW of renewable energy installed by 2030. The programs envisioned under the Master Plan are estimated to require USD 935 million of investment over 15 years, supporting 92 projects that could provide electricity to 265,000 households and 1.34 million people by 2030.[82] Only a small percentage of this financing has been committed to date, with the World Bank, AfDB and the EU providing the majority of the funds. The RESMP includes five main programs (**Figure 14**) that include plans for both transmission and distribution network extensions as well as a combination of mini-grid and stand-alone solar system applications to reach rural communities, households, and public buildings by 2025. The Government's long-term vision for electrification anticipates the grid reaching 89% of the country's population, with the remaining 11% of the population being served by off-grid solutions in 7,000 settlements.[83]

[79] "Ministry of Lands, Mines Launches $550M Rural Energy Master Plan," Front Page Africa Online, (2016): http://frontpageafricaonline.com/news/2016news/ministry-of-lands-mines-launches-us-550m-rural-energy-master-plan/
[80] "ECOWAS Renewable Energy Policy," ECOWAS, (2015): http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf
[81] "Investment Prospectus: General assessment and perspectives," ECREEE, (2016): http://www.ecreee.org/sites/default/files/presentation_of_action_agendas_and_ip_advancements_by_national_directors_for_energy_-_liberia.pdf
[82] "Rural Energy Strategy and Master Plan," RREA: http://liberiaruralenergy.org/
[83] Ibid.

Figure 14: Rural Energy Strategy and Master Plan – Five Main Programs



Source: Rural and Renewable Energy Agency

1.3.3 Energy and Electricity Law

The 2015 Electricity Law of Liberia is the current legal code governing the electricity sector, organizing the transport, distribution and sales segments, and defining the roles and functions of all participating entities. The law includes provisions for the establishment of the LERC under the MME, as well as the RREA and the REFUND. There are no specific legal provisions within the law that provide a regulatory framework for the off-grid sector. The key objectives of RREA as specified in the electricity law include:

- To promote improved access to modern energy services in the rural areas of Liberia
- To accelerate the economic transformation of rural Liberia by promoting the development and supply of modern energy products and services with an emphasis on locally available renewable resources
- To introduce and promote policies and regulations in the exercise of the functions of the Agency
- To administer, secure, enforce, design and execute policies, strategies, plans and programs relating directly and indirectly to the functioning, growth and development of the rural energy sector
- National Renewable Energy Action Plans (NREAPs)

1.3.4 Framework for Stand-alone Systems

Figure 15 is an overview of the key national policies, programs, laws, and regulations pertaining to Liberia's framework for stand-alone systems. The gaps in this framework are addressed in **Section 1.3.5**. To date, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing slowly, as evidenced by the country's relatively low energy access score in the World Bank Regulatory Indicators for Sustainable Energy (RISE) evaluation. In 2017, Liberia ranked 14th in West Africa and the Sahel and was among the lowest scoring access-deficit countries in the world (**Figure 16**).

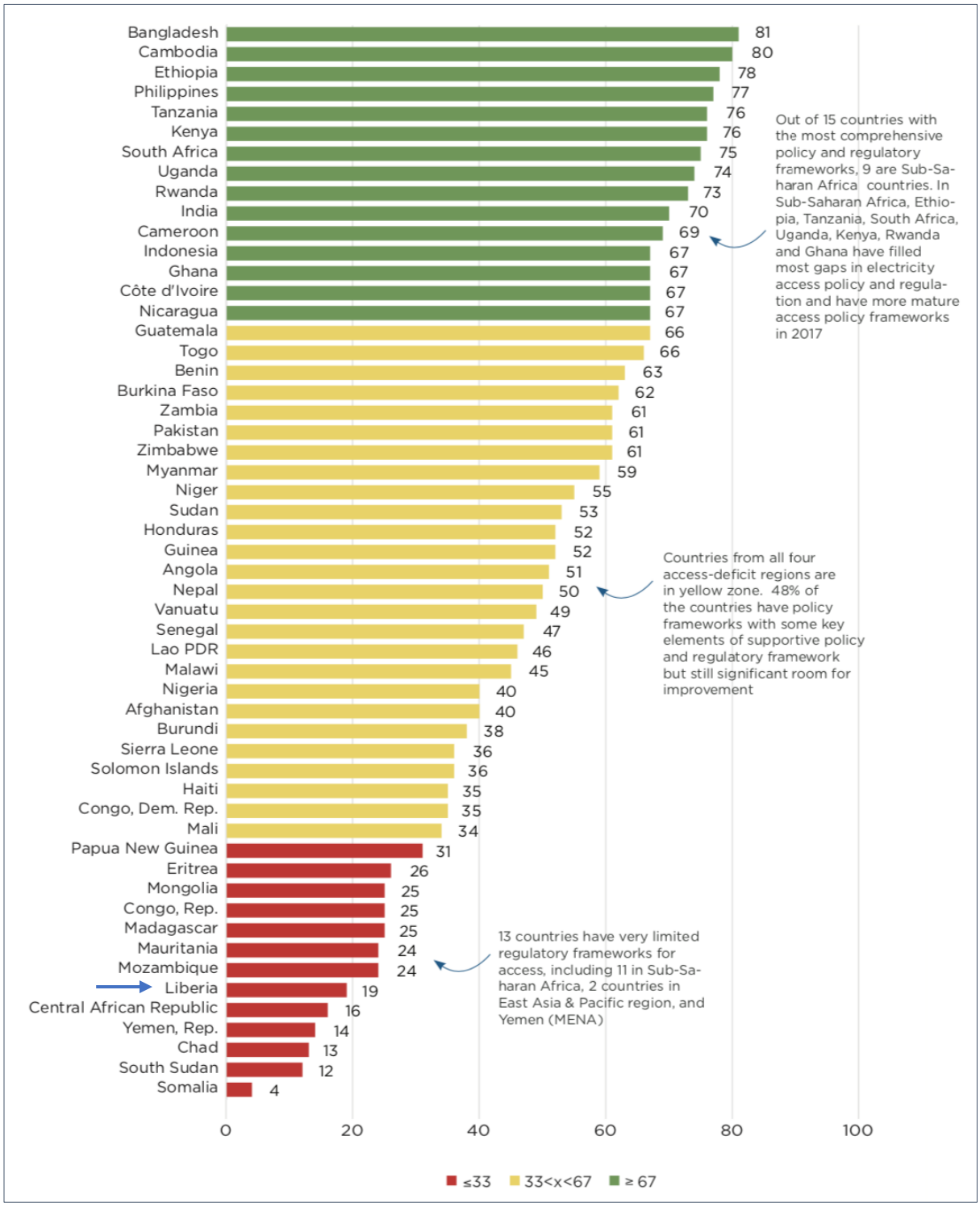
Figure 15: Policy and Regulatory Framework for Stand-Alone Systems

LIBERIA			
	World Bank RISE 2017 Energy Access Score: 19 World Bank RISE 2015 Energy Access Score: 20	2017 ranking among West Africa and the Sahel (ROGEP) countries: 14th (out of 16)	
Policy/Regulatory Support and Financial Incentives	**Specific National Policies, Laws and Programs**		
	National electrification policy with off-grid provisions	x	
	Integrated national electrification plan	√	RESMP
	Energy/electricity law with off-grid provisions	x	
	National programs promoting off-grid market development	√	WB LREAP, Lighting Africa
	Specific target for rural electrification	√	35% access by 2030
	Financial Incentives		
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	x	
	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: World Bank RISE and Stakeholder interviews; GreenMax Capital Advisors analysis

Figure 16: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017[84]



Source: World Bank Regulatory Indicators for Sustainable Energy

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

1.3.4.1 Existence of Specific National Programs

The RESMP, developed in 2010 by RREA, MME and other stakeholders, is the most relevant national program related to the expansion of Liberia's off-grid sector. NRECA International is also a strategic partner to the RREA on major components of the Master Plan. Additionally, the Liberia Investment Plan for Renewable Energy (IPRE) is a key plan supporting the GoL's rural electrification objectives.[85] The REFUND, launched by the RREA in 2013, is also intended to drive the Fund's efforts to finance renewable energy projects in the country, with a focus on channeling development funding to rural areas. Outside of GoL initiatives, there are several off-grid programs being undertaken by development partners (**Table 9**).

1.3.4.2 Financial Incentives

There are currently no financial incentives in place to support an enabling environment for the stand-alone solar market in Liberia. The GoL has a 25% customs duty on solar products, which needs to be lowered significantly or removed entirely to support growth of the country's off-grid solar market. The World Bank-supported LIRENAP project intends to support bulk procurement of solar products to reduce costs of imports. The REFUND also intends to make credit lines available to local banks to provide financing and TA to companies operating in the off-grid space. REFUND is also exploring the possibility of partnering with local FIs to utilize credit lines / risk mitigation products for the sector.[86]

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 quality standards for stand-alone systems in Liberia.

1.3.4.4 Concession Contracts and Schemes

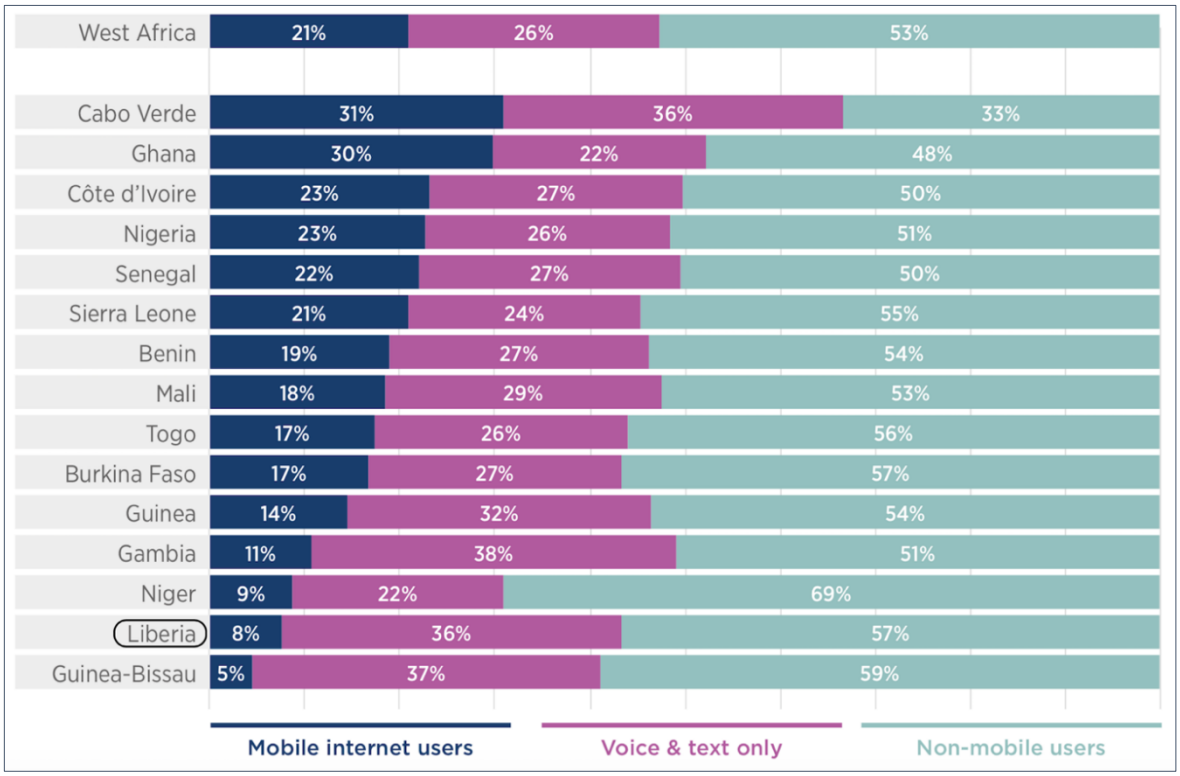
No contractual framework currently exists in Liberia to support development of the off-grid sector. Off-grid and decentralized grid investments and assets – coming mostly from grants – will be managed in a hybrid license model where grant-funded assets will be owned by REFUND and "leased" to licensed private operators who will operate, maintain and upgrade such assets in exchange for a variable lease fee. Licensees will be allowed to invest and own new assets which are not grant funded. Regional Distribution Companies and private operators will be allowed to enter the off-grid space, while 'Rural Services Units' of the RREA will support with the procurement of distribution of stand-alone solar equipment and systems.[87]

1.3.4.5 Specific Business Model Regulation

No specific business model regulations exist for the off-grid sector in Liberia, although the Government can take measures to support PAYG business models that have already been deployed by private solar companies engaged in the market. As was demonstrated in East Africa in recent years, the proliferation of mobile money platforms can rapidly facilitate energy access. Recent data suggests that there is an opportunity for the GoL to bring together key stakeholders in the off-grid sector (solar providers, telecommunications companies etc.) to take advantage of the country's steadily growing mobile Internet usage (**Figure 17**) and high rates of mobile phone ownership in rural areas (**Figure 18**).

[85] "Liberia SEforALL Action Agenda," SEforALL, (2015): http://se4all.ecreee.org/sites/default/files/sustainable_energy_for_all_se4all_action_agenda_report_2015_-_liberia.pdf
[86] "Rural Energy Strategy and Master Plan," RREA (2016): http://liberiaruralenergy.org/?q=content/building-capacity
[87] Ibid.

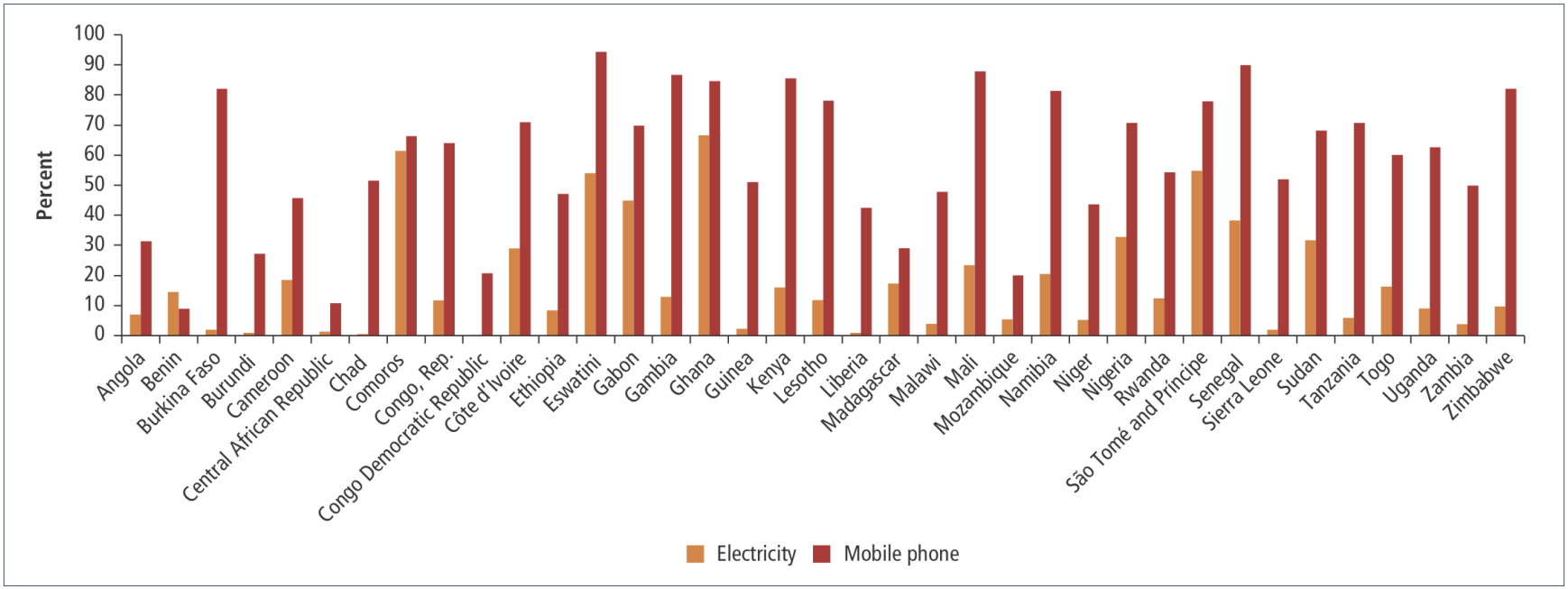
Figure 17: West Africa Mobile Internet Penetration Rates, 2017[88]



Source: GSMA Intelligence

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

Figure 18: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)[89]



Source: World Bank

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

1.3.5 Capacity Building and Technical Assistance

To overcome the challenges surrounding rural electrification, a range of technical and financial resources from both the public and private sector must come together. At the institutional level, appropriate Government ministries and agencies (RREA) as well as the electricity market regulator, LERC, will play key roles. At the legal level, a regulatory framework will need to be put in place to provide appropriate incentives for private sector participation. Local FIs and MFIs will need to develop and implement new financial products and administrative procedures to lend to the off-grid sector. 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 7 identifies some of the policy/regulatory challenges facing off-grid market development in Liberia and the proposed mitigation measures/TA interventions to overcome these gaps.

Table 7: Gaps in the Off-Grid Policy and Regulatory Framework[90]

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Specific National Policies, Laws and Programs	**A. Insufficient National Electricity / Electrification Policy**	
	a. No policy exists for rural electrification	a. Help Government establish a clear Rural Electrification Policy which encourages least cost, integrated planning for all options
	b. Government is subsidizing fossil fuel electricity production	b. Support 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. Insufficient focus on or understanding of framework to support private sector participation	a. Help Government improve the planning framework of the RESMP 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 expedite process of unbundling / electricity market liberalization)

[90] NOTE: "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 Liberia (**Table 2**), including the Ministry of Lands, Mines and Energy (MME), the Department of Energy (DOE), the Rural and Renewable Energy Agency (RREA), Regulatory Authority (LERC and ERB), the Liberia Energy Network (LEN), and the public utility, the Liberia Electricity Corporation (LEC) among other national and local authorities.

	D. Insufficient national policies, laws, programs and/or action plans targeting off-grid market development	
	a. Insufficient focus on or understanding of framework to support private sector participation	a. Help Government strengthen the medium-long term rural electrification strategy and create appropriate incentives for private sector participation in the country through the RESMP
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[91] 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 (e.g. through the Renewable Energy Fund, REFUND) d. Help Government create PPP schemes to share high project development and market entry costs particularly with developers in remote areas (e.g. through REFUND) e. Help Government analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede clean energy development
3. Standards and Quality	**A. Insufficient Market Data**	a. Help Government establish a Special Task Force (within DOE or RREA) 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
	B. 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[92]

[91] Focus group participants indicated that existing taxes can be as high as 25%.
[92] Focus group participants highlighted the urgent need for quality standards and indicated that the Liberian market would benefit greatly from such a program.

	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 (e.g. through RREA) b. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through RREA)
	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 (e.g. through RREA and/or LEN) b. Support development and implementation of programs to educate consumers, retailers and distributors on the benefits of quality certified solar products vs. counterfeit / poor quality products
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	a. Help Government understand all options and models for possibilities of granting geographic concessions to private operators of SHS.[93]

[93] 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.

	b. Need for understanding of emerging models for 'Integrated Private Utilities' or 'Energy Companies of the Future'	b. Help Government to understand and develop approaches to facilitate pilots of 'Integrated Private Utility' or 'Energy Company of the Future' schemes.[94]
	c. Public procurement or public finance/budget laws that hamper deployment of energy services models for public facilities	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. Lack of standardized contracts for energy services provided by private system operators to public facilities	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. Insufficient protection for stranded investments	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[95]
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[96] 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[97] c. Support off-grid entrepreneurs and telecommunications companies in building the capacity of and fostering linkages between telecommunications companies / mobile money providers and off-grid solar companies to help roll out technology platforms and PAYG business models

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

[94] 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.

[95] 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.

[96] 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.

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

1.4 Development Initiatives

1.4.1 National Government Initiatives

The Government has made off-grid development a national priority through the RREA and its strategic roadmap – the RESMP. These development plans have been supported by a number of GoL, bilateral and multilateral donor and DFI initiatives as outlined in **Table 8** and **Table 9**.

Table 8: National Government Off-Grid Development Programs

Project/Program	Timeline	Market Segment(s)	Activity
RREA RESMP Beyond the Grid Program (BTG)	Three phases (2015-2020; 2020-2025; and 2025-2030)	Stand-alone solar PV	• Aims to provide 2.2 MW of off-grid electricity access in areas outside of current grid expansion plans through 2025 • The program plans to utilize off-grid solar to electrify households and public buildings (schools, health facilities etc.) • Three initiatives: (i) Solar villages and home systems; (ii) solar community services; and (iii) solar portable lamps
RREA RESMP Decentralized Grid Program (DG)	Three phases (2015-2020; 2020-2025; and 2025-2030)	Solar-diesel "transitional" mini-grids	• Decentralized renewable energy electrification program focusing initially on solar/diesel mini-grid systems. • Estimated USD 292 million in investment and up to 53 MW of production to electrify 96,800 households, 489,000 individuals
RREA RESMP Building Capacity Program	All three phases	Rural electrification training and awareness raising	• Capacity building and awareness raising program of the RESMP to strengthen the applicable public-sector programs, project assistance with funding and contract aid, new institutional frameworks, rural energy training centers, the REFUND, and communication assistance.[98] • An estimated budget of USD 52 million is anticipated for the nationwide program

1.4.2 DFI and Donor Programs

A number of Development Finance Institutions (DFIs) and donor agencies have been engaged in various programs and initiatives supporting development of the clean energy and off-grid sectors in Liberia. A summary of relevant donor agency activities can be found in the **Table 9**.

[98] "Building Capacity," RREA RESMP, http://liberiaruralenergy.org/?q=content/building-capacity

Table 9: DFI and Donor-Funded Off-Grid Development Programs

Project/Program	Timeline	Market Segment(s)	Description
World Bank, Liberia Renewable Energy Access Project (LIRENAP)	2016-ongoing	Decentralized energy, solar home systems.	• The project has three components: decentralized electrification in Lofa County to expand access to about 50,000 people; technical assistance to strengthen rural electrification institutions and regulations; and market development of stand-alone solar systems to provide access to over 100,000 people.[99] • There are seven sites in Lofa and one site in Grand Bassa. Total support is $27 million USD; World Bank support adds up to $2 million USD.
World Bank, Liberia Accelerated Electricity Expansion Project (LACEEP)	Ongoing	Rural electrification, grid electricity	• Goals of LACEEP are to scale up electrification by connecting domestic, commercial and industrial consumers to the grid; and strengthening the Liberia Electricity Corporation (LEC) to improve its operational and financial performance and long-term sustainability.[100] • Total support, all from the world bank, is USD 35 million.
EU National Indicative Program (NIP)[101]	2014-2020	Energy sector development, including rural electrification	• A total of EUR 100 million has been allocated for projects and programs in Liberia's energy sector, with EUR 45 million dedicated to rural electrification initiatives.
EnDEV, GIZ	2015-ongoing	Pico solar, SHS	• Promotion of pico solar market and supporting solar lamps in the following regions: Nimba, Bong, Lofa, Grand Bassa, Margibi, Gbarpolu • SHS program that gives support/donation to over 250 health, education and social facilities in Liberia. • EnDev also works alongside RREA, REASL, and NGOs to promote small business selling solar products and is involved in outreach, marketing and awareness campaigns. • As of the 2017, the program had successfully installed a total of 3,750 SHS, including 427 SHS in public institutions.
Africa Renewable Energy and Access program (AFREA)	World Bank ESMAP	Renewable Energy	• AFREA has provided support for the development of the Catalyzing New Renewable Energy in Rural Liberia Project, notably by assisting the government of Liberia to establish a rural and renewable energy agency
Power Africa	USAID	Rural electrification	• Power Africa is supporting the development of the nascent off-grid sector. • USAID Liberia has notably conducted three renewable energy pilot projects under community-based ownership models which concluded that solar is the most feasible renewable energy technology to scale up in rural Liberia.
ACP-EU Energy Facility	EU	Rural electrification, solar PV	• The ongoing Light Up Project (2016-2019) supports the development of off-grid solar PV solutions for lighting and cooking, targeting 10,000 villages. As at December 2017, over 2,000 products (solar and cook stove) have been sold through the 10 retailers that have been identified.

[99] "New Energy Project Targets 150,000 Liberians for Increased Access to Affordable and Reliable Electricity," World Bank, (January 11, 2016): http://www.worldbank.org/en/news/press-release/2016/01/11/new-energy-project-targets-150000-liberians-for-increased-access-to-affordable-and-reliable-electricity

[100] "LACEEP Overview," World Bank, http://projects.worldbank.org/P133445/liberia-accelerated-electricity-expansion-project-laceep?lang=en&tab=map

[101] "Ministry of Lands, Mines Launches US$550M Rural Energy Master Plan," Front Page Africa (August 2016): http://frontpageafricaonline.com/news/2016news/ministry-of-lands-mines-launches-us-550m-rural-energy-master-plan/

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 Liberia's off-grid sector.

In 2012, the Lighting Africa Lighting Lives in Liberia project was launched to help jump start the market for pico-solar lighting capacity in the country. From 2014-2017, over 35,000 units of pico-solar equipment were sold, and 70,000 Liberians met their basic electricity needs through this initiative.[102]

In 2014, NRECA International partnered with USAID to start a multi-year program to support the RREA. The program envisions building RREA's technical and management capacity through an investment portfolio of USD 178 million. This is part of a nationwide effort to electrify the country's rural areas using primarily off-grid renewable resources.[103]

In 2018, Mercy Corps partnered with RREA and GIZ/EnDev to launch the Liberia Energy Access Practitioner (LEAP) network. LEAP is an initiative that aims to support GoL rural electrification efforts to extend solar energy to remove villages throughout the country.[104]

[102] "Lighting Lives in Liberia," Lighting Africa, https://www.lightingafrica.org/country/liberia/
[103] "Liberia," NRECA, (2018): http://www.nrecainternational.coop/where-we-work/liberia/
[104] Yates, D., "Only 2% of Liberia's Population Has Access to Renewable Energy," Liberian Daily Observer, (August 13, 2018): https://www.liberianobserver.com/news/only-2-of-liberias-population-have-access-to-renewable-energy/

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

This section presents the overall market assessment for stand-alone off-grid solar (OGS) energy systems in Liberia. **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 10** 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 10: Indicative Total Cash Market Potential for Off-Grid Solar PV Products in Liberia, 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	137,225	412	$6,175,137	$4,258,715
Plug and play	0	0	$0	$7,886,510
Small SHS	0	0	$0	$17,508,052
Medium and Large SHS	0	0	$0	$13,012,742
Household Subtotal	**137,225**	**412**	**$6,175,137**	**$42,666,019**
Institutional				
Water supply	283	995	$2,486,188	-
Healthcare facilities	77	70	$174,488	-
Primary and secondary schools	543	657	$1,709,370	-
Public lighting	60	30	$89,925	-
Institutional Subtotal	**963**	**1,752**	**$4,459,971**	-
Productive Use				
SME applications for microenterprises	337	84	$210,500	-
Value-added applications	83,424	10,532	$55,495,164	-
Connectivity / ICT (phone charging)	1,696	678	$ 1,461,841	-
Productive Use Subtotal	**85,457**	**11,294**	**$57,167,505**	-
TOTAL	**223,645**	**13,458**	**$67,802,613**	

Source: African Solar Designs analysis

2.1 Demand – Households

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

2.1.1 Overview of Household Market Segment

According to the International Energy Agency (IEA), in 2016 there were 832,815households (4.16 million people) in Liberia without access to electricity.[105] In that year, an estimated 12% of the population had access to electricity, with the rate of access at 16% in urban areas and 3% in rural areas.

This section gives an introduction to household consumer market segments, their characteristics and size (**Table 11**). 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.

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

Table 11: Household Consumer Market Segments[106]

Income Quintile	% HH w/o Access	# HH w/o Access	Avg. GDP per HH per year	Energy Tier	% HH w/o Access	# HH w/o Access	Avg. GDP per HH per year	Energy Tier	% HH w/o Access	# HH w/o Access	Avg. GDP per HH per year	Energy Tier	Geographic segments	Description
	2018 Scenario				2023 Scenario				2030 Scenario					
Highest 20%	55%	104,102	$3,637	Tier 3	1%	2,185	$3,655	Tier 3	1%	2,597	$3,655	Tier 2	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[107]
Fourth 20%	90%	170,349	$1,964	Tier 2	2%	4,369	$1,973	Tier 1.5	2%	5,193	$1,973	Tier 1.5	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%	179,812	$1,453	Tier 1.5	7%	15,535	$1,460	Tier 1.5	3%	7,790	$1,460	Tier 1		
Second 20%	100%	189,276	$1,066	Tier 1.5	99%	216,267	$1,071	Tier 1	4%	10,387	$1,071	Tier 1	Low income rural	• Engaged in farming, SME or mining support activities • Lives more than 15km from the nearest grid connection.
Lowest 20%	100%	189,276	$678	Tier 1	100%	218,451	$681	Tier 1	73%	188,538	$681	Tier 0		
Total Households without electricity access		**832,815**			**Total**	**456,807**			**Total**	**214,505**				

Source: IEA and World Bank; African Solar Designs analysis

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

[107] 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**

As shown in **Table 12**, Liberia has a moderate level of extreme poverty (households living below USD 1.90 a day). However, the vast majority of the country's households have a low income.

Table 12: Poverty Headcount in Liberia, 2014

Poverty headcount ratio	% of population
Lives at or below $1.90 a day*	38.6%
Lives at or below $3.20 a day*	73.8%
Lives at or below $5.50 a day*	93%

*2011 PPP

Source: World Bank

According to focus group discussions (FGDs), the government is the highest wage employer in Liberia. The wage scale for civil servants is from USD 100 – 500. Wages for laborers outside government employment is set at USD 3.50 per day/ $91 per month for unskilled workers and USD 5.50 per day/USD 143 per month for skilled workers. The majority of households in rural areas rely on subsistence agriculture. Important cash crops include rubber and palm oil. Growth in agricultural income has been suppressed due to weak global prices for these crops, alongside the country's continued recovery from the Ebola virus outbreak. Gold and iron ore exports are contributing to economic growth, but do not create broad based employment.

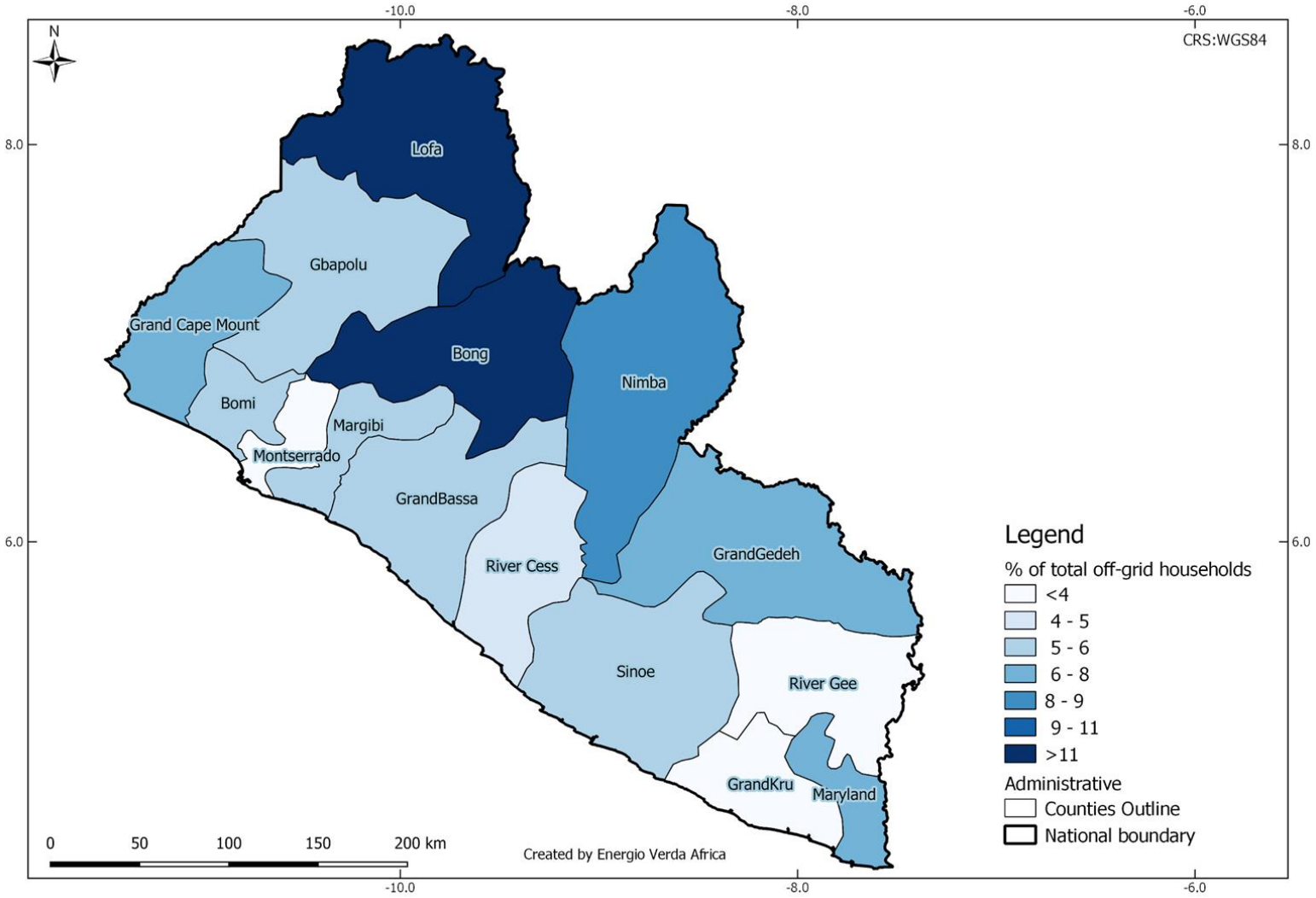
- **Geographic Components of the Solar Market**

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 19-22)** 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 19-22)**, the total size of the OGS market will decrease over time. 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. In both the 2023 and 2030 scenarios, the district of Bong is projected to retain the largest number and percentage of off-grid households in the country. Bong is the third most populated district in Liberia and known for its mining industry.

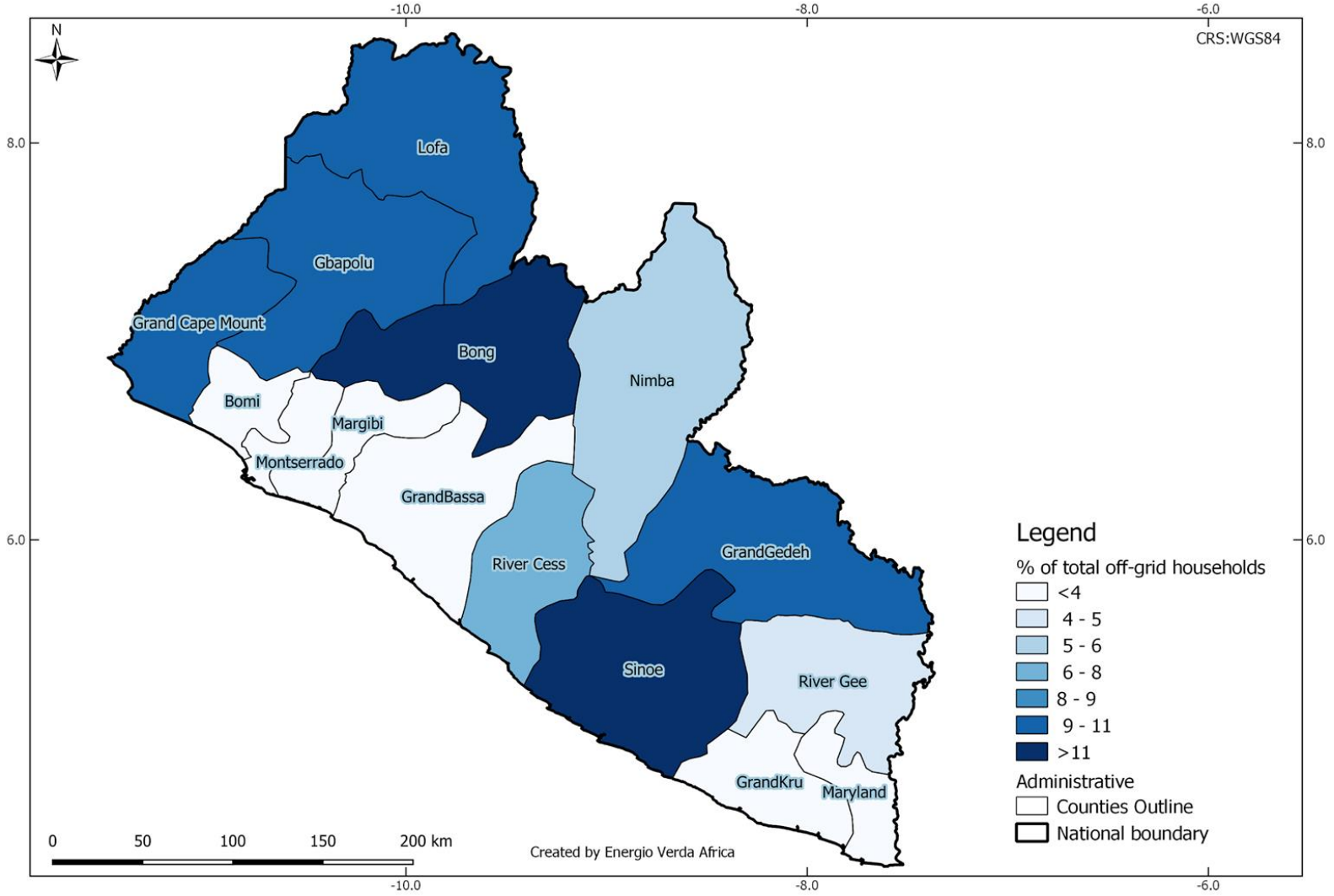
Figure 19: Distribution of Potential Off-Grid Households by Region, 2023[108]



Source: Energio Verda Africa GIS analysis

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

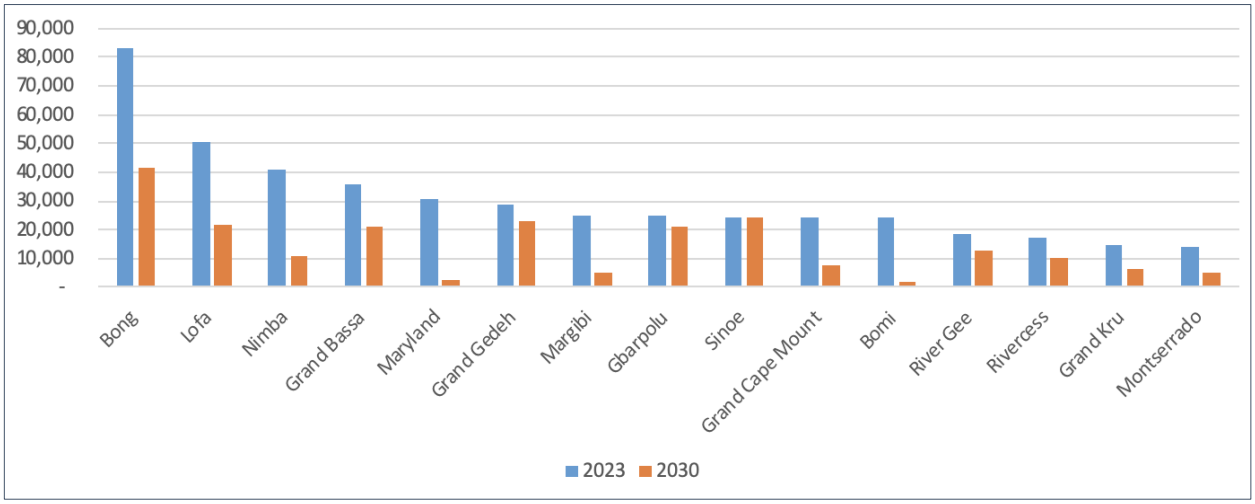
Figure 20: Distribution of Potential Off-Grid Households by Region, 2030[109]



Source: Energio Verda Africa GIS analysis

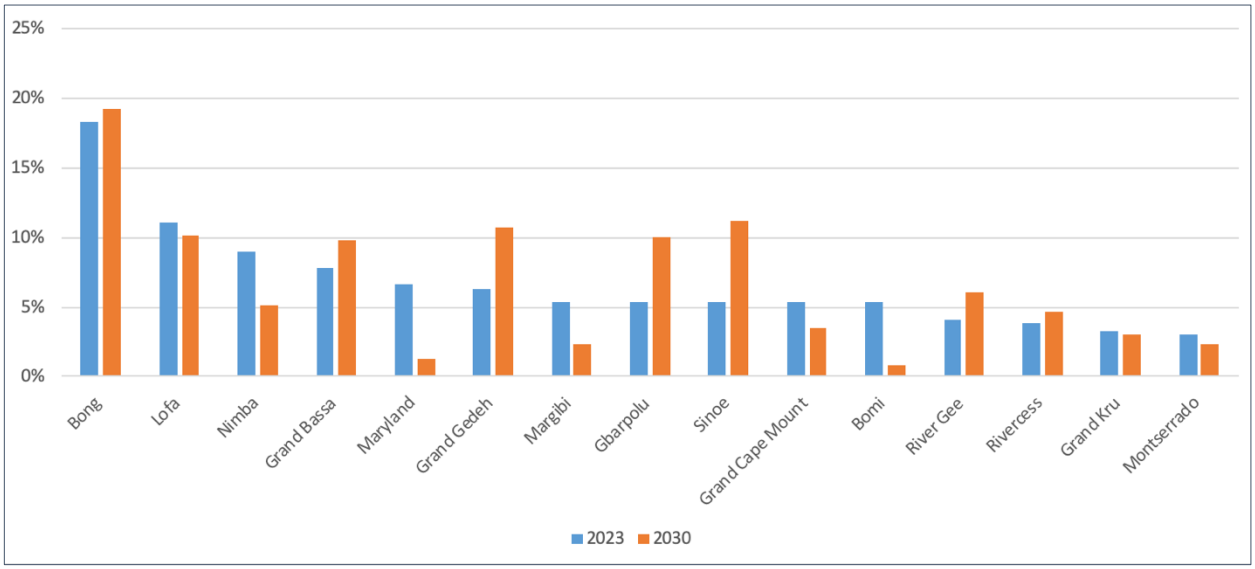
[109] See **Annex 1** for more details, including data sources.

Figure 21: Estimated Number of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

Figure 22: 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, energy is commonly used in off-grid rural households for lighting, entertainment, communication, computers, and SME activities. The typical household monthly energy expenditure is US$25. During the rainy season, when roads are impassable, the prices of goods increase uncontrollably, especially for the counties in southern region, which can drive up household energy expenditure. Diesel is mainly used by SMEs and affluent homes with generators.

Table 13 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 14**. 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 **Table 15** and **Figure 23.**

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 13: Rural Energy Technology and Costs[110]

Technology	Description	Average Life (Years)	# of Units/ Month	Unit Operating Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)
					2018 Scenario		2023 Scenario		2030 Scenario	
Torch lights/Electric Lanterns	Torch lights/electric lanterns powered by D-type, AA-type or AAA-type batteries	0.5	16	$0.16	$2.00	$2.56	$2.40	$3.07	$3.65	$4.67
Cell Phone Charging	Done at a charging station	-	8	$0.13	$0.00	$1.04	$0.00	$1.25	$0.00	$1.90
Smart Phone Charging	Done at a charging station	-	16	$0.13	$0.00	$2.08	$0.00	$2.49	$0.00	$3.80
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	$0.16	$0.00	$1.28	$0.00	$1.53	$0.00	$2.34
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	$0.65	$50.00	$2.60	$59.89	$3.11	$91.25	$4.74
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	23	$0.91	$100.00	$21.30	$119.8	$25.51	$182.49	$38.86

Source: African Solar Designs analysis

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

Table 14: 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	$3.60	$4.31	$6.57
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	$7.44	$8.91	$13.58
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	$13.40	$16.05	$24.45
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	$21.29	$25.51	$38.86

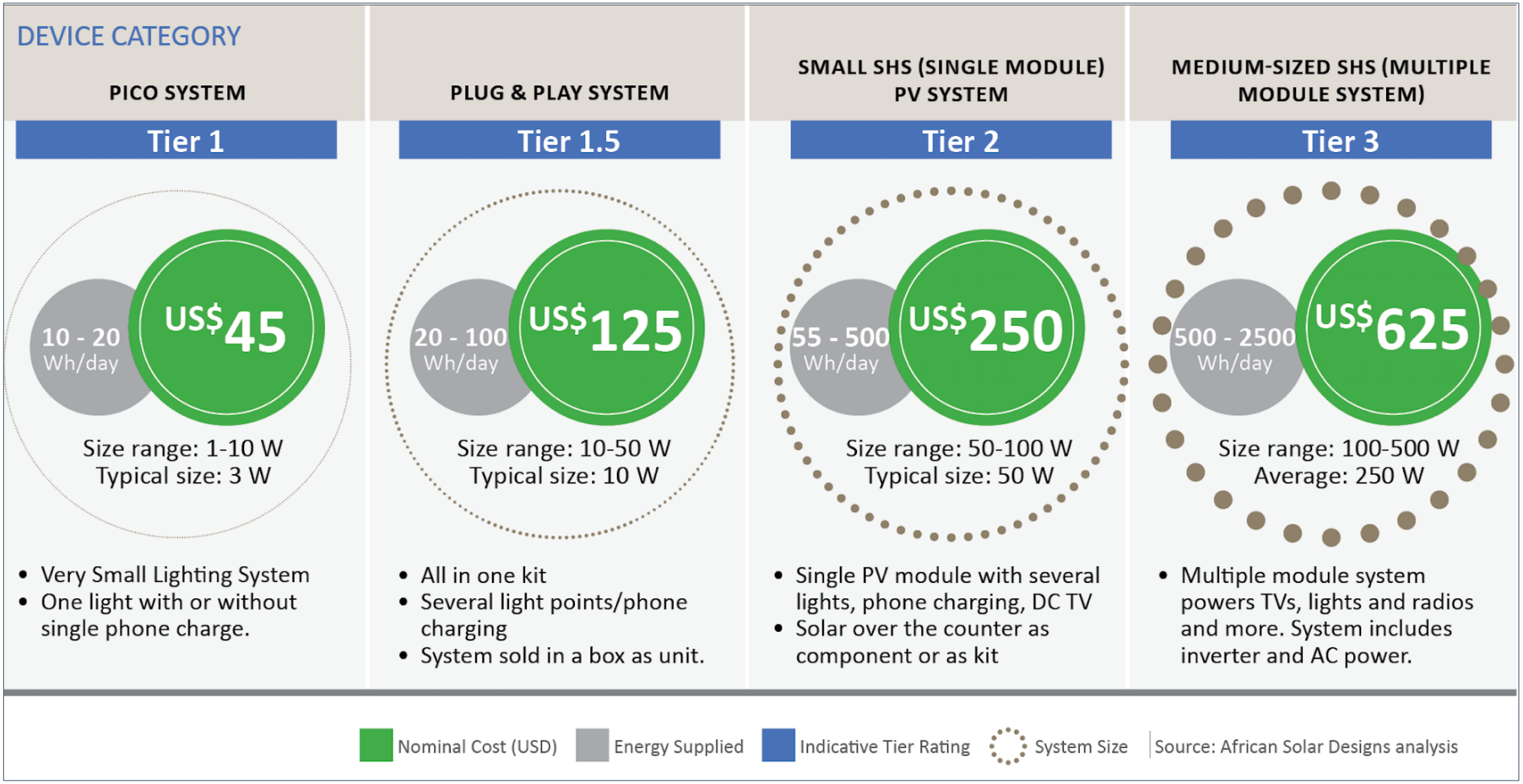
Source: African Solar Designs analysis

Per **Table 14**, 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 23**.

Figure 23: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

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

According to the FGD feedback, solar use in households is just beginning to gain momentum through the distribution of solar products by the Rural and Renewable Energy Agency to create awareness. Suppliers are concentrated in Monrovia. Only RREA distributors with pico and micro systems are somewhat distributed across the country.

Currently, Voinjama in northern Lofa County is able to pay for safe drinking water supply (16 water Kiosks) as compared with Gbarnway, in lower Lofa where solar for basic lighting was introduced some years back but payment for service has been challenging as there was no income generating activities in this rural village. The Western, Central and Southern regions have no known distribution.

- **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 15** 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 15: Energy Expenditure of Different Income Groups

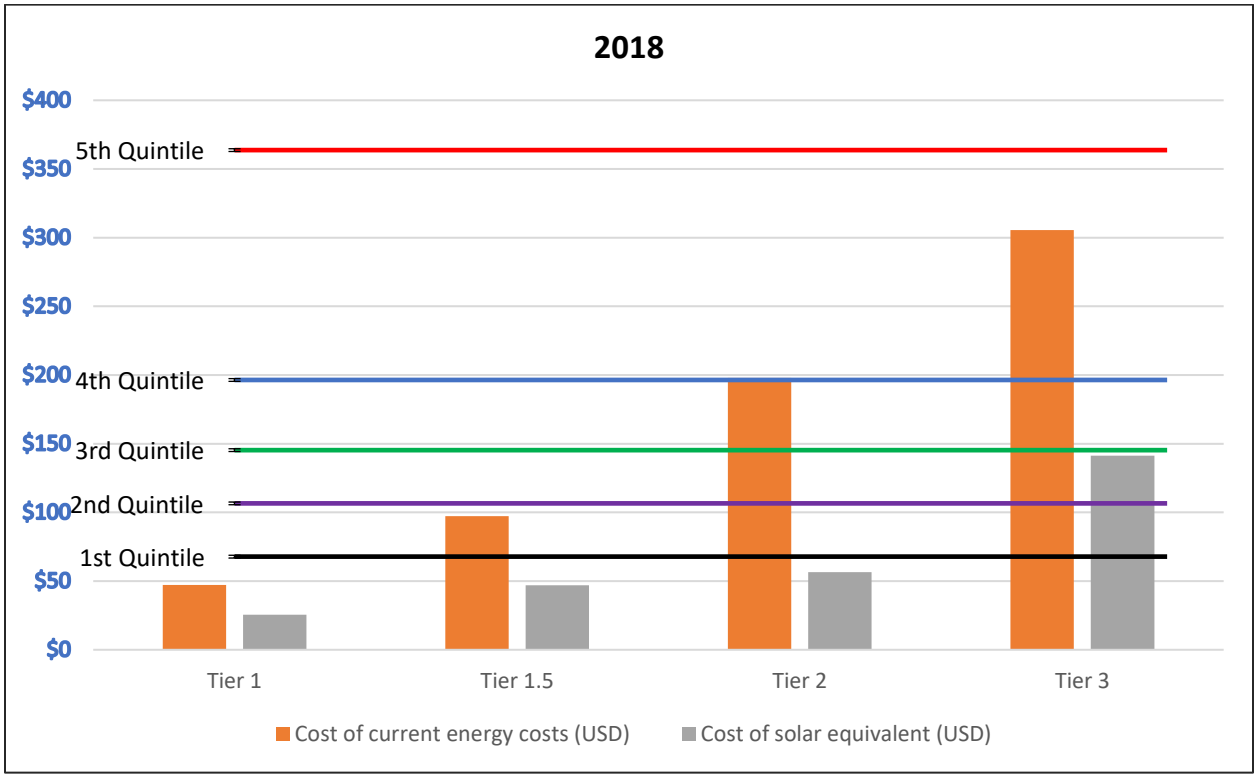
Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	$11.30	$56.51	10%	$5.65
2nd Quintile of Population	$17.76	$88.81	10%	$8.88
3rd Quintile of Population	$24.22	$121.10	10%	$12.11
4th Quintile of Population	$32.73	$163.67	10%	$16.37
Highest Quintile of Population	$60.62	$303.11	10%	$30.31
2023 Scenario				
Lowest Quintile of Population	$11.36	$56.78	10%	$5.68
2nd Quintile of Population	$17.85	$89.23	10%	$8.92
3rd Quintile of Population	$24.34	$121.68	10%	$12.17
4th Quintile of Population	$32.89	$164.45	10%	$16.45
Highest Quintile of Population	$60.91	$304.57	10%	$30.46
2030 Scenario				
Lowest Quintile of Population	$11.36	$56.78	10%	$5.68
2nd Quintile of Population	$17.85	$89.23	10%	$8.92
3rd Quintile of Population	$24.34	$121.68	10%	$12.17
4th Quintile of Population	$32.89	$164.45	10%	$16.45
Highest Quintile of Population	$60.91	$304.57	10%	$30.46

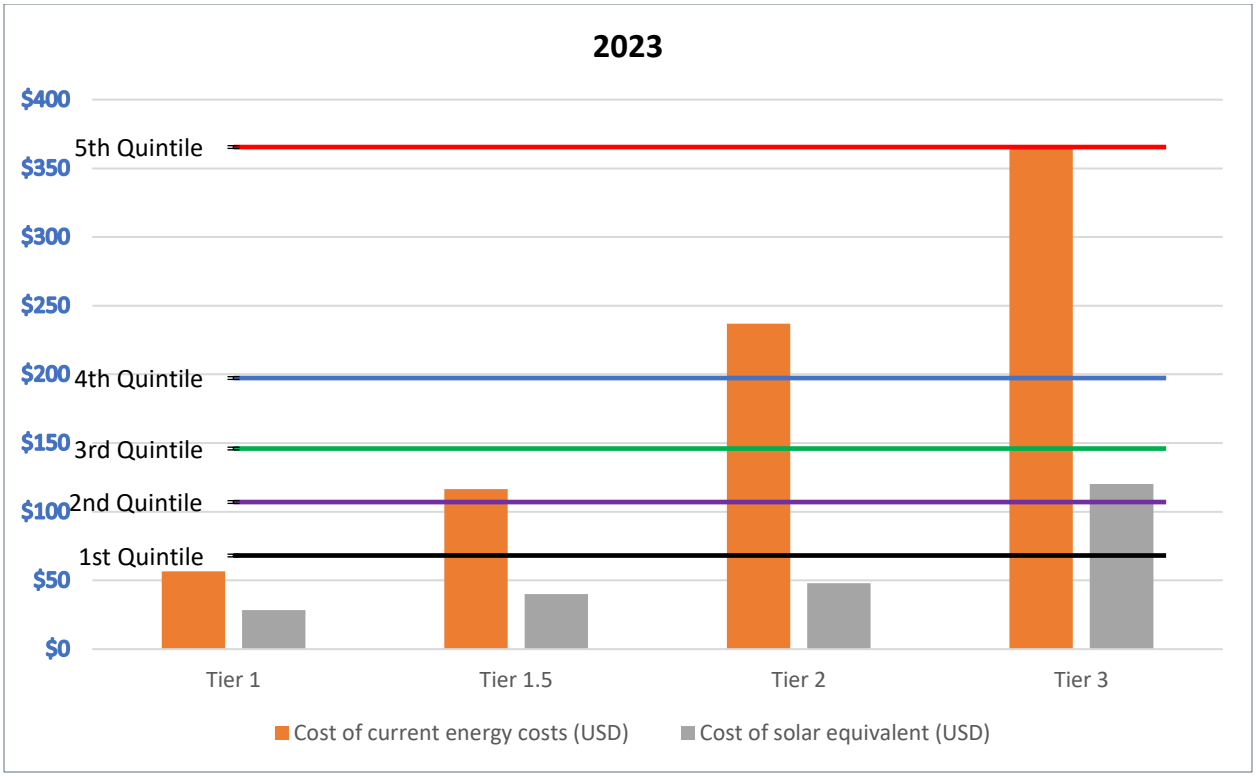
Source: African Solar Designs analysis

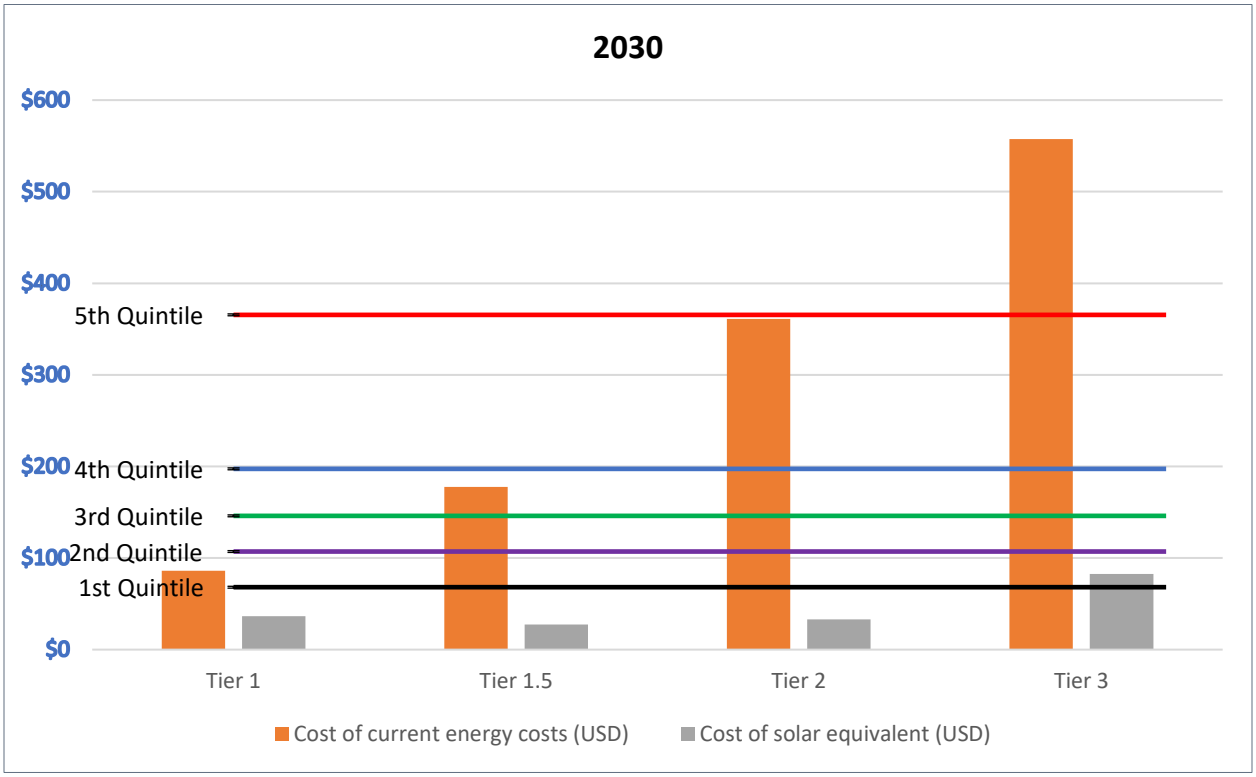
Figure 24 summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual 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 24: Annual Household Energy Budget by Quintile, Annual Energy Costs and Cost of Solar Equivalents







Source: African Solar Designs analysis

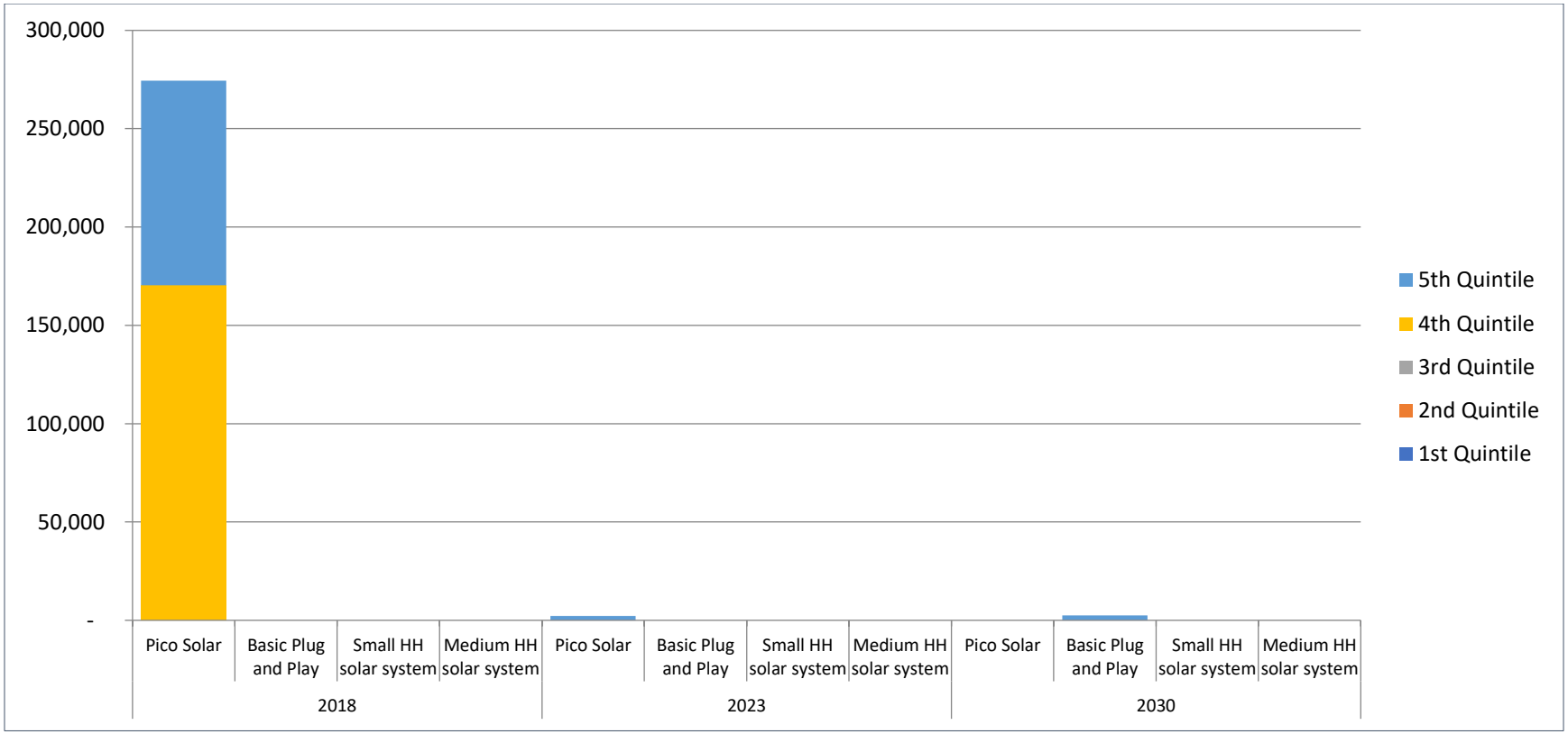
2.1.3 The Market for Household Devices without Consumer Finance

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 15**. 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, only households without access in the top two income quintiles – 4 and 5 – can afford an OGS system unfinanced in the 2018 scenario. Even then, these households can only afford to purchase pico solar systems. The three lowest quintiles would either have to continue using their current energy systems or save for a longer period to afford an OGS system. Based on the assumption that 55% of the households in the highest quintile live in urban areas and are connected to the grid, the annualized off-grid cash market for pico solar systems is limited to 137,225 units in 2018. This market size would decrease further in 2023 and 2030, as shown below.

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



Source: African Solar Designs analysis

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

Table 16: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	137,225	412	$6,175,137
Basic Plug and Play	0	0	$0.00
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**137,225**	**412**	**$6,175,137**
2023 Scenario			
Pico Solar	1,092	3	$54,802
Basic Plug and Play	0	0	$0.00
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**1,092**	**3**	**$54,802**
2030 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	866	9	$63,249
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**866**	**9**	**$63,249**

Source: African Solar Designs analysis

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

- In the extremely low income off-grid environment, many consumers will not be able to afford even the smallest systems. As can be seen, the absolute poverty of rural areas means that a large number of the lowest three quintiles by income cannot afford any system.
- The most common type of systems which the market can afford on a cash basis are pico and small plug and play systems. Based on available income figures Tier 2 and Tier 3 solutions are less viable for the vast majority of the population.
- 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

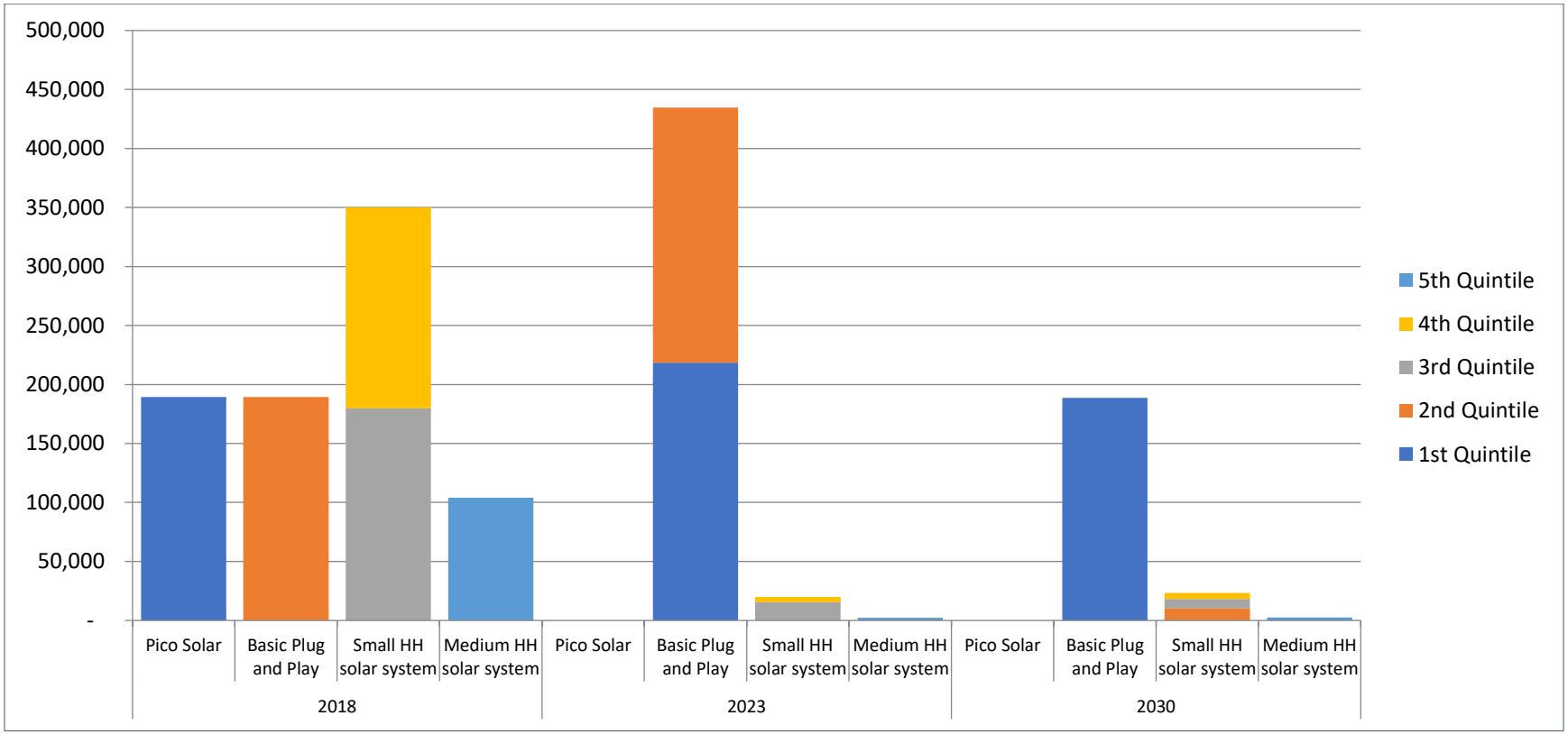
- **Financial Model**

In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with a 22.97% p.a. interest rate[111] 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 service 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.

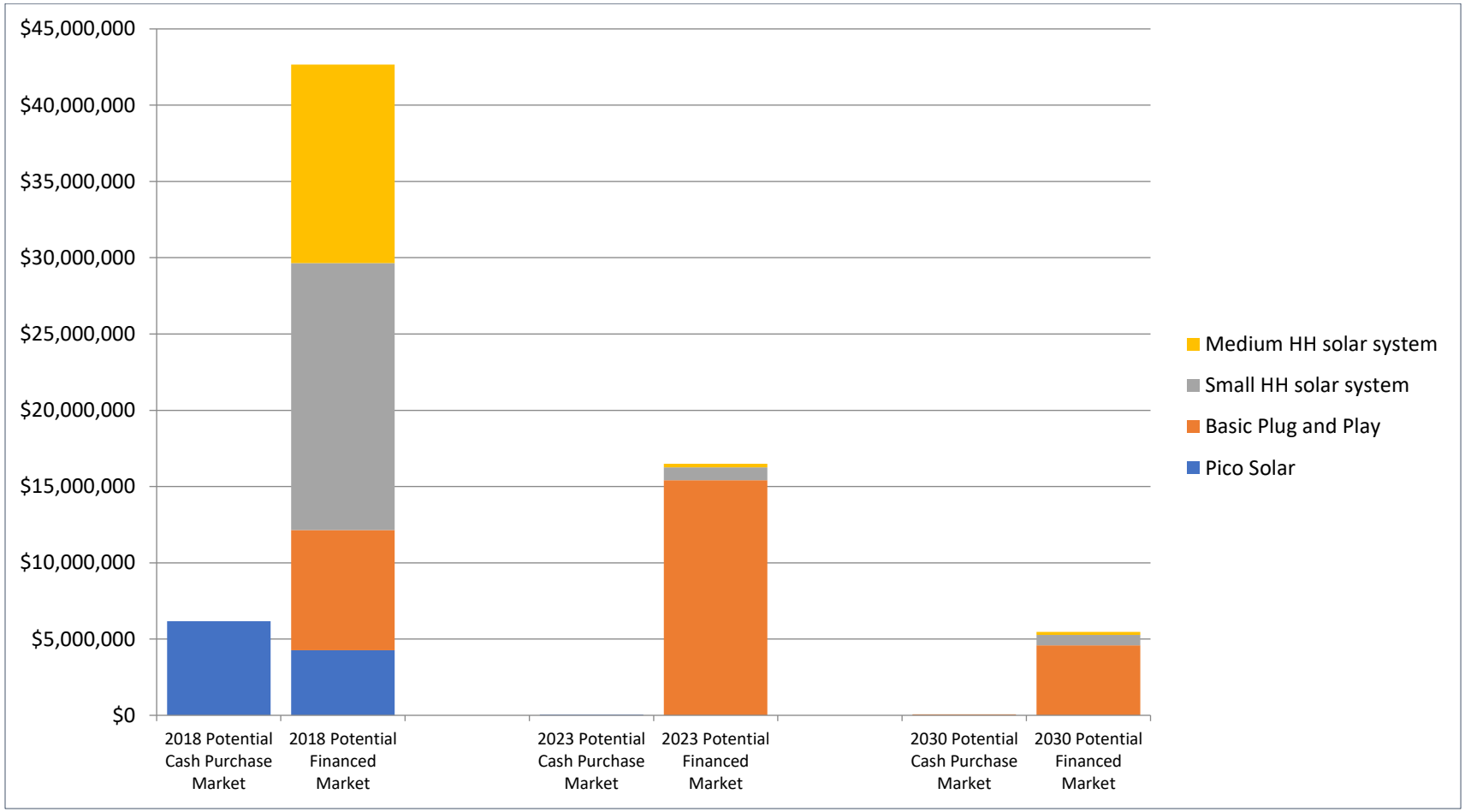
[111] Central Bank of Liberia, Annual Report, (2017): https://www.cbl.org.lr/doc/annualreport_2017.pdf

Figure 26: Estimated Number of Households Able to Afford Financed OGS Systems by Income Group



Source: African Solar Designs analysis

Figure 27: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

In 2018, without financing, only 548,901 households (33% of the total households in calculated off-grid areas) could afford an OGS system. However, with financing, 832,815 households (100% of all households in calculated off-grid areas) could afford an OGS system as all the off-grid households are enabled to acquire at least one OGS system. Consequently, the annualized potential market size increases from USD 6,175,137 to USD 42,666,019 (**Figure 27**).

The least-cost electrification 2023 scenario calculates that 456,807 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 significantly from 2,185 (0.5% of the total households in calculated off-grid areas) to 456,807 (100% of all households in calculated off-grid areas) as the 454,622 off-grid households in the four lowest income quintiles are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 54,802 to USD 16,498,331 (**Figure 27**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems would drop to 214,505. Under this scenario, with financing, the number of households with the ability to acquire at least one OGS system increases from 2,597 (1.2% of the total households in calculated off-grid areas) to 214,505 (100% of the total households in calculated off-grid areas) as the 211,908 off-grid HH in the four lowest income quintiles are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 63,249 to USD 5,465,107 (**Figure 27**).

Table 17 presents the estimated annualized financed market potential for off-grid solar product sales in the country's household sector.

Table 17: Estimated Financed Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	94,638	284	$4,258,715
Basic Plug and Play	63,092	631	$7,886,510
Small HH solar system	70,032	3,502	$17,508,052
Medium HH solar system	20,820	5,205	$13,012,742
Total	**248,583**	**9,622**	**$42,666,019**
2023 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	144,906	1,449	$15,418,717
Small HH solar system	3,981	199	$847,171
Medium HH solar system	437	109	$232,443
Total	**149,324**	**1,757**	**$16,498,331**
2030 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	62,846	628	$4,592,277
Small HH solar system	4,674	234	$683,085
Medium HH solar system	519	130	$189,746
Total	**68,039**	**992**	**$5,465,108**

Source: African Solar Designs analysis

2.1.5 Analysis of 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 Liberia. 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 18 shows the estimated annualized cash market potential for institutional users in Liberia. 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.

Table 18: Indicative Total Cash Market Potential for Institutional Sector[112]

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	143	215	$537,188
	Medium power pumping system	103	413	$1,031,500
	High power pumping system	37	367	$917,500
	Subtotal	283	995	$2,486,188
Healthcare	Health post (HC1)	56	14	$35,250
	Basic healthcare facility (HC2)	12	19	$46,313
	Enhanced healthcare facility (HC3)	9	37	$92,925
	Subtotal	77	70	$174,488
Education	Primary schools	272	136	$407,850
	Secondary schools	271	521	$1,301,520
	Subtotal	543	657	$1,709,370
Public lighting	Public lighting (excluding street lighting)	60	30	$89,925
TOTAL		**963**	**1,752**	**$4,459,971**

Source: African Solar Designs analysis

[112] 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 19: 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 20**. The distribution of potential off-grid water points is shown in **Figures 28-30**.[113]

Table 20: Estimated Cash Market Potential for Water Supply[114]

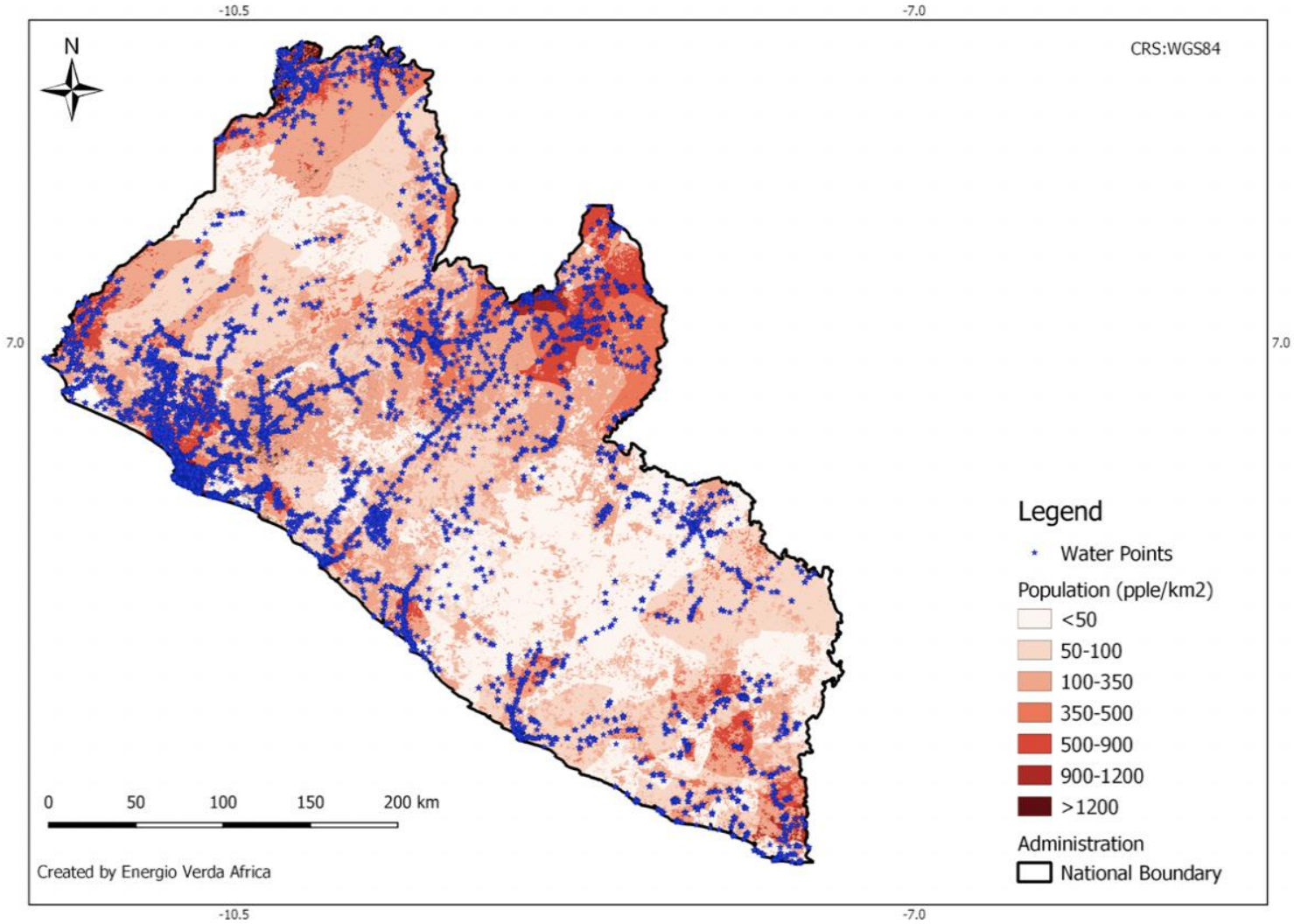
Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	143	215	$537,188
Medium power	103	413	$1,031,500
High power	37	367	$917,500
Total	**283**	**995**	**$2,486,188**

Source: African Solar Designs analysis

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

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

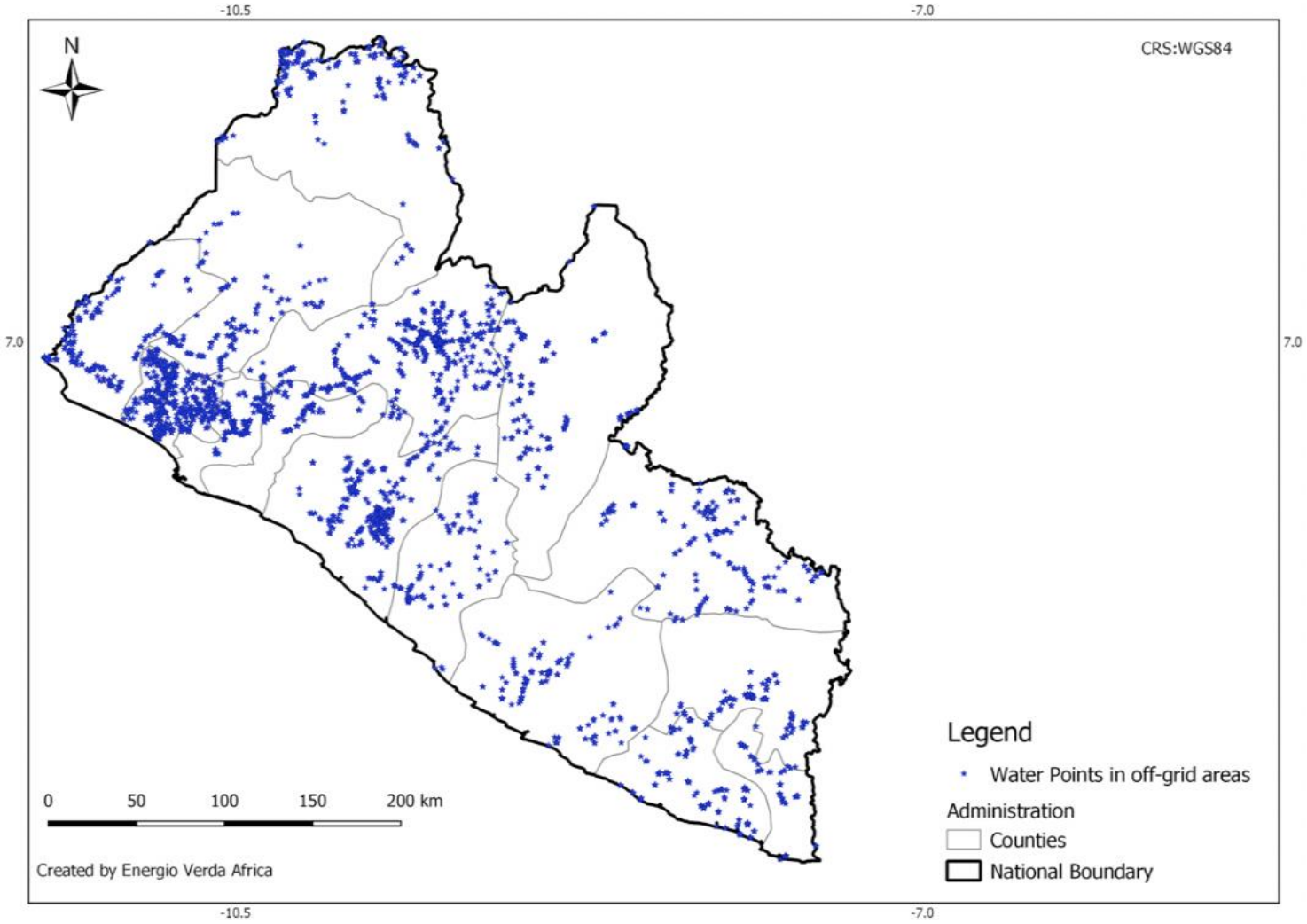
Figure 28: Distribution of Potential Off-Grid Water Points and Population Density[115]



Source: Energio Verda Africa GIS analysis

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

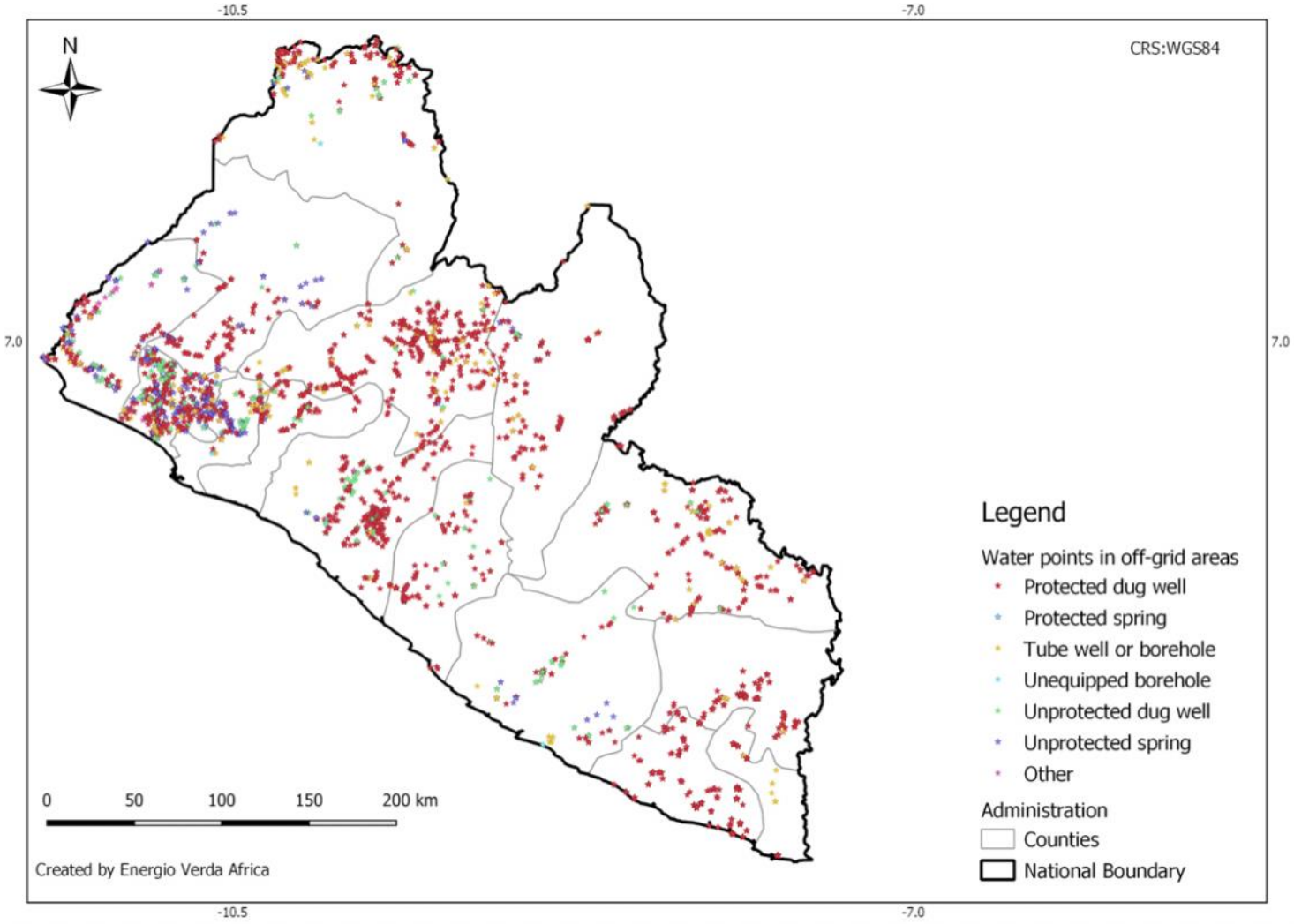
Figure 29: Distribution of Potential Off-Grid Water Points[116]



Source: Energio Verda Africa GIS analysis

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

Figure 30: Distribution of Potential Off-Grid Water Points by Category[117]



Source: Energy Verda Africa GIS analysis

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

- **Healthcare**

Table 21: 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)	706 off-grid healthcare facilities were identified that could be electrified by stand-alone systems

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

Available GIS data identified off-grid health facilities categorized according to their size (HC1, HC2, and HC3) that could be electrified by stand-alone systems.[118] 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 22**). The assumptions of system size below are based on the services offered at each of these facilities.

Table 22: Healthcare Facility Categorization and Electricity Demand[119]

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

[118] NOTE: This represents a small subset of the overall health infrastructure in the country; See **Annex 1** for more details.
[119] "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 23**. The distribution of potential off-grid health facilities is shown in **Figure 31**.

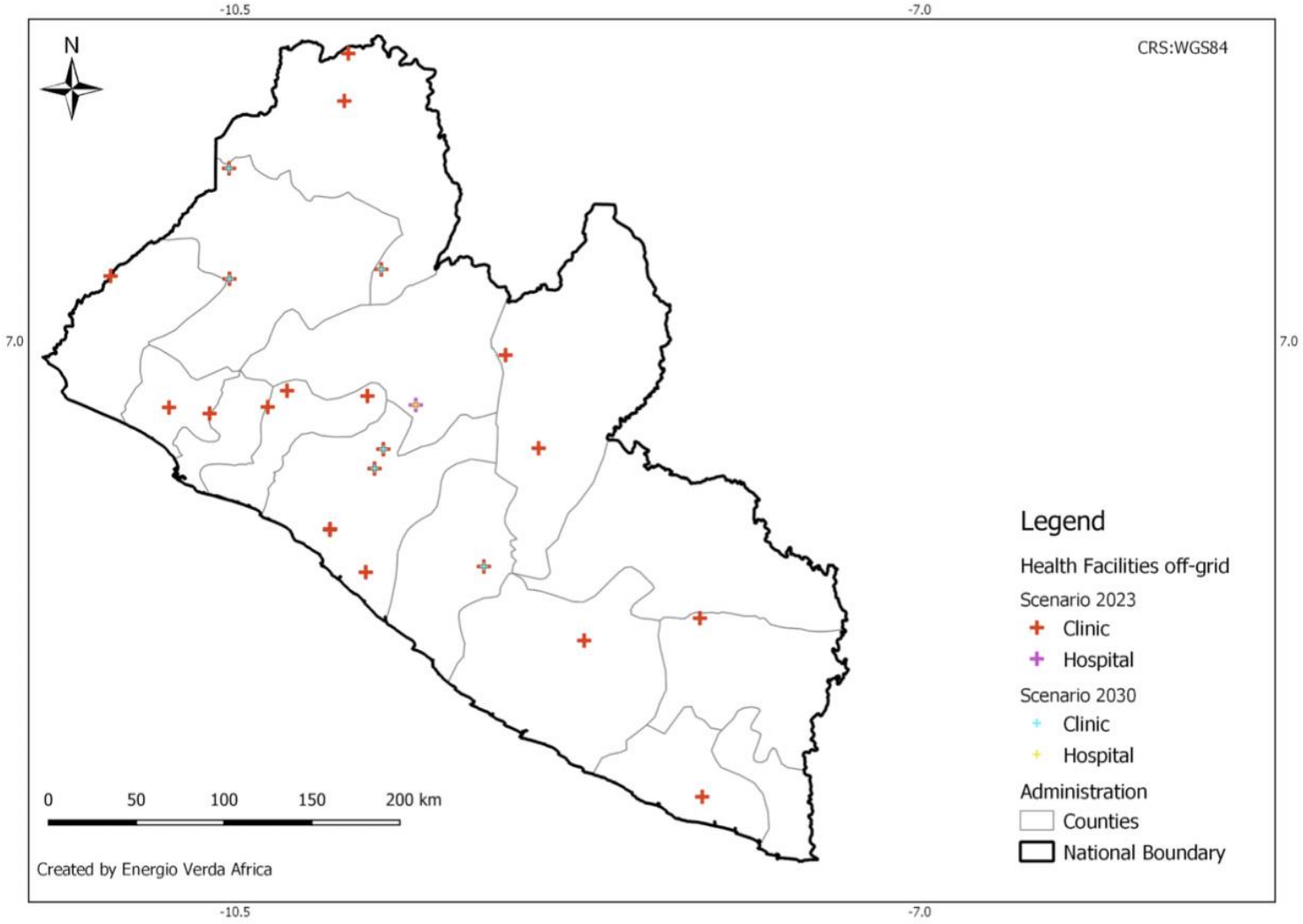
Table 23: Estimated Cash Market Potential for Healthcare Facilities[120]

Type of Facility	Units	kW Equivalent	Cash value (USD)
HC1 Health post	56	14	$35,250
HC2 Basic healthcare facility	12	19	$46,313
HC3 Enhanced healthcare facility	9	37	$92,925
Total	**77**	**70**	**$174,488**

Source: African Solar Designs analysis

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

Figure 31: Distribution of Potential Off-Grid Healthcare Facilities, 2023 and 2030[121]



Source: Energio Verda Africa GIS analysis

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

- **Education**

Table 24: Key Assumptions for Education Sector Analysis[122]

Sector	System Sizes	Key Assumptions
Education	• Elementary schools (500 W) • Secondary schools (1,920 W)	5,438 off-grid primary schools and 5,423 off-grid secondary schools were identified that could be electrified by stand-alone systems

Focus group participants observed that solar applications are being utilized in several off-grid schools for lighting and ICT purposes. Most of the programs that financed the installation of solar in these schools were grants from donor agencies and did not cover ongoing maintenance. The education sector analysis considered the electricity needs of off-grid primary and secondary schools.[123] These include lighting, ICT (computers, tablets etc.), communication (phone charging), laboratories and staff housing. The size of a school and number of students determines the amount of energy it requires. The analysis identified off-grid primary and secondary schools that could be electrified by stand-alone systems. To establish electricity demand, an assessment of equipment found within each type of school was undertaken, with the daily demand of each used to calculate the system size required to cater to the load of the school (**Table 25**).

Table 25: Education Center Categorization and Electricity Demand[124]

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

Source: GIZ; African Solar Designs analysis

Based on these assumptions, the estimated annualized cash market potential for primary and secondary schools is presented in **Table 26**.

Table 26: Estimated Cash Market Potential for Primary and Secondary Schools[125]

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	272	136	$407,850
Secondary school	271	521	$1,301,520
Total	**543**	**657**	**$1,709,370**

Source: African Solar Designs analysis

[122] 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**).
[123] 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.
[124] "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
[125] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

- **Public Lighting**

Table 27: Key Assumptions for Public Lighting Sector Analysis[126]

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 28**.

Table 28: Estimated Cash Market Potential for Public Lighting[127]

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	60	30	$89,925

Source: African Solar Designs analysis

2.2.3 Ability to Pay and Access to Finance

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

Institutional users that rely on government or donor funds for the purchase and O&M of solar systems may be constrained by limited funds and/or competing budget priorities. Thus, local communities benefiting from solar electrification would also have to bear some long-term costs for the maintenance of systems and replacement of parts. In the event that public or donor funding is made available to cover the initial capital expenditure, funds can be raised by local communities through a minimal tariff to customers of the health facilities, water pumping stations etc. for long-term O&M. A market standard of 5-10% of the capital expenditure is accepted as a rate for annual maintenance of systems.[128]

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.

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

The Liberian economy has been undergoing structural changes, especially since the recent Ebola crisis. Although mining, agriculture and fisheries are the primary sectors, the service industry has been growing in recent years.[129] In 2016, services represented 30% of GDP and employed 42% of the labor force.[130] However, agriculture and fisheries still play an important role in Liberia's economic growth, trade and employment. About half of the population is employed in the agricultural sector, mostly as smallholder farmers.[131] Poor land tenure, insufficient inputs, high pre and postharvest losses due to inadequate facilities and technology reduce Liberian productivity; farmers barely produce enough to meet their own consumption needs. Thus, solar powered applications could boost the productivity and tap into the economic potential of the agricultural sector, particularly at the smallholder farmer level.

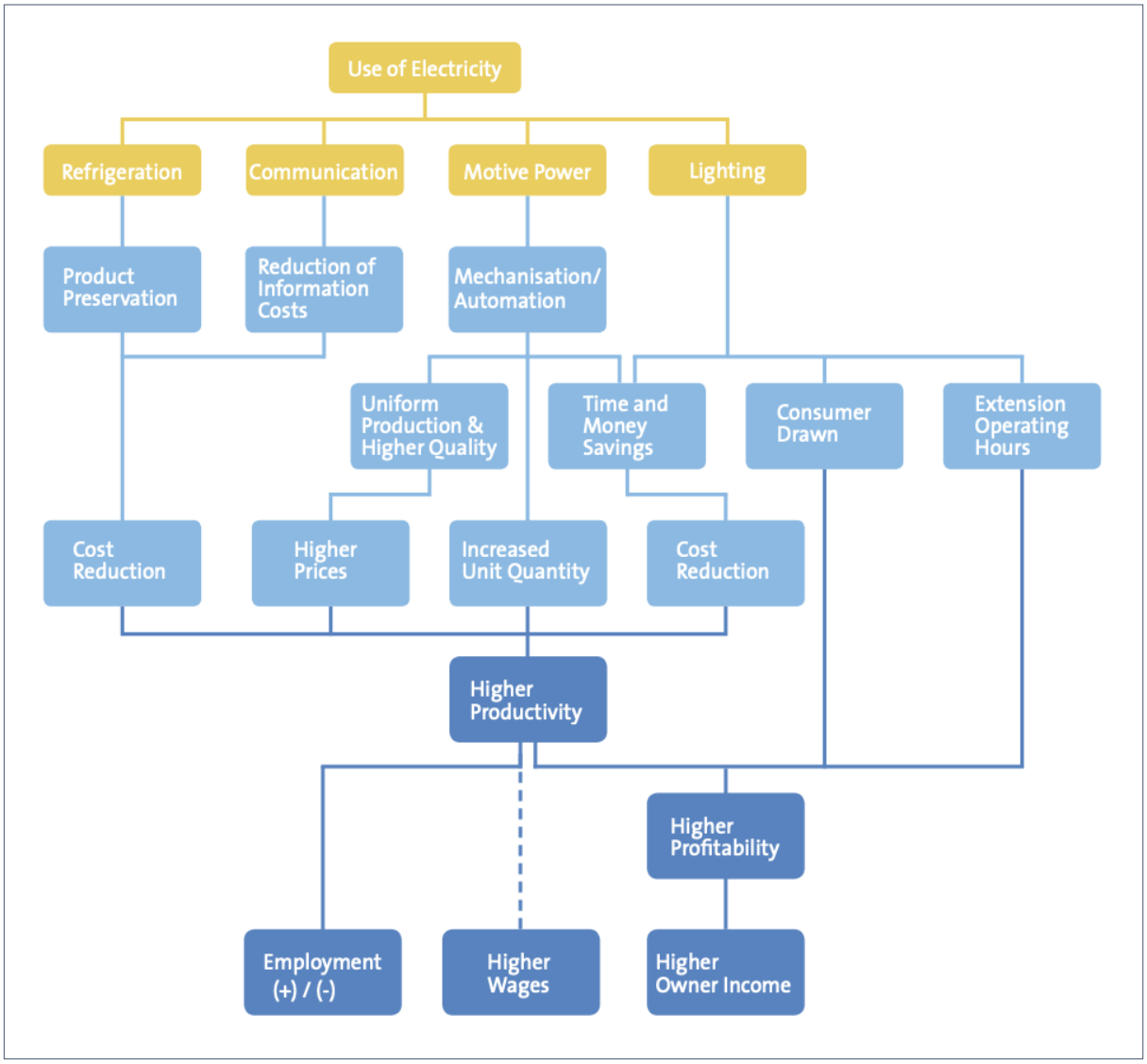
A lack of adequate and reliable electricity supply has also contributed to a slowdown in the country's economic growth and development. More than 60% of firms identified electricity as a major constraint to their operations and growth. Given the importance of consistent energy access to the profitability of most enterprises, business owners are often forced to utilize off-grid solutions, usually fossil-fuel powered

[129] Service sector hires are largely concentrated in Monteserado County thus the structural transformations have not trickled into other areas. The majority of the population, particularly in rural areas, still depends on informal trade and agriculture for employment.
[130] "International Development Association, International Finance Corporation, Multilateral Investment Guarantee Agency, Country Partnership Framework for the Republic of Liberia, for the period of FY19-FY24," World Bank, (October 2018): http://documents.worldbank.org/curated/en/585371528125859387/pdf/LBR-SCD-draft-10-06012018.pdf
[131] Ibid.

generators. Off-grid solar applications could play a significant role in helping these businesses and in turn supporting GoL 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 to which firms can afford to invest in off-grid solar solutions is determined largely by increases in productivity, profitability, and employment/wages from the investment in the off-grid appliance (**Figure 32**).

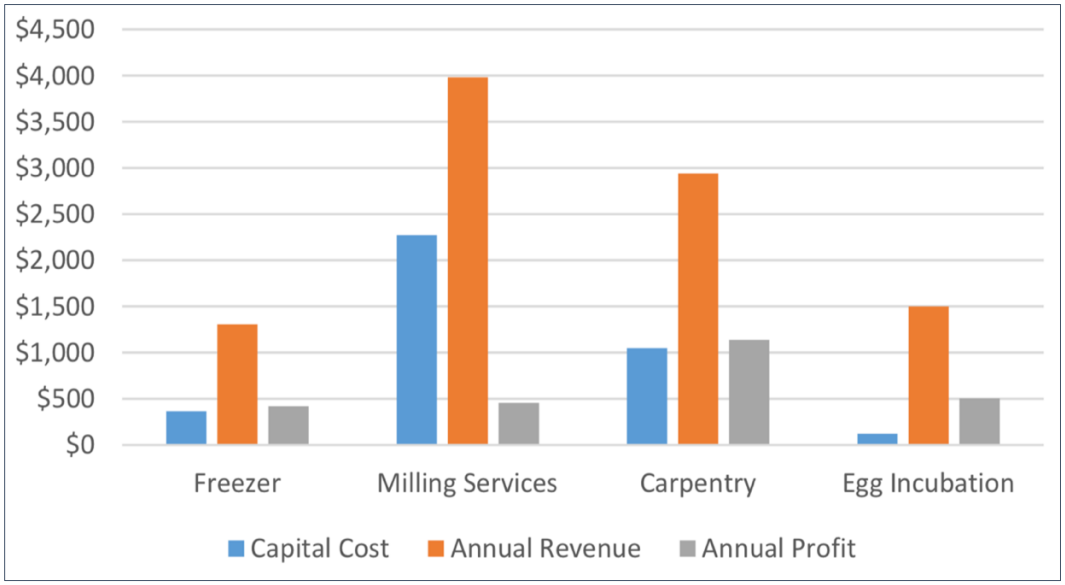
Figure 32: Pathways from Electricity to Income Generation[132]



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

[132] 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 33: Analysis of Cost, Revenue, and Profit for Various Productive Use Applications[133]



NOTE: Annual profit does not include recovery of cost capital

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

Source: African Solar Designs

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 29**).

Table 29: 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

[133] "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 and peri-urban areas in Liberia. In order to address energy access and reliability issues, the Government and donor community have implemented several programs to support growth of the off-grid sector outside of Monrovia.[134]

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 30** presents the estimated annualized cash market potential for off-grid solar productive use applications.

Table 30: Indicative Total Cash Market Potential for Productive Use Sector[135]

Productive Use Sector		Units	kW Equivalent	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	337	84	$210,500
Value-added Applications	Irrigation	83,333	10,000	$ 54,166,667
	Milling	31	202	$ 504,184
	Refrigeration	60	330	$ 824,313
	Subtotal	83,424	10,532	$55,495,164
Connectivity Applications	Phone Charging	1,696	678	$ 1,461,841
TOTAL		**85,457**	**11,294**	**$57,167,505**

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

- **SME Applications for Village Businesses**

Access to solar powered appliances can have a wide-ranging impact on SMEs, many of which would otherwise rely on diesel or petrol-powered generators to power their enterprises. Close to 33% of SMEs in emerging markets use fossil fuel powered generators in order to address energy insecurity.[136] For ECOWAS countries, independent power generation via fossil fuel powered generators is especially prevalent.[137]

In Liberia, power outages account for an estimated 3.8% of annual sales losses. Accordingly, unreliable electricity supply has resulted in 75% of Liberian firms owning generators (**Figure 34**). Off-grid solar solutions could therefore play a significant role in reducing fuel costs and addressing the challenges of power quality for businesses in the country.

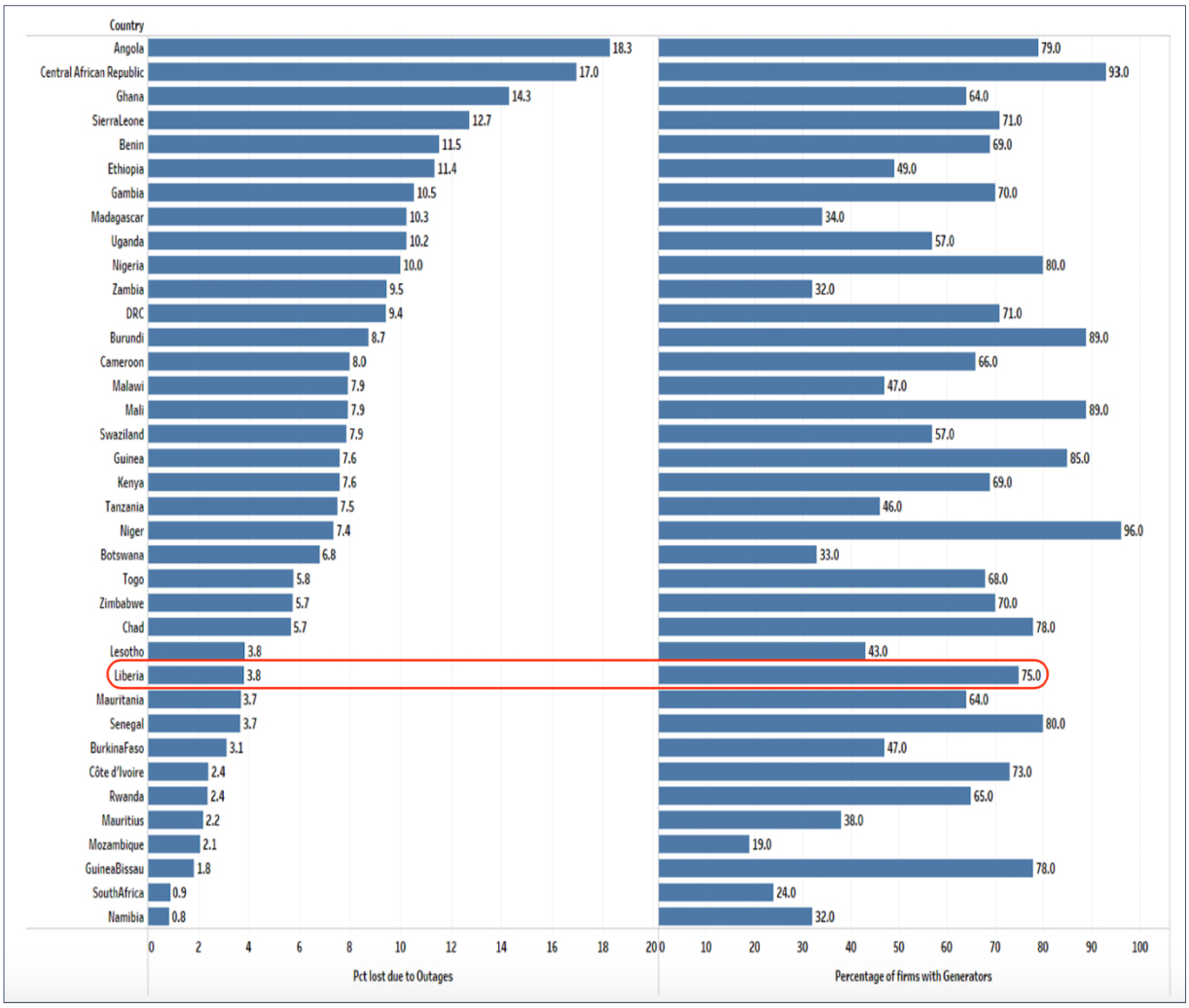
[134] "New Energy Project Targets 150,000 Liberians for Increased Access to Affordable and Reliable Electricity," World Bank (2016): http://www.worldbank.org/en/news/press-release/2016/01/11/new-energy-project-targets-150000-liberians-for-increased-access-to-affordable-and-reliable-electricity;
"AECF launches Competition targeting Private Sector in Renewable Energy in Liberia," Africa Enterprise Challenge Fund (AECF), (2018): https://www.aecfafrica.org/media_centre/news/AECF_launches_competition_targeting_private_sector_in_renewable_energy_in_liberia

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

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

[137] Ibid.

Figure 34: Percentage of Sales Lost due to Power Outages and Percentage of Firms with Generator[138]



Source: Center for Global Development

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

With the exception of replacing diesel gensets, the estimation of the available market for off-grid solar appliances for SMEs is not as closely correlated with economic indicators. Nonetheless, some widely marketed solar powered appliances are more centrally related to the revenue generation of SMEs. Investments in such appliances in off-grid and low-income settings are more likely to be sustainable. This

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

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.[139]

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 210,500 (**Table 31**).

Table 31: Estimated Cash Market Potential for SMEs – Barbers and Tailors[140]

No. of SMEs with Constrained Access to Finance[141]	Units	kW Equivalent	Cash Value (USD)
1,684	337	84	$210,500

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.

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 (**Table 32**). 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.

[139] 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
[140] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[141] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap

Table 32: Major Donor-Funded Projects in Agriculture in Liberia[142]

Grant Recipient (s)	Commitment (USD thousand)	Type of Financing
Fish Town Artisan Fishery Association (FAFA)	154,220	Grant
Suakoko Rural Women Cooperative Society (SURWOCOP)	86,208	Grant
Doolakeh Multipurpose Cooperative Society	88,368	Grant
Community Women's Dream for Sustainability	82,580	Grant
Kukatonon Women Agriculture Cooperative (KWAC)	90,300	Grant
From God to Man Agriculture Multipurpose Cooperative	88,500	Grant

Source: World Bank

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.[143] 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 Liberia are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 35**).

It is important to note that many Liberian farmers may be discouraged from making long-term investments in irrigation on their land due to unclear land tenure rights. Many farmers depend on land and property collateral to finance new inputs, but weak property rights and ongoing land disputes hinder them. A New Land Rights Act that is currently under review may ease this problem.[144]

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 33 presents the estimated annualized off-grid solar cash market potential for smallholder value-added solar irrigation applications in Liberia, which has an estimated cash value of USD 54.1M (see **Annex 2** for more details).

Table 33: Estimated Cash Market Potential for Value-Added Applications – Irrigation[145]

Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation	Units	kW Equivalent	Cash Value (USD)
500,000	83,333	10,000	$ 54,166,667

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

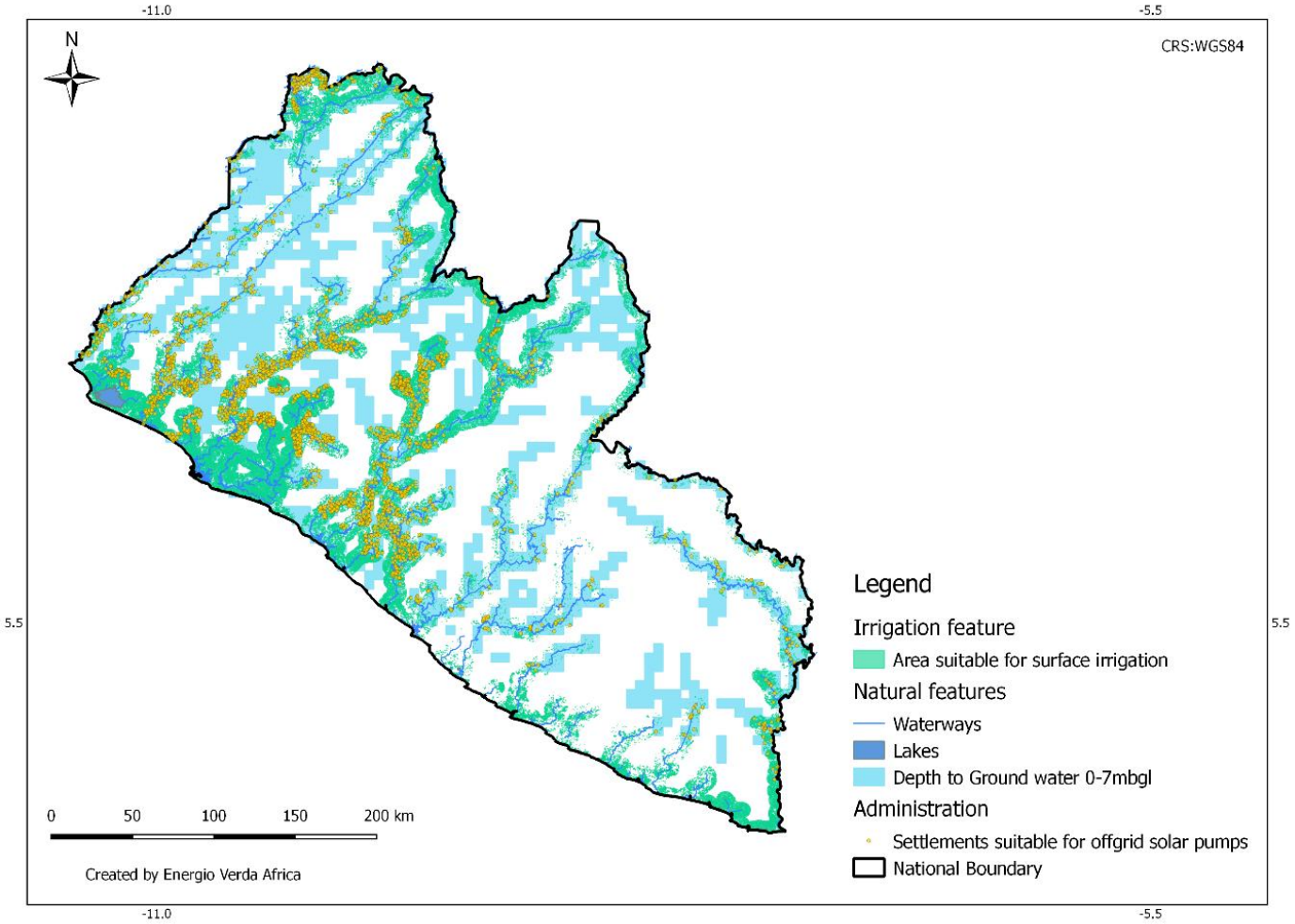
[142] "International Development Association, International Finance Corporation, Multilateral Investment Guarantee Agency, Country Partnership Framework for the Republic of Liberia for the Period FY19-FY24," World Bank, (October 2018): http://documents.worldbank.org/curated/en/374031541438293964/pdf/liberia-cpf-11012018-636768792698663889.pdf

[143] *See* GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS

[144] "Liberia, Selected Issues," International Monetary Fund, (2016): https://www.imf.org/external/pubs/ft/scr/2016/cr16239.pdf

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

Figure 35: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps



Source: British Geological Survey, Bureau of Statistics; ESA Climate Change Initiative; Rural and Renewable Energy Agency; Energio Verda Africa GIS analysis[146]

[146] 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 34 presents the estimated annualized off-grid solar market potential for smallholder value-added solar grain milling applications in Liberia, which has an estimated cash value of USD 504,184 (see **Annex 2** for more details).

Table 34: Estimated Cash Market Potential for Value-Added Applications – Milling[147]

Estimated No. of Solar Mills	Units	kW Equivalent	Cash Value (USD)
621	31	202	$ 504,184

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 35 presents the estimated annualized off-grid solar market potential for smallholder value-added solar refrigeration applications in Liberia, which has an estimated cash value of USD 824,313 (see **Annex 2** for more details).

Table 35: Estimated Cash Market Potential for Value-Added Applications – Refrigeration[148]

Off-Grid Market Centers	Units	kW Equivalent	Cash Value (USD)
1,199	60	330	$ 824,313

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

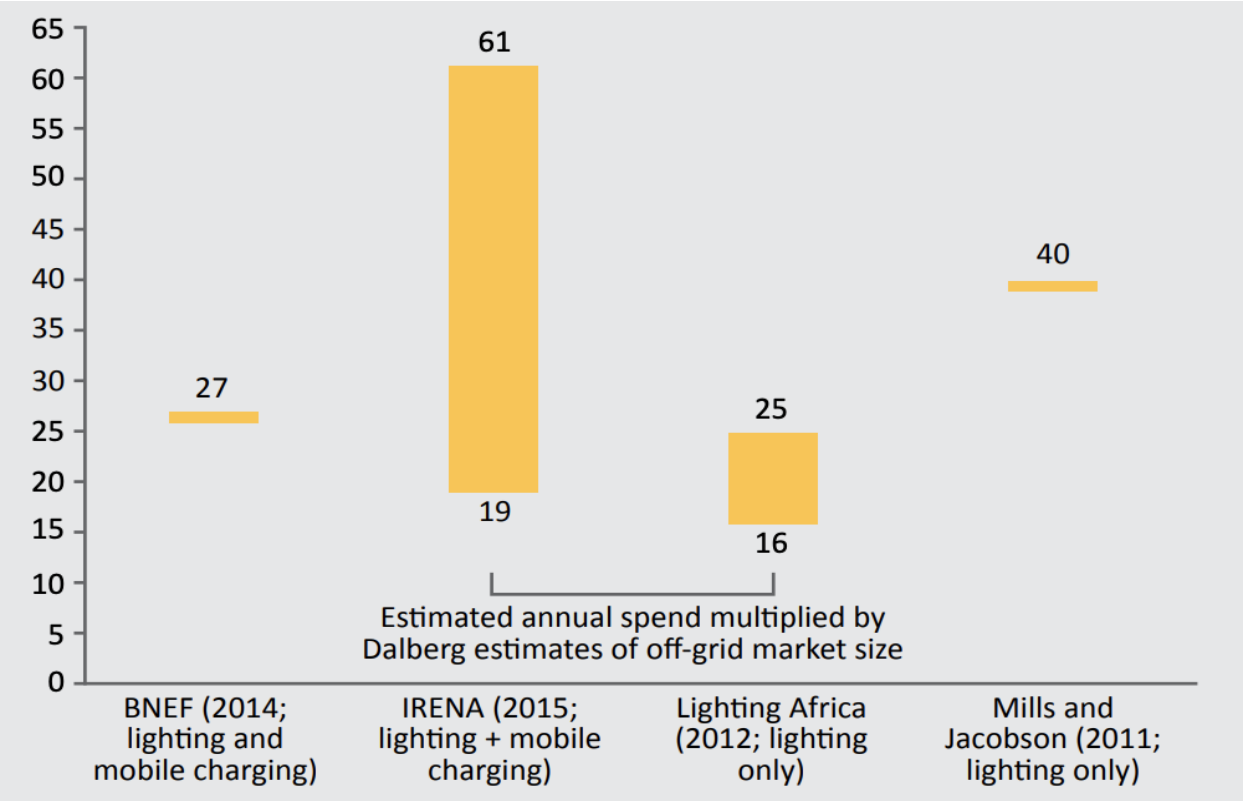
Ultimately, it should be recognized that the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry out the market sizing analysis does not incorporate the idiosyncratic considerations of each agricultural product's value chain.

- **Connectivity Applications**

Mobile phone charging stations/kiosks make up a critical segment of off-grid solar demand, as the market for solar phone charging is expected to grow significantly in the near-term. Household rates of mobile phone ownership often greatly exceed rates of electricity access (**Figure 18**), while households spend a significant share of income on lighting and phone charging (**Figure 36**). Increasingly, OGS devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

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

Figure 36: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging[149]



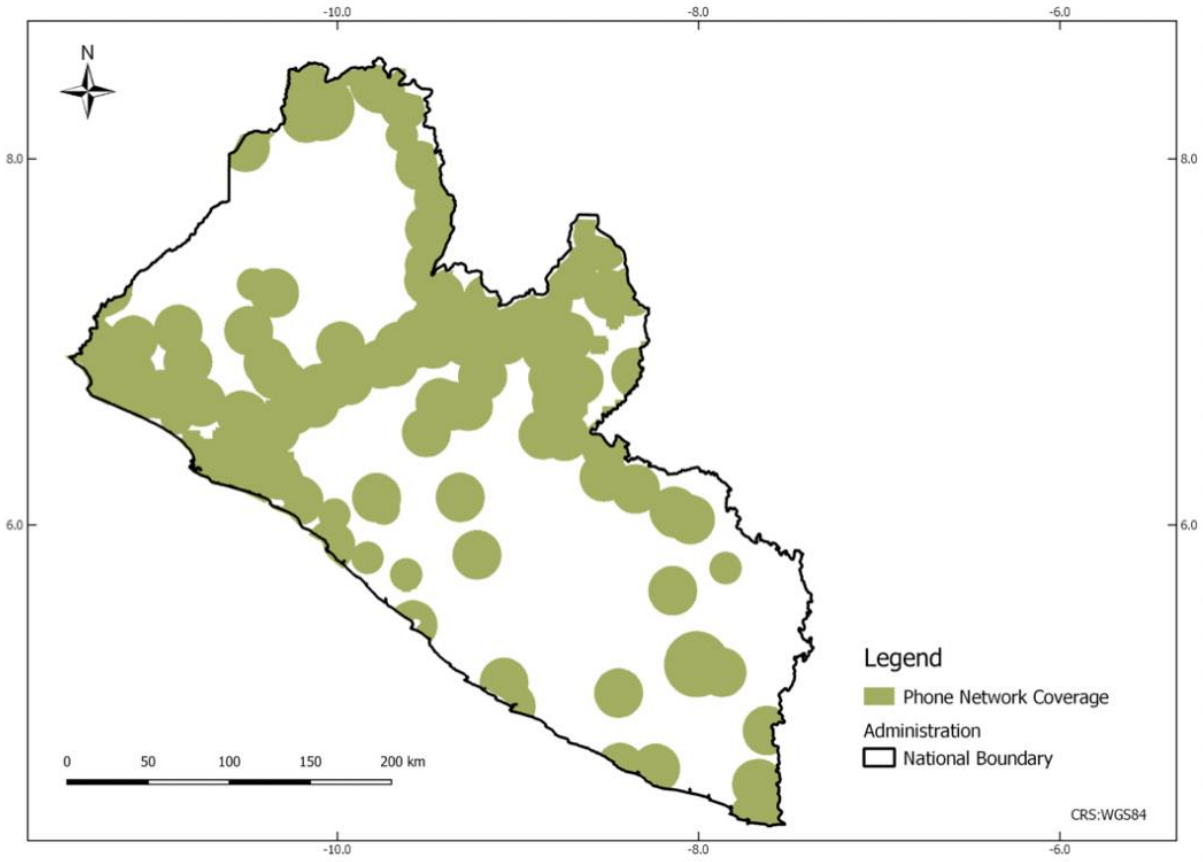
NOTE: Figures in Billion USD

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

Figure 37 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 17**).

[149] "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 37: Mobile Phone Network Geographic Coverage[150]



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 36** presents the estimated annualized cash market potential for off-grid solar mobile phone charging enterprises in Liberia, which has an estimated cash value of USD 1.4 million (see **Annex 2** for more details).

Table 36: Estimated Cash Market Potential for Mobile Phone Charging Enterprises[151]

Mobile Subscribers[152]	Rural Population (%)[153]	Units	kW Equivalent	Cash Value (USD)
1,700,000	50%	1,696	678	$ 1,461,841

Source: GSMA; World Bank; African Solar Designs analysis

[150] See **Annex 2** for more details.
[151] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[152] "The Mobile Economy: Sub-Saharan Africa," GSMA, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[153] 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 Liberia. 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.

The focus group discussion yielded additional insights into the off-grid solar PUE sector from a consumer point of view:

- Many companies cannot afford the up-front cost of solar products and systems. A potential solution to this problem would be to implement a third-party ownership system and increased access to financing potentially through concessional loans.
- Revised or lower tariffs from the current 17% - 23% on solar products is desired.
- There is also a high degree of skepticism regarding the reliability and quality of solar powered appliances, and as a result, more should be done to raise awareness and set appropriate standards for solar products.

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Liberia, 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 37**.

Table 37: 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

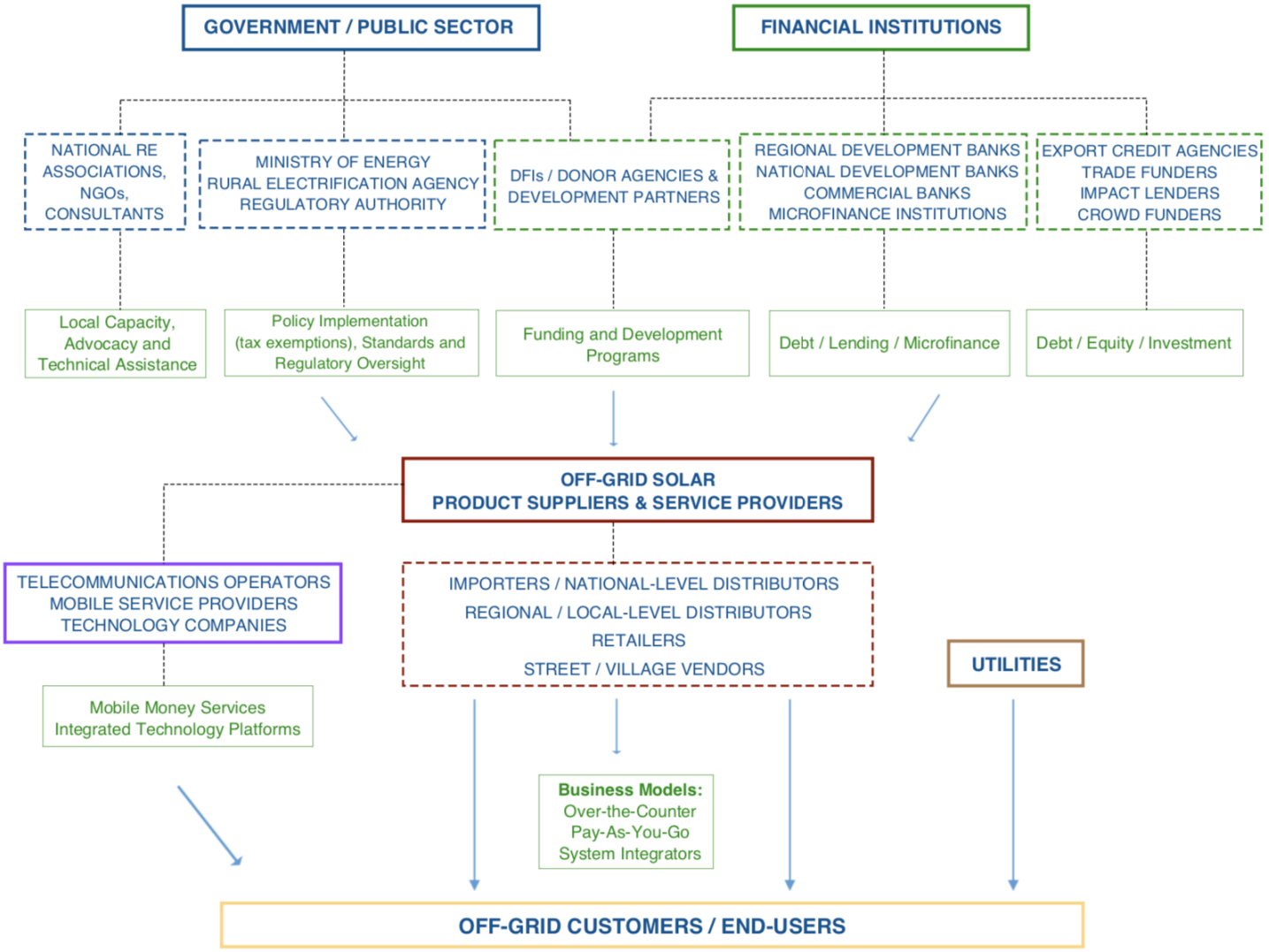
The off-grid solar supply chain in Liberia is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 38**). Liberia is a small but quickly growing solar market. Some market segments driving OGS demand include water pumping in Voinjama (Lofa County), PUE in Totota (Bong County) under a NRECA electrification project, and institutional demand to power Phebe Hospital in Gbarnga (Bong County) among others.

The Liberian solar PV market is characterized by the prominent role played by the Rural and Renewable Energy Agency (RREA) in procuring, importing and distributing solar products, especially small SHS, under a range of projects and programs sponsored by donor agencies and development partners.[154] There are also a wide range of products and systems offered by solar companies in the market (by both the formal and informal sector) and, as examined in further detail below, there are a number of business models currently being utilized. Power supply is often not sufficient, continuous, or reliable (**Figure 4** and **Figure 5**), further supporting expanded use of solar PV equipment by this consumer segment.

The main business model deployed by local solar companies is cash/over-the-counter sales, while a few companies have started to utilize PAYG sales. 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.

[154] In 2016, the RREA released a Rural Energy Master Plan that includes provisions for increasing the penetration of off-grid pico solar products and solar home systems, with a target of distributing 250,000 pico solar lamps by 2030.

Figure 38: 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.[155] 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.

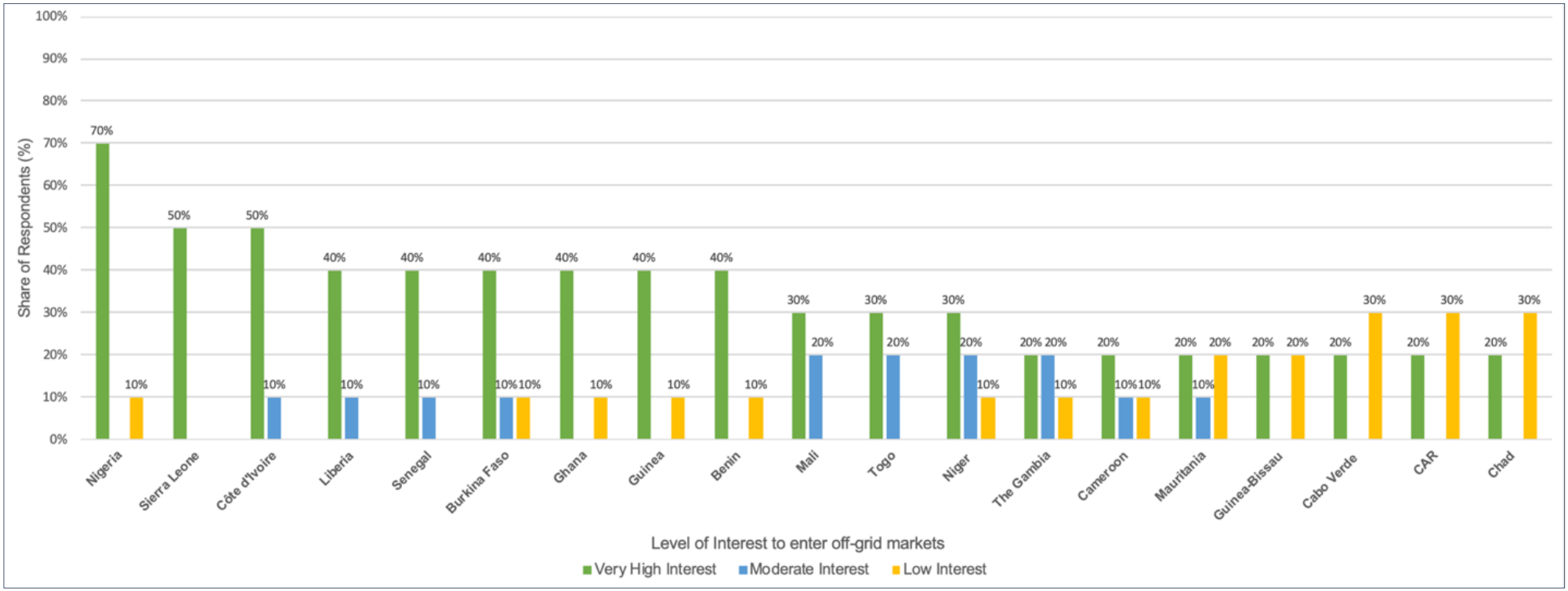
Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money 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.[156]

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.[157]

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 39**. 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.

[155] "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
[156] Ibid.
[157] "Insights from Interviews with Off-Grid Energy Companies," ECREEE, (June 2018).

Figure 39: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[158]



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

[158] 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 Liberia

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

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

Focus groups and stakeholder interviews identified nearly 30 companies operating in Liberia's solar sector, offering a wide range of products and services to consumers throughout the country (see **Annex 2** for a complete list of identified companies). In addition to local firms, the formal market includes international players that enter the market to install systems for donor-funded projects. As of 2018, most of the solar companies operating in Liberia were Tier 1 companies, with no Tier 3 companies in the market. Regardless, most formal players are Lighting Global and GOGLA affiliated companies. Most firms are distributors of international brands, or retailers, typically offering pico solar or SHS products. 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.

The Liberia Rural Renewable Energy Agency (RREA) acts as an institutional wholesaler. Under the World Bank Lighting Global initiative, RREA imports duty-free pico and SHS units and sells these products on consignment to its partners. Having a Liberian government agency directly involved in the market lowers the transaction costs for solar companies, removing risks associated with the import and distribution of products.

Additional retailers/wholesalers include Eco-Power Liberia, Jerrut Enterprise, and Total Liberia. Alternative Energy, Universal Empowerment Mission, Union Strong Group of Companies, West Coast Energy, Barefoot Liberia, and Sjedi Green Energy are all manufacturer representatives that distribute international brands in Liberia. Some companies specialize in their product and service offering, targeting specific market segments (e.g. Sjedi, Total Liberia selling pico solar to households) or customers with their products (e.g. West Coast Energy, only sells multiple module and very large SHS). Cash/over-the-counter sales are most commonplace, while Sjedi Green Energy is the only firm that currently offers PAYG financing as an option to customers.

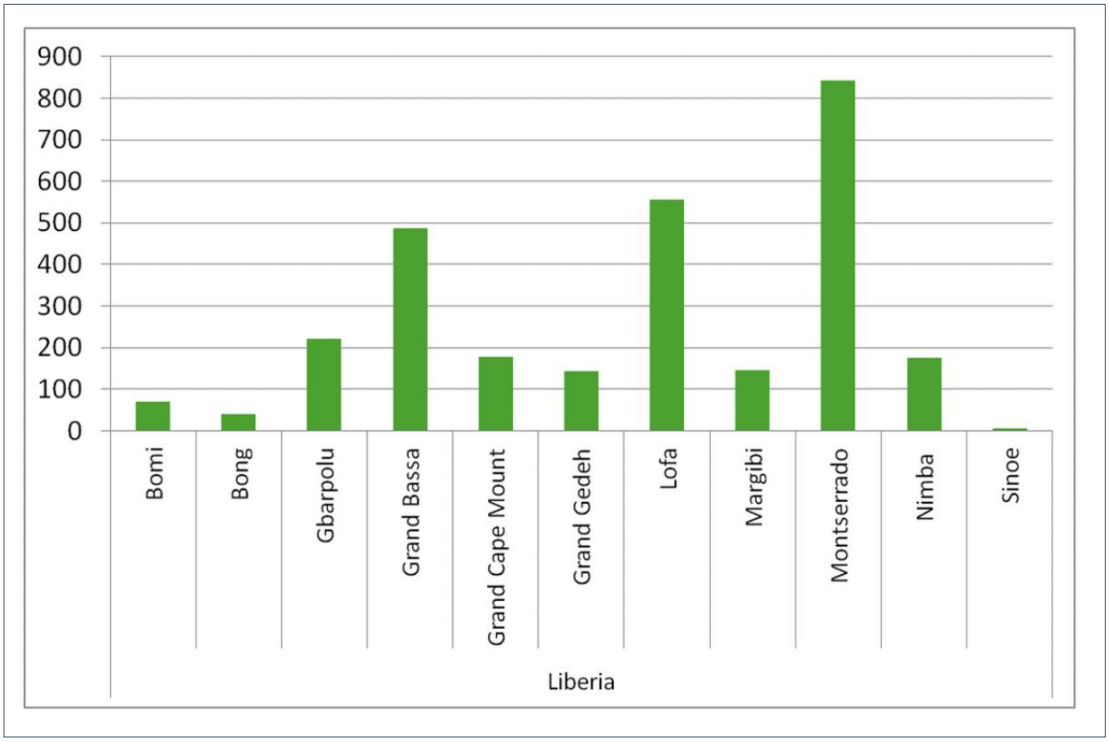
Most solar companies in Liberia are self-financed, using their own funds to operate and grow their business, while some suppliers have been able to secure external sources of funding and/or grants (e.g. Alternative Energy is the implementing agency of USAID off-grid program in Liberia; the NGO Mercy Corps / Light Up Liberia is funded by the EU). One potential source of local funding is BRAC, which was identified as a microfinance institution providing credit to SMEs in the energy sector. Focus group participants indicated that the solar market is characterized by an abundance of low-quality unlicensed products, low levels of technical capacity, and a general lack of knowledge and skills-sharing among main players.

- **Sales Volumes and Revenue**

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

Figure 40 is an overview of the number of pico solar products sold by county under the GIZ-EnDev program. A total of 2,859 pico solar products were sold between 2014-2017 nationwide under this program.[159]

Figure 40: Pico Solar Lighting Product Sales by County



Source: GIZ – EnDev Liberia

Using reports published by GOGLA,[160] some basic information on the market is presented below (**Table 38**). It is worth noting that the data only includes figures from GOGLA-affiliated companies/certified product sales and GOGLA membership represents a minority of the companies active in Liberia's OGS market.

[159] GIZ-EnDev Liberia: https://endev.info/content/Liberia

[160] "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf; and
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

Table 38: Total Sales Volume and Cash Revenue for Stand-alone Systems in Liberia, 2016-17

Sales Volume / Revenue	2016	2017	Total
Total Volume of Products Sold (Units)			
Total Volume of Products Sold	11,976	14,336	**26,312**
Pico Solar	14,089	15,251	**29,340**
SHS	2,113	915	**3,028**
Total Cash Sales Revenue (USD)			
Total Cash Sales Revenue	$217,558	$553,717	**$770,965**
Pico Solar	$208,558	$476,197	**$684,755**
SHS	$8,690	$77,520	**$86,210**

Pico solar products categorized as 0-10W
SHS products categorized as >10W

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

Source: GOGLA, Lighting Global and World Bank; GreenMax Capital Advisors analysis

- **Over the period 2016-2017, 29,940 units were sold in Liberia for a total cash sale revenue of USD 770,965:** From the available data (only a partial set of data was available), Liberia was one of the smaller OGS markets in the region.
- **Sales figures remain volatile, as Liberia is still a nascent off-grid solar market:** While sales volumes and revenue have gradually increased, the market is still in a dynamic period of growth.

➢ Main Solar Products and Components

Table 39 lists the brands of common solar products and components in Liberia. The list does not include non-certified brands that are also common in the country's grey market.[161]

Table 39: Off-Grid Solar Products and Components in Liberia

Systems	Companies
Distributors of pico solar lanterns	Jerrut Enterprise, Universal Empowerment International
Single Module distributors	RREA
Multi module system distributors	West Coast Energy and Union Stroup Group
Very large system supplier	West Coast Energy and Union Strong Group
Product / Components	**Brands**
Pico solar lanterns	D.light, GreenLight Planet, Barefoot, Fosera
Solar Module	Sun Tech (USA)
Controllers	Outback, Morningstar
Inverters	Outback (USA), Magnum, Kisae
Chargers	Magnum
Refrigerator	Sundanzer, Poly
Polycrystalline	Suntech
Gel Battery	Deka Solar (USA)

Source: Stakeholder interviews

[161] 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.

➢ **Market Prices**

Table 40 presents average prices for off-grid systems and components in Liberia's solar market. Although sales volumes are growing, prices of certified products for consumers are still slightly higher than in mature solar markets.

Table 40: Estimated Prices of Solar Systems and Components in Liberia

Off-Grid System / Component	Price range (USD / per unit)
Pico solar	$25-$40
Solar Module (300kW)	$285
Inverter (2,000kW)	$2,250
Gel Battery (210Ah)	$730

Source: Stakeholder interviews

➢ **Importation Clearance Processes**

Several authorities are involved in the importation of solar products into Liberia – the Ministry of Energy, the Ministry of Finance and Development Planning (for customs and excise), the Ministry of Commerce and Industry (MOCI), and the Bureau Veritas Liberia (BIVAC)[162] Taxes are paid as follows:

- 1.5% Free on Board (FOB) price for BIVAC inspection
- 1.2% to the MOCI or a minimum of USD 190
- 15% customs duty
- 10% ECOWAS Tax
- 7% Good and Services Tax

Taxes apply for all products, except those imported by RREA. For solar portable lamps, applicable taxes can reach 25%, thereby considerably increasing the cost. To import solar products into Liberia, it can take between six to eight weeks for the cargo to reach the country and up to five days for the clearance process to finalize without penalty (including approval by the government agencies involved). There are no quality standards in place, even though RREA imported products are Lighting Africa-approved. As a result, there is an influx of lower-quality solar PV-products in the market.

2.4.4 Overview of Business Models

➢ **Company Approach to Market**

Liberia's off-grid solar market is still in its early stages of development. All of the companies identified in the sector are classified as Tier 1 companies, selling products and services mainly to households and/or institutions. As the private sector does not have large-scale distribution capacity, public agency RREA is directly involved in the market and plays a central role in procuring, importing, selling and distributing Lighting Global-certified pico solar and SHS on consignment to retailer partners. Over-the-counter cash sales remains the dominant model.

While some companies continue selling a wide range of products, others have started to specialize in order to focus on specific consumer segments **(Table 41**). For most formal solar companies, their most important

[162] "Liberia – Import requirement and documentation," Select USA (2017): https://www.selectusa.gov/article?id=Liberia-Import-Requirements-and-Documentation

clients are households and large institutional groups such as NGOs and other public institutions. PAYG is still in its early stages and restricted to a few companies (Eco-Power, Sjedi Green Energy). While there are many established manufacturer representatives, there is no local manufacturer or assembler in the country, although Sjedi Green Energy indicated they are considering building a local assembly unit in the country.

- **Business Models**

There are four primary business models used in the market, although in reality PV sector players 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 suppliers** cooperate with many of the major OGS brands to distribute products in the country.
- **The PAYG sector** is still in its early stages of development in Liberia. Suppliers are building up client bases that number in the tens of thousands and are quickly evolving to develop credit mechanisms that fit with local income patterns. The margins are made from subscriptions of thousands of consumers who buy systems through created accounts. The task of installation and after sales services are undertaken by agents. Common products sold include plug and play systems that are fully designed. Very few distributors and retailers in Liberia utilize this business model (e.g. Eco Power).

Table 41: 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 Liberia are both large-scale (acting as suppliers and distributors) and medium size and are mainly located in large cities and towns around the country. They sell lighting/electrical products, including solar, pico systems and also large panels for urban customers.	Mature commercial market
	Informal: Kiosks, street vendors form a key pico-product retailer segment (that has not been fully explored). They sell low-priced products which are often short-lived. They have been seen as the entry points for black market low quality solar products to the country.	Early stage commercial development
System integrator	Integrators operate out of central offices with small specialized staff. They do not typically carry stock for sale over-the-counter. Instead, they deal directly with consumers and institutional clients and provide as per orders. Integrators target the NGO/donor market and participate in procurement tenders for supply and installation of larger systems.	Mature commercial market
Plug and Play system supplier	These suppliers distribute equipment to 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

Source: Stakeholder interviews; African Solar Designs analysis

- **Company Financing**

In Liberia, interviewed stakeholders indicated that a lack of capital was one of the major challenges faced by the supply chain. Suppliers require significant working capital to purchase equipment, build up and renew inventory, conduct marketing campaigns, and cover field costs. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited. Most of the firms surveyed in Liberia are self-financed with cash flow covered by shareholders and founders and from on-going business transaction. They combine it with external sources of funding (equity) and/or donor funding/grants but these resources are limited for most. Some companies are also availed credit terms by out of country suppliers and distributors.

Most local and international companies in Liberia are unable to raise funds to expand their business. In 2017, there were nine commercial banks, 13 microfinance institutions and 10 rural-community finance institutions operating in the Liberian financial market in 2017. Local financiers have yet to develop an appetite for the solar sector. They are extremely conservative with regard to solar enterprises and feedback from focus group discussions confirmed that loans are too expensive for most solar companies, requiring high collateral and high interest rates. Commercial financiers are not set up to service solar distributor financing requirements. While microfinance institution BRAC was noted to be offering credit to SMEs, including solar players, local SME financing is generally 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.

Consumer financing arrangements are also limited in the country, while PAYG is utilized by only few players, and MFIs and typically do not avail consumer credit (as they focus on company financing). 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. Focus group participants noted that the Village Savings and Loan Association (VSLA) is a locally based association that is providing credit to purchase solar equipment at the village level.

- **Evolving Business Models**

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

Table 42: Evolving Off-Grid Solar Business Models

Partnership	Description
Solar Distributors	• 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 Liberia 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 GoL 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 GoL, RREA or on formal projects.

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

2.4.6 Equipment Quality and the Impact of Uncertified Equipment

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

participants noted that while overall customer awareness on solar is high, awareness of product quality is still low.

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. Feedback from focus group meetings suggested that there is a role for the GoL to lower or remove tariffs on solar products sold directly by private companies. High tariffs increase solar products prices and costs for end-users and allow cheaper non-certified market to expand.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

Liberia'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.

Furthermore, focus group participants indicated that local capacity to support solar PV market development, installation and maintenance was lacking in the country. Solar professionals and entrepreneurs have a background in electricity or engineering but often do not have specific training in solar energy. While professionals typically lack skills in one or several solar segments (either in design, sizing, or installing systems), there is little effort in knowledge sharing to create complementarity among solar players. Sales and marketing skills also need to be improved, as local industry stakeholders suggested that this was contributing to slow development of solar in the country. Enhanced sales, marketing and management skills would allow solar players to reach out to new customers.

The synergy with formal training institutions is 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 users' needs and ability to pay, and operate and maintain systems. While FGDs mentioned the lack of PV-related course or vocational training, two institutions are known to provide technical solar technology training in Liberia – Stella Maris Polytechnic and the United Methodist University (UMU). Some of the other areas where TA and capacity building is needed to support growth of the solar market include (but are not limited to) the following:

- 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. To date, only solar products procured by RREA are exempted.
- 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.
- Stakeholders also believe that end-users consumer finance is important to unlock solar market growth in Liberia. Upfront cost remains a barrier for low-income populations with a low ability to pay. Consumer finance facilities including PAYG generalization, VSLA system in rural areas.
- Knowledge, technical capacity and expertise is possessed by a few professionals in the industry working for large established solar companies; the majority of vendors lack the expertise or knowledge necessary to adequately service the market.
- 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.
- Improved communication and advertising would help reach new customers. It could also inform customers on the importance of certified / high-quality products.
- Among some of the major structural challenges indicated by FGD participants are: (i) the level of mobile phone penetration in Liberia and the telecommunications coverage (3G and 4G), prevents the development of the PAYG system; (ii) low-income and low-purchasing power of the population makes it challenging for people to afford high-quality products; and (iii) the lack of quality of infrastructure, and notably the poor road network impedes growth of a robust retailer and distributor network in rural areas.

Table 43 presents various areas of support and associated capacity building for the OGS supply chain in Liberia. 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. Tax exemption would not only be granted to RREA imported solar products but to all approved companies importing Lighting Global-certified equipment.
- **Supply chain financing**: Access to grants and concessional loans/soft loans at low/preferential interest rates is a priority for stakeholders in Liberia. Further, the establishment of a guarantee facility to finance initial investments and working capital was mentioned as a key factor for the growth of the solar sector.
- **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 43: Capacity Building and Technical Assistance for the OGS Supply Chain in Liberia[163]

Area of Support	Description	Rationale
Tax exemptions on solar technology	• Implementation of VAT and import duty exemption on all solar products (not limited to RREA)	• 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 Liberia	• 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	• 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

[163] 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 Liberia, including a summary of key barriers to and drivers of market growth and an overview of gender considerations. The synopsis presented below is largely based on feedback obtained from interviews with local officials and industry stakeholders, as well as focus group discussions and surveys assessing the demand and supply side of the market (see **Annex 2**).

2.5.1 Barriers to Off-Grid Solar Market Growth

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

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

Market Barrier	Description
Demand[164]	
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

[164] 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 Liberia, 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 45 is a summary of the key drivers of OGS market growth in the country.

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

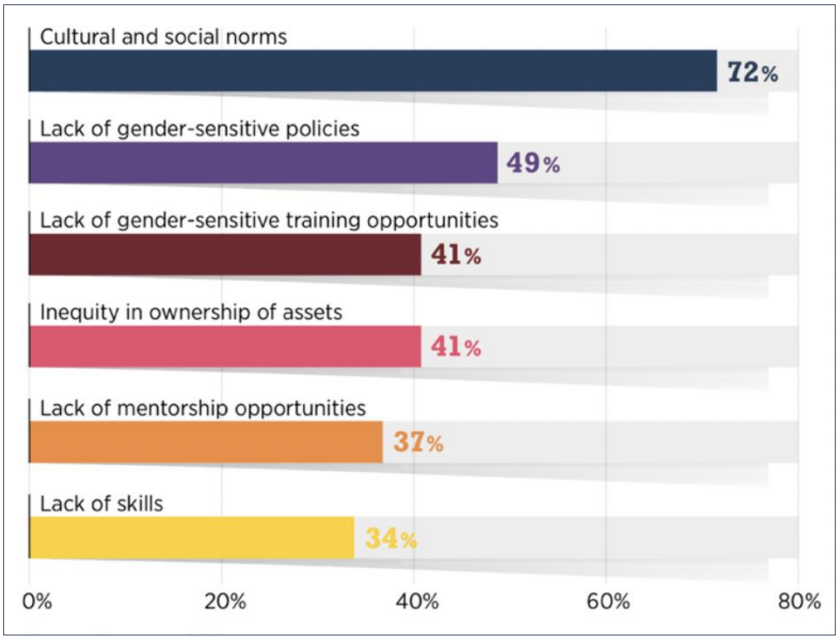
Market Driver	Description
Strong off-grid electricity demand	• Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	• The Government is viewed 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	• While Liberia's OGS market is only starting to utilize PAYG financing solutions, this model has the ability to grow rapidly by leveraging increasing rates of mobile phone ownership and mobile internet usage in rural areas
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[165]

Given that the off-grid market is only beginning to emerge in Liberia, 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 41**). 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.

Figure 41: 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.[166] 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.[167]

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, technicians, and part time and full-time employees and entrepreneurs.[168] Women also have unique social

[165] See **Annex 4** for more details
[166] "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
[167] "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
[168] "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

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.[169]

The gender analysis undertaken in Liberia 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)[170]
- Extensive household responsibilities reduce their ability to generate income and service credit
- Financial literacy among women remains low and there is a lack of education and information available to women on access to financial resources

A number of initiatives exist that seek to address some of these challenges and help improve the rate of participation among women in Liberia's energy and off-grid sectors. At the national level, Liberia's National Energy Policy (2009) acknowledges the nexus between energy access and women's health and empowerment. The policy also recognizes the potential women have as a strong influence in marketing campaign roles for energy access in rural communities. As part of this process, the Government plans to carry out a "gender audit" of the energy sector and to establish a gender focal point at the Ministry of Energy to promote inclusive participation for women in the sector.

In 2018, ECREEE partnered with AfDB to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of inclusion of women in the energy value chain – only 2% of energy sector entrepreneurs in West Africa today are women. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Liberia.[171]

[169] See **Section 3.2** for more details.
[170] 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.**
[171] "Feasibility study promotes women's participation in energy transition," ESI Africa, (7 May 2018): https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/

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.[172]

- **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.[173]

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

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

3.2 Financial Market Overview

3.2.1 Market Structure

The financial sector in Liberia has been undergoing a rebuilding process since the end of the country's 14-year civil war in 2003. The Central Bank of Liberia (CBL) is at the apex of the financial system and is responsible for licensing, regulating and overseeing the Liberian financial sector, including both commercial banks and non-bank financial institutions (insurance companies, microfinance banks and credit unions). **Table 46** below presents the number and categories of financial institutions regulated by the CBL.

Table 46: Licensed Financial Institutions in Liberia, 2018

License Type	Number of FIs
Commercial banks	9
Insurance companies	19
Insurance brokers	2
Rural community finance institutions	12
Development finance company	1
Mobile money providers	2
Microfinance institutions	18
Credit unions	285
Village savings and loan associations	2,300
Foreign exchange bureaus	152

Source: Central Bank of Liberia

The Liberian banking sector accounts for about 85% of the total assets of the country's financial market. The country's banks, which are mostly privately-owned, recorded significant growth between 2017 and 2018 (**Table 47**). It is important to note that these increases can be partly attributed to the depreciation of the Liberian dollar over this period.[174]

Table 47: Banking Sector Financial Indicators (LRD million)

Indicator	Oct-2016	Oct-2017	Oct-2018
Total assets	83,245.4	108,292.7	157,950.8
Net assets	78,993.1	98,269.2	142,059.1
Net loans	33,638.0	47,270.0	63,684.7
Deposits	54,711.0	65,304.4	85,500.6

Source: Central Bank of Liberia

Ecobank Liberia and the Liberian Bank for Development and Investment control approximately 40% of the banking sector by customer base. The banks are primarily focused on providing agricultural loans and short-term trade credit services for relatively large customers in major towns, while the rural areas are served by credit unions, village savings and loan associations (VSLAs), rural community finance institutions (RCFIs), and microfinance institutions.

[174] Central Bank of Liberia, Annual Report 2017: https://www.cbl.org.lr/doc/annualreport_2017.pdf; and Central Bank of Liberia, Annual Report 2018: https://www.cbl.org.lr/doc/Annual_Report_2018_Feb_12_2019.pdf

- **Banking Sector Financial Soundness Indicators**

Asset-Based Indicators: The relatively high number of non-performing loans (NPLs) remains a key challenge in the Liberian banking sector and continues to negatively impact profitability. In 2018, along with growth in lending, the banking system recorded a 53% increase in the volume of NPLs to LRD 10.7 billion (USD 66.5 million) compared with 2017. This translated into a 0.4% increase in the NPL ratio to 13.8% in 2018 (**Table 48**).[175]

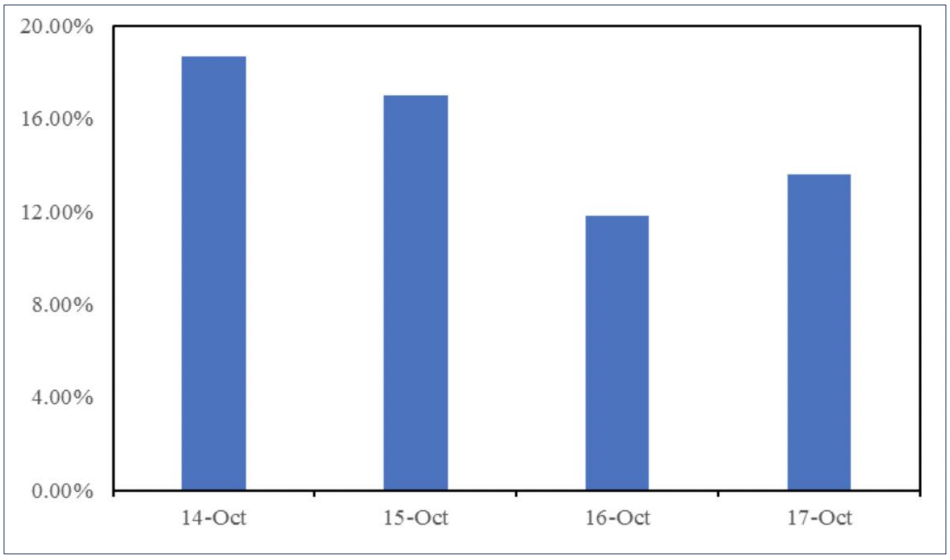
Table 48: Banking Sector Asset-Based Indicators

Indicator (%)	Oct-2016	Oct-2017	Oct-2018
Classified loans to total loans	16.4%	14.9%	15.6%
Non-performing loans to total loans	11.8%	13.6%	13.8%
Provisions to classified loans net of interest in suspense	64.3%	59.7%	64.3%
Provisions to NPLs net of interest in suspense	93.8%	63.1%	74.7%
Liquid assets to net assets	27.7%	31.7%	26.9%
Net loans to deposits	61.5%	72.4%	43.7%
Liquidity ratio	36.8%	41.8%	40.7%

Source: Central Bank of Liberia

Non-performing loans have decreased from a high of nearly 20% during the 2014 Ebola crisis (**Figure 42**). The current level of NPLs can largely be attributed to a decline in the country's primary commodity prices, as the trade sector accounted for 28% of total NPLs in 2017.[176] The CBL, in collaboration with the Liberia Bankers Association and commercial banks, has embarked on strict measures to address this situation. The CBL continued its policy measures against delinquent borrowers, including barring such borrowers from the use of banking sector services.

Figure 42: Banking Sector Non-Performing Loans to Total Loans (%), 2014-2017



Source: Central Bank of Liberia

[175] CBL Annual Report 2017 and CBL Annual Report 2018.
[176] CBL Annual Report 2017.

With respect to liquidity, the banking system recorded adequate liquid assets in 2018 with all nine banks recording liquidity ratios above the 15% regulatory requirement. However, the liquidity ratio in 2018 declined slightly by 1.2% to 40.7% from where it stood in 2017.[177]

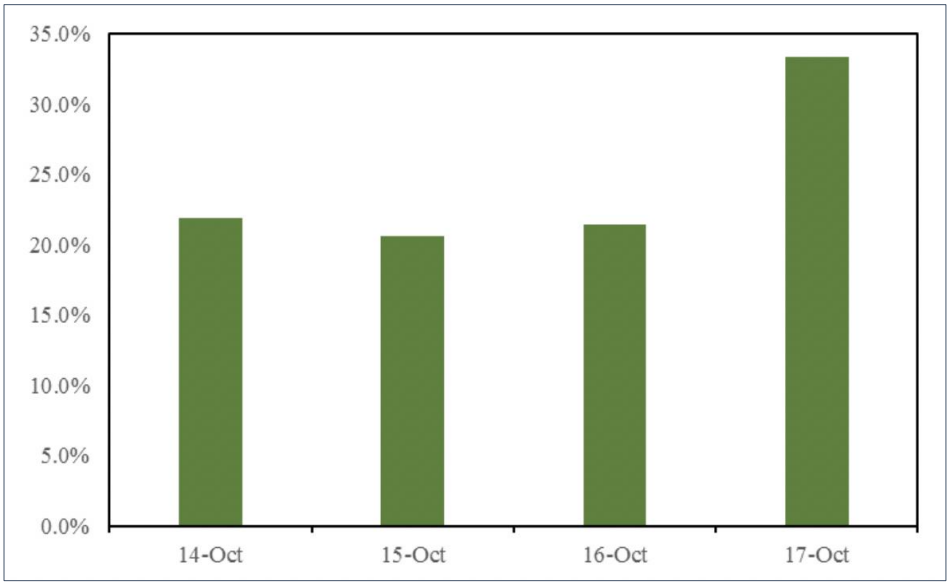
Capital-Based Indicators: The banking sector's capital adequacy ratio (CAR) fell by 5.8% year-over-year (YOY) to 27.6% in 2018 (**Table 49**) due to growth in loan assets, which were significantly risky assets on the balance sheets of banks. All nine commercial banks remained in excess of the minimum regulatory requirement of 10%. In addition, the sector showed improvement in reported capital net of provisions, which increased to LRD 24.2 billion (USD 150 million) in 2018 while all but one of the banks reported capital in excess of the minimum regulatory requirement of USD 10 million.[178]

Table 49: Banking Sector Capital Adequacy Indicators

Indicator	Oct-2016	Oct-2017	Oct-2018
Reported capital net of provisions (LRD million)	11,923.3	16,501.4	22,455.9
Reported net capitalization (%)	15.1%	18.4%	36.1%
Capital adequacy ratio (%)	21.4%	33.4%	27.6%

Source: Central Bank of Liberia

Figure 43: Banking Sector Capital Adequacy Ratio (%), 2014-2017



Source: Central Bank of Liberia

Income and Performance Indicators: The profitability of the Liberian banking sector remains low due to low levels of intermediation and high NPLs. In 2018, the sector experienced decline in profitability as net operating profit declined by 16.2% YOY to LRD 1.4 billion (USD 8.7 million) in 2018. In addition, return on assets (ROA) fell to 1.1%, while return on equity (ROE) declined to 6.4% (**Table 50**). However,

[177] CBL Annual Report 2018.
[178] Ibid.

operating expenses decreased by 25.7% YOY to LRD 8.1 billion (USD 50.3 million) in 2018 as a result of some cost cutting measures.[179]

Table 50: Banking Sector Profitability Indicators

Indicator (%)	Oct-2016	Oct-2017	Oct-2018
Return on assets	1.1%	1.7%	1.1%
Return on equity	7.8%	10.8%	6.4%
Non-interest income to total revenue	50.9%	48.2%	50.3%
Net interest margin over average assets	6.9%	1.2%	0%

Source: Central Bank of Liberia

- **Distribution of Credit by Sector**

The total credit to various sectors of the economy expanded by 33% to LRD 72.7 million (USD 450,000) in 2018 from LRD 54.7 million (USD 340 million) recorded in 2017. The growth in credit stock was mainly underpinned by expansions in the following sectors: trade, construction, extractive industry and agriculture (**Figure 44**). The expansion was mainly driven by a gradual increase in economic activity, primarily in the private sector, on the back of gradual improvement in the energy sector coupled with a relatively stable political environment following the last general and presidential elections. The share of total credit to the private sector remained high at 96.9% as of November 2018, reflecting the continued importance of the sector in the growth and development of the economy.[180]

Figure 44: Commercial Bank Loans by Economic Sector (LRD million)

	Dec-16		Dec-17		Nov-18	
	L$	Share (%)	L$	Share (%)	L$	Share (%)
Agriculture	1,793.90	4.4	2,699.80	4.9	4,274.0	5.9
Extractive (Mining & Quarrying)	47.9	0.1	121.4	0.2	458.8	0.6
Manufacturing	2,193.90	5.4	1,684.10	3.1	1,554.1	2.1
Construction	4,330.60	10.6	4,465.00	8.2	7,536.1	10.4
Services	3,153.70	7.7	7,957.90	14.6	7,696.8	10.6
Trade	10,737.00	26.4	16,575.30	30.3	24,154.8	33.2
Personal	5,040.40	12.4	13,556.60	24.8	14,825.7	20.4
Gen. Government	-	-	-	-	1,357.5	1.9
Central Bank	-	-	-	-	0.4	0.0
Public Corporations	40.6	0.1	895.5	1.6	892.6	1.2
Oil and Gas	1,466.10	3.6	2,801.70	5.1	4,638.5	6.4
Others	11,924.30	29.3	3,921.20	7.2	5,356.4	7.4
TOTAL Loan (All Sectors)	**40,728.30**	**100**	**54,678.40**	**100**	72,745.6	100.0
Total Loans (Private Sector)	40,687.70	99.9	53,782.90	98.4	70,495.1	96.9

Source: Central Bank of Liberia

[179] Ibid.
[180] CBL Annual Report 2018.

3.2.2 Financial Inclusion

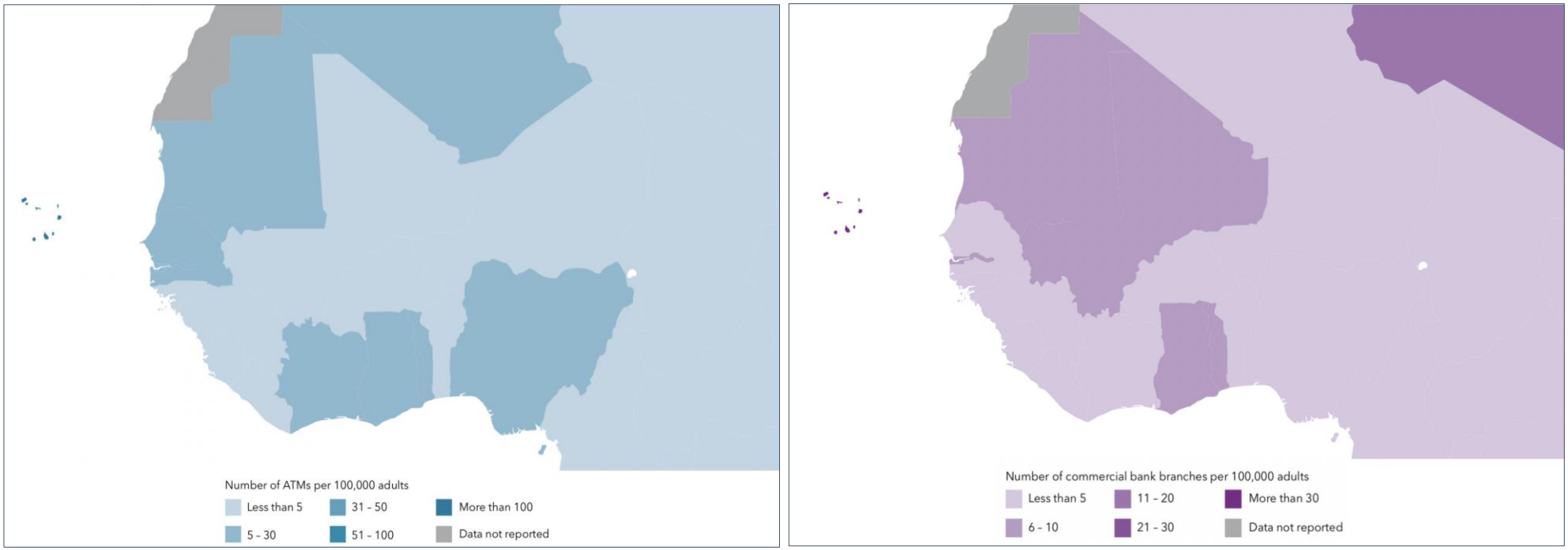
- **Access to Financial Services**

Access to financial services represents an ongoing challenge in West Africa and the Sahel. Overall, about three-quarters of the region's population remains financially excluded, lacking access to banking and financial services through formal institutions (**Figure 45**).[181] 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%.[182] Many countries across the region have also seen a sharp increase in mobile money account ownership (**Figure 46**) and transaction volume (**Figure 47**).

[181] "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

[182] 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 45: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017[183]

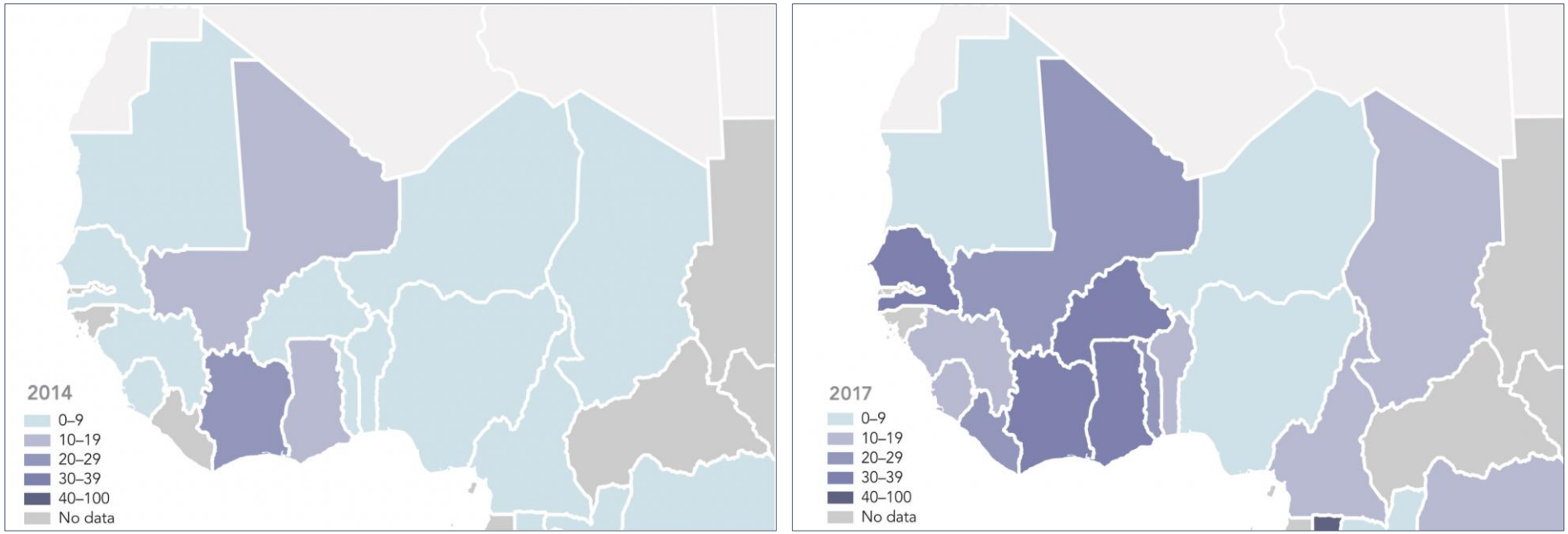


Source: International Monetary Fund

Figure 45 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.

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

Figure 46: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[184]



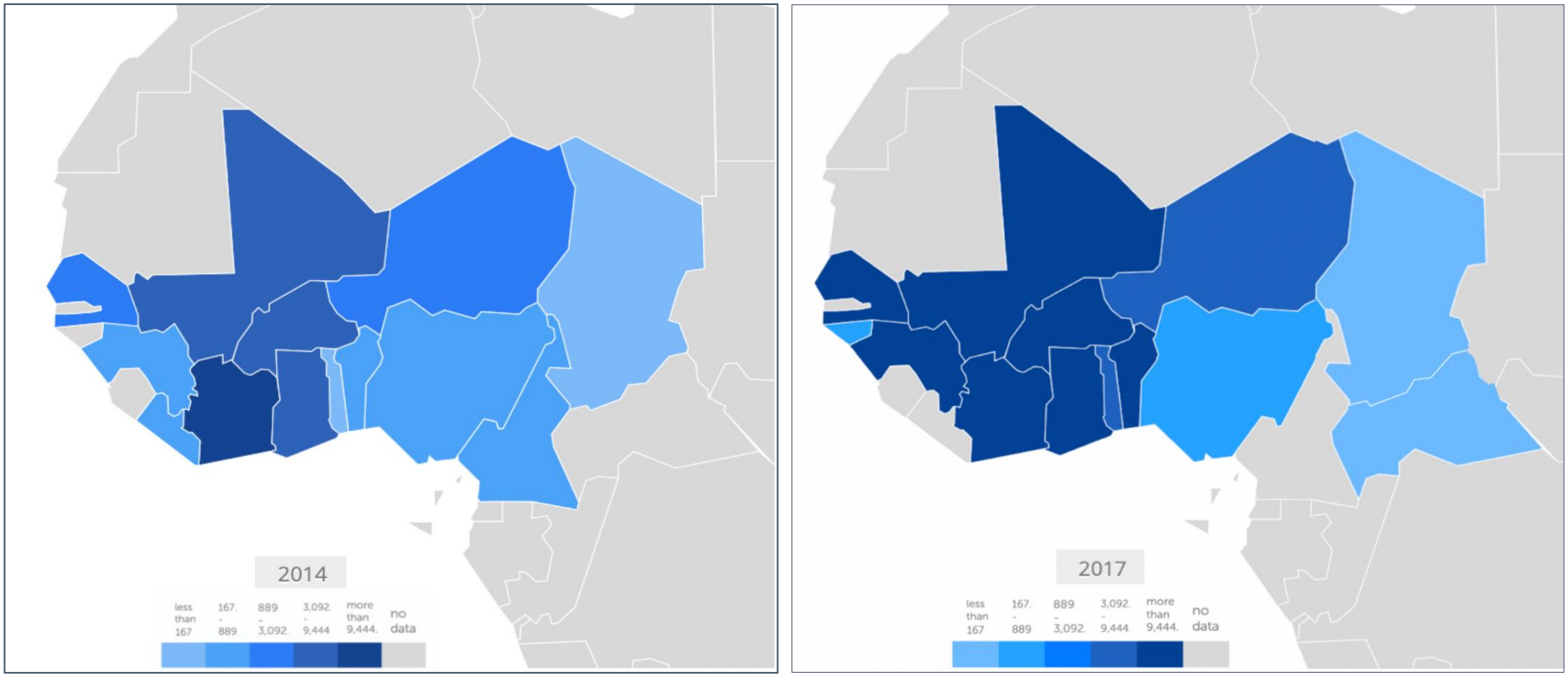
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 46 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.

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

Figure 47: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[185]



NOTE: Maps exclude Cabo Verde (no data)

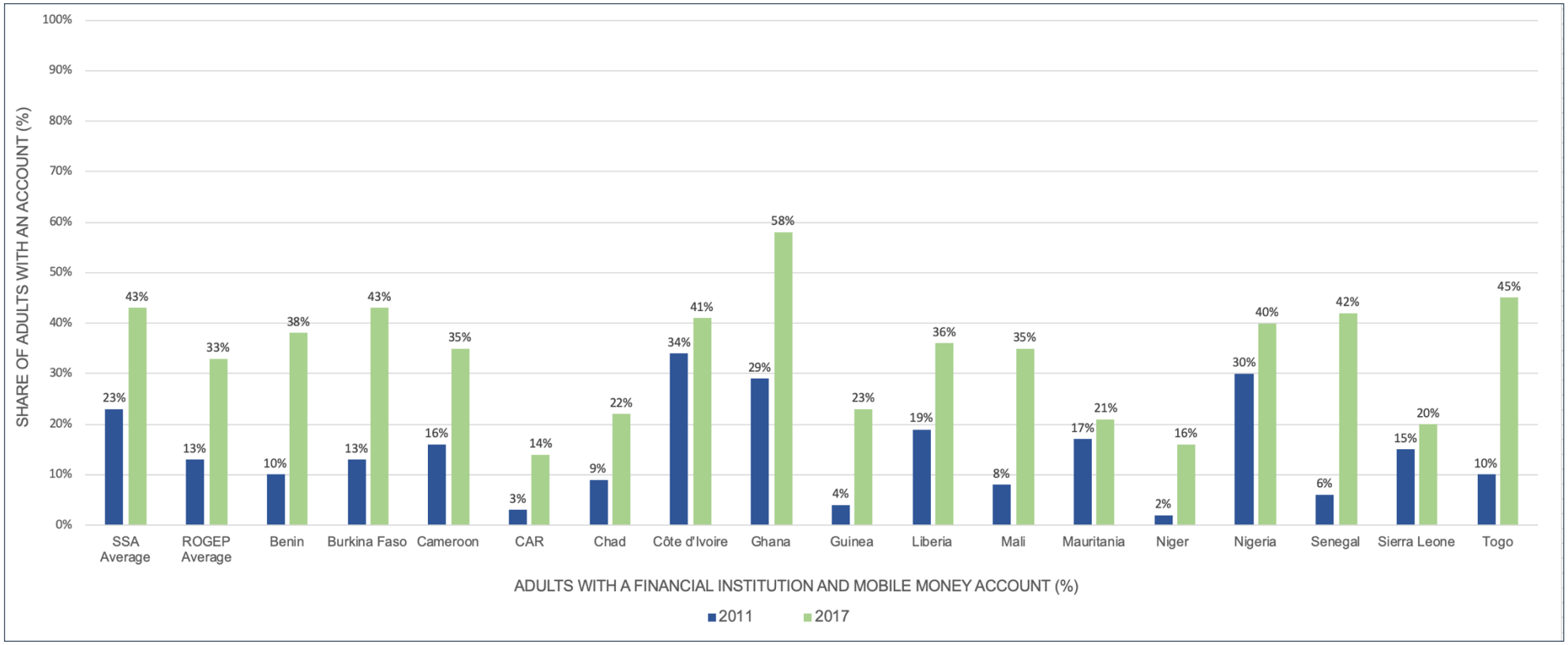
Source: International Monetary Fund

Figure 47 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.

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

In 2017, 36% of Liberia's adult population had an account at a financial institution or with a mobile money service provider, up from 19% in 2011 In 2017, the country's rate of financial inclusion was slightly above the West Africa and Sahel region's average, but still below the average for Sub-Saharan Africa (**Figure 48**).

Figure 48: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017[186]



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

Source: World Bank Global Findex Database

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

A financial inclusion baseline survey conducted in 2013 by the CBL with support from the Alliance for Financial Inclusion found that 72% of adults did not have an account with a formal financial institution.[187] A subsequent study carried out by the International Monetary Fund (IMF) in 2015 revealed a significant improvement in rates of financial access, with the share of adults with deposit accounts at commercial banks nearly doubling between 2011 and 2014, from 16.3% to 28.3%, while those with loan accounts more than doubled, going from 7.2% to 14.8% in the same period (**Table 51**).[188]

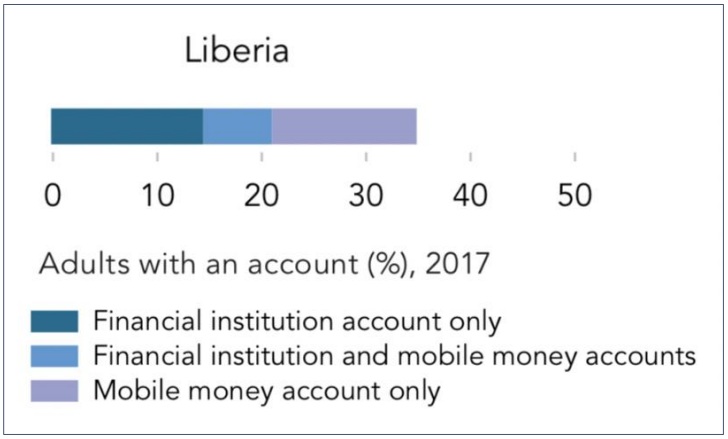
Table 51: Access to Finance Indicators

Indicator	2010	2011	2012	2013	2014
Number of commercial bank loan accounts per 1,000 adults (%)	7.3%	7.2%	10.7%	15.7%	14.8%
Number of commercial bank deposit accounts per 1,000 adults (%)	13.4%	16.3%	19.6%	26.9%	28.3%
Number of branches of commercial banks per 100,000 adults (%)	3.6%	3.7%	3.6%	3.8%	3.7%
Number of ATMs	33	33	32	40	45
Number of ATMs in the three largest cities	29	29	19	38	43
Mobile Banking: Number of active accounts	-	-	22,521	51,571	99,464
Mobile Banking: Active accounts (% of registered accounts)	-	-	60.1%	34.3%	37.4%
Mobile Banking: Active accounts per 1,000 adults (%)	-	-	9.4%	21%	39.4%
Mobile Banking: Number of transactions per 1,000 adults	-	-	466.2	790.4	677.3
Mobile Banking: Value of transactions (% of GDP)	-	-	0.4%	1%	2.2%
Outstanding deposits with commercial banks (% of GDP)	1.9%	2.3%	2.2%	2.5%	2.4%
Outstanding loans with commercial banks (% of GDP)	1%	1%	1.1%	1.4%	1.4%

Source: International Monetary Fund

In Liberia, financial inclusion has improved considerably in recent years, driven primarily by the proliferation of mobile money services (**Figure 49**). The expansion of digital financial services, especially mobile money has created new opportunities to better serve women, the lower-income population and other groups that are traditionally excluded from the formal financial system.

Figure 49: Financial Institution Account Ownership in Liberia, 2017[189]



Source: World Bank Global Findex Database

[187] "Increasing Responsible Financial Inclusion in Liberia," Financial Sector Development Implementation Plan (FSIDP), Government of Sierra Leone, (2016): https://www.firstinitiative.org/projects/increasing-responsible-financial-inclusion-liberia
[188] "Liberia Financial Sector Profile," Making Finance Work for Africa (mfw4a) Partnership, (2016): https://www.mfw4a.org/fileadmin/data_storage/documents/MFW4A-documents/Country_FSP_LIBERIA__-1.pdf
[189] Demirguc-Kunt et al., 2017.

Widespread mobile phone ownership (**Figure 18)**, rapidly growing mobile internet usage (**Figure 17**) and extensive network coverage (**Figure 37**), have led to the proliferation of mobile money services and platforms in the country. These dynamics are collectively increasing usage of mobile banking services, expanding overall access to financial services and driving financial inclusion in Liberia. Mobile money technology also plays a critical role in the application of off-grid solar solutions, particularly for Pay-As-You-Go systems that rely on the interoperability between digital financial services and stand-alone solar devices.

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

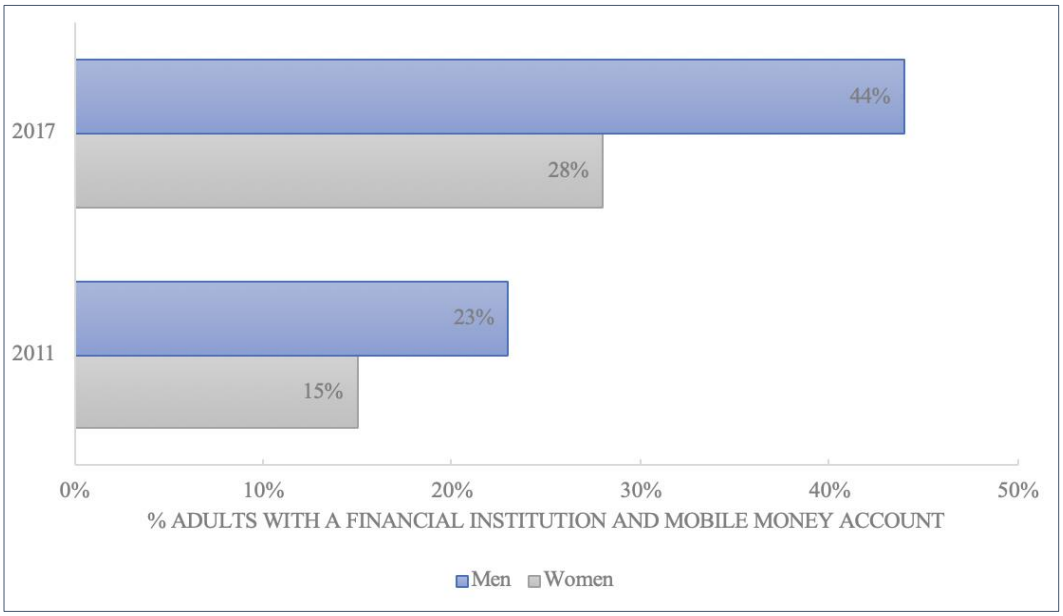
According to data from the World Bank's 2017 Global Findex survey – which examines, among many things, the extent of financial inclusion in Sub-Saharan Africa (SSA) – women in the region are about 10% less likely to have an account at a financial institution or with a mobile money service provider than men.[190] This dynamic can be attributed to a number of interrelated factors. Women in Sub-Saharan Africa experience financial exclusion mainly due to low or irregular sources of income and limited access to land and credit. The region's elevated levels of poverty, social and cultural norms, and lower levels of education and rates of literacy also make it difficult for women to access and use financial services.

Studies have found that increasing financial inclusion can significantly empower women by increasing savings, reducing levels of inequality, and improving decision-making power in the household. Supportive government programs, policies and regulations are therefore critical to overcoming the barriers that women face and driving overall progress towards financial inclusion.[191]

Despite the country's overall progress, Liberia's gender gap in financial inclusion doubled from 8% in 2011 to 16% in 2017 (**Figure 50**). Yet, there are preliminary signs that mobile money might be helping to close this gap. While men are about twice as likely as women to have an account at a financial institution, women are only 8% less likely to have a mobile money account as men, which is equal to the regional average (**Figure 51**).[192]

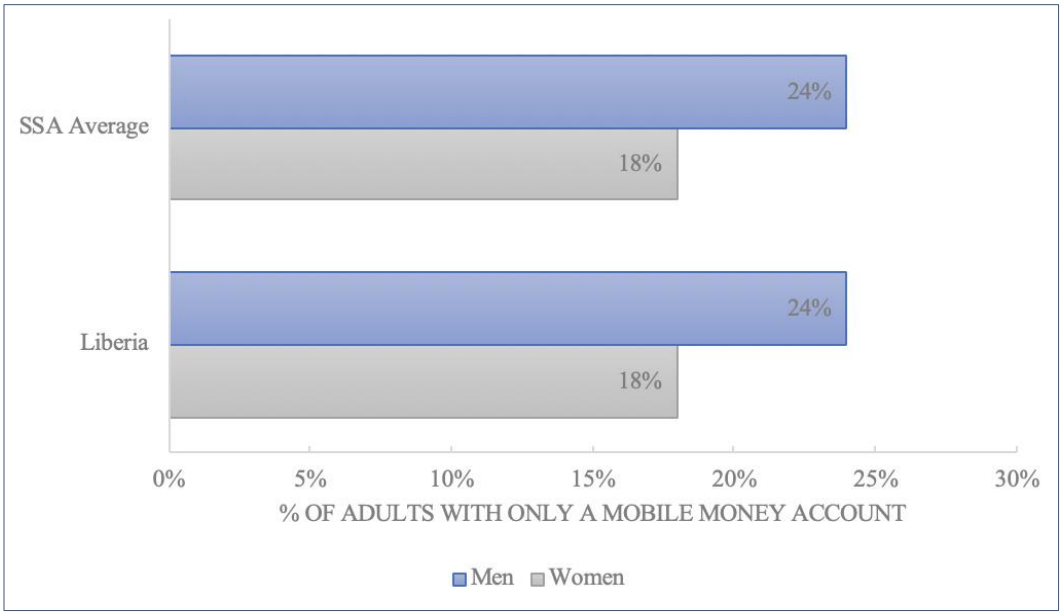
[190] Demirguc-Kunt et al., 2017.
[191] El-Zoghbi, M., "Measuring Women's Financial Inclusion: The 2017 Findex Story," Consultative Group to Assist the Poor (CGAP), (30 April 2018): https://www.cgap.org/blog/measuring-womens-financial-inclusion-2017-findex-story
[192] Ibid.

Figure 50: Financial Inclusion Gender Gap in Liberia[193]



Source: World Bank Global Findex Database

Figure 51: Gender Gap in Mobile Money, 2017[194]



Source: World Bank Global Findex Database

Given the importance of digital financial services, this sector has been the focus of GoL financial inclusion policies. In 2014, the CBL launched the National Strategy for Financial Inclusion (NSFI) and subsequently

[193] Demirguc-Kunt et al., 2017.
[194] Ibid.

in 2016, the Financial Sector Development Implementation Plan (FSDIP).[195] Under these initiatives, the CBL amended its mobile money regulations to allow other institutions besides banks to provide mobile money services in the country. In 2018 the CBL approved several products and services for FIs to further expand the digital financial services ecosystem. Two banks, Ecobank Liberia and the UBA Liberia, were given approval for agent banking, which empowers banks to further expand in areas where bank branches are not physically present. In addition, the Liberian Bank for Development and Investment (LBDI) and GN Bank Liberia were given approval to collaborate with mobile service providers to roll out mobile money platforms. Two mobile money providers – Orange Money and Lonestar Cell MTN Mobile Money – are presently operating in all 15 counties in the country in collaboration with commercial banks.[196]

In 2018, mobile money activities continued to increase in usage and volume of transactions as shown in **Table 52**. However, the spread of more sophisticated mobile banking services remains limited due to weaknesses in connectivity, liquidity management challenges, and other economic constraints.[197]

Table 52: Mobile Money Services Indicators[198]

Indicator	2017	2018
Registered mobile money subscribers / accounts	1,868,821	2,685,471
Active mobile money subscribers	247,042	303,581
Registered agents	3,525	6,722
Active agents	1,980	3,888
Mobile money transaction value (USD)	26,877,745	33,062,071
Mobile money transaction value (LRD)	7,084,718,049	27,776,002,857

Source: Central Bank of Liberia

In addition, the Microfinance and Financial Inclusion Unit of the CBL, which is responsible for advancing the bank's financial inclusion agenda, works with MFIs, credit unions, VSLAs and a range of other organizations with the aim of supporting financial inclusion through sound institutions and a diversity of products and services.

[195] "Increasing Responsible Financial Inclusion in Liberia," First Initiative, https://www.firstinitiative.org/projects/increasing-responsible-financial-inclusion-liberia
[196] CBL Annual Report 2018.
[197] "Republic of Liberia – From Growth to Development: Priorities for Sustainably Reducing Poverty and Achieving Middle-Income Status by 2030," World Bank, (May 2018): http://documents.worldbank.org/curated/en/585371528125859387/pdf/LBR-SCD-draft-10-06012018.pdf
[198] CBL Annual Report 2018.

3.2.3 Commercial Lending Environment

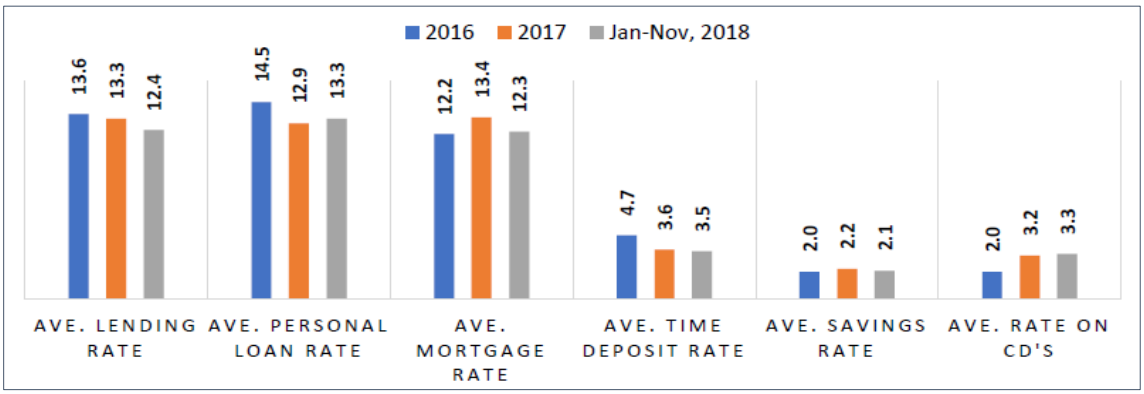
- **Maturity Structure of Bank Deposits and Credit**

Customer deposits (mostly short-term) remain the dominant source of funding in the banking system, representing 71.5% of total liabilities and capital and 63.4% of total assets in 2018. The country lacks a secondary market, severely constraining the ability of banks to offer long-tenor loans. Consequently, most banks offer loans with maturities between six months and two years.[199]

- **Interest Rates**

Average interest rates in the economy showed mixed results between 2017-2018, with increases recorded for average interest rates on both personal loans and certificates of deposit, but decreases for the lending rate, mortgage rate, time deposits rate and saving deposits rate and 91-day treasury bill rate (**Figure 52** and **Figure 53**). The gradual reduction in lending rates points to increased competition and intermediation in the banking sector.

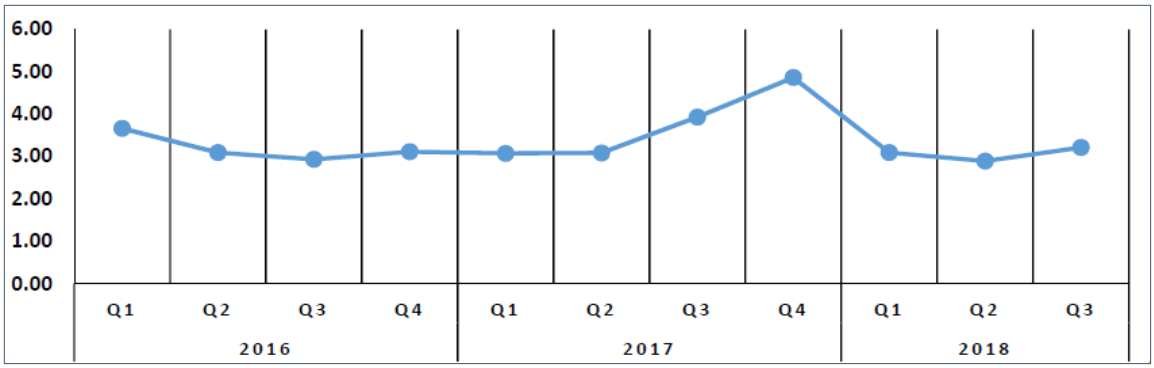
Figure 52: Average Commercial Bank Interest Rates (%)



Source: Central Bank of Liberia

Figure 53: Average Quarterly Yields (%), Government of Liberia Treasury Bill Auctions[200]

=



Source: Central Bank of Liberia

[199] CBL Annual Report 2018.
[200] Central Bank of Liberia, Financial and Economic Bulletin, July – Sept. 2018: https://www.cbl.org.lr/doc/febulletin_july_september_2018_revised.pdf

In 2018, average headline inflation broadly increased to an estimated 23.4%, up from 12.4% in 2017 (**Table 53**).The rise in inflation is generally attributed to the deterioration in the country's trade balance, low foreign exchange inflows, depreciation of the Liberian dollar, and GoL policy on the prices of petroleum products on the local market.[201]

Table 53: Inflation Rates

Indicator	2015	2016	2017	2018
Rate on Certificates of Deposit	2.0%	2.0%	3.2%	3.3%
Consumer prices (annual average)	7.8%	8.8%	12.4%	23.4%
Consumer prices (end of period)	8.0%	12.5%	13.9%	28.7%

Source: Central Bank of Liberia

- **Foreign Exchange Market**

Liberia has a floating exchange rate system with both Liberian dollars (LRD) and the US dollars (USD) as legal tender. The exchange rate is determined by market supply and demand forces. However, the CBL regularly intervenes in the foreign exchange market through weekly foreign exchange auctions and monthly government treasury bill auctions in order to stabilize the exchange rate, facilitate imports, maintain a low inflation rate, and spur economic growth. Typically, large-scale business and government transactions in the country are conducted in USD, while retail or day-to-day routine transactions are conducted largely in LRD. Contracts and tax agreements are typically specified in USD, and about 85 % of taxes are paid in USD.[202]

Table 54: Official Exchange Rate (LRD-USD)[203]

Exchange Rate	2013	2014	2015	2016	2017	2018
End of Period	82.50	82.50	88.50	102.50	125.45	157.56
Period Average	77.52	83.89	86.19	94.43	112.71	157.50

Source: *Source*: Central Bank of Liberia and International Monetary Fund

In 2018, the Liberian dollar depreciated sharply by about 25% to LRD 157.50/USD from LRD 125.50/USD in 2017 (**Table 54**). The depreciation was attributed to the country's high trade deficit, heightened demand for foreign exchange to facilitate import payments, and increased Liberian dollar expenditure by the GoL due to low US dollar revenue receipts. Amid infrastructure challenges, a weakened real sector of the economy continued to constrain exports earnings and weaken the local currency. The situation was worsened by a lingering gap in foreign exchange inflows to the economy created by the departure of the United Nations Mission in Liberia (UNMIL),[204] which was a significant contributor of foreign exchange in the country. The pace of the depreciation moderated towards the end of the year, largely as a result of the CBL's intervention in the foreign exchange market to help smooth out volatility and maintain exchange rate stability.[205]

[201] Ibid.
[202] "Liberia Financial Sector," Export.gov, https://www.export.gov/article?id=Liberia-Financial-Sector
[203] International Financial Statistics (IMF): http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B
[204] UNMIL was a peacekeeping force established in September 2003 to support the implementation of the ceasefire agreement and the peace process in Liberia following the resignation of President Charles Taylor and the conclusion of the Second Liberian Civil War. UNMIL completed its mandate on 30 March 2018.
[205] CBL Annual Report 2018.

- **Collateral Requirements**

Banks in Liberia have stringent collateral requirements, typically about 150% of loan principal, and also require traditional collateral such as land or real estate property.[206] This eliminates commercial credit from the purview of many Liberian businesses, especially MSMEs, due to their inability to provide acceptable collateral. In a bid to improve access to credit for MSMEs, the CBL, with support from IFC, launched a collateral registry at the height of the Ebola crisis in June 2014. The registry is a public web-based platform that allows lenders to determine any prior security interests, as well as establish their security interests over movable assets such as motor-vehicles, agricultural equipment, crops and accounts receivable pledged as collateral.[207] The performance of the collateral registry system is presented in **Table 55**.

Table 55: Collateral Registry Performance Indicators[208]

Indicator	2017	2018
Total registered users	51	54[209]
No. of financing statements registered during period	527	149
No. of movable assets and/or collateral registered during period	1080	329
Total no. of movable assets registered at end of period	2,902	3,231
Total value of loans registered in the system as of end of period	USD 382 million; LRD 82.5 million	USD 1 billion; LRD 90 million

Source: Central Bank of Liberia

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 Liberia'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. To date, a large share of loans from domestic lenders have been issued to the trade and agriculture sectors.

3.2.4.1 Programs Supporting Financial Institutions in Off-Grid Solar Lending

- **USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR)**

The CEADIR engagement in West Africa took place from 2016 to 2018. The program's objective was to strengthen the capacity of FIs for clean energy lending in eight West African countries (Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone) addressing their common challenges by developing the capacity of bank staff to provide loans for various clean energy technologies and business models and adapting their support to the specific context each country. CEADIR supported local banks by

[206] "Helping Liberia's Banks Better Serve the Country's SMEs," International Finance Corporation, https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/helping_liberia_+banks_better_serve_countrys_smes; and
"Liberia: Rapid eTrade Readiness Assessment," United Nations Conference on Trade and Development, (2018): https://unctad.org/en/PublicationsLibrary/dtlstict2018d2_en.pdf
[207] Collateral Registry of Liberia: http://www.registry.cbl.org.lr/Home/About
[208] CBL Annual Report 2017 and CBL Annual Report 2018.
[209] These include 17 corporate clients (commercial banks, microfinance institutions and non-bank financial institutions), 31 individual clients and others who used the system between January and November 2018.

delivering a national workshop on stand-alone solar and mini-grids, which was complemented with one-on-one technical assistance to help banks develop clean energy lending strategies.[210] Five local FIs participated in CEADIR (Access Bank Liberia, UBA, Ecobank, International Bank Liberia, and LBDI), while two local FIs – Access Bank Liberia and UBA – prepared a bank diagnostic to identify specific areas for assistance. CEADIR supported each bank as described below.[211]

Access Bank Liberia: CEADIR connected Access Bank Liberia with Mercy Corps, which had EUR 55,000 (USD 67,000) earmarked for microloans for individuals to purchase pico solar products. As an NGO, Mercy Corps needed to partner with a local FI that could warehouse the funds and issue the loans on its behalf. As of May 2018, Access Bank Liberia was in the process of developing a partnership with Mercy Corps to identify and screen potential applicants for OGS microloans.

UBA Liberia: CEADIR facilitated discussions between UBA and PayGo solar start-up, Lodicha, regarding debt financing for the implementation of its business plan alongside equity investment made by its founder. CEADIR also facilitated discussions between UBA and Alternative Energy Liberia.

3.2.4.2 Key Barriers to Off-Grid Solar Lending

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

One of the main barriers to off-grid solar lending in Liberia identified by interviewees is that local FIs have a relatively limited understanding of the sector. Most FIs lack expertise in assessing risks associated with OGS lending and structuring/developing customized products for the sector. While donor programs such as CEADIR have provided a level of capacity building to participating local FIs in the country, there remains a significant gap to be filled. Indeed, all of the interviewed FIs stressed the need for technical assistance and capacity building to facilitate off-grid solar lending.

- **Access to Credit**

Liberia is ranked 112th out of 190 countries on the "getting credit" indicator in the World Bank's 2019 'Doing Business' assessment as the country's financial system is characterized by low levels of financial intermediation.[212] According to the World Bank Enterprise Surveys, personal savings is a more common source of business capital than lending for SMEs, as low repayment rates make it difficult for FIs to lend to SMEs. According to the survey, SMEs in the country are often required by FIs to make informal payments equal to between 10-20% of the approved loan amount. And while larger firms reported better levels of access to finance from local banks, they also encountered informal payment requests and other improper practices. One of the reasons for this is that NPLs in Liberia are very high and enforcement remains difficult due to a poor land title system and a slow judicial system. Poor infrastructure also remains a major impediment to the expansion of financial services across the country. Credit is largely inaccessible to most of the population as banks are generally averse to lending to low-income and informal segments of the population given the risks and their lack of experience.[213]

[210] USAID CEADIR: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
[211] "Market Assessment Report on Clean Energy: Liberia," USAID Climate Economic Analysis for Development, Investment and Resilience (CEADIR), (June 2018): https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
[212] "Doing Business 2019: Liberia Economy Profile," World Bank, http://www.doingbusiness.org/content/dam/doingBusiness/country/l/liberia/LBR.pdf
[213] "Liberia: Employer-Assisted Housing Feasibility Study," Centre for Affordable Housing Finance in Africa, (May 2017): http://housingfinanceafrica.org/app/uploads/AHI_CAHF_Liberia-Feasibility-Report_August-2017-1.pdf; and "Republic of Liberia – From Growth to Development: Priorities for Sustainably Reducing Poverty and Achieving Middle-Income Status by 2030," World Bank, (May 2018): http://documents.worldbank.org/curated/en/585371528125859387/pdf/LBR-SCD-draft-10-06012018.pdf

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

Due to an extremely high rate of NPLs, banks in Liberia offer loans at high interest rates, typically around 15%. This constrains capital investment and limits new business development in the country. Loan tenors vary between six months and two years as there is limited long-term financing available mainly due to the lack of a secondary market. All of the interviewed FIs emphasized that in order to make OGS projects attractive, it would be necessary to access alternative funding options with low interest rate and longer tenors for on-lending to providers and end-users/SMEs.

- **Lack of Credit History/Collateral Requirements**

Liberia lacks a national identification system as well as an effective credit rating system. Local banks currently rely on the CBL's credit reference system (CRS), a manually-updated spreadsheet that was established in 2005. The CRS contains credit history and/or any derogatory information about certain borrowers. In an effort to upgrade this system, the CBL launched the Enhanced Credit Reference System Project aimed at establishing a full-fledged, automated credit reference bureau that will be used not only by FIs, but other credit and utilities services providers. In 2018, the CBL completed the pilot phase of the project, which was financed and implemented in collaboration with the country's commercial banks, Diaconia and Liberian Enterprise Development Finance Company (LEDFC). The second and third phases of the project will be implemented in 2019.[214]

In addition, most firms lack business records or documentation necessary for credit approvals and wouldn't be able to meet the collateral requirements of most banks. While the collateral registry has partially addressed this problem, its usage is still limited. The lack of a secondary market for collateral and inefficiencies in the judicial system further hamper access to credit, especially for local entrepreneurs. Obstacles such as poor roads, lack of affordable electricity and unreliable remote communication further increase the risk in accepting collaterals outside of Monrovia. All of the interviewed local commercial banks emphasized the need for credit guarantees to encourage off-grid solar lending.[215]

- **Foreign Exchange Risk**

The dual currency system in Liberia was identified by interviewees as a barrier to off-grid solar lending. Typically, large-scale business transactions (such as equipment importation for off-grid solar companies) are conducted in US dollars, while retail or day-to-day routine transactions are largely carried out in Liberian dollars. However, the Liberian dollar has continued to decline in value relative to the US dollar in recent years, falling from LRD 82.5/USD as of end-December 2013 to LRD 157.5/USD as of end-December 2018 (**Table 55**). The volatility of the Liberian dollar remains a major problem for the cash flow of off-grid solar companies, whose revenue streams are mainly denominated in the local currency, therefore making it difficult to attract working capital.[216]

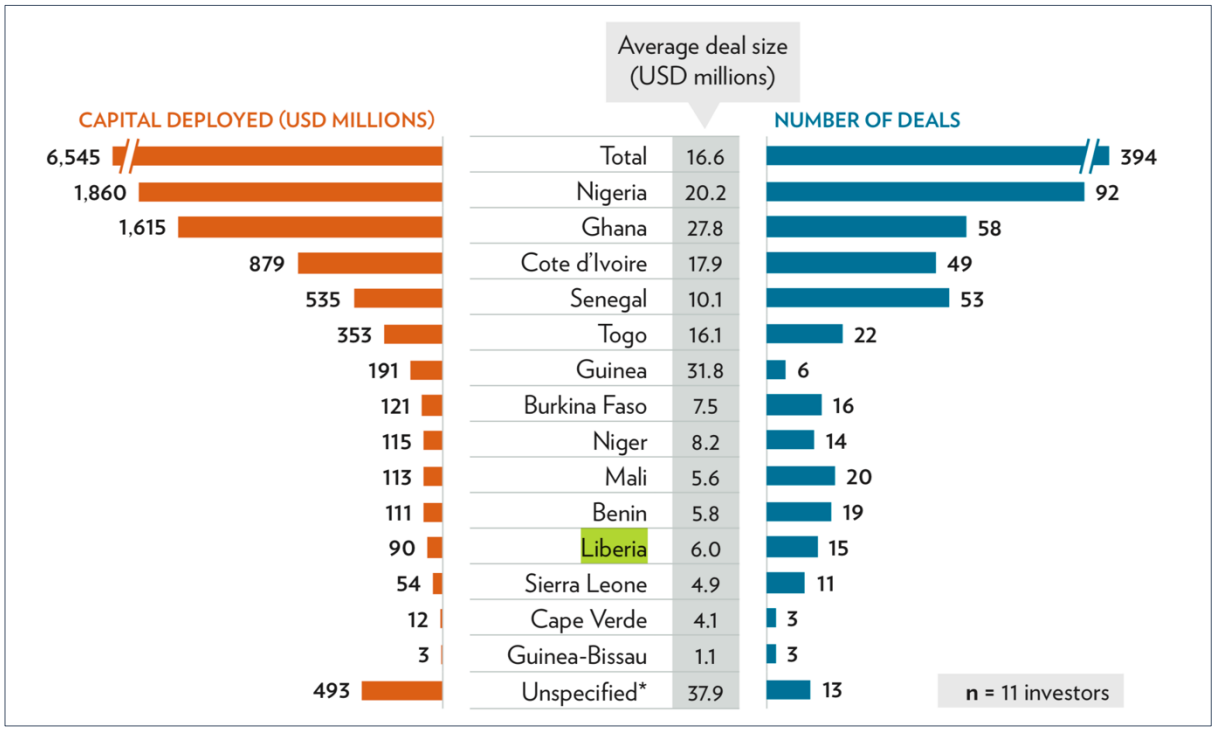
[214] CBL Annual Report 2018.
[215] "Liberia Financial Sector," Export.gov, https://www.export.gov/article?id=Liberia-Financial-Sector; and "Liberia: Article IV Consultation – Press Release and Staff Report," International Monetary Fund, (July 2016): https://www.imf.org/external/pubs/ft/scr/2016/cr16238.pdf
[216] CBL Annual Report 2018.

3.3 Financial Institutions[217]

3.3.1 Development Finance Institutions

Between 2005 and 2015, Liberia received a total of USD 90 million in DFI funds with an average deal size of USD 6 million; the amount comprised about 1.4% of the total DFI investment across West Africa over this period (**Figure 54**).[218]

Figure 54: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Several DFIs are active in Guinea, including AfDB, AFD/Proparco, IFC, and KFW/DEG among others. While these DFIs have regional off-grid solar financing programs, their activity in Liberia has been largely focused on other sectors. The identified DFI programs relevant to the energy and off-grid solar sector in the country are described below.

- **African Development Bank Sustainable Energy Fund for Africa / Facility for Energy Inclusion**

The **Sustainable Energy Fund for Africa (SEFA)** is a USD 60 million multi-donor trust fund administered by the African Development Bank with the objective of supporting sustainable private sector led economic growth in African countries through the efficient utilization of clean energy resources and support small- and medium-scale renewable energy project development.[219]

[217] Excluding commercial banks, which are reviewed in detail in **Section 3.2**.
[218] "The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities and Challenges," Global Impact Investing Network and Dahlberg, (2015): https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf
[219] "Sustainable Energy Fund for Africa," African Development Bank, (2018): https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/

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.[220] The launch of the FEI in 2016 led to a significant increase in AfDB financing for distributed renewable energy throughout Sub-Saharan Africa.[221] The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[222]

- **International Finance Corporation**

Through its Conflict Affected States in Africa initiative, IFC is supporting small businesses in the country by partnering with the GoL and financial intermediaries to help SMEs obtain access to financing.[223] Under this initiative, IFC is also providing support to a number of commercial banks in the country (including LBDI, Access Bank Liberia, GTB Liberia and Ecobank Liberia) to enable them expand their SME banking services and build robust SME portfolios.[224]

3.3.2 Economic Development Finance Institutions

The Liberian Enterprise Development Finance Company (LEDFC) is the only local development finance company in Liberia. LEDFC was established in 2007 by CHF International in collaboration with the US Overseas Private Investment Corporation (OPIC) and the Robert L. Johnson Foundation to provide loans and technical assistance to Liberian-owned SMEs. In 2013, LEDFC was acquired by the Ghana Growth Fund Company (GGFC), a subsidiary of Groupe Nduom.

LEDFC offers two loan products to SMEs in Liberia: short term loans (up to 23 months) geared towards working capital and other short-term needs and medium-term loans (two-five years) for investments in equipment and other productive assets. The loans range between USD 10,000 to USD 1 million. LEDFC typically requires collateral valued at 140% of the loan amount in form of equipment, assignment of receivables and contracts, real property (including land, buildings), assignment of insurance on assets, pre-signed checks, pledge of corporate stock and sales assignment. LEDFC also co-lends or participates in loans that are originated by other banks and MFIs. As of 2017, LEDFC had provided debt financing and technical assistance to over 500 Liberian-owned SMEs in nine of the 15 counties in the country.[225]

[220] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com
[221] Lee, A. Doukas, A. and DeAngelis, K., "The African Development Bank and Energy Access Finance in Sub-Saharan Africa: Trends and Insights from Recent Data," Oil Change International and Friends of the Earth U.S., (November 2018): http://priceofoil.org/content/uploads/2018/11/AfDB-Energy-Access-Finance-report-high-quality.pdf
[222] "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/
[223] "Helping Liberia's Banks Better Serve the Country's SMEs," International Finance Corporation, https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/helping_liberia_+banks_better_serve_countrys_smes
[224] Sibanda, Z. and Mensah, H., "IFC Helps LBDI Promote Access to Finance for Liberian SMEs," International Finance Corporation, (September 12, 2017): https://ifcextapps.ifc.org/IFCExt%5CPressroom%5CIFCPressRoom.nsf%5C0%5C2F3316CF3FD62C9A8525819900505A36
[225] Liberian Enterprise Development Finance Company: http://ledfcliberia.com

3.3.3 Microfinance Institutions

Building a sustainable microfinance sector has been a key policy agenda of the GoL in the post-war years as a mechanism for promoting access to financial services for all Liberians. The CBL established a microfinance unit in 2006 and subsequently in 2010, the Microfinance Policy, Regulatory, and Supervisory Framework for Liberia was approved. The microfinance sector continues to play an important role of providing credit services, mainly to rural and poor communities across the country.

As of 2018, there were 17 registered non-deposit-taking MFIs and one deposit-taking MFI (Diaconia) operating in the country. The sector, which had predominantly been concentrated around Monrovia and its surrounding areas, is increasingly expanding its client base as illustrated in **Table 56**. The World Bank is working with the GoL to implement reforms aimed at strengthening the regulation and supervision of the sector, consumer protection and financial capacity, and is also collaborating with the Network of Microfinance Institutions in Liberia (NEMIL) and MFIs in the country to provide technical assistance and capacity building to MFI staff.

Table 56: Microfinance Sector Financial Indicators

Indicator	June-2017	Sept-2017	Sept-2018
Total number of clients	23,478	26,352	36,296
Total loans outstanding	USD 4.5 million	USD 4.8 million	-
Total mandatory savings	USD 0.84 million	USD 0.84 million	-

Source: Central Bank of Liberia

3.3.4 Rural Community Finance Institutions

In line with the National Strategy for Financial Inclusion adopted in 2009, the CBL approved an implementation plan for the establishment of Rural Community Finance Institutions (RCFIs) in all of Liberia's counties. The RCFIs are licensed to provide banking services such as taking deposits, extending credit, paying the salaries of civil servants, and offering money transfer services (including remittances) and mobile money services in rural communities. The RCFIs are owned by community members through capitalization share purchases and are also managed by these members.

As of 2018, the CBL, in partnership with Afriland First Bank, had supported the establishment of 12 RCFIs, which are operating in eight of the 15 counties in Liberia. The services provided by the RCFIs have successfully alleviated the burdens previously faced by many teachers and health workers to access their salaries in the rural areas. The RCFI sub-sector is growing quickly, as the total number of customer accounts among all RCFIs increased from 8,029 in 2016 to 11,790 in 2017.[226] **Table 57** shows the impressive growth of the RCFI sector.

In 2017, the GoL and International Fund for Agricultural Development (IFAD) signed a USD 5.5 million Financing Agreement to implement the Rural Community Finance Project (RCFP) in order to strengthen and improve the general operating conditions of the RCFI sector. The RCFP, which is to be launched in 2019, will support establishment of additional RCFIs and provide additional resources to existing RCFIs in the form of additional seed capital, fixed assets, IT systems, and capacity building.[227]

[226] RCFI accounts include savings, salary and borrower account holders.
[227] CBL 2018 Annual Report

Table 57: Rural Community Finance Institutions Financial Indicators[228]

RCFI	County	No. of Shareholders		Total Deposits				Total Loans	
		2016	2017	2016		2017		2016	2017
				LRD	USD	LRD	USD	LRD	LRD
Gbahlay-Geh RCFI	Nimba	306	346	28,524,015	10,294	47,747,226	37,701	1,605,007	3,554,779
Grand Kru RCFI	Grand Kru		862	265,120	1,428	34,719,885	115,875	634,440	1,808,122
Rivergee RCFI	River Gee		745	6,725,545	179,143	20,176,635	537,429	4,280,325	8,564,564
Gbarpolu RCFI	Gbarpolu	343	343	3,311,231	34,855	10,069,026	31,178	150,665	6,589,536
Rivercess RCFI	River Cess		168	1,286,100	6,706	898,500	26,018	-	6,000,000
Sinoe RCFI	Sinoe	203	203	3,439,620	15,907	7,988,855	35,844	-	453,204
Sanniquellie RCFI	Nimba	420	550	7,000,360	15,230	24,343,383	56,853	4,374,000	4,351,331
Zorlayea RCFI	Lofa	327	327	3,859,298	27,318	27,513,210	42,299	610,887	594,794
Kolahun RCFI	Lofa	729	730	4,679,660	10,854	12,622,094	34,878	828,330	1,553,335
Totota RCFI	Bong	125	126	2,997,475	6,228	9,695,195	38,090	-	-
Tappita RCFI	Nimba	-	323	3,086,345	2,190	11,141,257	14,865		2,359,933
Foya RCFI	Lofa	-	246	-	-	-	-	-	
Total		**3,483**	**4,969**	**65,174,769**	**310,153**	**206,915,266**	**997,048**	**12,483,654**	**35,829,598**

Source: Central Bank of Liberia

3.3.5 Credit Unions

Credit unions are member-based institutions engaged in savings mobilization and credit extension to rural Liberians. They have played a key role in providing financial services in rural areas of the country since their creation in the 1970s. Liberia's two civil wars that spanned 14 years left the credit union system devastated with a multitude of challenges including a lack of basic infrastructure, a culture of aid dependency, poor regulation and a population with little faith in financial institutions.

In 2013, the World Council of Credit Unions (WOCCU) received funding from MasterCard Foundation through the UN Capital Development Fund to implement the MicroLead program, which was designed to revitalize the sector by developing four regional credit unions (RCUs) to serve as models for the rest of the credit unions and strengthen the Liberia Credit Union National Association (LCUNA).[229] WOCCU worked with local stakeholders including the CBL, LCUNA, the Cooperative Development Agency – which supervises the sector – and existing credit unions, known as primary credit unions (PCUs), to establish RCUs in four predetermined regions. The program originally set out to reach 40,000 Liberians within four years. This number was later revised downward to 30,000. While the target was not met, mainly due to the Ebola outbreak,[230] by the end of the program in June 2016, the four RCUs had established headquarters with modern banking halls, eight branch offices and 14 service points, covering 14 of Liberia's 15 counties. As of December 2015, RCUs had reached 6,436 members, including 427 groups (cooperatives, schools and small family businesses) that are counted as single credit union members.[231] **Table 58** shows the performance of the four RCUs as of March 2016.

[228] Central Bank of Liberia, Annual Report 2017: https://www.cbl.org.lr/doc/annualreport_2017.pdf

[229] LCUNA was established in 1973 to train member credit unions, monitor their activities (inspect their financial records at least bi-annually), and provide standardized financial ledgers, passbooks, receipts, and payment vouchers.

[230] The MicroLead program was suspended from July 2014 to March 2015 due to the Ebola Outbreak as most rural areas where the project was operating were quarantined.

[231] These groups typically range in size from 25 to 35 people, although some have up to 150 people while small businesses have fewer people. This increases the reach and potential impact of the RCUs to an additional 10,675 Liberians (based on a group size of 25).

The MicroLead program provided training and capacity building for thousands of credit union staff, leaders and members. The program also supported the CBL and other stakeholders to prepare draft credit union regulations and in December 2015 the GoL passed the new credit union regulations. These regulations spell out the requirements and the prudential standards for credit unions in the country to be licensed.[232] As of 2018, there were a total of 285 credit unions operating in the country.[233]

Table 58: Regional Credit Unions Financial Indicators, 2016

Indicator	Region I MNCU[234]	Region II UPSCU[235]	Region III TSCU[236]	Region IV USCU[237]	Total RCUs
Number of Active Borrowers	150	26	25	66	267
% of Female Borrowers	34%	38%	44%	23%	33%
% Rural Borrowers	100%	100%	100%	100%	100%
Gross Loan Portfolio (USD)	$77,698	$32,289	$20,829	$33,894	$164,710
Average Loan Balance per Borrower	$518	$1,241	$833	$514	$617
Average Loan Balance per Borrower/GNI/ Capital	136%	326%	219%	135%	162%
Number of Active Depositors (Voluntary)	1,224	1,930	1,556	1,726	6,436
Institutions (including SGs, PCUs, cooperatives and schools, small family businesses, among others)	109	158	70	90	427
% of Female Depositors (Voluntary)	57%	35%	51%	33%	42%
% Rural Depositors (voluntary)	100%	100%	100%	100%	100%
Deposits (total voluntary savings)	$103,239	$47,434	$109,146	$67,176	$326,995
Average Deposit Balance per Saver	$84	$25	$70	$39	$51
Average Deposit Balance per Saver/ GNI/Capita	22%	6%	18%	10%	13%
Portfolio at Risk >30 days	38%	49%	5%	42%	38%
Number of Board Members	9	9	9	9	36
% of Female Board Members	22%	22%	44%	44%	33%
Number of Managers	8	15	16	9	48
% of Female Managers	75%	73%	38%	44%	56%

Source: UN Capital Development Fund

3.3.6 Village Savings and Loan Associations

In 2008, Cooperative for Assistance and Relief Everywhere, Inc. (CARE) launched its Access Africa program in Liberia to start up village savings and loan associations (VSLAs) across the country to complement other existing microfinance arrangements. Six VSLAs made up of 144 women were initially piloted in collaboration with the GoL and CARE. Based on the positive outcomes of the pilot, the Ministry of Gender, Children and Social Protection expanded the training of rural women in the VSLA nationwide.[238]

As of 2017, there were 2,300 VSLAs (all self-managed by members) operating in all the 15 political subdivisions of the country.[239] Each VSLA consists of an average of 30 members (99% of which are

[232] "Credit Union Revitalization in Liberia: MicroLead Expansion Project," United Nations Capital Development Fund, World Council of Credit Unions, and MasterCard Foundation, (July 2017): https://uncdf-cdn.azureedge.net/media-manager/77613?sv=2016-05-31&sr=b&sig=9RAn%2FG%2BaCQRkoXDMul0DAnjAdynK7h%2B1ECWM4UezC1Q%3D&se=2019-02-26T16%3A24%3A45Z&sp=r

[233] CBL Annual Report 2017.

[234] Multi-National Credit Union

[235] United Savings Progressive Savings Union

[236] Trust Savings Credit Union

[237] Unity Savings Credit Union

[238] "The Impact of the Ebola Virus Disease on Village Savings and Loans Associations in Liberia," Food and Agriculture Organization of the United Nations, (2014): http://www.fao.org/fileadmin/user_upload/emergencies/docs/VSLA%20Rapid%20Assessment_December%2019%202014.pdf

[239] CBL Annual Report 2017.

women) who agree to make contributions to a shared fund at regular meetings. Members help the fund grow by borrowing from it and paying back the loan with interest. Loans are typically extended for a term of three months at an interest rate of 10%, for working capital for an SME or personal needs.[240] The group agrees on a date when each member will receive a share of the common fund plus accumulated interest.

VSLAs in Liberia were adversely affected by the Ebola outbreak that hit the country as economic activities of members were curtailed creating general loss of normal incomes. Consequently, members were unable to continue share-based savings contributions which led to member's inability to service their loans to their respective VSLAs rendering them illiquid and putting them at risk of bankruptcy, thereby jeopardizing their capacity to serve their members.[241] Subsequently, the CBL began to take steps to combat the challenges posed by Ebola and to enhance the revitalization of the rural economy. In line with this, the CBL extended its grace period under the Loan Extension and Availability Facility (LEAF), in addition to loan refinancing options for some non-bank groups that were on track with their repayment prior to the Ebola outbreak.[242] The CBL continues to work with these VSLAs to formalize their operations. It has supported the National Apex of VSLAs (NAPEX) in building an effective internal training department. Development partners such as FAO and USAID have also been active in revitalizing VSLAs across the country.[243]

3.3.7 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.[244] The informal financial sector often serves as a major source of savings and credit services for women, the low-income population and others who lack access to formal institutions. Informal financial institutions typically include individual money lenders as well as collective entities such as Rotating Savings and Credit Associations and Accumulated Savings and Credit Associations, among other groups.[245]

Much like other African states, informal financial services are widely available in Liberia (**Figure 55**). 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.

---

[240] "Liberia: Financial Sector Development Implementation Plan – FIRST Initiative," Central Bank of Liberia, (2016): https://www.cbl.org.lr/doc/LiberiaFinancialSectorDevelopmentImplementation.pdf

[241] "The Impact of the Ebola Virus Disease on Village Savings and Loans Associations in Liberia," Food and Agriculture Organization of the United Nations, (2014): http://www.fao.org/fileadmin/user_upload/emergencies/docs/VSLA%20Rapid%20Assessment_December%2019%202014.pdf

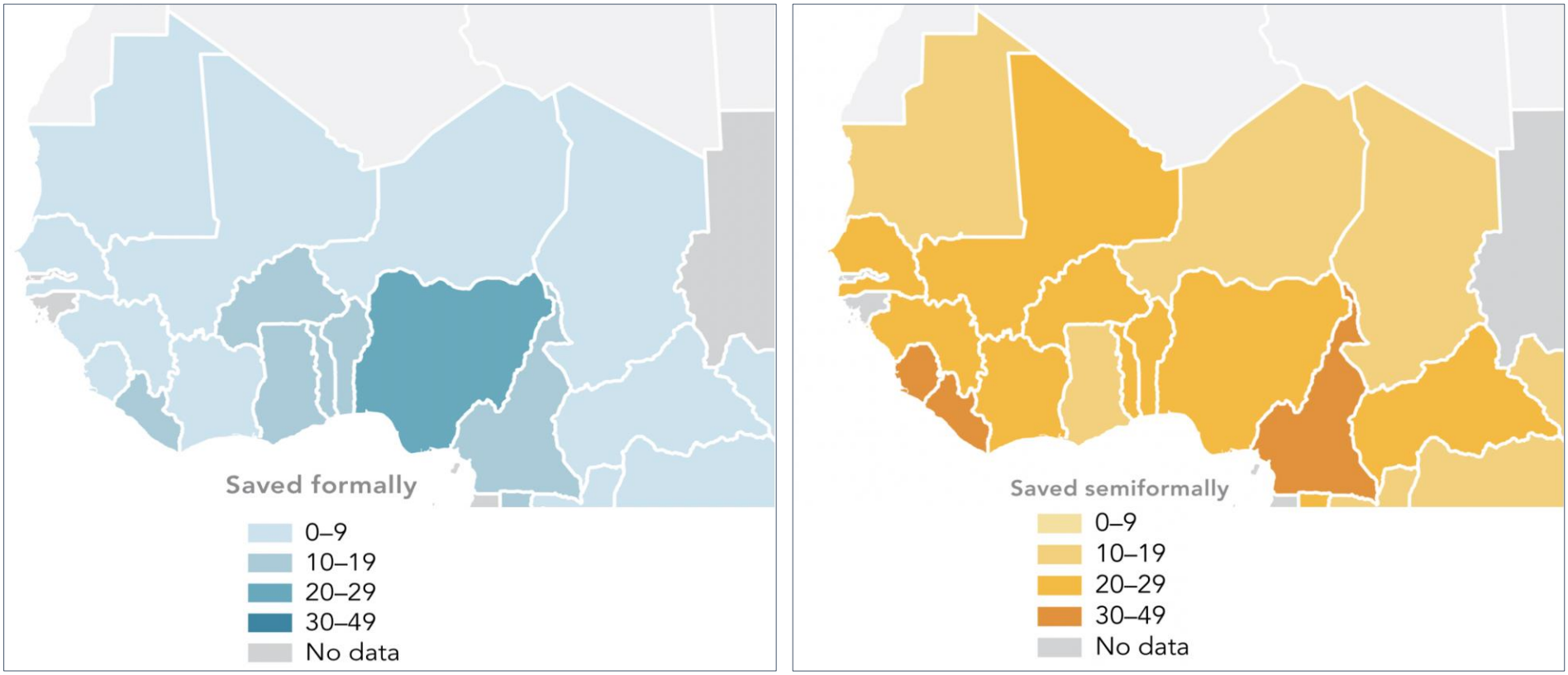
[242] In 2012, the CBL made available over LRD 200 million to MFIs, Credit Unions and VSLAs throughout the country through the LEAF as a means of boosting financial inclusion and enhancing output and employment. The program was intended to provide soft loans to MFIs, credit unions and VSLAs. The program provided loans to these institutions for a three-year period, later extended to five years, at 3% to facilitate onward lending to their clients and members.

[243] "Restoring their Hope for Sustainability: Rural Women Disbursed L$ 381,810 from VSLA," United Nations in Liberia, http://lr.one.un.org/content/unct/liberia/en/home/one-voice/press-releases/UNOPS_Regional_Director_visits_Liberia_Country_Office112111.html; and "FED Monthly Report, February 2016," USAID, (May 8, 2018): https://www.land-links.org/document/fed-monthly-report-february-2016/

[244] "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

[245] Klapper, L., Singer, D., "The Role of Informal Financial Services in Africa," Journal of African Economies, (24 December 2014): https://academic.oup.com/jae/article-abstract/24/suppl_1/i12/2473408?redirectedFrom=fulltext

Figure 55: Share of Adults Saving in the Past Year (%), 2017[246]



NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 55 shows how the savings behavior of adults varies in West Africa and the Sahel. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. Saving semi-formally is much more common than saving formally across the region, including in Liberia.

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

3.3.8 Impact Investors

Between 2005 and 2015, impact investors deployed two direct investments, totaling USD 0.6 million in Liberia.[247] A brief review of the activities of impact investors in the OGS space to date is presented below.

- **Broad Cove**

Broad Cove Partners, a US impact investor, is building affordable, eco-friendly houses powered by off-grid solar systems in Monrovia. In 2007, the Liberian National Housing Authority (NHA) invited Broad Cove Partners to submit a proposal to develop affordable housing. The company eventually entered an agreement with the NHA to develop 1,200 single-family homes on a 300-acre parcel of land in the Monrovia region. The first phase of the project, consisting of about 80 homes at prices ranging from USD 25,000 to USD 30,000, was supported by a USD 1.9 million OPIC loan granted in 2011.[248]

- **Daphne Foundation**

In 2009, the Daphne Foundation supported a solar lighting pilot project in the King Gray Community in Liberia. The project provided lighting to three classrooms in the community school as well as a charging station.[249]

3.3.9 Crowd Funders

Crowdfunding in Liberia has been relatively limited. Although the demand for capital continues to grow, crowdfunding remains a challenging source of financing for SMEs. Across Africa as a whole, crowdfunding amounted to USD 70 million in 2015 – less than 1% of global crowdfunding.[250] Moreover, roughly 75% of the capital raised by African start-up companies in 2017 was raised in Kenya, Nigeria, and South Africa.[251] Additionally, unlike most emerging markets, countries in West Africa and the Sahel do not have regulatory frameworks in place to offer protection to investors, which discourages potential investment.

To date, no commercial off-grid solar projects have been financed through crowd-funding in Liberia. However, Village Improvement Project, Inc., a nonprofit startup, raised funding on GlobalGiving, a crowdfunding platform focused on non-profits, to distribute solar lanterns to 187 households in rural village communities in Liberia in December 2015.[252] The social lending crowdfunding platform, Kiva, also recently launched the Liberia Enterprise Assistance Program (LEAP) to support development of the country's MSME sector.[253]

[247] "The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities, And Challenges," Global Impact Investing Network and Dahlberg, (2015): https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf
[248] "Building Affordable, Sustainable Homes: Broad Cove Eco-homes Liberia," U.S. Overseas Private Investment Corporation, (2012): https://www.opic.gov/opic-action/featured-projects/sub-saharan-africa/building-affordable-sustainable-homes-broad-cove-ecohomes-liberia
[249] "Liberia Community-School Lighting Pilot Project," Clinton Foundation, (2009): https://www.clintonfoundation.org/clinton-global-initiative/commitments/liberia-community-school-lighting-pilot-project
[250] "Crowdfunding in Emerging Markets: Lessons from East African Startups," World Bank (2015): https://www.infodev.org/infodev-files/crowdfunding-in-east-africa.pdf
[251] Disrupt Africa: https://www.siliconcape.com/disrupt-africa-funding-report-2017/
[252] Village Improvement Project: https://www.globalgiving.org/microprojects/give-solar-lanterns-to-24-village-homes-in-liberia/reports/?subid=65562
[253] Kiva – Liberia Enterprise Assistance Program: https://pages.kiva.org/blog/kiva-launches-in-liberia

3.4 Summary of Findings

- **Opportunity for ROGEP Credit Lines:** The Liberian banking sector remains characterized by low level of financial intermediation and poor asset quality, which depresses profitability. Consequently, banks offer loans at high interest rates in order to boost their net interest income. In addition, loans are typically short-term due to the lack of a secondary market in the country. However, OGS providers in Liberia have found it unprofitable to accept these loan terms, which constrains growth of the sector. All of the interviewed FIs stressed the need to access alternative funding options with low interest rates, which would provide sufficient margin spread, and longer tenors for on-lending to providers and end users/SMEs, in order to make off-grid solar projects attractive. Stakeholder interviews suggested that there is a potential for ROGEP to place as much as USD 17 million in credit lines if priced reasonably. Hard currency denominated lines of credit from ROGEP would need to be offered at deeply concessional pricing in the range of 2-5% with tenors of 3-7 years in order to be widely accepted by FIs operating in the market.

- **Collateral Requirements:** Commercial banks in Liberia have high and stringent collateral requirements of over 150% due to historically high level of NPLs. In addition, the banks often require local businesses to make informal upfront payments equal to between 10 to 20% of approved loan amounts. Most local OGS companies cannot meet these requirements. Therefore, 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, all of the commercial banks interviewed 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 most 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.

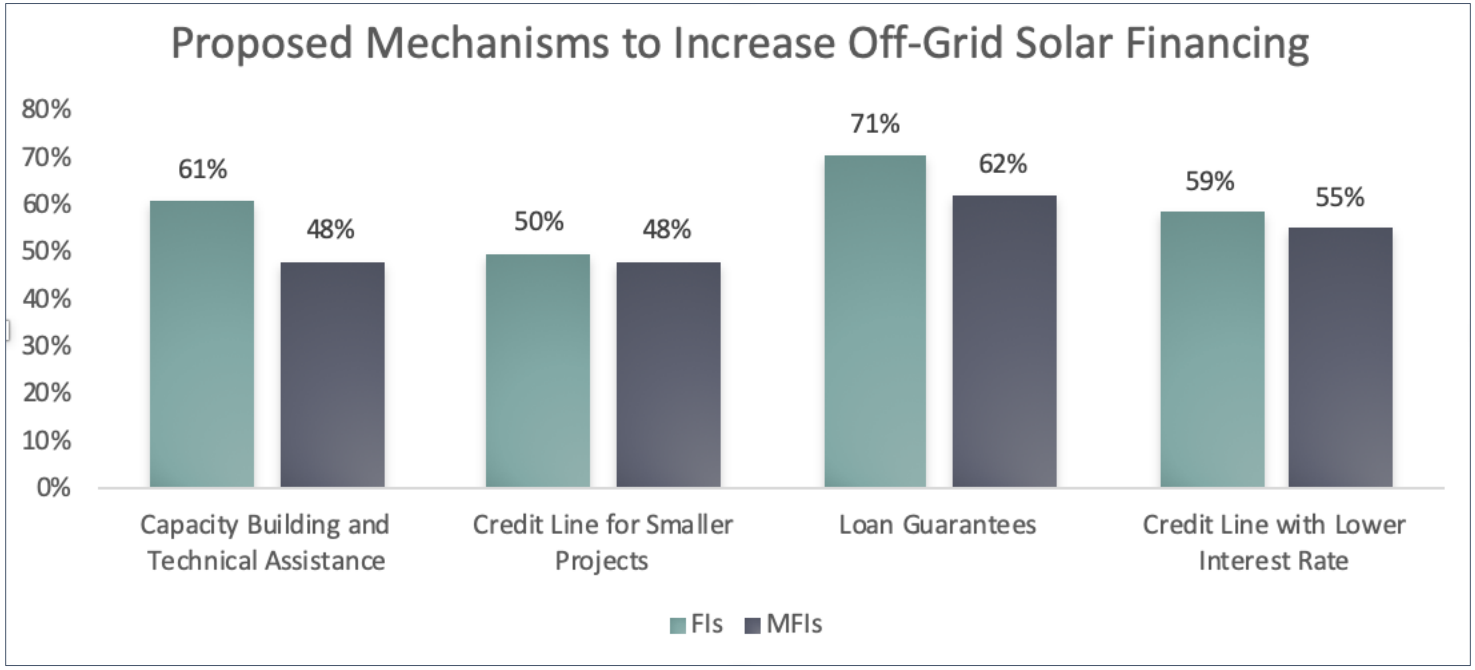
- **Risk Perception of New Lenders:** Due to low repayment rates, commercial banks in Liberia seldom lend to local SMEs and remain cautious of lending to local OGS companies, which are mostly startups with no credit history. In order to attract lenders to this market segment, there is a need for reasonably priced credit enhancement mechanisms. To cover these "market entry" risks for lenders that are unwilling to enter the market, guarantee instruments that cover first loss are needed. However, first-loss coverage does not address the key issue of collateral and is therefore likely insufficient on its own to stimulate growth in FI engagement unless it is coupled with third-party guarantee coverage.

- **Technical Assistance:** A well designed TA intervention is just as important as reasonably priced credit lines and credit enhancements in accelerating OGS lending in Liberia. All of the interviewed FIs emphasized the need for TA in various forms. The recommended key areas of focus include training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of standalone solar firms and projects, extensive due diligence support to qualify products and approve vendors: and support to new lenders to the space in product structuring and development as well as building deal flow. The TA intervention should build upon relevant past programs such as CEADIR. Special attention should also be paid to offering advisory services on the side of the standalone solar enterprises. Lenders opine that these entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

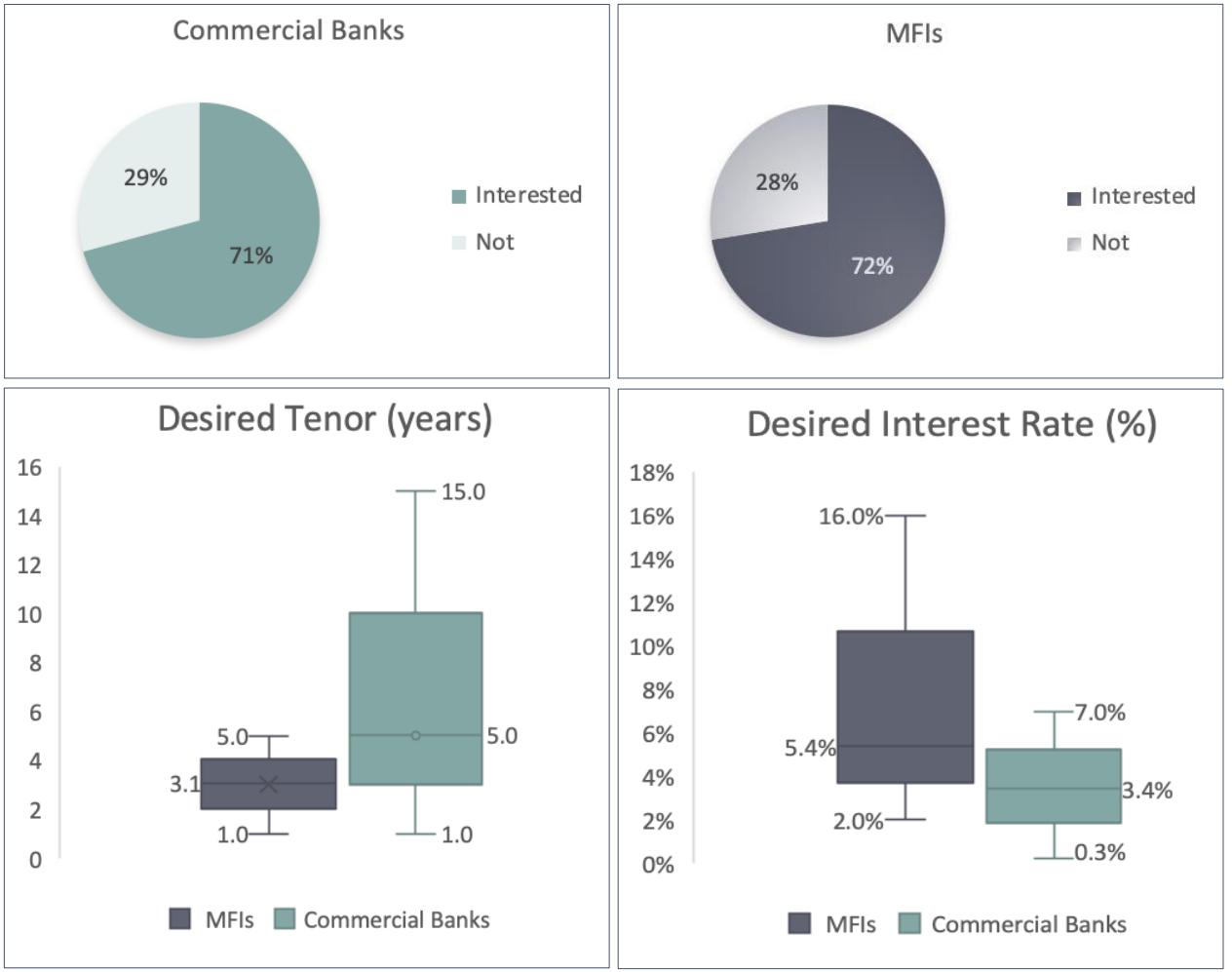
- **Digital Financial Services**: The advent of digital financial services and mobile money is one of the most important developments in off-grid solar market development to date, as it has allowed new and innovative business models to emerge that are now driving unprecedented growth in the sector. Mobile

communication technology facilitates payments for solar products and systems (lease-to-own, pay-as-you-go) and/or for electricity usage (energy-as-a-service) and enables monitoring for operations and maintenance of equipment. Expanding access to mobile money services also creates new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. The Government should take steps to support capacity building of and foster linkages between off-grid solar companies operating in the market and key stakeholders from various sectors, including energy access policymakers and regulators, financial and telecommunications companies, mobile network operators, financial service providers (commercial banks and microfinance institutions), mobile money service providers, international organizations, NGOs and civil society groups involved in financial inclusion etc.

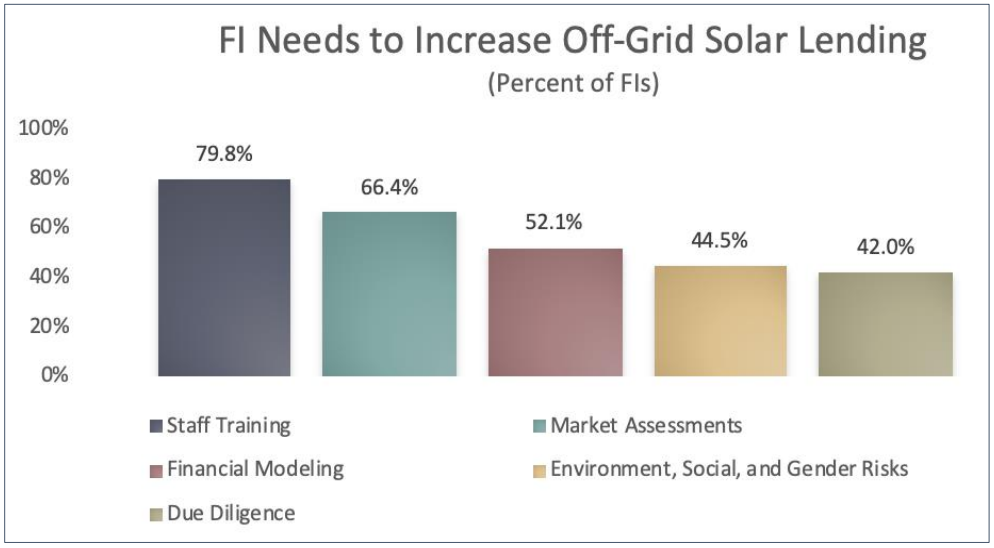
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from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



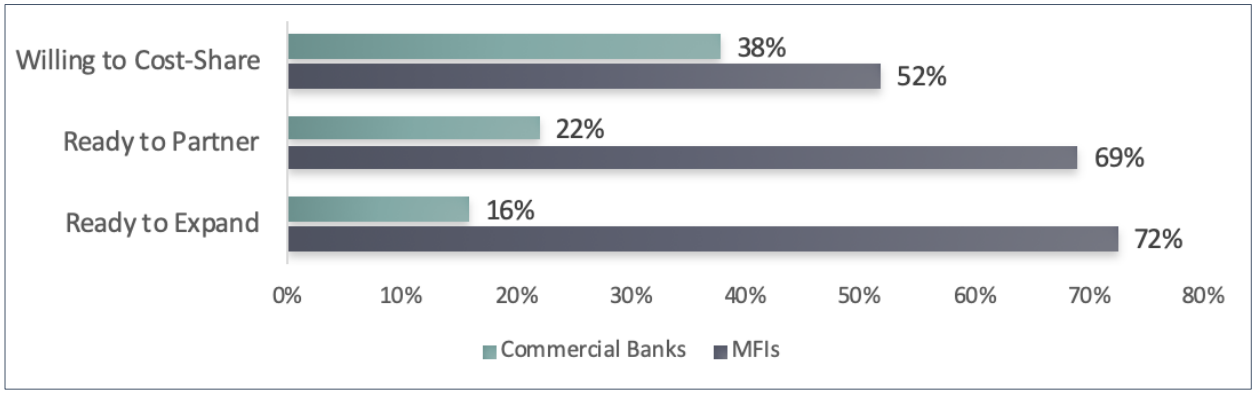
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy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



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



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



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

ANNEX 1: TASK 1 METHODOLOGY

STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

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

GIS DATA ANALYSIS APPROACH / METHODOLOGY

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

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

1.1. Categorization/definition of settlements: Scenario 2023

1.1.1. *Electrification by grid extension* – settlements which are located within 5 km of the current electrical grid network[254] (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)[255] 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)[256], plus an additional 50 people per km^2 for greater feasibility of mini-grids[257] and are within 1 km[258] of a social facility (education center or health facility) and existing mini-grids of 2018.

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

1.2. Categorization/definition of settlements: Scenario 2030

1.2.1. *Electrification by grid extension* – settlements which are located within 15 km of the current electrical grid network (according to LEC) or within 5 km of planned future line extensions[259]

[254] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[255] 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
[256] http://ec.europa.eu/eurostat/web/rural-development/methodology
[257] Identified in discussions with different international mini-grid developer.
[258] Preferred maximum distance for mini-grids from discussions with different international developer.
[259] 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, mines and urban areas; average worker distance in Africa is 10 km, a distance of 5 km is added to include the growth of businesses in the periphery of the growth centers.[260]

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." [261]

A Voronoi polygon analysis[262] was used to create boundaries for each identified settlement. These boundaries were then used in combination with the population density layer to estimate the total settlement population of the given year. The current annual national population growth rate of 2.5%[263] was applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses.

[260] 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.
[261] https://www.worldpop.org
[262] To learn more about Voronoi polygons, see wikidot: http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons
[263] https://data.worldbank.org/indicator/SP.POP.GROW?locations=LR

2. Summary of Key Datasets

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

Overview of Key Datasets of the Least-Cost Electrification Analysis								
Dataset	Description	Criteria used by technology						Source and Year
		Scenario 2023			Scenario 2030			
		On-grid	Mini-grid	Off-grid	On-grid	Mini-grid	Off-grid	
Electricity grid network (current)	Current national grid network (HV & MV lines)	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	RREA, 2015
Electricity grid network (planned)	Future network planned to be built (HV & MV lines) as set out in Scenario 1B of the RESMP	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	RREA, 2015
Mini-grids	Existing mini-grids in 2018 and mini-grids in plan in the BTG program	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	RREA, 2015 and 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 [264]	≥ 350 people per km^2	≤ 350 people per km^2	Not considered	Not considered	Not considered	WorldPop, 2014
Settlements	Settlement layer giving location of settlements across Liberia (cities, towns, villages)	Used	Used	Used	Used	Used	Used	RREA, 2015
Social facility: health centers	Hospitals, health centers, clinics and posts as collected by the Standby Task Force; Indicator of active local economy	Not considered	≤ 1km distance[265]	≥ 1km distance	Not considered	Not considered	Not considered	Humanitarian Data Exchange (HDX), 2017[266]

[264] 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

[265] Preferred maximum distance for mini-grids from discussions with different international developer.

[266] Representing data from http://www.standbytaskforce.org/

Growth center: airport, mines, 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 mines: HDX, 2015 urban areas: ECOWREX website, 2015[267]

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

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

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

1. HOUSEHOLD DEMAND

1.1 Household market segments

1.1.1 Total population without access to electricity was calculated using World Bank total population figures,[268] multiplied by electricity access rates from the International Energy Agency (IEA),[269] 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.

[268] World Bank Open Data, 2017: https://data.worldbank.org/
[269] 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 Liberia, 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%	55%
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."[270] Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.[271] 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:

[270] 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).
[271] 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 Liberia, as shown in 2.2.5).

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

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

1.3.8 The interest rate for consumer finance was estimated to be 22.97% p.a., based on the average interest rate of 12.97% charged by commercial banks in the country on personal loans and an assumed interest rate spread of 10% for Microfinance Institutions.[272]

2023 and 2030 Household Demand Scenario: Assumptions

1. The GIS analysis estimated that by 2023, 27.6% of the population will be grid connected, 30.6% will be connected by mini-grids while 41.8% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 73.9% of the population will be grid connected, 9.6% will be connected by mini-grids while only 16.5% of the population will be connected by off-grid stand-alone solutions. Based on these dynamics in the demographic patterns, coupled with the existing government plans, the following assumptions regarding the off-grid population based on the quintiles were made:
   - In the 2023 scenario, it was assumed that as the grid gets extended and mini-grids are deployed (based on GIS data), the households in the quintiles with the highest income will be given priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest quintile was assumed to have only 1% off-grid households, while the second

[272] Central Bank of Liberia, Annual Report 2017: https://www.cbl.org.lr/doc/annualreport_2017.pdf

and third highest quintiles were assumed to have 2% and 7% off-grid households respectively. The percentages of off-grid households in the bottom two 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 4% off-grid households respectively, while the lowest quintile was assumed to have 72.6% 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%	2%	2%
Third 20%	7%	3%
Second 20%	99%	4%
Lowest 20%	100%	72.6%

2. Inflation rates for Liberia: According to the IMF World Economic Outlook data, inflation in Liberia is estimated to be at 6.2% 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 1.062.

3. Based on a 2.5% population growth rate from the World Bank[273] and the population density dataset used in the study, the estimated total population will be 5,461,277 in 2023 and 6,491,742 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 58.2% in 2023 and 83.5% in 2030.

5. To estimate GDP, it was assumed that the current annual GDP growth rate of 2.5% will be maintained through 2023 and 2030.

Parameter	2023	2030
Population	5,461,277 (GIS estimate)	6,491,742 (GIS estimate)
GDP (constant 2010 USD)	$1,933,190,391	$2,297,955,877

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,[274] the price of pico solar products is expected to fall to USD 10.60 in 2020 and USD 10.10 in 2022 down from USD 10.90 in 2016. Based on these 2020 and 2022 figures, the average annual decrease in prices from 2020 was estimated at 2.36%. It was assumed that the annual price decrease will be maintained at this rate through 2030 (annual cost reduction factor of 0.98)

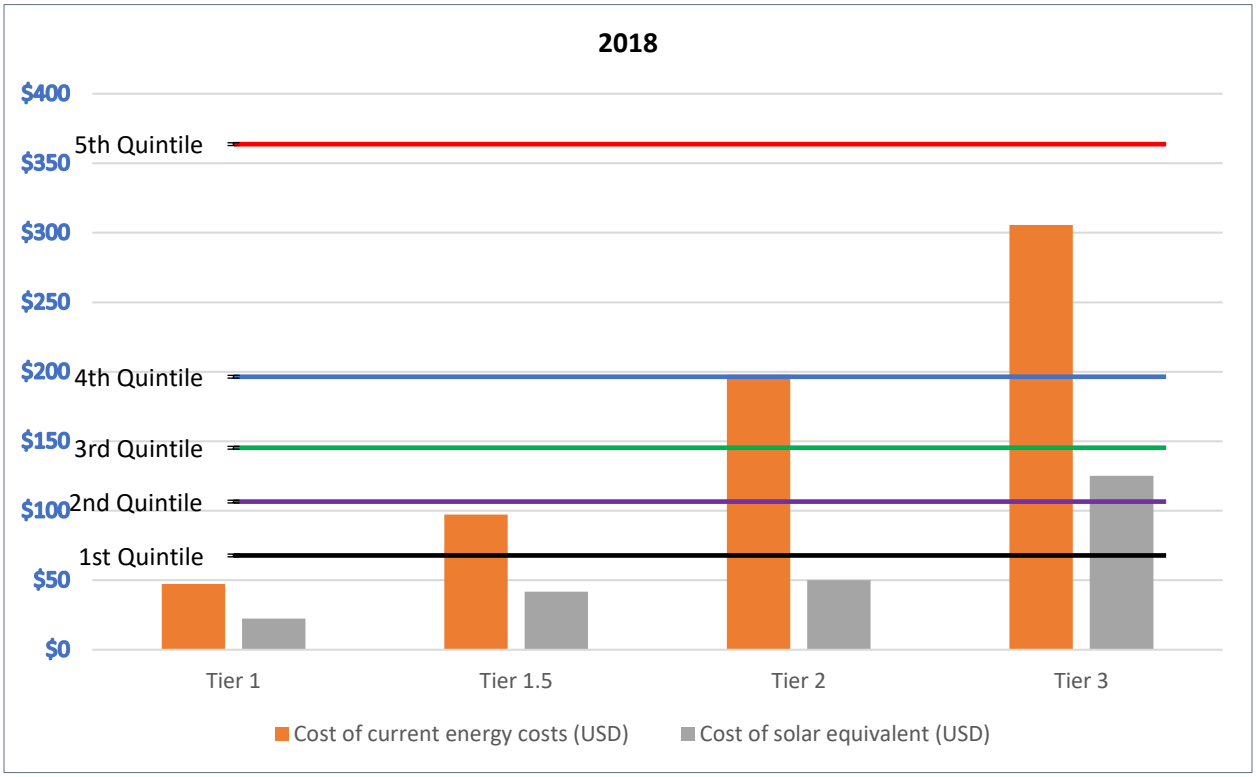
7. According to the same report, the price of small SHS components is expected to fall to USD 60.40 in 2020 and USD 47.40 in 2022, down from USD 77.80 in 2016. Based on these 2020 and 2022 figures, the average annual decrease in prices from 2020 was estimated at 10.76%. It was assumed that the annual price decrease will be maintained at this level through 2030 (annual cost reduction factor of 0.89).

[273] https://data.worldbank.org/indicator/SP.POP.GROW?locations=BJ
[274] "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

8. It was assumed that the interest rates in Liberia will stagnate at the rate of 22.97% 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:

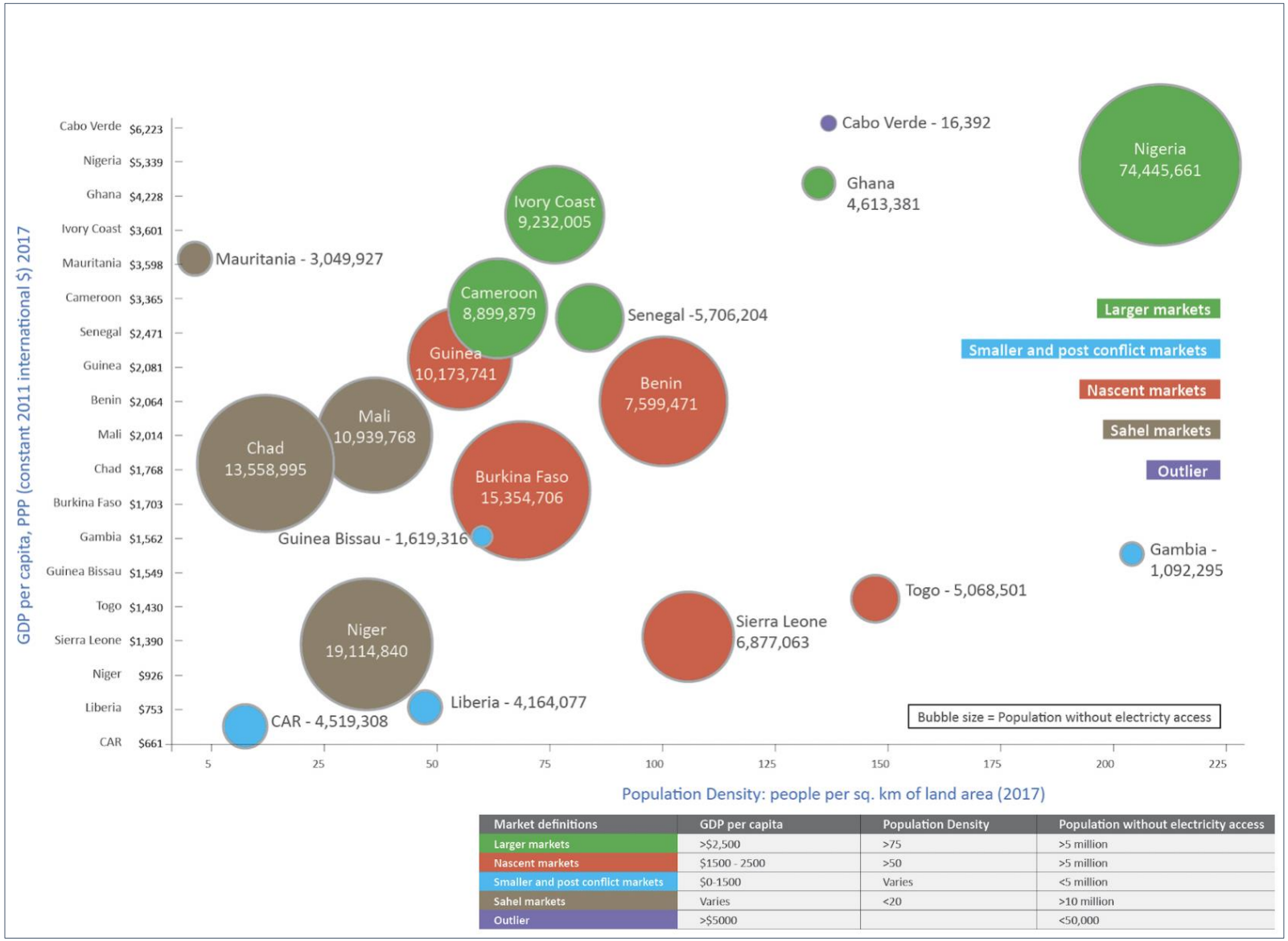
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	**Category 2:** Low-income / high population density	**Category 3:** High-income/ low population density	**Category 4:** High-income / high population density
Niger	Benin	Cameroon	Nigeria
Burkina Faso	Sierra Leone	Côte d'Ivoire	Ghana
Chad	Togo	Mauritania	Cabo Verde
Mali	Gambia	Senegal	
Guinea			
Guinea-Bissau			
Central African Republic			
Liberia			

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.[275] The solar PV sizing factor is based on the peak sun hours available across most of Africa.

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

Energy Needs Assumptions:

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

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

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

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

Public lighting: The electricity needs of a given town/market center (assuming two [2] public lighting points per market center)

2.3 Institutional Market Sizing Calculations

Household systems, cost and price per watt:

System Type	Tier Rating	USD/Watt[276]	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:

[276] 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

LIBERIA			
Water Supply	**Healthcare**	**Education**	**Public Lighting**
GIS data	GIS data	Local stakeholder interviews	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Liberia 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:[277]

- **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.

[277] 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[278]	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)[279]	X 25%	=	Smallholder Irrigation Potential (hectare)[280]	Divided by 0.3[281]	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	$650 (cost of solar pumping kit)[282]	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[283] adjacent to permanent surface water sources. As identified by experts in a study in Zambia[284] and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure 35** is a map of the cropland within a 5 km distance from permanent surface water.

[278] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap
[279] AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
[280] 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
[281] 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/
[282] 120W solar pumping kit: https://futurepump.com/futures-bright-farmers-kenya/
[283] "Prototype Land Cover Map over Africa at 20m Released," Esa, (February 2018): https://www.esa-landcover-cci.org/?q=node/187
[284] "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)[285]	X	70%[286]	X	50%[287]	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor[288]	=	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[289]	X	5,500 W[290]	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).

[285] Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
[286] Assumption that 70% of crops are milled
[287] Assumption that 50% of milled crops are processed at smallholder farmer level
[288] 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/
[289] https://www.citypopulation.de
[290] 5.5kW solar powered refrigeration system – *See*: https://www.deutschland.de/en/solar-powered-coldhubs-nigeria

Mobile Phone Charging Enterprises							
# of Mobile Phone Subscribers in 2017[291]	X	% rural population	Cost of solar phone charging appliances* divided by lifetime of 5 years	X	0.01 (assuming 1 phone charger per 100 mobile phone users)	=	Estimated Annualized Off-Grid Solar Market Potential for Phone Charging Enterprises

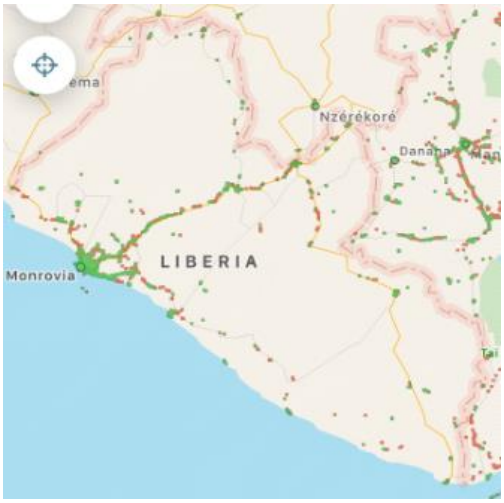
* Indicative Costs for Phone Charging Appliances[292]

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 37**). 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

[291] "The Mobile Economy, Sub-Saharan Africa," GSMA Intelligence, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[292] "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 Monrovia in July 2018
- Survey of 10 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- GOGLA semi-annual sales reports[293]
- 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 Liberia is included below:

1	African Energy
2	Alternative Energy
3	Barefoot Liberia
4	Biolight Renewable Energy (BRE)
5	Bill Johnson Business Center
6	BWI
7	Eco-Power Liberia
8	Fosera Liberia
9	Gbanway Woeyah Electric Cooperative
10	International Energy Services
11	JC-Engineering
12	Jerrut Enterprise
14	LEG Consultants
15	Liberia Gateway Inc
16	Lodisha Solutions, Inc
17	MEPEC Group INC
18	Sjedi Green Energy
19	Solar Eid Liberia
20	Solar Technology Inc.
21	Total Liberia INC
22	Union Strong Group of Companies
23	Universal Empowerment International
24	Vision Awake Africa for Development
25	West Coast Energy

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

[293] "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2018): https://www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h1_2018-opt.pdf
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf
"Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT

Data collection under Task 3 included a combination of desk research, collaboration with local experts, and extensive stakeholder engagement with key officials and representatives from local and regional commercial banks, microfinance institutions and other development banks and agencies in Liberia. 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.[294]

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.[295] 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

[294] The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.
[295] 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.[296] 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.[297]

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.[298] 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.[299] 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.[300]

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).[301] 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).

[296] "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

[297] 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

[298] "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

[299] Ibid.

[300] "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/

[301] "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 Monrovia in July 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Liberia 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[302] (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 Liberia

Despite progress made since the end of the civil war, structural inequalities and gender discrimination against women and girls persist in Liberia, 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 are still widespread 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 Liberia performs extremely poorly, ranking 181 out of 189 countries in the index.[303]

2.2 Gender and Poverty

Poverty remains widespread in Liberia, with 54% of the population living below the poverty line.[304] Poverty is more than twice as high in rural areas (71.6%) than in urban areas (31.5%).[305] According to UNDP statistics, 78.2% of the labor force is considered working poor at PPP USD 3.10/day.[306] 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

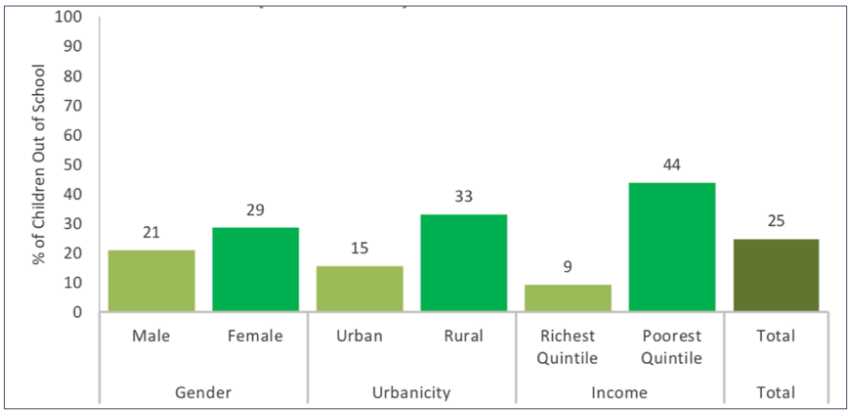
2.3.1 Education, Skills Development and Training

While Liberia 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. Nearly 60% of youth (aged 15-24) have not completed their primary education in Liberia.[307]

[302] 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.
[303] "UN Human Development Reports: Gender Inequality Index (GII)," UN Development Programme, (2018): http://hdr.undp.org/en/composite/GII
[304] Liberia | Data, https://data.worldbank.org/country/liberia
[305] Liberia Overview - worldbank.org, https://www.worldbank.org/en/country/liberia/overview
[306] "UN Human Development Indicators: Liberia," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/LBR
[307] "Liberia: National Education Profile, 2014 Update," Education Policy and Data Center, (2014): https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Liberia.pdf

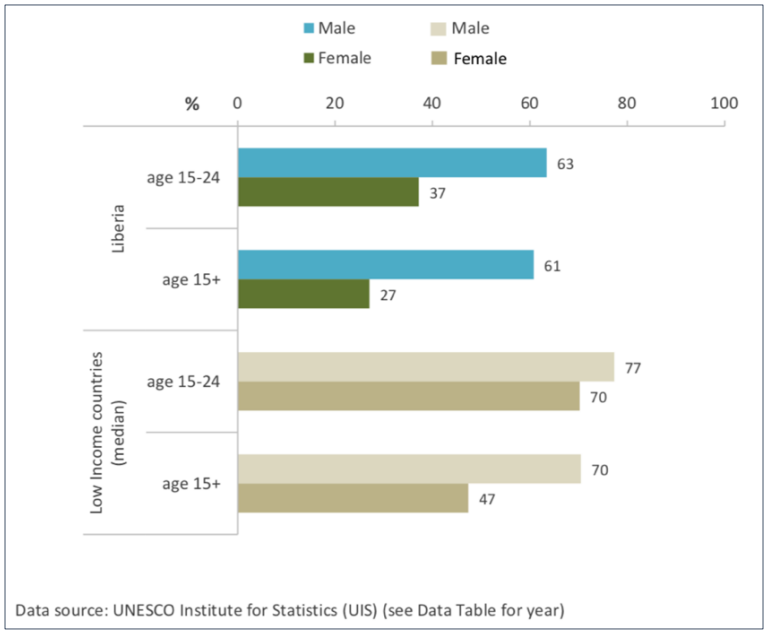
Only 18.5% of adult women in the country have attained some level of secondary education compared to 39.6% of men.[308] An estimated 21% of boys of secondary school age are out of school compared to 29% of girls of the same age.[309] Across the entire sector, there are huge disparities between the poorest and the richest youth in terms of access to education.[310] This trend remains consistent in literacy rates among Liberia's youth and adult populations, as just 27% of the country's female adult population is literate, compared to 61% of the adult male population.[311]

Percentage of Children of Secondary School Age (12-17) Out of School



Source: UNESCO Institute of Statistics

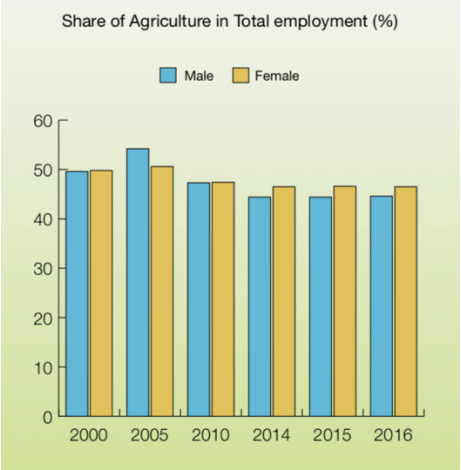
Literacy Rates Among Youth and Adult Populations



Source: UNESCO Institute of Statistics

[308] "UN Human Development Indicators: Liberia," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/LBR
[309] "Liberia: National Education Profile, 2014 Update," Education Policy and Data Center, (2014): https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Liberia.pdf
[310] Ibid.
[311] Ibid.

According to the UN, only 28.2% of women in Liberia had an account at a financial institution or with a mobile money service provider in 2017.[312] This can be attributed to the country's elevated levels of poverty, low or irregular sources of income, low rates of financial literacy, and a perceived lack of need. This is also a result of the fact that most banks are focused on serving the formal sector, while many women remain engaged in informal economic activities – especially in the agricultural sector, which still plays a significant role in the country's overall employment.[313]



Source: AfDB

The education sector in Liberia faces a complex set of challenges related to rebuilding and recovery from civil war, constrained national finances, poor infrastructure and the recent Ebola epidemic. Accelerating improvements in access to quality education for children is an urgent policy priority for the GoL. The Education Strategic Plan (ESP) 2010-2020 provides a strategic framework for development of the education sector and focuses on increases rates of access, particularly for the country's children and youth.

2.3.2 Fertility Rates and Reproductive Health

As of 2017, the fertility rate in Liberia remained high, at about five children per woman. The country also has an extremely high maternal mortality rate; for every 100,000 live births, 725 women die from pregnancy related causes. An estimated 31.1% of women have an unmet need for family planning.[314]

2.3.3 Participation and Decision-Making

Socio-cultural perspectives in Liberia 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.

[312] "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
[313] "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
[314] "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

Although women's level of participation in the economy is growing, they still lag behind men, with an adult labor force participation rate of 53.9% compared to 57.4% for men.[315] Despite having quotas in place to ensure great representation, as of 2017, women held only 9.9% of the country's seats in parliament.[316]

In 2011, Ellen Johnson-Sirleaf became the 24th President of Liberia and the first elected female Head of State in Africa. She served two terms as President. During her mandate, Sirleaf appointed Beatrice Sieh as chief of police and by 2016, Liberia's police force had become 17% female.

2.4 Gender Policy, Institutional and Legal Framework in Liberia

2.4.1 Gender Mainstreaming initiatives by the Government

Gender equality gained widespread support in post-war Liberia's development planning and discourse as a result of the extreme brutalities that women endured during the country's 14-year conflict. As a result, the Government of Liberia adopted gender mainstreaming as a pathway to achieve not only equality between the sexes, but also to address poverty reduction, economic growth, sustainable development and the improved well-being of its citizenry.

Liberia's policy framework for promoting gender equality and women's empowerment is guided mainly by its Poverty Reduction Strategy Paper (PRSP) 2008-2011, as gender equity is a specific crosscutting issue. The PRSP provides a strategic opportunity and entry point for assessing progress to ensure inclusive participation across all sectors of the economy.

The 1990 Constitution of Liberia guarantees fundamental rights and freedoms for all, irrespective of sex. In 2009, the GoL adopted a National Gender Policy (NGP), drafted in line with the Constitution to promote gender equality in Liberia. The GoL has also enacted several policies and action plans to promote gender equality and has signed on to key international and regional framework agreements protecting women's rights and children. The Ministry of Gender and Development was established to coordinate all gender mainstreaming in the country.

Legislation passed in 2010, the Gender Equity in Politics Act, along with a Gender Mainstreaming Policy of the National Election Commission together aimed to increase the involvement of women in Liberia's political process. The National Gender Forum is a multidisciplinary policy advisory body responsible for advising on gender equality issues nationally and monitoring progress toward fulfillment of national and international commitments.

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. The Liberian legal system consists of common law (based on Anglo-American law) and customary law, leading to inconsistencies when it comes to gender-related issues.

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.

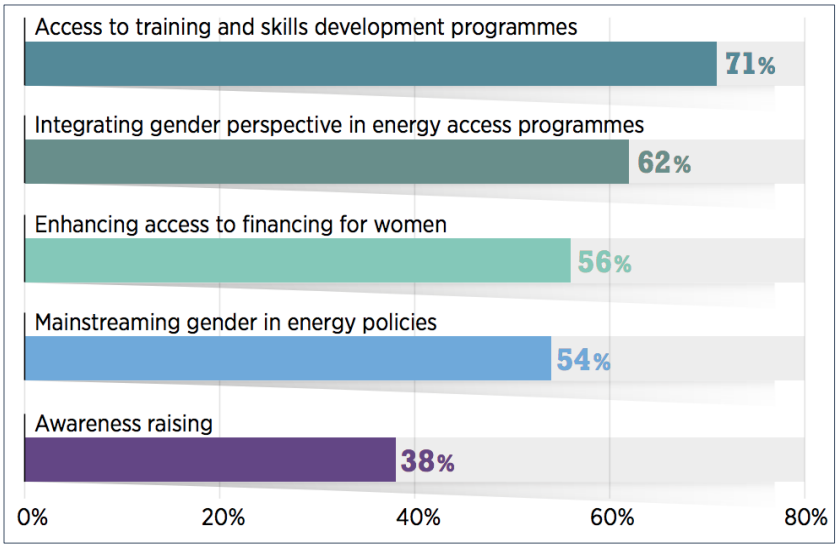
[315] "UN Human Development Indicators: Liberia," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/LBR
[316] Ibid.

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.[317]

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.[318]

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 Liberia's energy sector:[319]

- 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

[317] "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

[318] Ibid.

[319] **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

for women; and (ii) private sector on potential customer needs (e.g. clean cooking technologies, productive use of energy applications etc.)

- Undertake a "gender audit" of the energy sector and develop a gender action plan to inform long-term policy objectives targeting gaps in the existing framework and promoting inclusive participation (e.g. by adding gender categories to policies and projects and accounting for gender impacts in strategic planning).
- Establish a Gender Focal Point or Unit within key national 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.[320]

[320] "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

REFERENCES

Acumen, 2018, "Accelerating Energy Access: The Role of Patient Capital," https://acumen.org/wp-content/uploads/Accelerating-Access-Role-of-Patient-Capital-Report.pdf

African Development Bank, 2018, "Liberia Economic Outlook," https://www.afdb.org/en/countries/west-africa/liberia/

Africa Enterprise Challenge Fund, 2018, "AECF launches Competition targeting Private Sector in Renewable Energy in Liberia," https://www.aecfafrica.org/media_centre/news/AECF_launches_competition_targeting_private_sector_in_renewable_energy_in_liberia

Bavier, J., 2018, "Off-grid power pioneers pour into West Africa," Reuters, https://www.reuters.com/article/us-africa-power-insight/off-grid-power-pioneers-pour-into-west-africa-idUSKCN1G41PE

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

Bloomberg New Energy Finance, 2016, "How can Pay-As-You-Go Solar Be Financed?" https://www.bbhub.io/bnef/sites/4/2016/10/BNEF_WP_2016_10_07-Pay-as-you-go-solar.pdf

Bloomberg New Energy Finance - ClimateScope, 2017, "Liberia," http://global-climatescope.org/en/country/liberia/#/enabling-framework

Central Bank of Liberia, 2017, Annual Report, https://www.cbl.org.lr/doc/annualreport_2017.pdf

Central Bank of Liberia, 2018, Annual Report, https://www.cbl.org.lr/doc/Annual_Report_2018_Feb_12_2019.pdf

Centre for Affordable Housing Finance in Africa, 2017, "Liberia: Employer-Assisted Housing Feasibility Study," http://housingfinanceafrica.org/app/uploads/AHI_CAHF_Liberia-Feasibility-Report_August-2017-1.pdf

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

Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., 2018, "The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution," World Bank, Washington, DC. http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf

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

ECOWAS Center for Renewable Energy and Energy Efficiency, 2016, "Investment Prospectus: General assessment and perspectives," http://www.ecreee.org/sites/default/files/presentation_of_action_agendas_and_ip_advancements_by_national_directors_for_energy_-_liberia.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency / SEforALL, 2015, "Liberia National Renewable Energy Action Plan," http://se4all.ecreee.org/sites/default/files/national_renewable_energy_action_plans_nreap_-_liberia.pdf

ECOWAS, 2015, "ECOWAS Renewable Energy Policy," http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf

Education Policy and Data Center, 2014, "Liberia: Out of School Profile," https://www.epdc.org/sites/default/files/documents/Liberia_OOSC_Profile.pdf

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

European Investment Bank, 2018, "Le secteur bancaire en Afrique De l'inclusion financière à la stabilité financière," https://www.eib.org/attachments/efs/economic_report_banking_africa_2018_fr.pdf

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

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

Food and Agriculture Organization of the United Nations, 2014, "The Impact of the Ebola Virus Disease on Village Savings and Loans Associations in Liberia," http://www.fao.org/fileadmin/user_upload/emergencies/docs/VSLA%20Rapid%20Assessment_December%2019%202014.pdf

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

Front Page Africa Online, 2016, "Ministry of Lands, Mines Launches US$550M Rural Energy Master Plan," http://frontpageafricaonline.com/news/2016news/ministry-of-lands-mines-launches-us-550m-rural-energy-master-plan/

Global Impact Investing Network and Dahlberg, 2015, "The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities and Challenges," https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

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

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

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

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

Government of Sierra Leone, 2016, "Increasing Responsible Financial Inclusion in Liberia," Financial Sector Development Implementation Plan, https://www.firstinitiative.org/projects/increasing-responsible-financial-inclusion-liberia

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

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

International Energy Agency, 2017, "Energy Access Outlook, 2017: From Poverty to Prosperity," https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

International Finance Corporation, "Helping Liberia's Banks Better Serve the Country's SMEs," https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/helping_liberia_+banks_better_serve_countrys_smes

International Finance Corporation, 2018, "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aadc01b4/IFC-Côte_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES

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

International Renewable Energy Agency, 2016, "Solar PV in Africa: Costs and Markets," http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Solar_PV_Costs_Africa_2016.pdf

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

International Monetary Fund, 2016, "Liberia, Selected Issues," https://www.imf.org/external/pubs/ft/scr/2016/cr16239.pdf

Klapper, L., Singer, D., 2014, "The Role of Informal Financial Services in Africa," Journal of African Economies, https://academic.oup.com/jae/article-abstract/24/suppl_1/i12/2473408?redirectedFrom=fulltext

Lee, A. Doukas, A. and DeAngelis, K., 2018, "The African Development Bank and Energy Access Finance in Sub-Saharan Africa: Trends and Insights from Recent Data," Oil Change International and Friends of the Earth U.S., http://priceofoil.org/content/uploads/2018/11/AfDB-Energy-Access-Finance-report-high-quality.pdf

Liberia Rural Energy: Rural Energy Strategy and Master Plan, "Beyond the Grid," http://liberiaruralenergy.org/?q=content/beyond-grid

Liberia Rural Energy: Rural Energy Strategy and Master Plan, "Building Capacity," http://liberiaruralenergy.org/?q=content/building-capacity

Liberia Rural Energy: Rural Energy Strategy and Master Plan, "Decentralized Grid Program", http://liberiaruralenergy.org/?q=content/decentralized-grid

Lighting Africa, "Lighting Lives in Liberia," https://www.lightingafrica.org/country/liberia/

Ministry of Foreign Affairs, 2012, "Liberian Government and World Bank Sign West Africa Power Pool Agreement," http://mofa.gov.lr/public2/2press.php?news_id=659&related=7&pg=sp

NRECA International, 2018, "Liberia," http://www.nrecainternational.coop/where-we-work/liberia/

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

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

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

SEforALL, "Liberia SEforALL Action Agenda", https://www.SEforALL-africa.org/fileadmin/uploads/SEforALL/Documents/Country_AAs/SE4ALL-LIBERIA_AA_FINAL_AEAfinal-JSS.pdf

SEforALL, "SEforALL Africa Hub – Liberia," https://www.SEforALL-africa.org/seforall-in-africa/country-data/liberia/

Sibanda, Z. and Mensah, H., 2017, "IFC Helps LBDI Promote Access to Finance for Liberian SMEs," International Finance Corporation, https://ifcextapps.ifc.org/IFCExt%5CPressroom%5CIFCPressRoom.nsf%5C0%5C2F3316CF3FD62C9A8525819900505A36

Sustainable Energy for All, 2015, "Liberia SEforALL Action Agenda," http://SEforALL.ecreee.org/sites/default/files/sustainable_energy_for_all_SEforALL_action_agenda_report_2015_-_liberia.pdf

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

United Nations Capital Development Fund, World Council of Credit Unions, and MasterCard Foundation, 2017, "Credit Union Revitalization in Liberia: MicroLead Expansion Project," https://uncdf-cdn.azureedge.net/media-manager/77613?sv=2016-05-31&sr=b&sig=9RAn%2FG%2BaCQRkoXDMul0DAnjAdynK7h%2B1ECWM4UezC1Q%3D&se=2019-02-26T16%3A24%3A45Z&sp=r

United Nations Conference on Trade and Development, 2018, "Liberia: Rapid eTrade Readiness Assessment," https://unctad.org/en/PublicationsLibrary/dtlstict2018d2_en.pdf

United Nations Development Programme, 2015, "Gender Inequality Index," http://hdr.undp.org/en/composite/GII

United Nations Development Programme and ETH Zurich, 2018, "Derisking Renewable Energy Investment: Off-Grid Electrification," https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20(20181210).pdf

United States Agency for International Development, "Power Africa Liberia Fact Sheet," https://www.usaid.gov/powerafrica/liberia

United States Overseas Private Investment Corporation, 2012, "Building Affordable, Sustainable Homes: Broad Cove Eco-homes Liberia," https://www.opic.gov/opic-action/featured-projects/sub-saharan-africa/building-affordable-sustainable-homes-broad-cove-ecohomes-liberia

United States Agency for International Development-National Renewable Energy Laboratory and Energy 4 Impact, 2018, "Productive Use of Energy in African Micro-Grids: Technical and Business Considerations," https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf

World Bank, "LREAP Overview," http://projects.worldbank.org/P149683/?lang=en&tab=overview

World Bank, "West African Power Pool: CLSG Power System Redevelopment Sub-Program," http://siteresources.worldbank.org/INTENERGY2/Resources/exercise.pdf

World Bank, 2011, "Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa," http://siteresources.worldbank.org/INTARD/Resources/West_Africa_web_fc.pdf

World Bank ,2015, "Crowdfunding in Emerging Markets: Lessons from East African Startups," https://www.infodev.org/infodev-files/crowdfunding-in-east-africa.pdf

World Bank, 2016, "New Energy Project Targets 150,000 Liberians for Increased Access to Affordable and Reliable Electricity," http://www.worldbank.org/en/news/press-release/2016/01/11/new-energy-project-targets-150000-liberians-for-increased-access-to-affordable-and-reliable-electricity;

World Bank, 2017, "Sahel Irrigation Initiative Support Project," Project Appraisal Document, http://documents.worldbank.org/curated/en/515131512702151121/pdf/WESTERN-AFRICA-PADnew-11142017.pdf

World Bank, 2018, "International Development Association, International Finance Corporation, Multilateral Investment Guarantee Agency, Country Partnership Framework for the Republic of Liberia for the Period FY19-FY24," http://documents.worldbank.org/curated/en/374031541438293964/pdf/liberia-cpf-11012018-636768792698663889.pdf

World Bank, 2018, "Republic of Liberia – From Growth to Development: Priorities for Sustainably Reducing Poverty and Achieving Middle-Income Status by 2030," http://documents.worldbank.org/curated/en/585371528125859387/pdf/LBR-SCD-draft-10-06012018.pdf

World Bank, 2018, "RISE Liberia Retail Tariffs," http://rise.worldbank.org/country/liberia

World Bank, 2019, "Doing Business 2019: Liberia Economy Profile," http://www.doingbusiness.org/content/dam/doingBusiness/country/l/liberia/LBR.pdf

World Bank Energy Sector Management Assistance Program, 2018, "Policy Matters: Regulatory Indicators for Sustainable Energy," http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf

Yates, D., 2018, “Only 2% of Liberia’s Population Has Access to Renewable Energy,” Liberian Daily Observer, https://www.liberianobserver.com/news/only-2-of-liberias-population-have-access-to-renewable-energy/