



WORLD BANK GROUP



ECREEE
TOWARDS SUSTAINABLE ENERGY

REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

MALI REPORT

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ABBREVIATIONS & ACRONYMS

ADFD	Abu Dhabi Fund for Development
AER	Agence des Énergies Renouvelables du Mali (Mali Renewable Energy Agency)
AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
AMADER	Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale (The Agency for the Development of Rural Electrification and Domestic Energy in Mali)
APES	Association Professionnelle Solaire (Solar Professionals Association)
ASD	Africa Solar Designs
BADEA	Banque Arabe pour le Développement Economique en Afrique (Arab Bank for Economic Development in Africa)
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
BDM	Banque de Développement du Mali (Mali Development Bank)
BIC	Bureaux d'Information sur le Crédit (Information Credit Bureau)
BICIM	Banque Internationale pour le Commerce et l'Industrie au Mali (International Bank of Commerce and industry of Mali)
BOAD	Banque Ouest Africaine de Développement (West African Development Bank)
BNDA	Banque National de development Africain (The National Bank of African Development)
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CFA	Communauté Financière Africaine (African Financial Community)
CREE	Commission de Régulation de l'Électricité et de l'Eau (Electricity and Water Regulatory commission)
CMDT	La Compagnie Malienne pour le Développement du Textile (Malian Textile Development Company)
COD	Cash-on-Delivery
DFI	Development Finance Institution
DNE	Direction Nationale de l'Énergie (National Directorate of Energy)
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
EDM	Énergie du Mali
EIB	European Investment Bank
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUR	Euro
EVA	Energio Verda Africa
FAO	Food and Agriculture Organization of the United Nations
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion
FI	Financial Institution
FRES	Foundation Rural Energy Services
FX	Foreign Exchange

GDP	Gross Domestic Product
GIS	Geographic Information Systems
GNI	Gross National Income
GoM	Government of Mali
GOGLA	Global Off-Grid Lighting Association
GSMA	Groupe Spéciale Mobile Association (Global System for Mobile Communications)
HC	Health Center
HDI	Human Development Index
HFO	Heavy Fuel Oil
HH	Household
HEURA	Household Energy and Universal Access Project
ICT	Information and Communications Technology
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IsDB	Islamic Development Bank
kW	Kilowatt
kWh	Kilowatt-hour
LTO	Lease-to-Own
MEE	Ministère de l'Énergie et de l'Eau (Ministry of Energy and Water)
MFI	Microfinance Institution
MTF	Multi-Tier Energy Access Framework
MW	Megawatt
NGO	Non-Governmental Organization
NPL	Non-Performing Loan
O&M	Operation and Maintenance
OGS	Off-Grid Solar
OHADA	L'Organisation pour l'Harmonisation en Afrique du Droit des Affaires (Organization for the Harmonization of Business Law in Africa)
OMVS	Organization pour la Mise en Valeur du fleuve Sénégal (Senegal River Basin Development Organization)
PANER	Plan d'Action National des Énergies Renouvelables (National Renewable Energy Action Plan)
PAYG	Pay-As-You-Go
PEDASB	Projet Énergie Domestique et Accès aux Services de Base en milieu rural (Domestic energy and basic services access project in rural areas)
PENRAF	Projet de Promotion des Énergies Nouvelles et Renouvelables pour l'Avancement de la Femme (Project promoting Alternatives and Renewable Energy and Advancement of women)
PHARE	Production Hybride et Accès Rural à l'Énergie
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PREVES	Projet d'Électrification des Villages en Énergie Solaire (Rural Village Solar Electrification Project)
PRODER	Programme Décennal d'Électrification Rurale (Ten-Year Rural Electrification Program)
PUE	Productive Use of Energy

PV	Photovoltaic
RE	Renewable Energy
RISE	Regulatory Indicators for Sustainable Energy
ROA	Return on Assets
ROE	Return on Equity
ROGEP	Regional Off-Grid Electrification Project
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SHER	Systeme Hybride d'Electrification Rural (Hybrid Rural Electrification System Project)
SHS	Solar Home System
SME	Small and Medium Enterprise
SPV	Special Purpose Vehicle
SREP	Scaling-Up Renewable Energy Program
SSA	Sub-Saharan Africa
SSD	Sociétés de Services Décentralisés (Decentralized Services Company)
SUNREF	Sustainable Use of Natural Resources and Energy Finance
TA	Technical Assistance
UEMOA/WAEMU	Union Économique et Monétaire Ouest Africaine / West African Economic and Monetary Union
UN	United Nations
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak

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

KEY DEFINITIONS

ELECTRICITY ACCESS

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

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

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

OFF-GRID / STAND-ALONE SOLAR

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

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

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

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

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

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

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

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

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

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

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

Multi-tier Matrix for Measuring Access to Household Electricity Supply

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

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

WEST AFRICA AND THE SAHEL

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

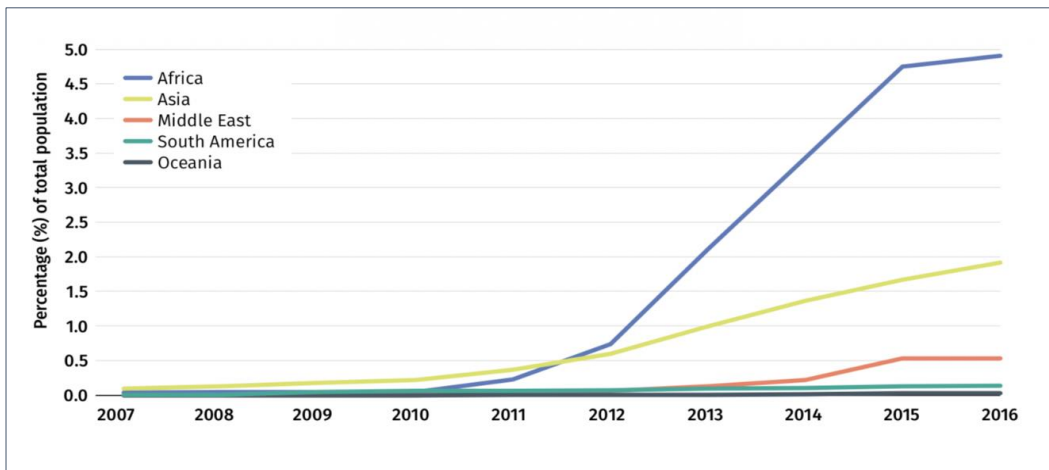


EXECUTIVE SUMMARY

I. INTRODUCTION

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

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



Tier 1 access and above

Source: International Renewable Energy Agency

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

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

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

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

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

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

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

¹³ IEA Energy Access Outlook, 2017.

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

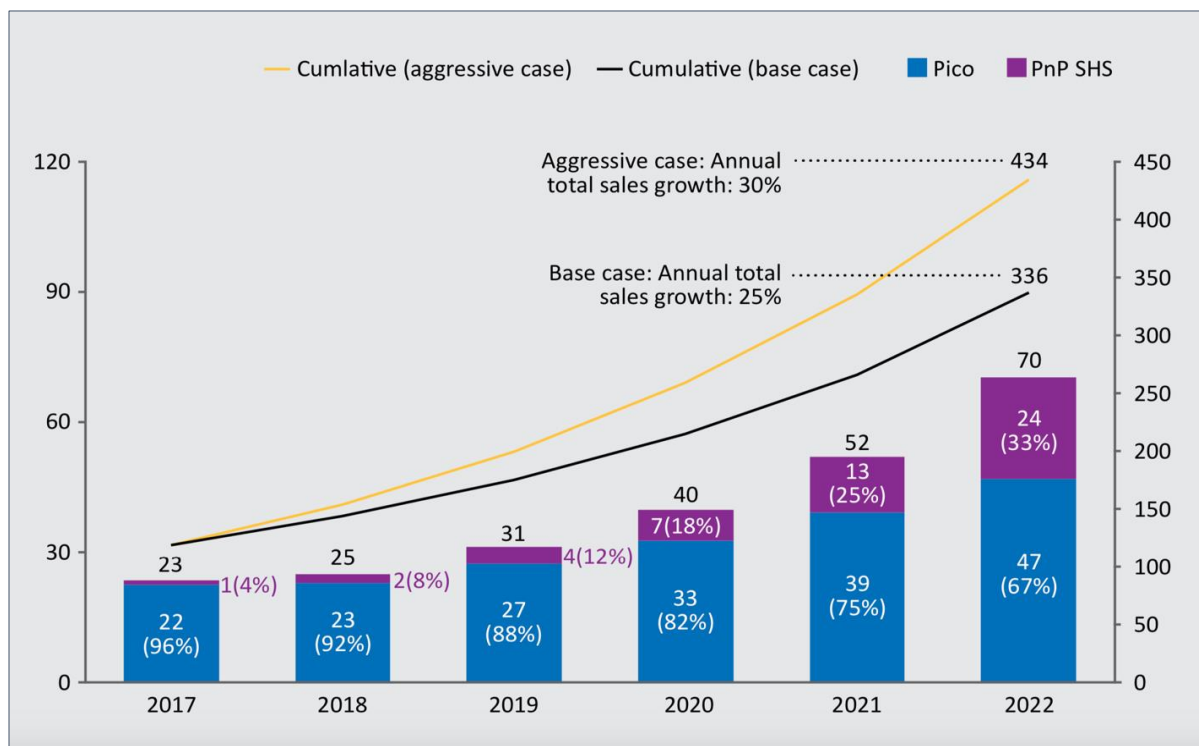
[https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20\(20181210\).pdf](https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20(20181210).pdf)

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

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

¹⁶ Ibid.

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



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

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

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

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

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

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

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

¹⁹ UNDP and ETH Zurich, 2018.

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

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

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

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

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

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

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

²¹ UNDP and ETH Zurich, 2018.

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

²³ ECOWAS Renewable Energy Policy, 2013:

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

II. BACKGROUND AND CONTEXT OF THE ASSIGNMENT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

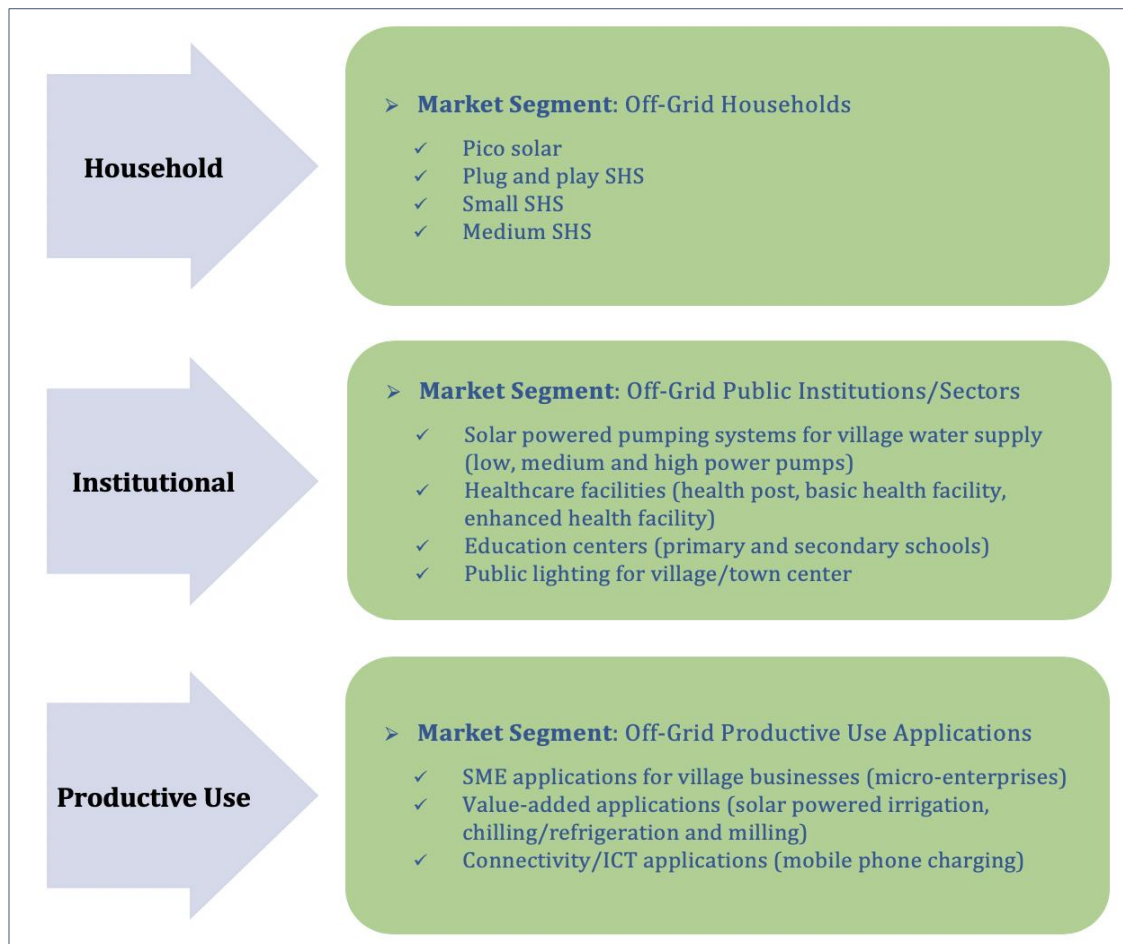
The institutional sector analysis combines available GIS data with secondary research to estimate potential demand based on assumptions about the electricity needs, usage patterns and associated costs of solar electrification of four public/institutional markets – water supply for off-grid communities,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

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

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

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

Figure ES-3: Analyzed Off-Grid Market Segments



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

III. EXECUTIVE SUMMARY

Mali is a landlocked country in the Sahel sub-region of West Africa, with abundant natural resources and a vast territory. The economy depends heavily on the agricultural sector, which contributes to nearly half of GDP and employs about 80% of the population. Economic growth has slightly declined in recent years, in part due to the country's fragile political situation. High population growth rates, drought and civil conflict have fueled poverty, which remains widespread, particularly in rural areas.²⁴

Access to electricity remains an ongoing challenge. In 2016, approximately 60% of the overall population in Mali – an estimated 11 million people – lacked access to electricity, with a significant disparity between rates of access in urban (83%) and rural (6%) areas.²⁵ Even where grid connections exist, power supply is often unreliable, with fewer than one-fifth of firms and one-third of households reporting reliable access to electricity when surveyed.²⁶ Off-grid electrification is a policy priority for the Government of Mali (GoM), which is committed to achieving universal access by 2030. To date, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector have had moderate success, as evidenced by the country's World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score. In the 2017 RISE evaluation, Mali ranked 12th among countries in West Africa and the Sahel.²⁷

The GoM has undertaken numerous off-grid programs with funding and support from development partners. In 2003, the Government established the Domestic Energy and Rural Electrification Development Agency (Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale, AMADER) to oversee the country's rural electrification initiatives. From 2003 to 2013, with financing from the Global Environment Fund and the World Bank, AMADER managed implementation of an extensive electrification program – the Household Energy and Universal Access Project (HEURA) – which led to the installation of over 10,000 solar home systems across the country. The HEURA program utilized an innovative approach driven by local private entrepreneurs, NGOs, decentralized groups and cooperatives, who were able to capitalize on their knowledge of the local market.²⁸ Following the HEURA project, with financing from the World Bank, the GoM launched the Rural Electrification Hybrid System Project (Système Hybride d'Électrification Rural, SHER), which was scheduled for implementation from 2013 to 2020. Like the HEURA project, the SHER provides incentives to private operators to increase rural electricity access to clean energy technologies.²⁹

AMADER is currently managing an additional rural electrification initiative – the Hybrid Production and Rural Access to Energy project (Production Hybride et Accès Rural à l'Énergie, PHARE), financed by AFD and the EU, which is utilizing solar-diesel hybrid systems to electrify rural localities. At the regional level, with support from ECREEE, the GoM has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan (Plan d'Action National pour les Énergies Renouvelables, PANER).

²⁴ "Mali Country Overview," World Bank, (2018): <http://www.worldbank.org/en/country/mali/overview>

²⁵ IEA Energy Access Outlook, 2017.

²⁶ 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>

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 "Household Energy and Universal Access Project," World Bank, (2011):

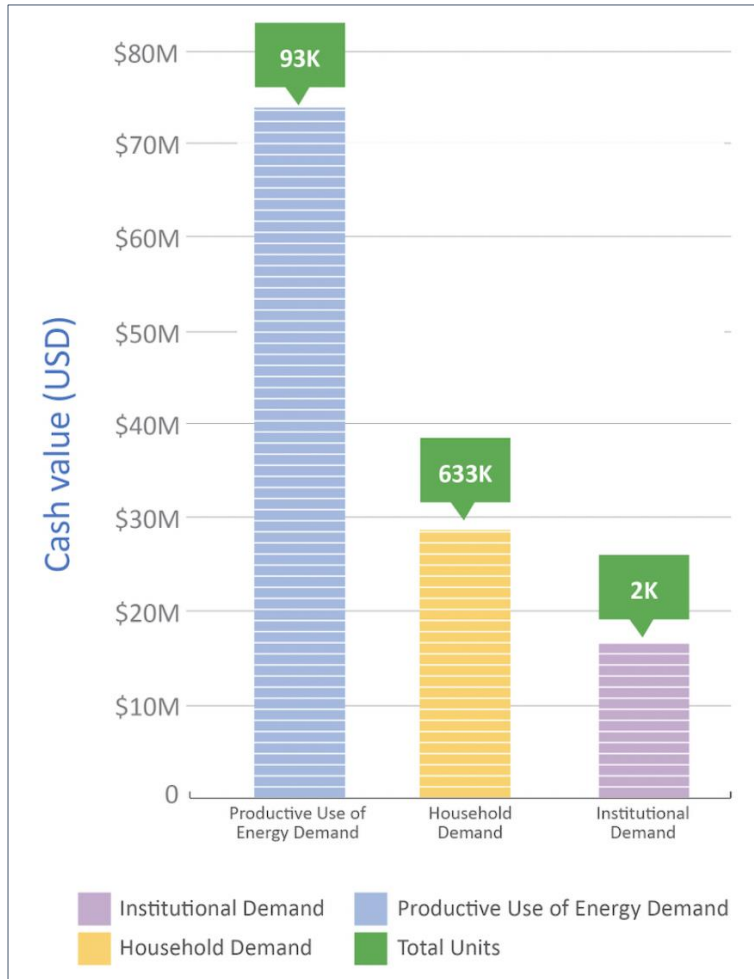
<http://documents.worldbank.org/curated/en/129511468280730120/pdf/600170PJPROP1110180Box365735B00PUBLIC0.pdf>

²⁹ "Rural Electrification Hybrid System Project," World Bank, (2013):

<http://documents.worldbank.org/curated/en/173911468052814928/pdf/PAD6880PAD0P13010Box379866B00OU0090.pdf>

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 Mali (**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 118.9 million. The productive use sector (USD 73.7M) makes up the majority of estimated demand, followed by the household (USD 28.6M) and institutional (USD 16.5M) sectors.

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

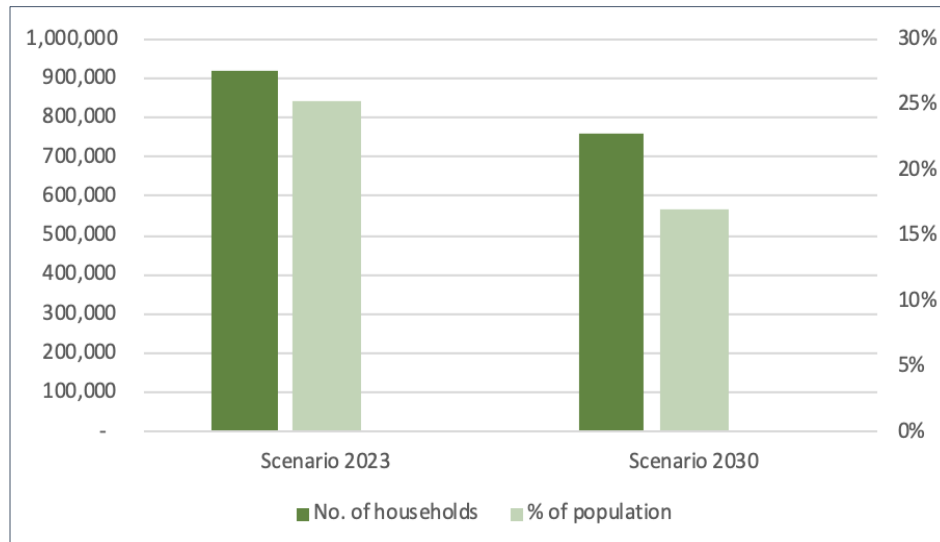


Source: African Solar Designs analysis

The least-cost electrification analysis found that by 2023, 1,028 settlements across Mali (928,649 households) will be connected to the main grid, representing 25.5% of the population. By 2030, this figure will increase to 5,267 settlements (2,257,905 households), equivalent to 50.4% 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 9,872 settlements (922,524 households), representing 25.3% of the population in 2023, as suitable for stand-alone systems, decreasing to 6,724 settlements (761,925 households) and 17% of the population in 2030 (**Figure ES-5**). While the total size of the OGS market will decrease slightly over time, the distribution of off-grid households across the country will remain similar through 2030.

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

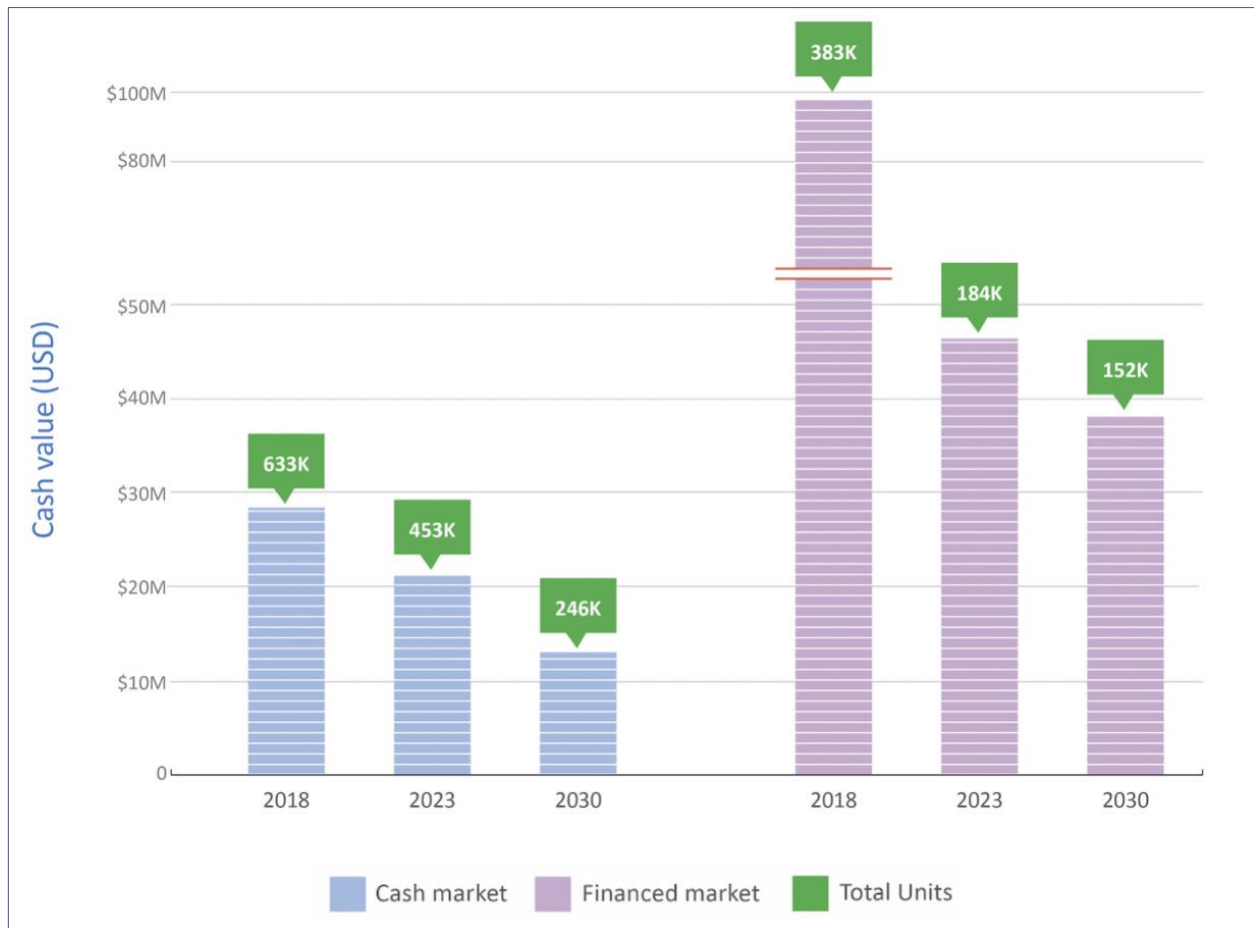


Source: Energio Verda Africa GIS analysis

According to the analysis, the annualized off-grid solar cash market potential for the household sector in 2018 is USD 28.7 million, with the estimated market value more than tripling in size to USD 98.9 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.

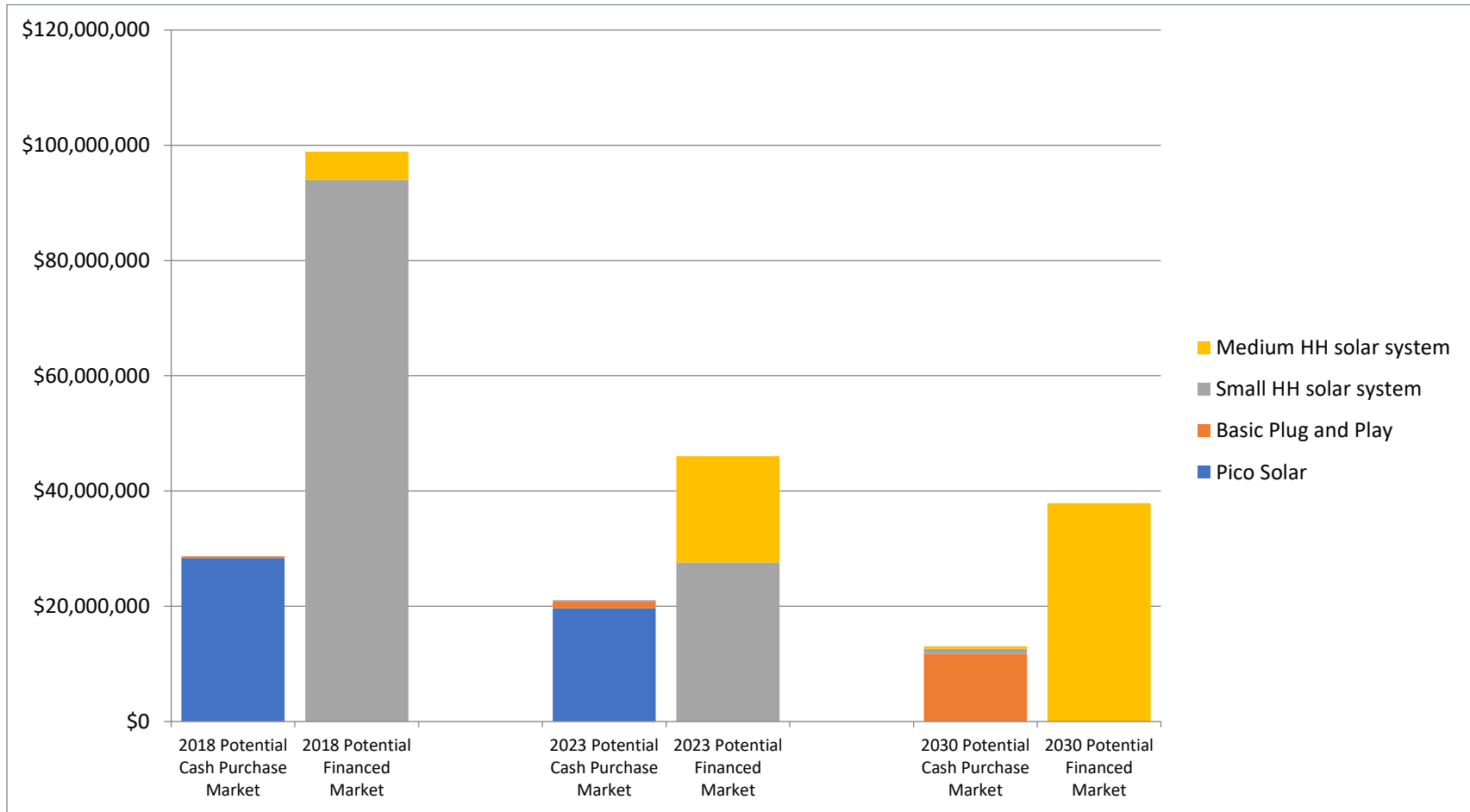
According to the assessment, the most common types of systems the market can afford on a cash basis are pico solar systems; however, this changes significantly with the introduction of financing (**Figure ES-7**). While affordability improves over time, households in the lowest income quintiles cannot afford any off-grid solar products without financing. Consumer financing will thus 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



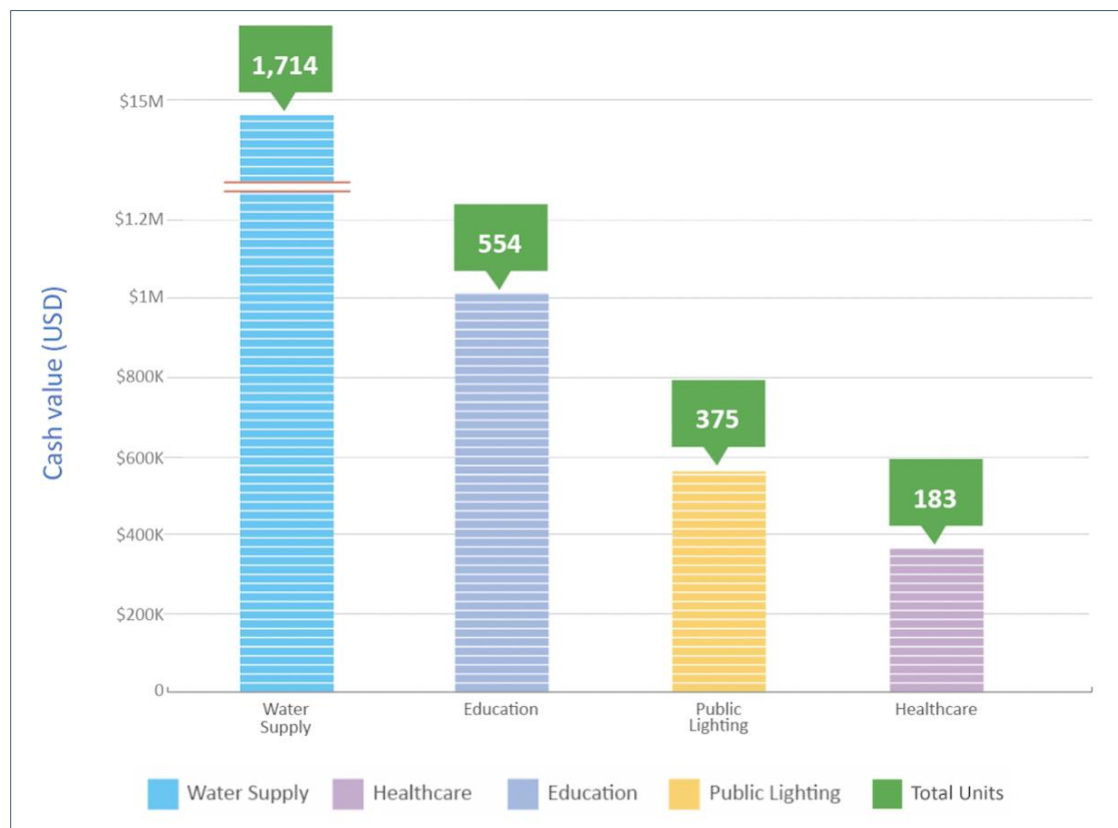
Source: African Solar Designs analysis

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

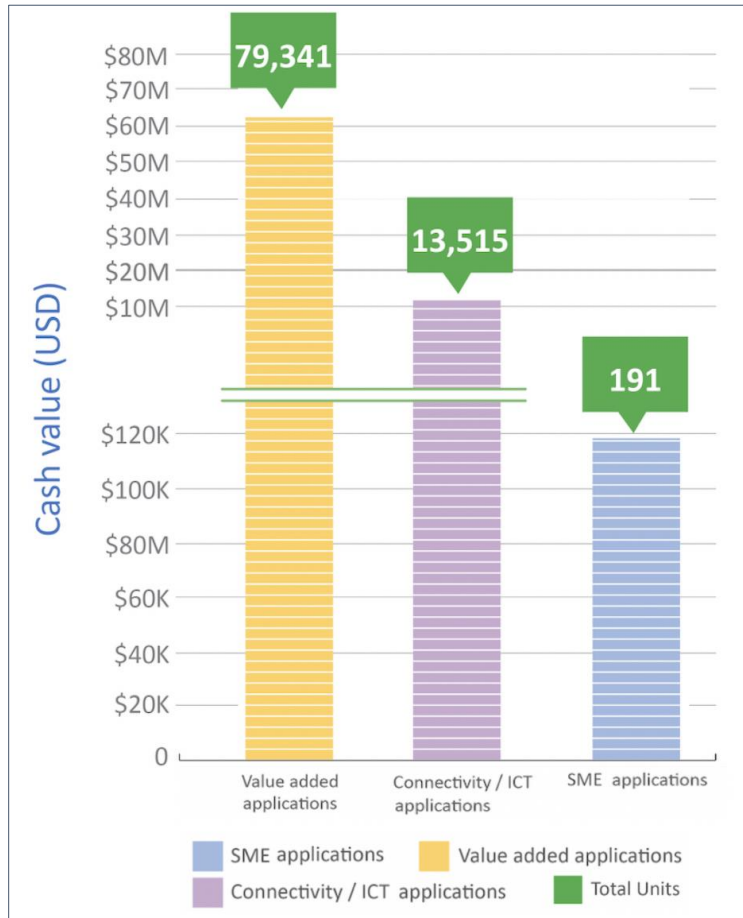


Source: African Solar Designs analysis

The estimated annualized cash market potential for Mali’s public/institutional sector in 2018 is USD 16.5 million (**Figure ES-8**). The institutional market segment with the largest potential is water supply (USD 14.5M), followed by education (USD 1M), public lighting (USD 561K) and healthcare (USD 354K). 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 73.7 million (Figure ES-9). The estimated demand from value-added applications represents most of the PUE market potential (USD 62M), followed by applications for connectivity (USD 11.6M) and SMEs (USD 119K).

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

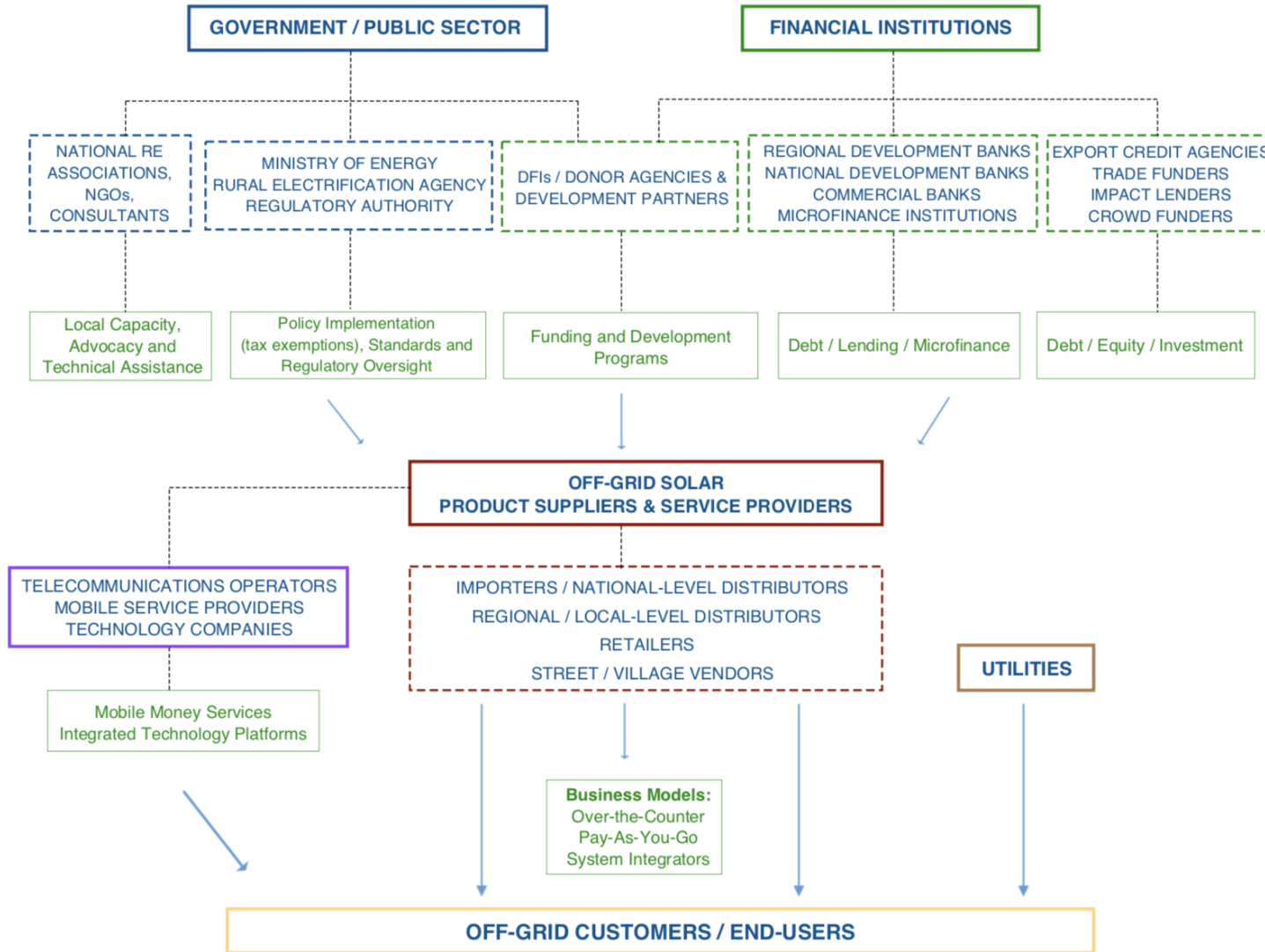
Following the estimates of market demand, this report analyzes the supply chain for off-grid solar products and services in Mali, which includes a wide range of stakeholders, including importers, distributors, wholesalers, retailers and end-users (**Figure ES-10**). The solar supply chain is made up 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.

Figures published by GOGLA indicate that off-grid product sales volume and revenue in Mali nearly doubled between 2016 and 2017. The Malian market was the fourth largest market in West Africa during this period, behind Nigeria, Burkina Faso, and Benin.

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.

Mali'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 Mali:

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

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 Mali 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.

With 13 commercial banks in Mali, the number of institutions relative to the population is extremely low. Furthermore, commercial banks operate mainly in urban areas, leaving many rural and low-income people and businesses with limited access to financial services. While microfinance institutions (MFIs) have helped fill this void, informal sources of financing also serve a significant portion of the population.

Although access to banking and financial services through formal institutions remains limited, Mali is experiencing a sharp increase in the availability and usage of digital financial services and mobile banking, driven by widespread mobile phone ownership, rapidly growing mobile internet usage and network coverage. This dynamic is driving greater financial inclusion; in 2017, 35% of the country’s adult population had an account at a financial institution or with a mobile money service provider, up from 8% in 2011. Despite this improvement, there is still a significant gender gap in rates of access to financial services, as women in Mali are 19% less likely than men to have an account at a financial institution or with a mobile money service provider.³⁰

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-

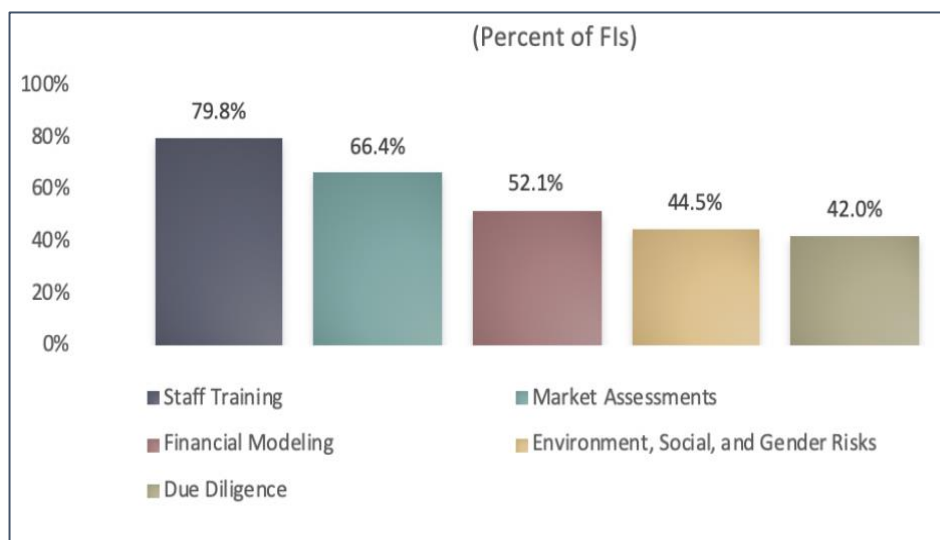
³⁰ Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., “The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution,” World Bank, (2017): <http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf>

grid solar solutions, particularly for PAYG systems that rely on the interoperability between digital financial services and stand-alone solar devices.

While there are several donor and DFI-funded programs and initiatives that have provided financing to support development of Mali’s off-grid solar market, these funds have largely 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 sector thanks to donor-funded initiatives such as AFD’s Sustainable Use of Natural Resources and Energy Finance (SUNREF) West Africa program.

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

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



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

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

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

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

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

³³ Ibid.

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

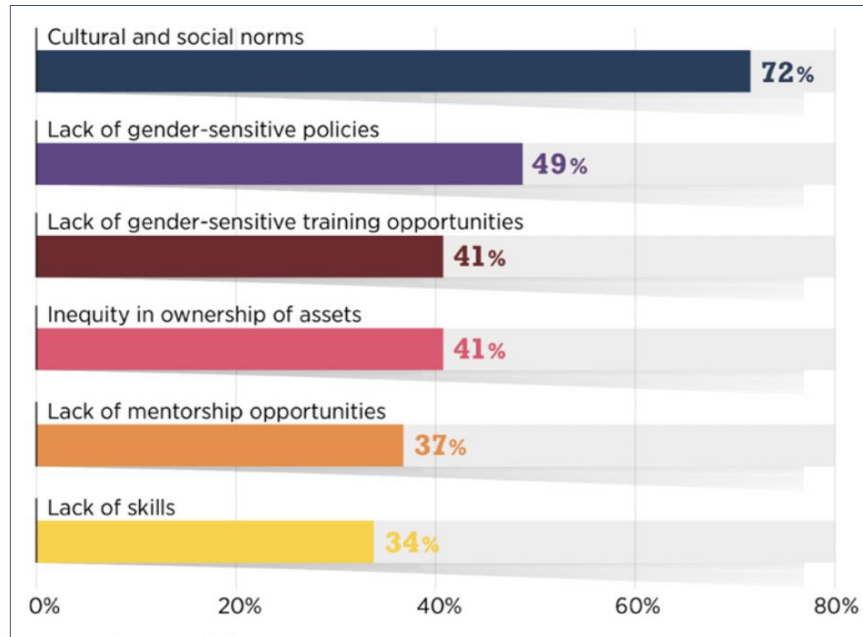
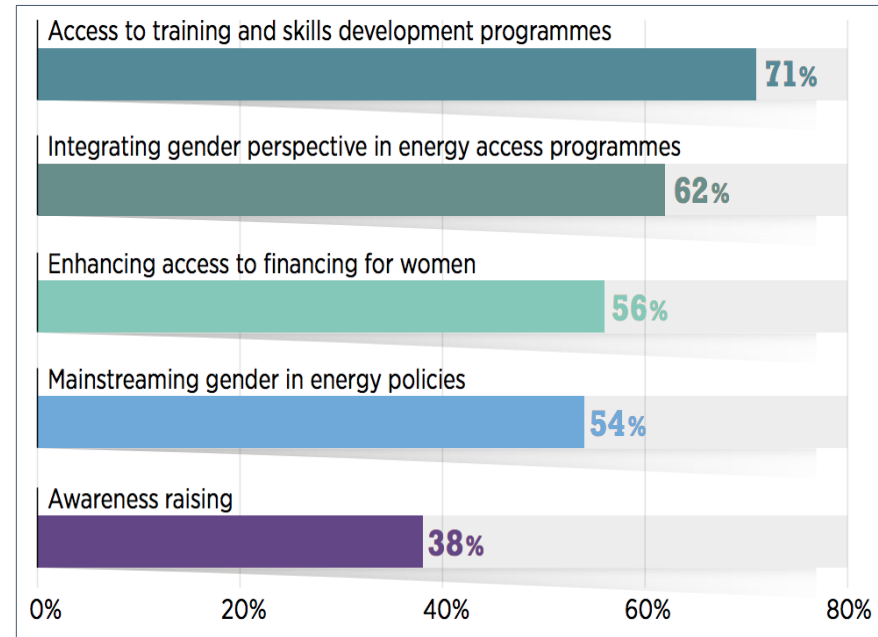


Figure ES-13: Measures to Improve Women’s Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in Mali 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 Mali.³⁴

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

I. STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

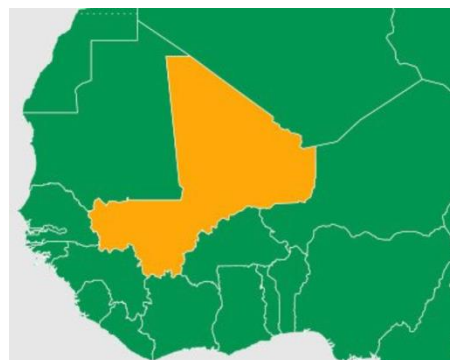
This section begins with a brief introduction of key macroeconomic and social indicators in Mali (**Section 1.1**). This is followed by an overview of the country’s existing energy sector (**Section 1.2**), with a focus on the status of energy access, including an assessment of both the on-grid and off-grid 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 off-grid stand-alone systems³⁵ in Mali 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

Mali is a landlocked country in the Sahel sub-region of West Africa, with abundant natural resources and a vast territory. The economy depends heavily on the agricultural sector, which contributes to nearly half of GDP and employs about 80% of the population. This leaves the country vulnerable to climate change and fluctuations in commodity prices. Economic growth has slightly declined in recent years, estimated at 5.5% in 2017 and projected to be 5% in 2018 and 4.9% in 2019, in part due to the country’s fragile political situation.³⁶ High population growth rates, drought and civil conflict have fueled poverty, which remains widespread, particularly in rural areas.³⁷

Table 1 : Macroeconomic and Social Indicators

Population	18 million ³⁸
Urban Population	41% of total
GDP	USD 15.3 billion
GDP growth rate	5.3%
GNI per capita*	USD 770
Unemployment rate	7.9 %
National poverty rate	43.6% (2009)
Urban	18.9%
Rural	50.6%
Currency	West African CFA franc (CFA)
Official language	French
Natural resources	Agricultural (cotton); ores (gold, bauxite, uranium)



* World Bank Atlas method (current USD)³⁹

All figures from 2017 unless otherwise indicated

Source: AfDB, World Bank and IMF⁴⁰

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

³⁶ “Mali Economic Outlook,” African Development Bank (2018): <https://www.afdb.org/en/countries/west-africa/mali/mali-economic-outlook/>

³⁷ “Mali Country Overview,” World Bank, (2018): <http://www.worldbank.org/en/country/mali/overview>

³⁸ 50.1% male/49.9% female

³⁹ “World Bank Open Data: Mali,” World Bank (2017): <https://data.worldbank.org/country/mali>

⁴⁰ “Mali: 2018 Article IV Consultation and Eighth and Ninth Reviews under the ECF Arrangement,” IMF, (2018): <http://www.imf.org/~media/Files/Publications/CR/2018/cr18141.ashx>

1.2 Energy Market

1.2.1 Energy Sector Overview

The National Directorate of Energy (Direction Nationale de l'Énergie, DNE), within the Ministry of Energy and Water (Ministère de l'Énergie et de l'Eau, MEE), is responsible for national energy policy formulation, promotion, coordination, monitoring and evaluation. Energy of Mali (Électricité du Mali, EDM-SA) is a vertically integrated private sector electricity utility, operating under a public service concession agreement for electricity supply in urban areas.⁴¹ Formerly a state-owned enterprise, the Government of Mali (GoM or “the Government”) retains 40% ownership of EDM. The institution operates as a monopoly over transmission and distribution, while generation is open to private independent power producers (IPPs) such as SOPAM-SA and Albatros Energie.⁴² EDM is currently the single buyer for power produced by these IPPs. The Regulatory Commission on Water and Electricity (Commission de Régulation de l'Électricité et de l'Eau, CREE) is the regulatory authority and operates under the supervision of the Prime Minister's Office and is responsible for granting concessions, promoting competition between private operators and supervising public procurements and tenders. The Domestic Energy and Rural Electrification Development Agency (Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale, AMADER) was created in 2003 to manage and oversee the country's rural electrification initiatives. Under public-private partnerships (PPPs), rural electricity concessions are granted to private operators called “Sociétés de Services Décentralisés” (SSD). About 60 of these operators produce and sell electricity in rural areas under the mandate of AMADER; since the 1990s, SSDs have installed 200 mini-grids and connected approximately 12,000 customers.⁴³

Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Direction Nationale de l'Énergie, (DNE) within the Ministry of Energy and Water (Ministère de l'Énergie et de l'Eau, MEE)	Ministry responsible for formulating national energy policy, ensuring coordination and control over regional and sub-regional services; The DNE is responsible for execution of energy policies and programs
Électricité du Mali (EDM-SA)	Private utility company responsible for electricity generation, transport and transmission in urban areas
Domestic Energy and Rural Electrification Development Agency (Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale, AMADER)	Development agency under the MEE responsible for: <ul style="list-style-type: none"> • Promoting rural electrification through investment subsidies • Preparing renewable energy Master Plan • Providing TA and financial assistance to operators in rural areas • Monitoring and evaluation of project achievements
Regulatory Commission on Water and Electricity (Commission de Régulation de l'Électricité et de l'Eau, CREE)	Regulatory authority under the Prime Minister's Office responsible for: <ul style="list-style-type: none"> • Supporting public electricity and water services • Protecting consumer interests • Promoting competition between private operators • Supervising public procurement and concessions granting • Executing control and approval of tariffs • Solving conflicts between contractors and operators
Renewable Energy Agency (AER-Mali)	Public agency under the MEE responsible for the promotion of renewable energy

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

⁴¹ “Mali electricity sector emergency project: PID/ISDS,” World Bank, (2018):

<http://documents.worldbank.org/curated/en/864571522875815839/pdf/Concept-Project-Information-Document-Integrated-Safeguards-Data-Sheet-Mali-Electricity-Sector-Improvement-Project-MESIP-P166796.pdf>

⁴² “Programme de valorisation à grande échelle des énergies renouvelables au Mali (SREP-Mali),” Direction Nationale de l'Énergie, (2015) : https://www.climateinvestmentfunds.org/sites/cif_enc/files/IT%20Mali%20PS.pdf

⁴³ “The potential of mobile for rural energy access in Mali,” GSMA Intelligence, (April 2017):

<https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/04/Mobile-for-Development-Utilities-The-potential-of-mobile-for-rural-energy-access-in-Mali.pdf>

1.2.2 Electricity Access: *Grid and Off-Grid*

Energy access in Mali represents a significant challenge. In 2016, about 60% of the population – 11 million people – did not have access to electricity, with a significant disparity in rates of access between urban (83%) and rural (6%) areas.⁴⁴ The Government has set a target of increasing rural electrification rates to 52% by 2020 and 81% by 2030.

1.2.2.1 Off-Grid Market Overview

Although electricity access in rural areas remains limited, considerable progress has been made in Mali’s off-grid sector thanks to a supportive institutional framework.⁴⁵ AMADER was established in 2003 as a separate Government agency to (i) promote electrification in rural and peri-urban areas; (ii) provide technical assistance and financial support to off-grid operators (including national and international companies, NGOs, decentralized groups, cooperatives etc.); and (iii) act as the de-facto regulator of the off-grid sector. AMADER provides financial support to the sector via the Rural Electrification Fund, REF (fund which is within AMADER), established to make rural electrification projects commercially viable and tariffs affordable.

From 2003-2013, the GoM, with financing from the Global Environment Fund (GEF) Trust Fund, the World Bank, national budget and private operators, designed and implemented an extensive household electrification program – the Household Energy and Universal Access Project (HEURA) and *Projet Énergie Domestique et Accès aux Services de Base en milieu rural (PEDASB)*. These initiatives led to the installation of over 10,000 solar home systems (SHS) across the country.⁴⁶ The HEURA program utilized an innovative approach driven by local private entrepreneurs, NGOs, decentralized groups, and cooperatives, who were able to capitalize on their knowledge of the local market. The initiative was ultimately implemented by more than 60 operators using a combination of diesel mini-grids and SHS.⁴⁷ AMADER managed implementation of the program and provided financial support to developers, entrepreneurs and communities through the REF. The strategy followed a dual approach:⁴⁸

- Top-Down / Priority Electrification Zones (“ZEM”): AMADER solicits bids for the electrification of designated areas through a competitive process and awards projects on the basis of the lowest tariff; in poorer rural areas where off-grid development is less commercially viable, the REF finances feasibility studies to prepare projects for competitive bidding
- Bottom-Up private initiative (“PCASER”): Projects are selected based on the developers’ ability to operate a viable project with the support of a fixed investment subsidy (up to 80% of project costs)

One of the country’s current off-grid development initiatives – the Rural Electrification Hybrid System Project (*Système Hybride d’Électrification Rural, SHER*) – has built on experience gained from the HEURA project and was scheduled for implementation from 2013-2020. Like the HEURA project, the SHER provides incentives to private operators to increase access and make connection packages affordable to the rural poor. The program intends to expand AMADER’s bottom-up electrification model into a more systematic and large-scale approach, including increased utilization of clean energy technology to increase

⁴⁴ “Energy Access Outlook, 2017: From Poverty to Prosperity,” International Energy Agency, (2017):

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

⁴⁵ “SREP Mali – Investment Plan: Scaling Up Renewable Energy, Volume 1,” AfDB, (2010):

[https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/SREP-Mali_IP_Volume1_EN_21Sept%20\(2\).pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/SREP-Mali_IP_Volume1_EN_21Sept%20(2).pdf)

⁴⁶ “Household Energy and Universal Access Project,” World Bank, (2011):

<http://documents.worldbank.org/curated/en/129511468280730120/pdf/600170PJPROP1110180Box365735B00PUBLIC0.pdf>

⁴⁷ “Output-Based Aid in Mali, Rural Electrification Hybrid System Project,” GPOBA, (2015):

<https://www.gpoba.org/sites/gpoba/files/OBA45%20Mali%20Electrification.pdf>

⁴⁸ “Mali’s Rural Electrification Fund,” AMADER, (2008): <http://siteresources.worldbank.org/INTENERGY2/Resources/presentation8.pdf>

access in rural areas.⁴⁹ Financed by the World Bank and implemented/managed by AMADER, SHER consists of subsidies and investments in expanding off-grid solutions as well as independent verification of outputs. Selection of operators is based on established criteria, which includes the following:⁵⁰

- Potential demand and prospect for economic growth at the proposed sites
- Demonstrated source of up-front capital
- Proven past performance
- Technical, economic and financial viability of the sub-project
- Clearly defined outputs; and
- Balanced geographic representation.

The selection process places particular emphasis on the pre-financing capacity of potential operators, as operators are required to fund the off-grid connections and internal wiring before receiving subsidies. Sources of pre-financing include revenues from energy and other activities as well as commercial loans.⁵¹ It is expected that the project subsidy will contribute to an acceptable rate of return for participating private operators. The SHER program aims to add a total of 4.8 MW in hybrid systems for an estimated cost of USD 6,800 per kW. Under this project, it is expected that:⁵²

- 9,600 households will benefit from mini-grid expansion
- 2,400 other households will gain access to 50-135Wp of solar home systems (SHS)
- Private distributors will benefit from a subsidy for the sale of 100,000 Lighting Africa-certified solar portable lanterns and SHS
- Rural schools and public/social facilities will be provided with 10,000 solar lanterns and solar home systems
- AMADER will lead communication and promotion campaigns to raise consumer awareness on energy efficiency and renewable energy appliances

By mid-2018, SHER had provided access to 103,914 people, (out of the 2020 target of 681,000), including the installation of 2,954 SHS and 11,000 connections to the mini-grids and solar kits.⁵³

Another national initiative is the Rural Electrification Hybrid System Project (REHSP)⁵⁴ for the period 2017-2019, which aims to increase electrification through hybrid systems in 32 localities (of which 10 localities are already electrified but will be strengthened). It will benefit over 170,000 people in rural areas, including households, community centers, and street lighting. The project is funded by the Abu Dhabi Development Fund (ADFD) and the Arab Bank for Economic Development in Africa (Banque Arabe pour le Développement Economique en Afrique, BADEA) for a total cost of USD 21.5 million.

⁴⁹ "Rural Electrification Hybrid System Project," World Bank, (2013):

<http://documents.worldbank.org/curated/en/173911468052814928/pdf/PAD6880PAD0P13010Box379866B00UO090.pdf>

⁵⁰ "Output-Based Aid in Mali, Rural Electrification Hybrid System Project," GPOBA, (2015):

<https://www.gpoba.org/sites/gpoba/files/OBA45%20Mali%20Electrification.pdf>

⁵¹ This is a potential area where local FIs, with support from ROGEP, can support private operators engaged in this program.

⁵² "Output-Based Aid in Mali, Rural Electrification Hybrid System Project," GPOBA, (2015):

<https://www.gpoba.org/sites/gpoba/files/OBA45%20Mali%20Electrification.pdf>

⁵³ "Rural Electrification Hybrid System Project, Implementation Status & Results Report," World Bank, (2018):

<http://documents.worldbank.org/curated/en/498931528197718501/pdf/Disclosable-Version-of-the-ISR-Mali-Rural-Electrification-Hybrid-System-Project-P131084-Sequence-No-08.pdf>

⁵⁴ "L'électrification rurale par systèmes hybrides de 32 localités rurales du Mali (PERSHY 32)," AMADER, (2017):

<http://www.amader.gouv.ml/portfolio/lelectrification-rurale-par-systemes-hybrides-de-32-localites-rurales-du-mali-pershy-32/>

A third project is the Hybrid Production and Rural Access to Energy project (le projet de production hybride et d'accès rural à l'énergie, PHARE), scheduled for implementation over the period 2017-2021.⁵⁵ This project is financed by French AFD and the EU and the GoM (EUR 41 million in total) and involved installing 60 solar / diesel hybrid plants in localities already electrified on the basis of a purely diesel thermal production, and to further extend the distribution network in these localities to make additional connections. A similar electrification project financed by KfW and consisting of the development of hybrid solar/diesel systems by six operators in 14 locations was completed in 2017.

A fourth initiative is the Rural Development Project by Solar Rural Electrification⁵⁶ (2017-2019), which is supported by the IsDB. The project intends to electricity 24 villages (Saloba communes: 13 localities and Sana: 11 localities) from two off-grid solar power stations (1 MWp and 1.2 MWp). Mali also benefits from the regional project, Programme Décennal d'Electrification Rurale (PRODER), which, in partnership with WAEMU, targets the construction of 13 solar PV/diesel hybrid plants to replace women's mill multifunctional platforms.

The West African Development Bank (Banque Ouest Africaine de Développement, BOAD) is also financing several ongoing initiatives to support off-grid development in Mali. One project, the Green Energy Service Centers for Communities in Rural Mali (2018-2021), which is being implemented by AER and AMADER, aims to electrify up to 100 rural off-grid communities from renewable energy sources, including solar and wind within five regions in Mali (Kayes, Koulikoro, Sikasso, Ségou and Mopti).⁵⁷ A follow up initiative, the Mali Solar Rural Electrification Project, was launched in 2019 with financing from the Green Climate Fund (GCF) and BOAD to support solar-based mini-grids for rural electrification. The project will be developed under a public-private-partnership (PPP) model, whereby the mini-grids will be constructed through competitive public tenders and eventually operated and maintained by private companies under 15-year concession agreements.⁵⁸

As a result of these robust rural electrification programs, several private international and local solar companies are active in Mali's off-grid sector, offering mainly SHS and pico solar products (see **Section 2.4** for more details on the supply chain). BNDA Development Bank is the most active financial institution in the country's energy sector, having financed several electricity network extensions and solar projects. The bank recently provided financing for the Akuo Kita Solar 50 MW Solar IPP project in Mali, with additional financing from the West African Development Bank and Emerging Africa Infrastructure Fund.⁵⁹ The institution has also signed an MoU with the Ministry of Energy and EDM to support the dissemination of individual solar kits throughout the country. The Bank also partnered on the project, "Projet Prêt Energie Renouvelable," implemented by AER-Mali from 2015 to 2017, which involved the installation of standalone solar PV systems for urban households. BNDA's familiarity with the energy sector allows for financing of projects in the form of a loan at rates that are reasonable.⁶⁰

1.2.2.2 Demand and Supply/Generation Mix

⁵⁵ "La France et l'UE apportent leur appui à l'électrification rurale au Mali," European Union, (2016): https://eeas.europa.eu/generic-warning-system-taxonomy/404_en/10787/La%20France%20et%20l'Union%20européenne%20apportent%20leur%20appui%20à%20l'électrification%20rurale%20au%20Mali

⁵⁶ "Projet d'énergie solaire pour le développement rural au Mali," AMADER, (2017): <http://www.amader.gouv.ml/portfolio/b-i-d/>

⁵⁷ "Green Energy Services Centres for Communities in Rural Mali, Concept Note," WADB, Green Climate Fund (GCF), (2017):

https://www.greenclimate.fund/documents/20182/893456/17750_-

[_Green_Energy_Service_Centres_for_Communities_in_Rural_Mali.pdf/ccd30188-3f59-476e-a9a2-6bc0e88563d4](https://www.greenclimate.fund/documents/20182/893456/17750_-Green_Energy_Service_Centres_for_Communities_in_Rural_Mali.pdf/ccd30188-3f59-476e-a9a2-6bc0e88563d4)

⁵⁸ "GCF scaling-up clean energy access through solar based mini-grids in Mali," Green Climate Fund, (23 April 2019):

[https://www.greenclimate.fund/news/gcf-scaling-up-clean-energy-access-through-solar-based-mini-grids-in-](https://www.greenclimate.fund/news/gcf-scaling-up-clean-energy-access-through-solar-based-mini-grids-in-mali?inheritRedirect=true&redirect=%2Fwhat-we-do%2Fnewsroom%2Fnews-stories)

[mali?inheritRedirect=true&redirect=%2Fwhat-we-do%2Fnewsroom%2Fnews-stories](https://www.greenclimate.fund/news/gcf-scaling-up-clean-energy-access-through-solar-based-mini-grids-in-mali?inheritRedirect=true&redirect=%2Fwhat-we-do%2Fnewsroom%2Fnews-stories)

⁵⁹ "Akuo Solar secures financing for 50MW solar project in Mali," PV Tech, (January 24, 2018):

<https://www.pv-tech.org/news/akuo-solar-secures-financing-for-50mw-pv-project-in-mali>

⁶⁰ See **Section 3** for more details.

Table 3: Electricity Sector Indicators, 2017⁶¹

Despite having a total installed capacity of 672 MW in 2017,⁶² after accounting for inoperable facilities, the available capacity was closer to 310 MW.⁶³ Mali’s hydropower potential is about 1 GW, coming both from national (193 MW) and regional sources via the Senegal River Basin Development Organization (OMVS). The country’s solar, biomass and wind resources are all promising. A total of 133 MW solar, 30 MW of bioenergy p and 20 MW of wind greenfield generation projects are in the pipeline to be commissioned by 2030.⁶⁴

Installed Capacity	672 MW
Thermal	357 MW
Hydropower	312 MW
Renewable (non-hydro)	3 MW
National electrification rate (2016)	41%
Urban electrification rate	83%
Rural electrification rate	6%
Population without access	10.9 million
Households without access	1.9 million
Electrification target (national)	81% by 2030

Source: EDM-SA, AER-Mali, IEA, and World Bank

Electricity consumption increased approximately 10% annually on average between 2009-2016. Rapidly growing demand combined with poor power sector planning and an overall lack of local capacity has forced the Government to rely on expensive imported diesel for power generation. To meet future demand, the Government plans diversify its energy mix by adding significant installed renewable energy capacity, mainly from hydropower and solar (Table 4).

Table 4: Current and Planned Installed Capacity⁶⁵

Installed Capacity (MW)	2017	2020 (planned)	2030 (planned)
Thermal	357	-	-
Large hydro	306	287	731
Small hydro	6	51	107
Solar	3	308	528
Bioenergy	-	15	30
Wind	-	-	20
Total Installed Capacity (MW)	672	-	-
Total thermal	357	-	-
Total renewable energy	315	661	1,416

Source: EDM-SA, AER-Mali, SEforALL National Renewable Energy Action Plan

Average retail electricity tariffs in Mali (USD 0.23/kWh)⁶⁶ do not reflect the cost of production, with the difference subsidized by the Government. Energy services for SHS kits 75-150 Wc are EUR 5.8-13 per month (CFA 3,815 to 9,000).

1.2.2.3 Transmission and Distribution Network

⁶¹ See Section 2.1 for more details on households/population without access to electricity

⁶² “Rapport Annuel D’ Activites, 2017,” Energie du Mali SA, (July 2017): https://www.edm-sa.com.ml/images/EDMSARapportAnnuelDactivites2017CRFvsc19072018_simplifiesweb.pdf

⁶³ “Mali electricity sector emergency project: PID/ISDS,” World Bank, (2018):

<http://documents.worldbank.org/curated/en/864571522875815839/pdf/Concept-Project-Information-Documents-Integrated-Safeguards-Data-Sheet-Mali-Electricity-Sector-Improvement-Project-MESIP-P166796.pdf>

⁶⁴ “USAID Power Africa: Mali Fact Sheet,” USAID, (2018): <https://www.usaid.gov/powerafrica/mali>

⁶⁵ “Mali National Renewable Energy Action Plan,” SEforALL/ECREEE, (2015): [https://www.se4all-](https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Mali_Plan_d_Actions_National_pour_les_Energies_Renouvelables.pdf)

[africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Mali_Plan_d_Actions_National_pour_les_Energies_Renouvelables.pdf](https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Mali_Plan_d_Actions_National_pour_les_Energies_Renouvelables.pdf)

⁶⁶ “Regulatory Indicators for Sustainable Energy: Mali,” World Bank, (2018): <http://rise.worldbank.org/country/mali>

EDM controls the transmission and distribution network of the country (**Figure 1**). Lack of maintenance and investment in the grid network has resulted in significant technical and commercial losses, estimated at 20.7% in 2017.⁶⁷ The country's low population densities and widely dispersed population centers makes grid extension extremely costly and often unfeasible. The national network expansion has focused on the distribution network in peri-urban/recently urbanized areas, and on connecting isolated localities with relatively high levels of demand for the national grid, leaving out the majority of the Malian population.⁶⁸

EDM manages both the national grid as well as several isolated mini-grids. The main grid connects the capital, Bamako, to the country's main urban centers (32 in total). EDM operates 28 isolated grid centers (mainly thermal), while two isolated grid centers are connected to Côte d'Ivoire's network. The transmission and distribution network consist mainly of: (i) a 150 kV-line connected Bamako and the Selingue dam to the cities of Fana and Ségou, (ii) a 63 kV-line connecting Ségou and Niono, and (iii) a 225kV line connecting Bamako to Kayes and Kita.⁶⁹ Mali is a part of the Senegal River Basin Development Organization (Organization pour la Mise en Valeur du fleuve Sénégal, OMVS) network and the West African Power Pool (WAPP). As a member of OMVS network, Mali receives electricity from the Manantali and Félou dams located within the country; the country imports electricity from Côte d'Ivoire through the WAPP (50 MW).⁷⁰

Overall, a significant gap exists between the infrastructure needs of the power sector and the resources available to invest in grid maintenance and extension to rural areas. As a result, the country's electricity network is often unreliable, as electricity demand far exceeds the installed capacity and is a significant challenge for the sector (**Figure 2**). The GoM plans to expand both on-grid and off-grid renewable and non-renewable energy sources to address growing demand. In the long-term, an increase in regional integration could help Mali meet its electricity needs through imports.⁷¹ The Government has received funding from the World Bank to fund the OMVS Power Grid and Extension Project.⁷²

⁶⁷ "Rapport Annuel D' Activites, 2017," Energie du Mali SA, (July 2017): https://www.edm-sa.com.ml/images/EDMSARapportAnnuelDactivites2017CRFvfsc19072018_simplifiesweb.pdf

⁶⁸ "Output-Based Aid in Mali, Rural Electrification Hybrid System Project," GPOBA, (2015): <https://www.gpoba.org/sites/gpoba/files/OBA45%20Mali%20Electrification.pdf>

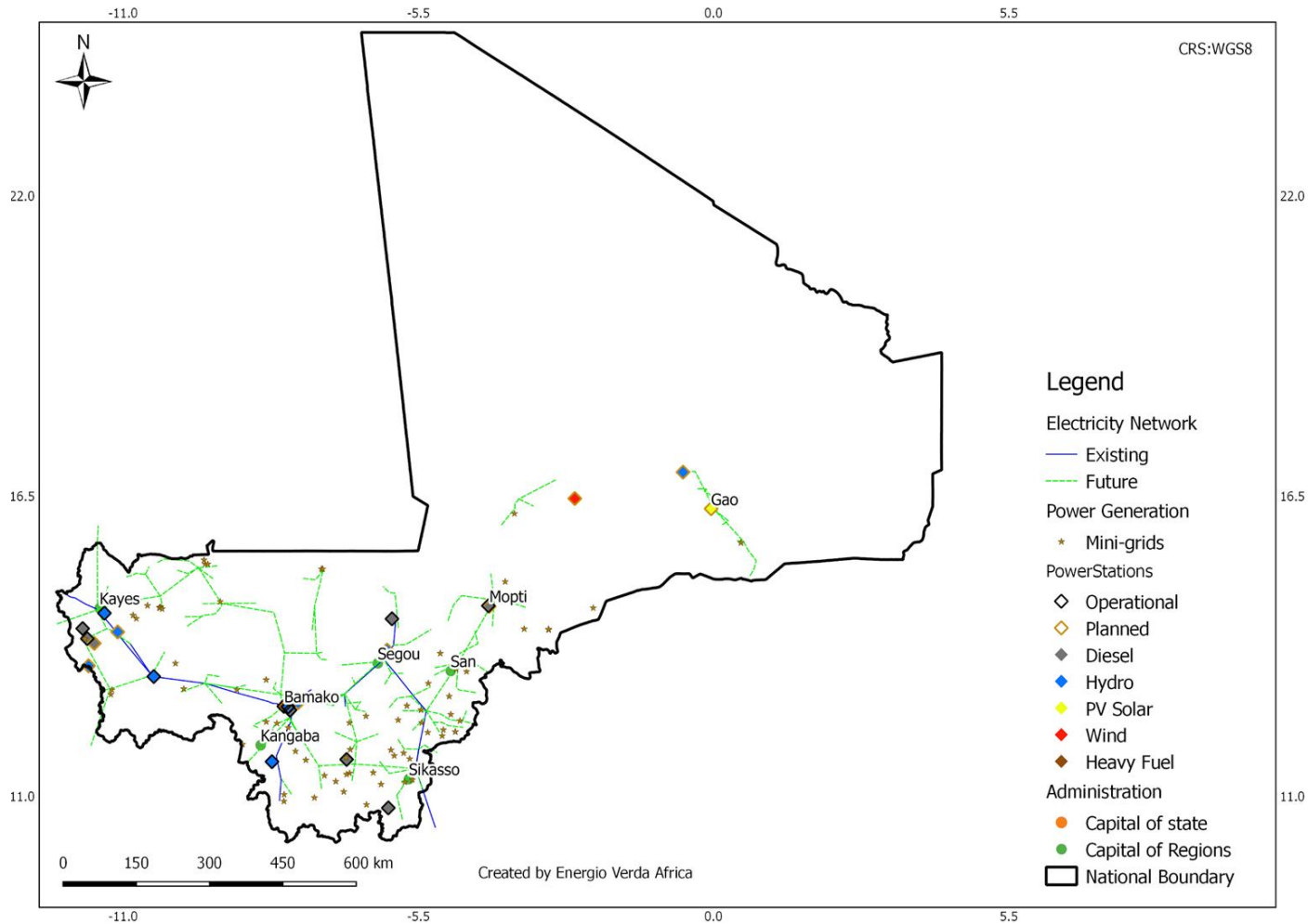
⁶⁹ "Caractéristiques du système électrique EDM-SA," EDM-SA, (2016): <https://www.edm-sa.com.ml/index.php/2014-05-27-14-05-11>

⁷⁰ "Setting the example for Cooperative Management of Transboundary Water Resources in West Africa," World Bank, (2014): <http://blogs.worldbank.org/nasililiza/setting-example-cooperative-management-transboundary-water-resources-west-africa>

⁷¹ "Mali Country Profile," AfDB, (2015): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Profil_ER_Mal_Web_light.pdf

⁷² "Mali to construct power lines connecting to Senegal," ESI Africa, (2018): <https://www.esi-africa.com/mali-seeks-construct-power-lines-connecting-senegal/>

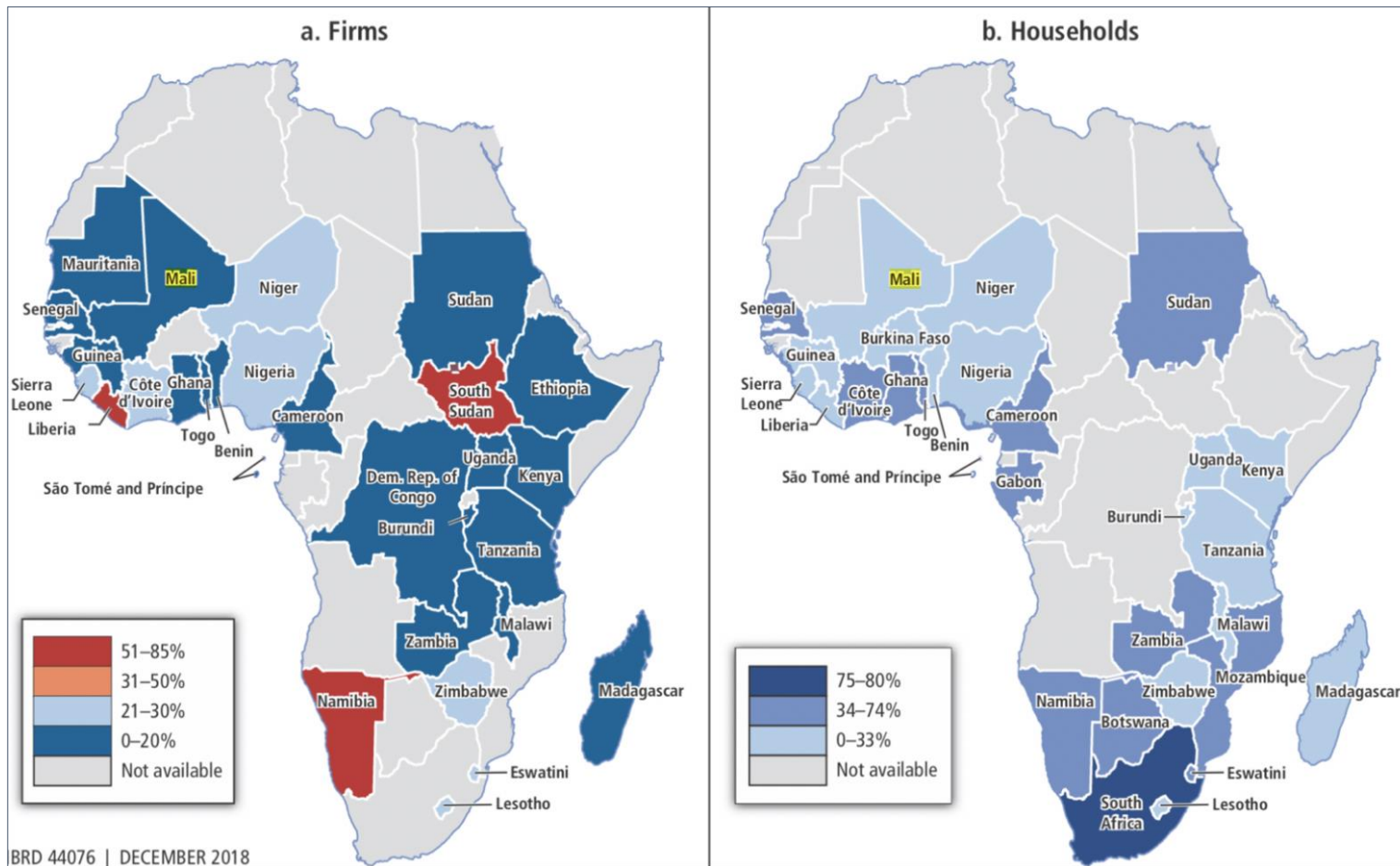
Figure 1: Electricity Transmission and Distribution Network⁷³



Source: Energo Verda Africa GIS analysis

⁷³ See Annex 1 for more details, including data sources.

Figure 2: Access to Reliable Electricity by Firms and Households in Africa⁷⁴



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

The maps in **Figure 2** illustrate the share of firms (Panel a) and households (Panel b) reporting access to a reliable supply of electricity. In Mali, fewer than 20% of surveyed firms and less than one-third of surveyed households reported having reliable access to electricity.

⁷⁴ 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 Mali through 2023 and through 2030 (“Scenario 2023” and “Scenario 2030”).⁷⁵ 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 Mali 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 Mali 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 6 km of existing grid lines and Power Stations managed by EDM-SA (Énergie du Mali) to connect to the grid.⁷⁶ Beyond this area, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km²) and have active local economies, evidenced by the presence of social facilities and by their proximity to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km²) or far from the national grid – are 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 (average densification distance announced by utilities across West Africa)⁷⁷ and 5 km of future planned line extensions are assumed to be connected. For mini-grids, future economic development – which will allow new settlements to grow sufficiently to become candidates for mini-grids – is assumed to occur in settlements within 1 km of mini-grid settlements (average distance of mini-grid coverage of different developers) identified in the scenario 2023 analysis, as well as within 15 km of economic growth centers – airports, 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 that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within scenario 2023.⁷⁸

Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 3.0%⁷⁹ was applied to the geospatial analysis to project population figures for scenario 2023 and 2030 analyses.⁸⁰ **Figure 3** shows population density across the country, which served as the basis for this analysis.

⁷⁵ NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to GoM electrification targets for 2030

⁷⁶ NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

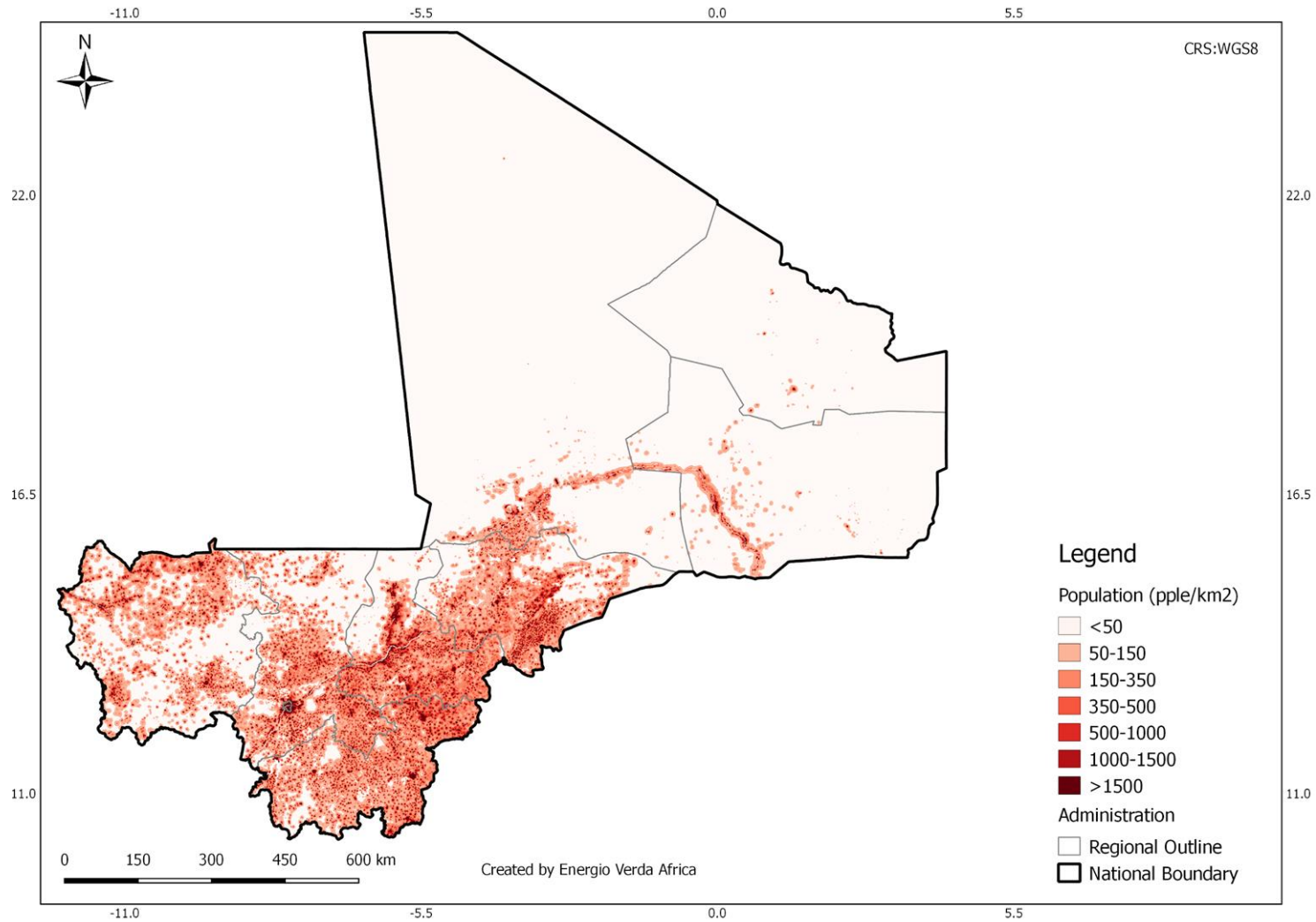
⁷⁷ For a time over 10 years. Stated in interviews conducted for this study.

⁷⁸ Note that this analysis was performed for the five-year scenario but not for the year 2030 scenario due to uncertainties regarding population densities being too high over such a long timeframe

⁷⁹ <https://data.worldbank.org/indicator/SP.POP.GROW?locations=ML>

⁸⁰ See **Annex 1** for the results of this analysis as well as more details on the approach and methods used

Figure 3: Population Density, 2015⁸¹



Source: Energio Verda Africa GIS analysis

⁸¹ 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 (5.7 persons/household).⁸²

Table 5: Results of Least-Cost Electrification Analysis⁸³

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	1,028	7,467	9,872	193	1,221	17,146
	% of settlements	5.6%	40.7%	53.7%	15.8%	6.6%	93.4%
	Total population	5,293,301	10,210,778	5,258,385	118,159	5,411,460	15,351,004
	% of population	25.5%	49.2%	25.3%	2.2%	26.1%	73.9%
	Number of households	928,649	1,791,365	922,524	20,730	949,379	2,693,159
Scenario 2030	Number of settlements	5,267	6,376	6,724	Not calculated	5,267	13,100
	% of settlements	28.7%	34.7%	36.6%	Not calculated	28.7%	71.3%
	Total population	12,870,061	8,322,177	4,342,974	Not calculated	12,870,061	12,665,151
	% of population	50.4%	32.6%	17.0%	Not calculated	50.4%	49.6%
	Number of households	2,257,905	1,460,031	761,925	Not calculated	2,257,905	2,221,956

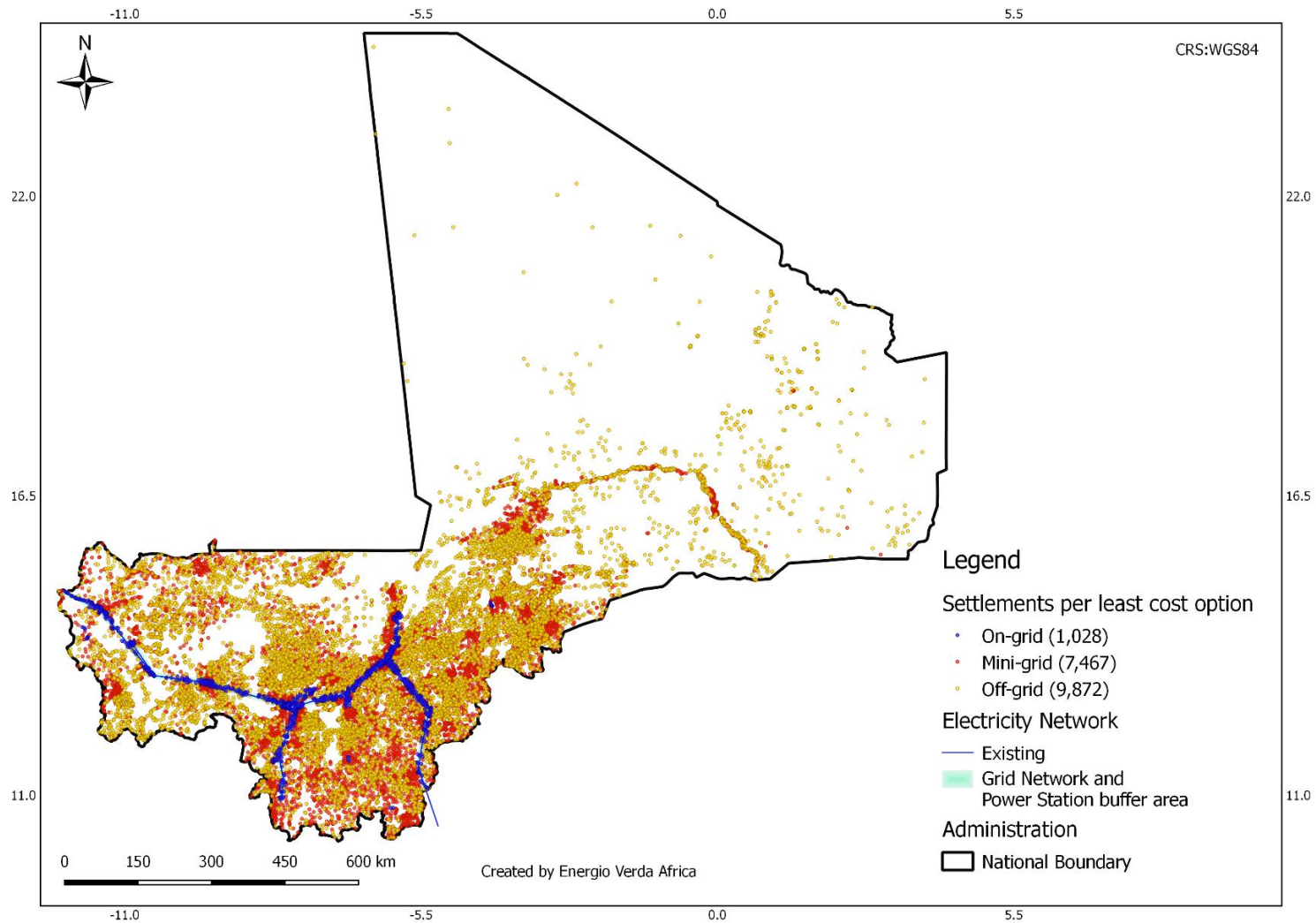
Source: Energio Verda Africa GIS analysis

⁸² “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

⁸³ NOTE: Decentralized power plants managed by private companies through development schemes from AMADER are considered as mini-grids and therefore reflected in the mini-grid column (64 out of 180 could be used for the analysis; coordinates available).

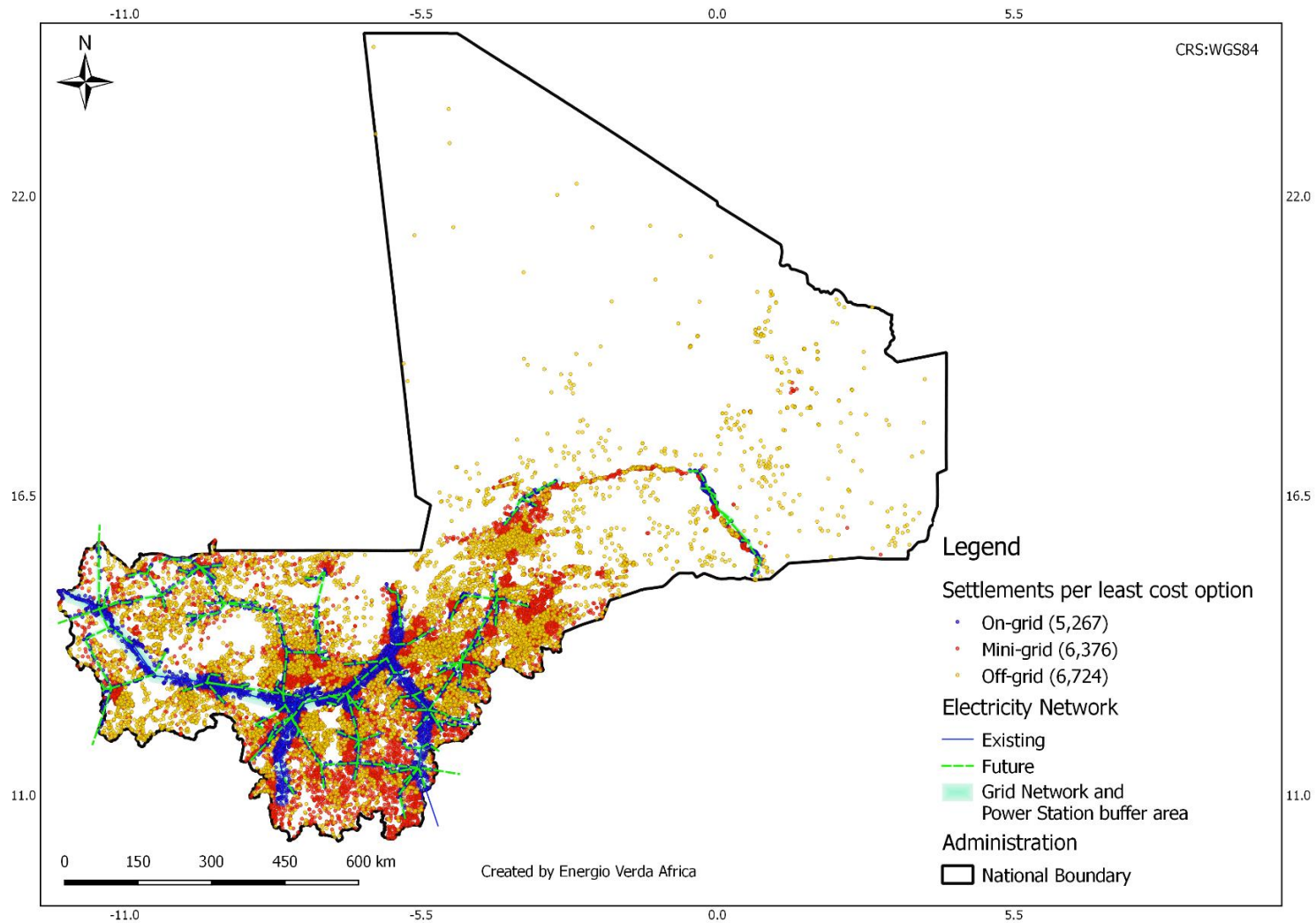
Figure 4: Distribution of Settlements by Least-Cost Electrification Option, 2023⁸⁴



Source: Energio Verda Africa GIS analysis

⁸⁴ Displaying identified settlements with known location (given coordinates) only; see **Annex 1** for more details, including data sources

Figure 5: Distribution of Settlements by Least-Cost Electrification Option, 2030⁸⁵



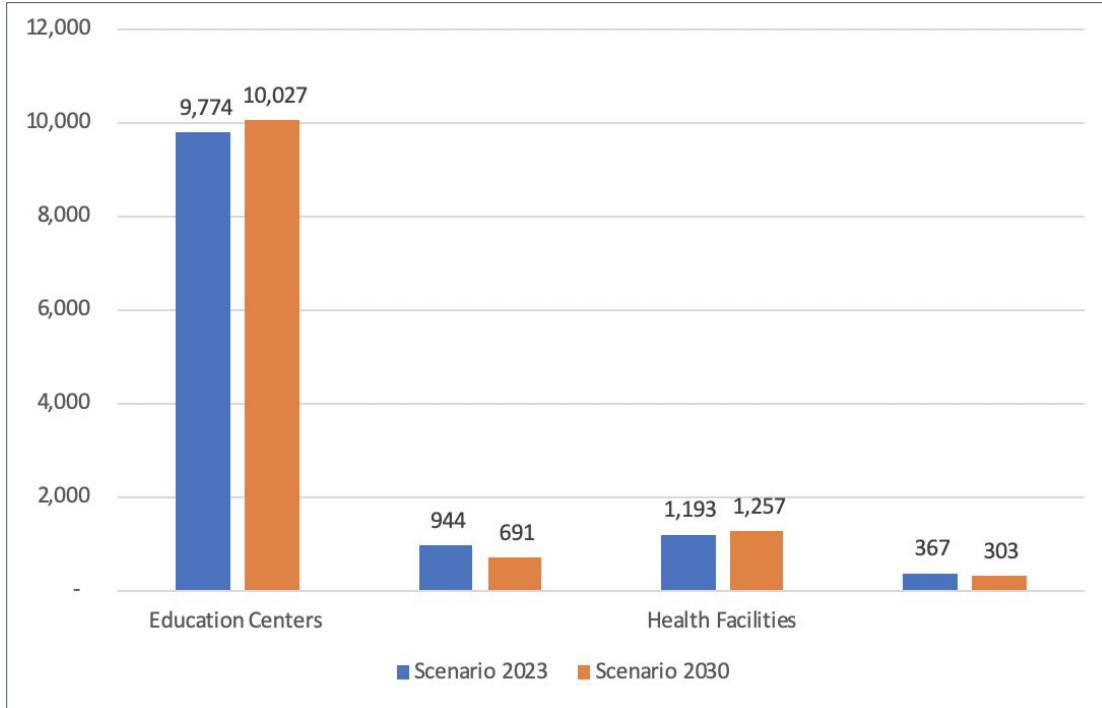
Source: Energio Verda Africa GIS analysis

⁸⁵ Displaying identified settlements with known location (given coordinates) only; see Annex 1 for more details, including data sources.

The analysis also covered the education centers and health facilities that will remain off-grid during the analyzed timeframes. The number of education centers (10,718) and health facilities (1,560) that were analyzed cannot be seen as comprehensive as not all were available for the geospatial analysis (institutions with known coordinates).

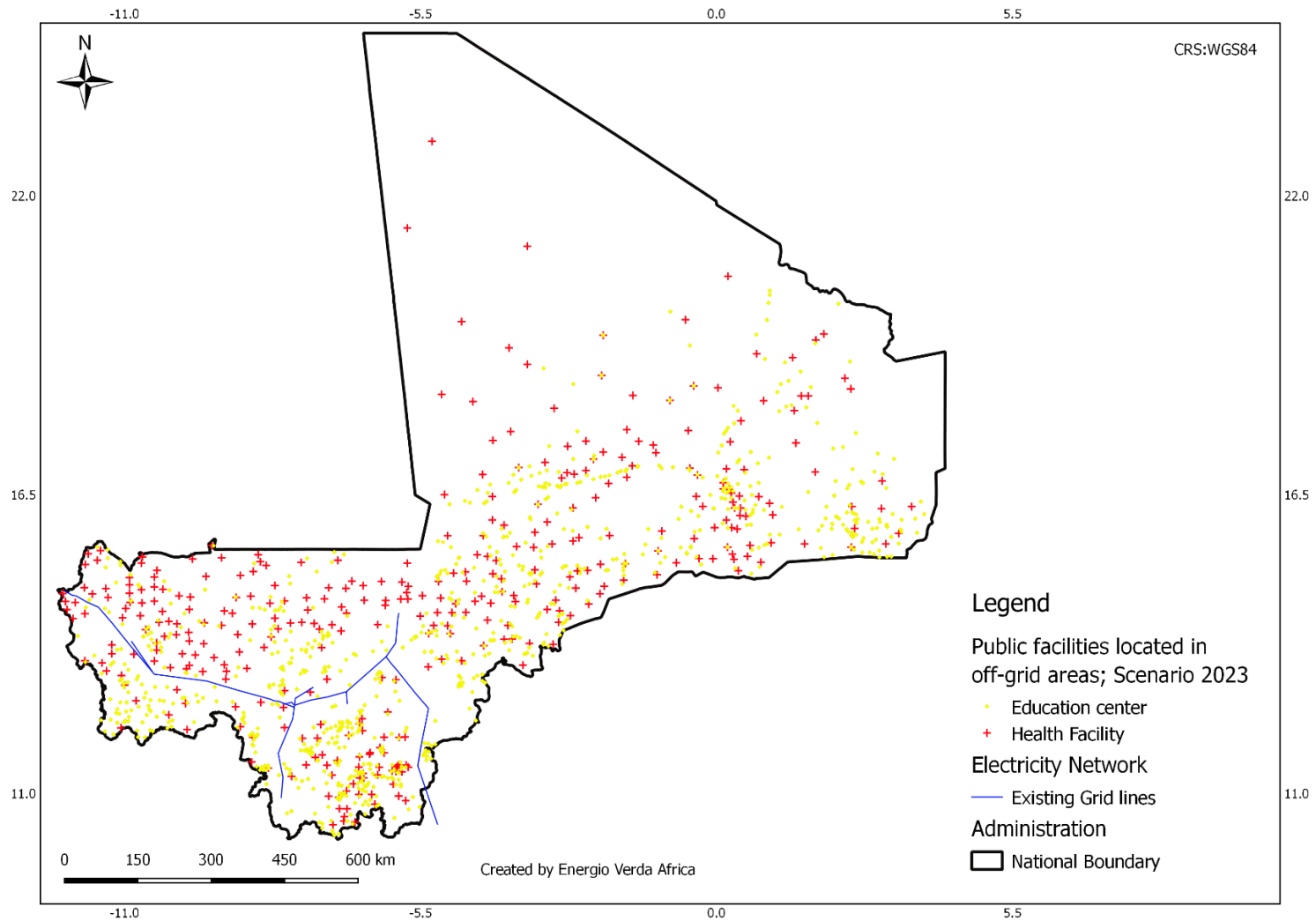
Figure 6 summarizes the number of education centers and health facilities that may be electrified (on-grid and mini-grid) or suitable for off-grid stand-alone solutions in scenarios 2023 and 2030. **Figure 7** and **Figure 8** illustrate the distribution of potential off-grid facilities across the country under the two scenarios.

Figure 6: Identified Social Facilities for On-Grid, Mini-Grid and Stand-alone Solutions, 2023 and 2030



Source: Energio Verda Africa GIS analysis

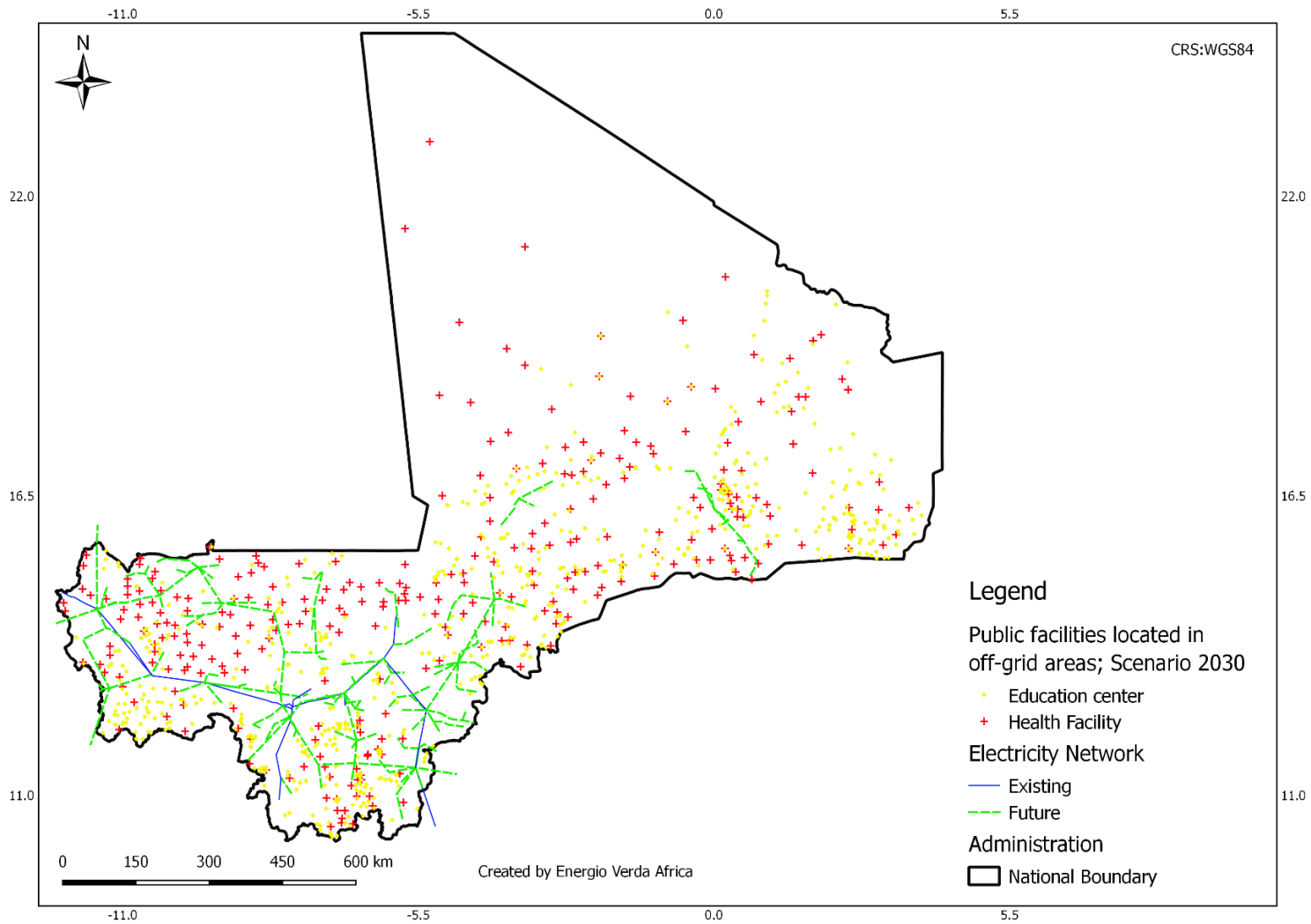
Figure 7: Distribution of Potential Off-Grid Social Facilities, 2023⁸⁶



Source: Energio Verda Africa GIS analysis

⁸⁶ Displaying identified facilities with known location (given coordinates) only; see **Annex 1** for more details, including data sources.

Figure 8: Distribution of Potential Off-Grid Social Facilities, 2030⁸⁷



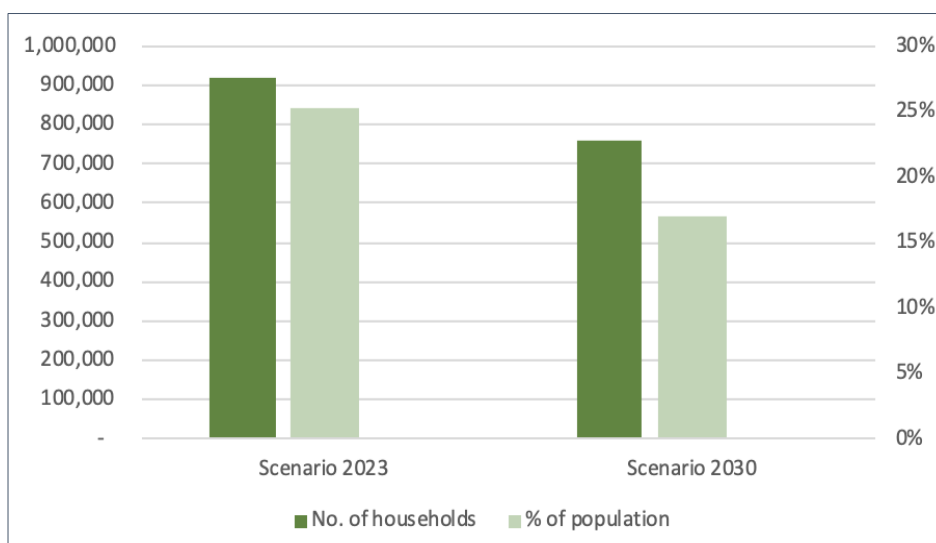
Source: Energio Verda Africa GIS analysis

⁸⁷ 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, 1,028 settlements across Mali (928,649 households) will be connected to the main grid, representing 25.5% of the population. By 2030, this figure will increase to 5,267 settlements (2,257,905 households), equivalent to 50.4% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030. Not all settlements in close proximity to electricity lines will connect to the main grid, largely due to the low density of these areas (dispersed settlements with a density below 350 people/km²). By 2023, an estimated 193 settlements located under the grid will meet these criteria (or 15.8% 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 7,467 settlements (1,791,365 households), or 49.2% of the population, decreasing to 6,376 settlements (1,460,031 households), or 32.6% 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 9,872 settlements (922,524 households) and 25.3% of the population in 2023, decreasing to 6,724 settlements (761,925 households) and 17.0% of the population in 2030 (**Figure 9**).

Figure 9: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

The analysis indicates that the off-grid stand-alone market has the potential to grow significantly. According to figures published by the Global Off-Grid Lighting Association (GOGLA),⁸⁸ an estimated 114,812 off-grid stand-alone solar PV products (pico solar and SHS) have been sold in Mali as of the end of 2017 (see

⁸⁸ "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

Section 2.4.3). The least-cost analysis estimates that 922,464 households in 2023 would be suitable for these solutions.

In its SEforALL National Renewable Energy Action Plan (PANER), the GoM envisions a significant share of the population will gain electricity access through a combination of mini-grids and stand-alone systems – 37% and 67%, respectively. However, the plan only anticipates that 7% of the population will be served by stand-alone systems in 2020 (**Table 6**). The findings of the least-cost analysis suggest that the Government may need to consider increasing the utilization of stand-alone solutions in its electrification planning in order to achieve its energy access targets, particularly in the near-term until planned grid extensions are realized.

Table 6: Estimated Share of Population Served by Stand-alone Systems⁸⁹

Share of population with access to stand-alone systems powered by renewable energy (%) *	2020 (target)	2030 (target)
	7%	31%

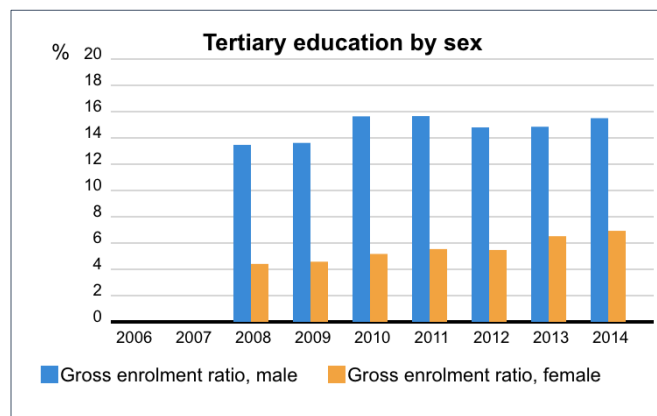
* Estimate does *not* include mini-grids

Source: SEforALL National Renewable Energy Action Plan (PANER)

1.2.2.5 Inclusive Participation⁹⁰

Inclusive participation in Mali 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. Mali 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.⁹¹ Female participation in education, particularly higher education, remains disproportionately low (**Figure 10**).⁹² While gender discrimination is widespread, these issues tend to be more pronounced in rural areas of the country.

Figure 10: Rates of Enrollment in Tertiary Education



Source: UNESCO Institute for Statistics

⁸⁹ “Plan d’Actions National des Énergies Renouvelables du Mali (PANER),” SEforALL / ECREEE, (2015): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Mali_Plan_d_Actions_National_pour_les_Energies_Renouvelables_pdf

⁹⁰ See **Annex 4** for more details

⁹¹ “Gender Inequality Index,” UNDP, (2015): <http://hdr.undp.org/en/composite/GII>

⁹² “Mali Participation in Education,” UNESCO Institute for Statistics, (2018): <http://uis.unesco.org/en/country/bf?theme=education-and-literacy>

The Government has adopted policies and action plans to promote gender equality. Mali has signed on to several key international frameworks and regional agreements related to gender equality. The GoM has established a Ministry for the Advancement of Women, Children and the Family as well as a National Gender Policy that endorses gender equality and the improvement of rights for women. The National Policy also includes gender-mainstreaming provisions and actions to be taken by 15 government ministries, including those involved in the management of public employment.

The Government has also made attempts to address gender equality in the energy sector. The Government has established a gender focal point at the Ministry of Energy and has taken additional measures under the regional framework, ECOWAS Policy for Gender Mainstreaming in Energy Access, to further improve inclusive participation for women in the energy sector. The regional policy aims to achieve this by helping governments and ministries integrate gender into energy policies and by conducting gender audits of the sector.

1.2.3 Key Challenges

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

- **Investment in Grid maintenance:** Increasing demand is putting pressure on power supply – a mismatch that will continue to burden the electricity network, which needs maintenance and investment to reduce losses and expand access. Grid network expansion is very expensive in Mali due to the vastness of the country’s territory, its low population density and scattered population centers. The cost of electricity connections in urban and semi-urban areas are very high and prohibitively expensive in rural areas. Without financial support to subsidize connections costs, grid expansion will likely be limited in rural areas, making off-grid solutions a more attractive option for rural electrification.
- **Electricity Tariffs:** Average electricity tariffs (USD \$0.23/kWh)⁹³ are slightly higher than the ECOWAS region’s average tariff of USD 0.20/kWh.⁹⁴ Mali subsidizes electricity tariffs for low-income consumers, providing electricity to poorer households below the cost of supply with funds from the GoM and the country’s utility (EDM) through a range of residential and commercial consumers who pay higher electricity rates. Despite this cross-subsidization scheme, average households in the country still spend a disproportionate amount of their income on electricity (**Figure 11**).
- **Utility Financial Performance:** EDM had a total loss amounting to USD 100 million in 2016 due to high generation costs, lack of tariff adjustments and high technical and commercial losses. As a result, payments to suppliers (including imports from Côte d’Ivoire) have been delayed, and EDM lacks the ability to invest adequately in network extensions and maintenance of grid infrastructure.⁹⁵ The risks that arise from this situation, combined with the high cost of electricity, have deterred private investment and IPPs from entering the country’s electricity market.
- **Imbalanced Energy Mix:** The country’s power sector is overly reliant upon fossil fuels and large hydropower, technologies that are susceptible to price volatility and climatic conditions, respectively. The GoM appears to be shifting a significant portion of its installed capacity to renewable energy (Table 5), although the majority of this will still come from large hydropower.

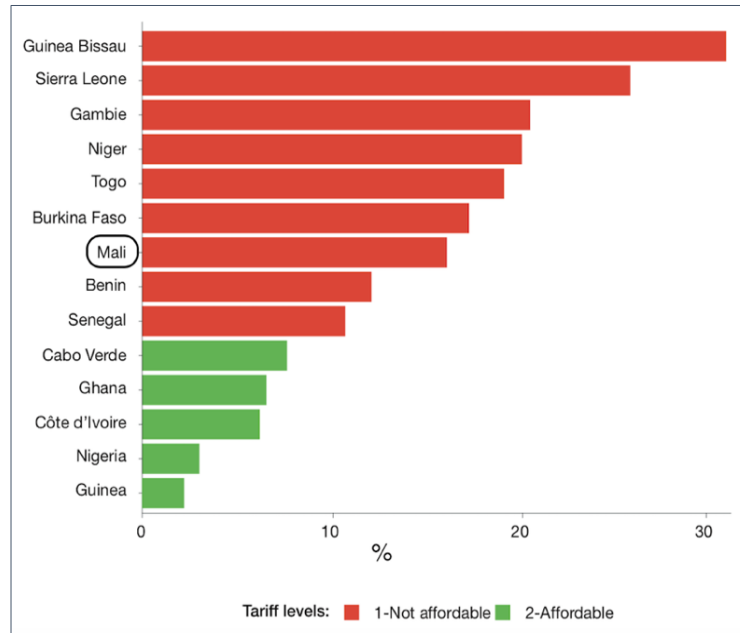
⁹³ “Regulatory Indicators for Sustainable Energy: Mali,” World Bank, (2018): <http://rise.worldbank.org/country/mali>

⁹⁴ “Electricity Tariffs in ECOWAS Region,” African Development Bank Group, Energy Policy, Regulation and Statistics Division, (September 2018): http://www.ecowrex.org/sites/default/files/pesr1_-_energy_statistics_bulletin_september_2018.pdf

⁹⁵ “Mali electricity sector emergency project: PID/ISDS,” World Bank, (2018): <http://documents.worldbank.org/curated/en/864571522875815839/pdf/Concept-Project-Information-Document-Integrated-Safeguards-Data-Sheet-Mali-Electricity-Sector-Improvement-Project-MESIP-P166796.pdf>

- Market and Policy Barriers:** Several factors constrain the country’s renewable energy and off-grid solar sector, such as a lack of clear institutional roles between different agencies, weak planning capacity, the absence of a clear framework for PPPs and IPPs, the mismatch between tariffs in urban and rural areas (with a necessary harmonization of tariffs), and capacity to channel funds for systematic large-scale projects, high upfront investment costs, lack of appropriate finance mechanisms to cover connection costs; and limited technical and human capital, notably in the PV/solar sector.

Figure 11: Share of Income Spent on Household Electricity in ECOWAS Countries, 2018



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

Source: ECOWAS Regional Electricity Regulatory Authority

- Local Financial Institutions:**⁹⁶ The BNDA Development Bank is active in the country’s energy sector; the bank recently provided financing for the Akuo Kita Solar 50 MW Solar IPP project in Mali, with additional financing from the West African Development Bank and Emerging Africa Infrastructure Fund.⁹⁷ The institution also signed a MoU with the Ministry of Energy and EDM to support the dissemination of individual solar kits.

Outside of this institution, however, experience in energy sector investment remains low, as 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

⁹⁶ The role of FIs is examined in further detail in Section 3.

⁹⁷ “Akuo Solar secures financing for 50MW solar project in Mali,” PV Tech, (24 January 2018): <https://www.pv-tech.org/news/akuo-solar-secures-financing-for-50mw-pv-project-in-mali>

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.⁹⁸

- **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.

⁹⁸ 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

Mali's electricity sector is organized by the National Energy Policy (PEN), under the National Office for Energy (DNE). This policy was implemented in 2006 and later revised in 2018.⁹⁹ The PEN's overall objective is to contribute to the country's sustainable development through the provision of affordable energy services, to increase access to electricity, and to promote socio-economic development. This policy intends to be inclusive and pragmatic by focusing on decentralization, liberalization and increasing competitiveness (through PPPs) of the energy sector.

In 2009, the GoM issued the National Energy Sector Policy Letter to lay out the Government's energy vision. The letter lists the projects to be realized between 2009 and 2020, including the strengthening of the interconnections with Côte d'Ivoire and Ghana as well as other investments in the internal transmission and distribution network.¹⁰⁰

In the RE sector, the National Strategy for Renewable Energy Development provides the following policy guidelines to support clean energy development: (i) promote the widespread use of RE technologies and equipment to increase the share of REs in the national electricity generation; (ii) develop the biofuel sub-sector for various uses (electricity generation, transportation, agricultural motorization, etc.); (iii) create better conditions to sustain RE services; and (iv) search for sustainable and suitable financing mechanisms for renewable energy.¹⁰¹ As a member state of ECOWAS, the GoM is also committed to the ECOWAS Regional Renewable Energy Policy¹⁰² 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 the share of RE in total generation and ensure that RE is used to serve the population without access through mini-grid and stand-alone systems by 2030.

1.3.2 Integrated National Electrification Plan.

An off-grid approach driven by the private sector will continue to be a central part of Mali's rural electrification strategy. Mali, however, does not currently have an integrated national electrification plan in place. In 2003, the GoM developed The Reference Framework for Rural Electrification, setting the general principles for rural electrification, but has relied on a range of donor-funded initiatives to achieve its objectives to date. In order to ensure private sector participation and continue the progress that has been made by AMADER to date, a comprehensive, integrated strategy needs to be developed (in the form of a Master Plan for rural electrification).

1.3.3 Energy and Electricity Law

In general, the GoM's policy documents are more developed than actual legislation and decrees, which reflects the lack of a legislative framework to effectively implement the GoM's key strategies and priorities. Ordinance No.00-19/P-RM (March 2000) is the main legislative framework for the electricity sector, which falls under the MEE/DNE. The ordinance established Mali's regulatory authority (CREE). Other energy

⁹⁹ Politique Énergétique Nationale du Mali, version provisoire, (April 2018).

¹⁰⁰ Ibid.

¹⁰¹ Ibid.

¹⁰² "ECOWAS Renewable Energy Policy," ECOWAS, (2015):

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

laws include Law No.03-006 (May 2003), creating the rural electrification agency (AMADER) as well as Ordinance No. 2014-012/P-RM (October 2014), establishing the renewable energy agency (AER).

With regards to RE, relevant laws include are Decree No. 02-107/P-RM (March 2002) on compliance and security standards for indoor electrical installations and equipment, Law No. 2014-0255/ME-SG (October 2014) establishing the National Energy Multi-Sectoral Group and Decree No.2014-0816/P-RM (October 2014) on VAT and tax exemption on imports of renewable energy equipment.¹⁰³

1.3.4 Framework for Stand-alone Systems

Figure 12 is an overview of the key national policies, programs, laws, and regulations pertaining to Mali’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 have had moderate success, as evidenced by the country’s energy access score in the World Bank Regulatory Indicators for Sustainable Energy (RISE) evaluation. In 2017, Mali ranked 12th among countries in West Africa and the Sahel (**Figure 13**).

Figure 12: Policy and Regulatory Framework for Stand-alone Systems

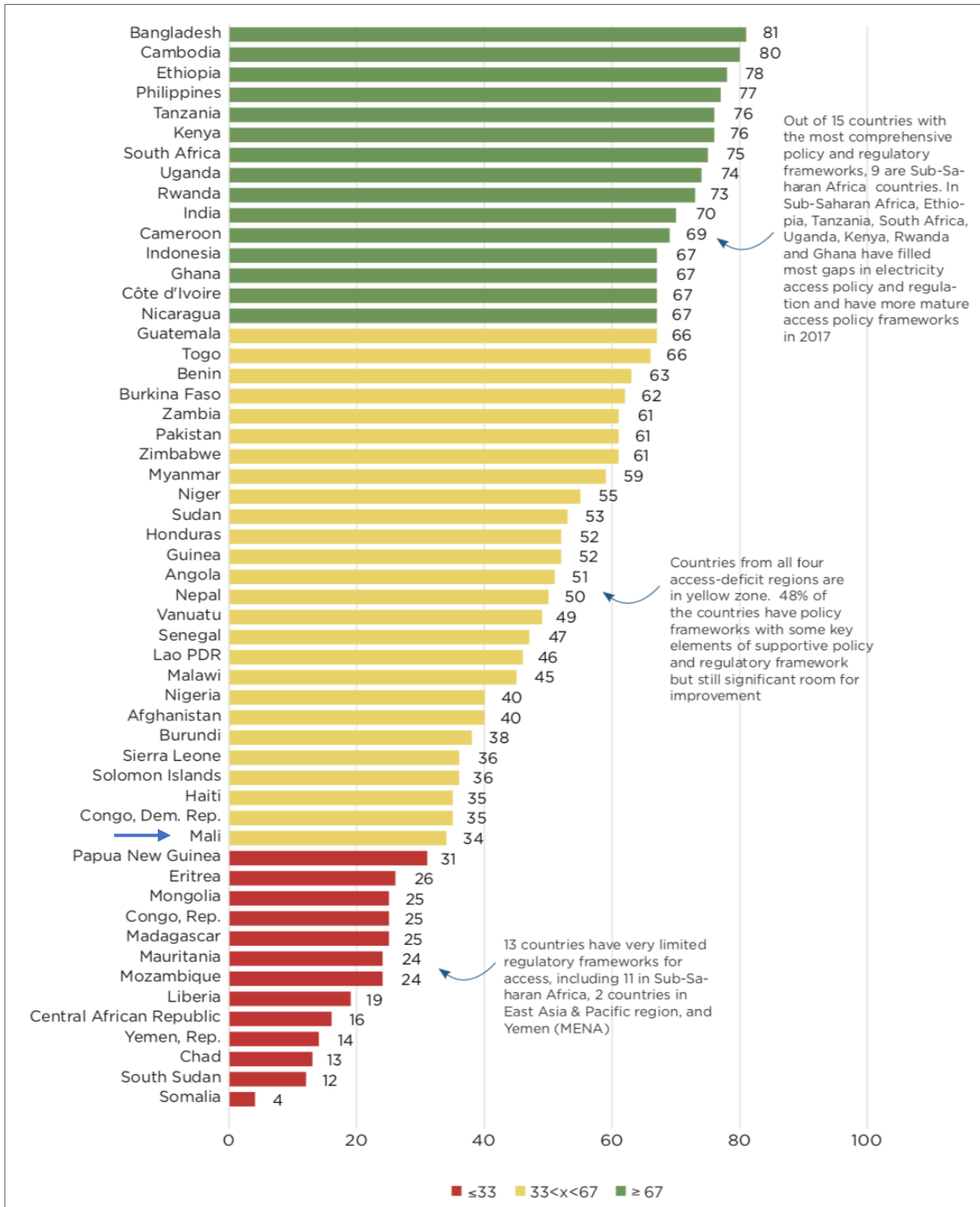
MALI			
	World Bank RISE 2017 Energy Access Score: 34 World Bank RISE 2015 Energy Access Score: 39	2017 ranking among West Africa and the Sahel (ROGEP) countries: 12 th (out of 16)	
Policy/Regulatory Support and Financial Incentives	Specific national policies, laws and programs		
	National electrification policy with off-grid provisions	√	National Energy Policy (PEN)
	Integrated national electrification plan	x	
	Energy/electricity law with off-grid provisions	x	
	National programs promoting off-grid market development	√	SHER, PHARE
	Specific target for rural electrification	√	81% by 2030
	Financial incentives		
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	√	Tax exemptions for solar equipment
	Standards and quality		
	Government-adopted international quality standards for stand-alone systems	√	SHER
	Government-certified program for solar equipment installers	x	
	Consumer awareness/education programs	x	
	Concession Contracts and Schemes	√	SHER; private off-grid concessions
	Business Model Regulation	x	

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

Source: d, Stakeholder interviews and GreenMax Capital Advisors analysis

¹⁰³ “SEforALL Action Agenda,” ECOWREX, (2017): http://www.ecowrex.org/system/files/final_report_on_se4all_consolidation.pdf

Figure 13: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017¹⁰⁴



Source: World Bank Regulatory Indicators for Sustainable Energy

¹⁰⁴ "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 Government has undertaken a number of projects and programs to support rural electrification and off-grid market development, most notably the HEURA (concluded in 2012), the ongoing SHER, REHSP, and PHARE projects among others (see **Section 1.2.2.1**).

1.3.4.2 Financial Incentives

Ordinance Law N°2014-0816 P-RM (27 October 2014) allows for a five-year VAT and tax exemption for solar equipment (solar modules, batteries, controllers, inverters, and lamps), provision still valid and confirmed as of July 2018.¹⁰⁵ Concessions granted to private off-grid operators under the AMADER program include subsidies granted by the REF to make tariffs affordable for rural customers and improve the rate of return for private operators. Under the HEURA project, private operators benefited from AMADER's investment subsidy (between 70% and 80% of the total project cost) for generation, transmission, distribution, and mini-grid access. The allocation of subsidies under SHER is based on criteria such as the number of customers to be connected in the first two years, as well as the average tariff and cost of investment by connected off-grid customers. The contribution of the private operators is recovered through cost-reflective tariffs approved by AMADER for mini-grids and fees-for-service for SHSs.¹⁰⁶

1.3.4.3 Standards and Quality

Under the SHER Project, AMADER and the REF require minimum equipment standards and quality of service standards that a rural electrification operator must comply with in order to receive a subsidy. The program also requires independent verification of outputs/results.

1.3.4.4 Concession Contracts and Schemes

Through AMADER's mandate, the GoM has established a concession approach whereby the REF is providing subsidies to off-grid operators to ensure they are receiving an acceptable financial rate of return while simultaneously ensuring that fee-for-service levels for rural customers are affordable. Under the SHER arrangement, AMADER and rural operators agree on two concessional contractual agreements, the authorization contract and the financing agreement ("convention de financement"), which allows the private operator to operate the mini-grids usually for a period of 15 years.¹⁰⁷ This concession framework, implemented and regulated by AMADER, has allowed operators to develop the off-grid market in stable conditions and allows for price adjustments where necessary.

1.3.4.5 Specific Business Model Regulation

No specific business model regulations exist for the off-grid sector in Mali, although the GoM can take measures to support business models that are already being deployed by solar companies. As was demonstrated in East Africa, the proliferation of mobile money platforms can rapidly facilitate energy access. Recent data suggests that there is an opportunity for the GoM to bring together key stakeholders in the sector (solar providers, technology companies, telecommunications companies etc.) to take advantage of the country's rapidly growing mobile internet usage (**Figure 14**) and high rates of mobile phone ownership in rural areas (**Figure 15**).

¹⁰⁵ Allowed by a five-year ordinance decree implemented from September 2009 and renewed in 2014 (running until September 2019)

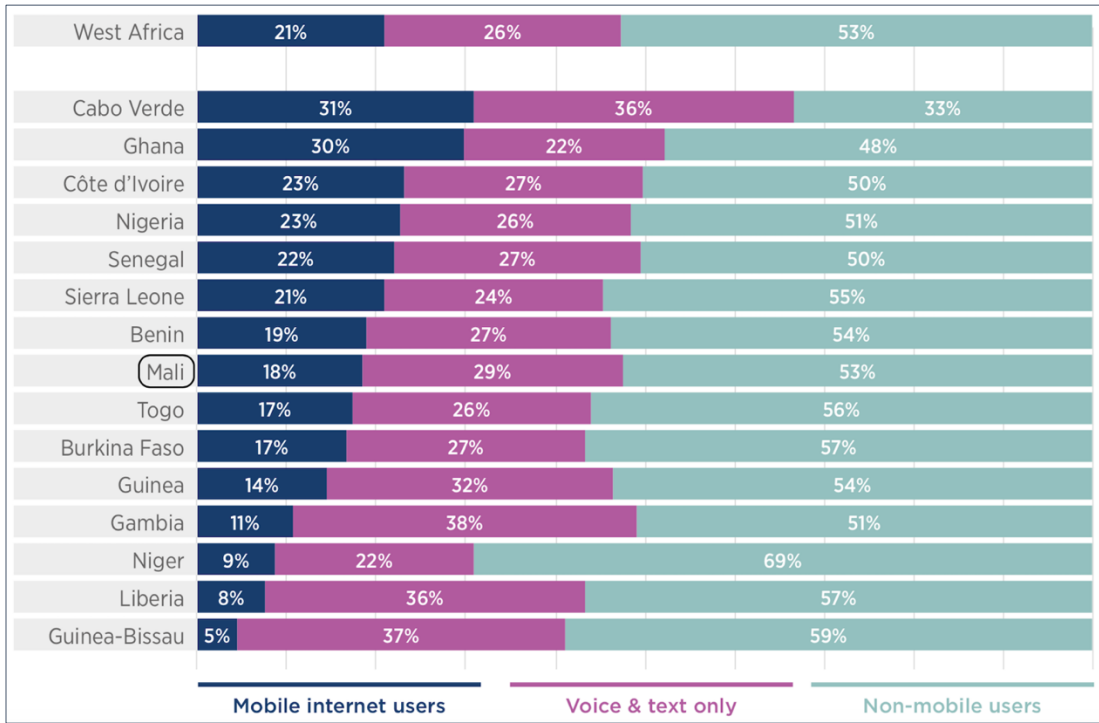
¹⁰⁶ "Output-Based Aid in Mali, Rural Electrification Hybrid System Project," GPOBA, (2015):

<https://www.gpoba.org/sites/gpoba/files/OBA45%20Mali%20Electrification.pdf>

¹⁰⁷ "Rural Electrification Hybrid System Project," World Bank, (2013):

<http://documents.worldbank.org/curated/en/173911468052814928/pdf/PAD6880PAD0P13010Box379866B00OU0090.pdf>

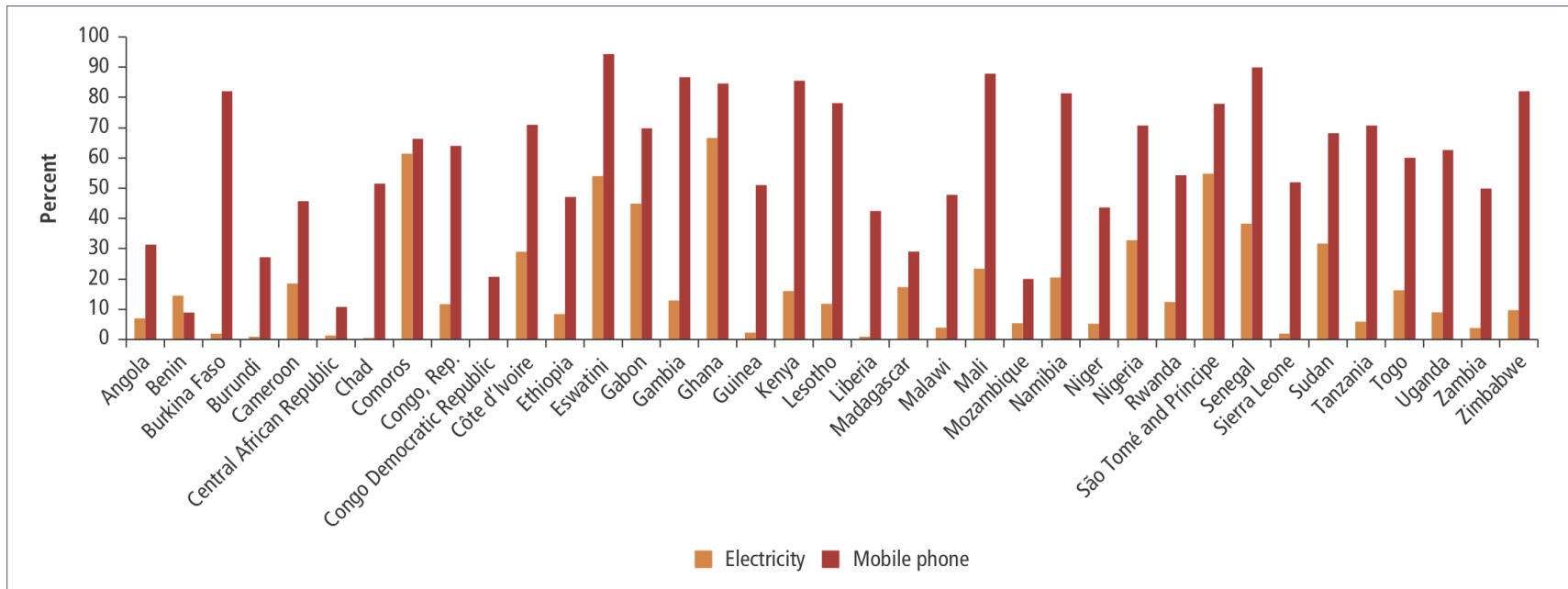
Figure 14: West Africa Mobile Internet Penetration Rates, 2017¹⁰⁸



Source: GSMA Intelligence

¹⁰⁸ "The Mobile Economy: West Africa 2018," GSMA Intelligence, (2018): <https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download>

Figure 15: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)¹⁰⁹



Source: World Bank

¹⁰⁹ Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake Reliability and Complementary Factors for Economic Impact," AFD and World Bank, (2019): <https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

1.3.5 Capacity Building and Technical Assistance

To overcome the challenges surrounding rural electrification, a range of technical and financial resources from both the public and private sector must come together. At the institutional level, the AMADER and the electricity market regulator, CREE, among others, will play key roles in establishing a supportive policy and regulatory framework. Additional reforms to the power sector may be required to provide the incentives necessary to increase private sector participation. Local FIs and MFIs will need incentives and support to develop and implement new financial products and administrative procedures to lend to the off-grid sector. International and local solar companies will need policy and financial support. Local technical capacity of the solar sector will need to be developed to ensure long-term O&M services are available and sustainable. Above all, financing and TA will be critical for all market actors – government, financial institutions, end-users, suppliers and service providers – in order to accelerate growth. **Table 7** identifies some of the policy/regulatory challenges facing off-grid market development in Mali and the proposed mitigation measures/TA interventions to overcome these gaps.

Table 7: Gaps in the Off-Grid Policy and Regulatory Framework¹¹⁰

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Specific National Policies, Laws and Programs	A. Lack of National Electricity / Electrification Policy	
	a. No policy exists for rural electrification	a. Help Government establish a clear Rural Electrification Policy that encourages least cost, integrated planning for all options
	b. Main focus of policy is on national grid extension only	b. Help Government develop a comprehensive, fully integrated electrification plan with least cost planning to consider where extension is the most efficient and sustainable approach to increasing energy access vs. development of the off-grid sector – mini-grids and stand-alone systems powered by local renewable resources
	c. Government is subsidizing fossil fuel electricity production	c. Help Government analyze where fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives
	B. Lack of Integrated National Electrification Plan	
	a. No integrated plan exists	a. Help Government develop a comprehensive, least cost, integrated plan for all rural electrification options (grid, mini-grid and off-grid) with clear and consistent targets and policies
b. Insufficient focus on or understanding of framework to support private sector participation	b. Help Government improve the planning framework under the DNE National Energy Policy (PEN) to encourage private participation in mini-grid and stand-alone solar system options, including <i>inter alia</i> preparation of guidelines to enhance collaboration between Government and private companies, industry associations, and other relevant stakeholders to coordinate development of effective policy that is flexible and responsive to the needs of the market	

¹¹⁰ 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 Mali (**Table 2**), including the Direction National (DNE) within the Ministry of Energy and Water (MEE), Rural Electrification Agency (AMADER), Regulatory Commission (CREE), Renewable Energy Agency (AER-Mali), and the public utility, EDM-SA, among other national and local authorities.

	<p>C. Lack of Energy and Electricity Law</p> <p>a. No specific Energy or Electricity Law with off-grid provisions exists</p>	<p>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 unbundling and electricity market liberalization)</p>
	<p>D. Insufficient national policies, laws, programs and/or action plans targeting off-grid market development</p> <p>a. No specific Off-Grid Policy, Law, or Action Plan in place</p> <p>b. Insufficient focus on or understanding of framework to support private sector participation</p>	<p>a. Help Government establish the medium-long term rural electrification strategy in the country through development and implementation of a rural electrification Master Plan</p> <p>b. Help Government improve off-grid framework to create incentives for private sector participation to expedite off-grid solar market growth, including <i>inter alia</i> preparation of procurement schemes and financing mechanisms designed to encourage PPP engagement in the off-grid sector</p>
<p>2. Financial Incentives (import duties, taxes, etc.)</p>	<p>A. Insufficiently supportive financial incentives / tax regime</p>	<p>a. 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 involved¹¹¹</p> <p>b. Help Government introduce appropriate grant and subsidy schemes (such as investment subsidy under HEURA project)¹¹² which require private funding matches and are predictable and not overly bureaucratic (e.g. through AMADER's Rural Electrification Fund)</p> <p>c. Help Government create PPP schemes to share high project development and market entry costs particularly with developers in remote areas (e.g. through AMADER's Rural Electrification Fund)</p> <p>d. Help Government analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede clean energy development</p>
<p>3. Standards and Quality</p>	<p>A. Insufficient Market Data</p>	<p>a. Help Government establish a Special Task Force (e.g. through AMADER) responsible for collaborating with the private sector to compile and regularly update a database of critical off-grid market data (including <i>inter alia</i> solar product imports, costs, sales volumes, resource potential etc., GIS data and other key demographic and socioeconomic indicators) that can be (i) utilized by policymakers to make informed electrification planning decisions based on accurate/updated market information, and (ii) made easily accessible to interested off-grid developers, investors and other key industry stakeholders</p>

¹¹¹ The GoM currently provides a five-year VAT exemption on solar equipment

¹¹² Under the Household Energy and Universal Access (HEURA) project, private operators benefited from AMADER's subsidy, which covered 70–80% of total project costs for generation, transmission, distribution and mini-grid access.

	<p>B. Need for verification procedures to ensure quality standard requirements are met</p>	<p>a. Help Government integrate existing quality standard requirements under the Rural Electrification Hybrid System Project (SHER) with appropriate oversight agencies (AER-Mali) to ensure quality-verification procedures are in place</p> <p>b. Help Government implement a legal framework that provides protections for consumers and suppliers, including <i>inter alia</i> 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</p>
	<p>C. Lack of capacity of local technical sector (solar PV technicians, installers, services providers etc.)</p>	<p>b. 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</p> <p>c. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through AMADER or AER-Mali)</p>
	<p>D. Insufficient attention of private companies to environmental/social standards and community engagement</p>	<p>a. Assist private sector and/or civil society organizations to ensure environmental/social standards are in place</p> <p>b. Assist in development of strategies encouraging inclusive gender participation</p> <p>c. Support with the implementation of a repair and recycling framework for off-grid solar systems and equipment¹¹³</p>
	<p>E. Insufficient public awareness</p>	<p>a. Support Government, trade associations and civic society organizations to develop and implement consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related national programs¹¹⁴</p> <p>b. Support development of programs to educate consumers, retailers and distributors on the benefits of quality certified solar products vs. 'non-standard' poor quality products</p>
<p>4. Concession Contracts and Schemes</p>	<p>A. Need for communication and streamlining in licensing and permitting procedures</p> <p>a. Insufficient communication and streamlining</p>	<p>a. 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</p>
	<p>B. Lack of understanding of emerging concession and energy services schemes for off-grid providers</p>	

¹¹³ The Endev/GIZ program is piloting a recycling program: <https://www.donilab.net/fr/appel-candidature-concours-de-recyclage>

¹¹⁴ The Rural Electrification Hybrid System Project (SHER) includes a public awareness component

	<ul style="list-style-type: none"> a. Need for understanding of different SHS concession schemes b. Need for understanding of emerging models for 'Integrated Private Utilities' c. Public procurement or public finance/budget laws that hamper deployment of energy services models for public facilities d. Lack of standardized contracts for energy services provided by private system operators to public facilities e. Insufficient protection for stranded investments 	<ul style="list-style-type: none"> a. Help Government understand all options and models for possibilities of granting geographic concessions to private operators of SHS¹¹⁵ b. Help Government to understand and develop approaches to facilitate pilots of 'Integrated Private Utility' schemes.¹¹⁶ c. Help Government develop procurement and public finance laws that will facilitate stand-alone solar system investment for public facilities (schools, health care facilities, etc.) d. Help Government, trade associations or civic society organizations develop model bilateral PPA and Energy Services Contracts for small scale IPPs and ESCOs to sell power or deliver energy services to public facilities (i.e. schools, health care facilities) or deliver solar street lighting services to municipalities e. Help Government develop proper procedures and guidelines to protect against stranded investments from competition among all on-grid and off-grid rural electrification approaches¹¹⁷
5. Business Model Regulation	A. Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers	<ul style="list-style-type: none"> a. Support capacity building of regulators, Government, and key stakeholders about different pricing schemes¹¹⁸ offered by stand-alone solar system providers to improve understanding and help avoid unnecessary interventions to regulate b. Support regulators and off-grid enterprises to collaborate specifically on developing pricing schemes for productive use market segment¹¹⁹ c. Support off-grid entrepreneurs and telecommunications companies in building the capacity of and fostering linkages between telecommunications companies / mobile money providers and off-grid solar companies to help roll out technology platforms and PAYG business models

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

¹¹⁵ 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.

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

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

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

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

1.4 Development Initiatives

1.4.1 National Government Initiatives

The GoM has prioritized grid-connected electricity generation (2017-2020) which include upgrading the generation capacity and the national transmission network. It also includes the restoration of several power plants (143 MW in total), the rehabilitation and improvement of the transmission and distribution system, and increasing the country's regional interconnection capacity with Côte d'Ivoire, Senegal, and Mauritania.¹²⁰ In the long-run, massive investments are needed in all electricity segments during the period 2015-2034: (i) USD 7.1 billion for EDM grid connection, (ii) USD 2.8 billion for the off-grid sub-sector (isolated networks and mini-grids), (iii) USD 1.4 billion for the transmission segment, and (iv) USD 27 million per year for the distribution segment (or about USD 540 million).

The GoM's has quite a number of ongoing solar off-grid and rural electrification projects: SHER, PHARE, PERSHY32, the Rural Development Solar Project, regional project PRODER, the Green Energy Service Centres for Communities in Rural Mali, and the Rural Village Solar Electrification (Projet d'Electrification des Villages en Energie Solaire, PREVES).

1.4.2 DFI and Donor Programs

There has been significant Development Finance Institution (DFI) and donor activity in Mali's grid-connected electricity sector (**Table 8**). The World Bank's Mali Energy Sector Support Project (2009-2018) supports transmission and distribution, energy efficiency and institutional capacity building. The Bank is assisting EDM to conduct financial and tariff related reforms and is also providing TA with all PPA transactions. The AfDB is supporting national and regional transmission network development, as well as the upgrade of Sotuba II hydropower plant. The European Commission and the European Investment Bank (EIB) are involved in the Guinea-Mali interconnection project. Other major DFIs are the IFC, the EU, AFD and the IsDB.

In the off-grid sector, the World Bank has a major project to develop a rural electrification hybrid system (SHER project), as well as to distribute 100,000 solar lanterns and 2,400 solar kits. This project is co-financed by AfDB and is implemented by AMADER. Mali was one of the six countries selected to be part of AfDB Climate Investment Fund program, Scaling Up Renewable Energy Program in Low Income Countries: Mali SREP (2010-2012). The EU delegation is a major partner in the energy and RE sector. Through the EU Energy facility, it is promoting solar lanterns, solar home systems, education and health centers electrification, public lighting, productive use and biomass.¹²¹ The EU recently financed a project with the French AFD to improve hybrid production and energy access.

The French Development Agency (AFD) is active in the renewable energy sector, through its Hybrid Production and Access to Electricity Project (PHARE). This project, implemented by AMADER, and co-financed with the aims at transforming 60 thermal mini-grids into hybrid mini-grids in rural areas, working together with local private operators.

¹²⁰ "Mali electricity sector emergency project: PID/ISDS", World Bank, (2018): <http://documents.worldbank.org/curated/en/864571522875815839/pdf/Concept-Project-Information-Documents-Integrated-Safeguards-Data-Sheet-Mali-Electricity-Sector-Improvement-Project-MESIP-P166796.pdf>

¹²¹ "Accès à des services énergétiques modernes et durables au Mali," EU Delegation, (2014): https://eeas.europa.eu/delegations/armenia/10688/acces-des-services-energetiques-modernes-et-durables-au-mali_fr

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

Project/Program	Sponsor	Timeline	Market Segment(s)	Description
Mali solar rural electrification project ¹²²	Green Climate Fund	2019 - present	Solar energy access	<ul style="list-style-type: none"> • USD 39 million project, including USD 9.4 million loan from BOAD (West African Development Bank), intends to reach approximately 250,000 beneficiaries
Household Energy and Universal Access Project (HEURA)	World Bank (funding from Africa Renewable Energy Access program, AFREA)	2004-2012	Mini-grid, standalone solar, off-grid	<ul style="list-style-type: none"> • Under the HEURA project, private operators benefited from AMADER's subsidy (70–80% of total project cost) for generation, transmission, distribution and mini-grid access. • About 1.2 million people were granted access to modern energy services (including public lighting) from 2004-2012
Rural Electrification Hybrid System Project (SHER)	World Bank: IDA, SREP, GPOBA	2013-2020	Mini-grid, standalone solar, off-grid	<ul style="list-style-type: none"> • USD 44.9 million project with goal of expanding modern energy access in rural Mali and increasing RE usage. The project has the following three components: <ul style="list-style-type: none"> - Expansion of mini-grid services; - Development of the off-grid lighting and standalone solar lantern markets in Mali (100,000 solar lanterns and 2,400 solar kits), and increased promotion of energy efficiency; - Capacity building/project management support
Hybrid production and access to electricity (PHARE) ¹²³	AFD, EU	2016-2020	Rural Electrification	<ul style="list-style-type: none"> • EUR 20 million project aims to electrify 32 localities in rural Mali with hybrid diesel/solar systems
Rural Electrification by Hybrid System Project (REHSP)	ADFD, BADEA	2017-2019	Rural electrification by hybrid systems	<ul style="list-style-type: none"> • USD 21.5 million project aims to use solar to electrify localities and improve others already with access • Aims to benefit over 170,000 people in rural areas, including households, community centers, and street lighting
Rural Development Project by Solar Rural Electrification	IsDB	2017-2019	Rural electrification	<ul style="list-style-type: none"> • USD 17.1 million in funding for electrification of 24 villages from two solar power stations (1 MWp and 1.2 MWp)
Programme de Développement des Energies Renouvelables et l'Efficacité Energétique (PRODERE)	WAEMU (UEMOA)	2014-2017	Solar home systems, solar kits and Pico solar lanterns	<ul style="list-style-type: none"> • XOF 2.34 billion / EUR 3.6 million in funding for large-scale development of SHS, PV solar kits and pico solar lanterns in the eight UEMOA countries • 45 beneficiary locations (five regions): 2,670 solar PV SHS, 378 PV street lighting, 18 drinking water supply systems
Green Energy Service Centres for Communities in Rural Mali	WADB, GEF	2018-2021	Solar off-grid	<ul style="list-style-type: none"> • USD 80 million in funding to develop off-grid solar plants (50 kWc to 100 kWc) through PPPs Ownership and management of the off-grid plants by the communities themselves, to develop, install, manage the system in place
Projet d'Électrification villageoises par Énergie Solaire (PEVES)	India, National Budget	2003-2018	SHS, solar pumping, Lanterns, refrigerators,	<ul style="list-style-type: none"> • Phase 1: 2003-2007 (1,830 SHS, 120 street lights, 20 solar kits, 12 solar pumps, 12 SHS for rural community centers, 12 SHS cellphone center • Phase 2: 2009-2013 (180 solar water pump systems, 2700 SHS for public lighting, 461 pico lanterns)

¹²² Green Climate Fund, Mali solar rural electrification project: <https://www.greenclimate.fund/projects/fp102>

¹²³ "Électrification rurale: 60 centrales par hybridation solaire photovoltaïque au Mali," AFD, (2016): http://prod1-afd-mig.integra.fr/home/pays/afrique/geo-af/mali/ctnscroll_ActualitesList/6_6

Project/Program	Sponsor	Timeline	Market Segment(s)	Description
				<ul style="list-style-type: none"> Phase 3: 2014-2018 (15,000 SHS, 40 PV solar water pump systems, 1,000 pico lanterns)
Green Africa Power (GAP) Program	Private Infrastructure Development Group (PIDG)	Ended in 2014	RE, off-grid energy, rural electrification	The Green Africa Power (GAP) program, which is managed by Camco Clean Energy Limited, is a financing facility which offers debt and credit lines to private developers of RE projects in Mali
Scaling Up Renewable Energy Program (SREP)	AfDB, World Bank, IFC, National Energy institutions	2010-2011	Solar PV	<p>This program had three components:</p> <ul style="list-style-type: none"> The Rural Electrification Hybrid System The Project for Scaling Up Renewable Energy in Mali The Segou Solar Park (amounting to about USD 35 million)
Projet de Promotion des Énergies Nouvelles et Renouvelables pour l'Avancement de la Femme (PENRAF) ¹²⁴	UNDP, TICAD (Japan)	2004-2012 (Phase 1), 2010-2016 (Phase 2)	Solar home systems	<ul style="list-style-type: none"> Phase 1: 312 villages in Koulikoro, Ségou, Sikasso, Mopti and creation of Sirakorola "solar village" Phase 2: Creation of 3 "solar villages" (Kléla, Ambidedi and Kolongo Tomo)
Carbon Initiative for Development	World Bank	2016-2024	Pico solar, mini-grids	<ul style="list-style-type: none"> Ci-Dev will support the PV hybridization of 250 diesel-based mini-grids and the distribution of 750,000 solar lanterns to rural households, with funds being used to improve regulatory and program management capacity within AMADER for the PV/diesel mini-grid hybridization component and to provide a subsidy to help households afford the solar lanterns
ElectriFi	European Commission and Power Africa		Rural electrification	<ul style="list-style-type: none"> ElectriFi is supporting the development of a demand-driven innovative Flex-Grid technology, based on a demand-driven rural electrification approach, including the development of metering and payment solutions. ElectriFi provided EUR 100,000 for the construction of the pilot project in Mali.
ACP-EU	European Union	2014-2018	Pico solar	<ul style="list-style-type: none"> In Mali, the Access to Modern and Sustainable Services Project (2014-2018) targets the distribution of clean cooking and clean lighting solutions (including the distribution of solar lanterns)
Power Africa	USAID		Pico solar, SHS	<ul style="list-style-type: none"> Power Africa has supported 150,000 off-grid connections since its inception, through official private sector partners operating in the off-grid sector. The majority of these connections are solar lanterns, while the rest are more advanced SHS
En-Dev / GIZ	Multi-donor partnership		Solar PV	<ul style="list-style-type: none"> In Mali, EnDev's work is focused on developing PV-driven communal battery charging stations and stand-alone PV systems to provide electricity to households and social infrastructure (schools, health centers, city halls and solar street lights). O&M is provided by service providers through a revolving fund financed by fees charged for communal services.

¹²⁴ "Mali: L'énergie solaire, un miracle pour les femmes," UNDP: http://www.undp.org/content/undp/fr/home/ourwork/ourstories/1_energie_solaireaumaliunmiraclepourlesfemmes.html

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 Mali's off-grid sector.

An example is the implementation of EU projects by Agronomes et Vétérinaires Sans Frontières (AVSF), which successfully distributed solar equipment, improved cookstoves and biogas, and public lighting. AVSF is also implementing AFD's project for Access to Modern and Sustainable Energy Services (AFREA). GERES Mali is another NGO developing off-grid technologies for productive use through solar PV panels and Jatropha PVO.¹²⁵ Other NGOs and civil society organizations that are active in the off-grid sector include, SNV, AMEDD AMEDO, and Mali Folke Centre.¹²⁶

Mali-based Yeelen Kura is particularly active in the promotion of off-grid solar solutions in rural areas. In partnership with the Dutch NGO Foundation Rural Energy Services (FRES), eight off-grid photovoltaic plants have been installed since 2014 in the localities of Koumantou, Kignan, Yorosso, Niena, M'pessoba, Kouri, Ourikela et Kolondiéba.¹²⁷ Yéélen-Kura also sells solar kits to households, small businesses, and institutions (about 750 clients in Dioila region), offering after-sale services for solar kits between 100 Wh and 756 Wh, in exchange for a monthly fee of between CFA 3,500-13,475 (USD 5-20).

Since 2012, Mercy Corps has been working to empower Malian communities to cope with and recover from resource scarcity, particularly in fragile conflict-affected areas. D-Lab's Off-Grid Energy program has partnered with Mercy Corps to identify opportunities for programs to sustainably increase energy access in the country.¹²⁸

In 2018, Africa GreenTec – a firm that designs and operates rural solar power plants – partnered with GLS Bank's impact investment / climate fund to provide solar electricity to as many as 50 villages in Mali.¹²⁹

¹²⁵ "Zones d'activités électrifiées au Mali (ZAE)," GERES, (2014): <http://www.geres.eu/fr/zone-d-activites-electrifiee-au-mali-zae#fiche-technique>

¹²⁶ "Energies renouvelables en Afrique : profil du Mali," AfDB & Climate Investment Fund, (2015) : <https://www.afdb.org/fr/news-and-events/opportunities-abound-in-malis-promising-renewable-energy-sector-says-new-country-profile-14235/>

¹²⁷ "Inauguration du Projet des huit mini-réseaux hybrides au Mali," Yeelen Kura, (2014): <http://www.yeelenkura.com/index.php/inauguration-du-projet-des-huit-mini-reseaux-hybrides-au-mali>

¹²⁸ "D-Lab: Off-Grid Energy in Mali," D-Lab, <https://d-lab.mit.edu/off-grid-energy/mali>

¹²⁹ "First subscribers to Africa GreenTec's corporate bond," PV Magazine, (February 7, 2018): <https://www.pv-magazine.com/press-releases/first-subscribers-to-africa-greentecs-corporate-bond/>

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

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

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

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

Table 9: Indicative Total Cash Market Potential for Off-Grid Solar PV Products in Mali, 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	631,078	1,893	\$28,398,506	\$0.00
Plug and play	2,169	22	\$271,082	\$0.00
Small SHS	0	0	0	\$94,011,092
Medium and Large SHS	0	0	0	\$4,879,468
Household Subtotal	633,247	1,915	\$28,669,588	\$98,890,560
Institutional				
Water supply	1,714	5,831	\$14,577,313	-
Healthcare facilities	183	142	\$353,925	-
Primary and secondary schools	554	354	\$1,008,735	-
Public lighting	375	187	\$561,825	-
Institutional Subtotal	2,826	6,514	\$16,501,798	-
Productive Use				
SME applications for microenterprises	191	48	\$119,125	-
Value-added applications	79,341	13,800	\$62,014,690	-
Connectivity / ICT (phone charging)	13,515	5,406	\$11,649,582	-
Productive Use Subtotal	93,047	19,254	\$73,783,397	-
TOTAL	729,120	27,683	118,954,783	

Source: African Solar Designs analysis

2.1 Demand – Households

This section analyzes the main characteristics of the household (HH) OGS demand in Mali. 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 1.9 million households (10.9 million people) in Mali without access to electricity.¹³⁰ In that year, an estimated 41% of the population had access to electricity, with the rate of access at 83% in urban areas and 18% in rural areas.

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

¹³⁰ See **Annex 2** for more details.

Table 10: Household Consumer Market Segments¹³¹

Income Quintile	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	2018 Scenario				2023 Scenario				2030 Scenario				Geographic segments	Description
					% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier		
Highest 20%	1%	6,506	\$8,972	Tier 3	1%	7,285	\$10,923	Tier 3	1%	8,960	\$12,749	Tier 3	High income rural	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Professionals, business owners and salaried people are likely to be connected to the grid. • Small portion without grid access desire replacement to generator power¹³² 				
Fourth 20%	5%	32,530	\$4,888	Tier 2	2%	14,570	\$5,951	Tier 3	2%	17,919	\$6,945	Tier 3	Low income peri-urban / urban "under-grid"	<ul style="list-style-type: none"> • Low income urban population engaged in SME work or casual labor • Lives near grid but cannot afford or does not have access to connection 				
Third 20%	90%	585,536	\$3,519	Tier 2	3%	21,855	\$4,284	Tier 2	3%	26,879	\$5,001	Tier 2						
Second 20%	99%	644,090	\$2,629	Tier 1.5	21%	150,306	\$3,200	Tier 2	4%	35,839	\$3,735	Tier 2	Low income rural	<ul style="list-style-type: none"> • Engaged in farming, or SME • Lives more than 15km from the nearest grid connection. 				
Lowest 20%	100%	650,596	\$1,738	Tiers 1,1.5	100%	728,508	\$2,116	Tiers 1,1.5	75%	672,328	\$2,469	Tiers 1,1.5						
Total Households without Access to Electricity		1,919,258			Total	922,524			Total	761,925								

Source: IEA and World Bank; African Solar Designs analysis

¹³¹ See **Annex 1** and **Annex 2** for more details.

¹³² 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**

Mali has a high level of extreme poverty (households living below \$1.90 a day). As shown in **Table 11** below, the vast majority of the country’s households have a low income. 2009 is the most recent year in which poverty data is available from the World Bank.

Table 11: Poverty Headcount in Mali, 2009

Poverty headcount ratio	% of population
Lives at or below \$1.90 a day*	49.7%
Lives at or below \$3.20 a day*	79.4%
Lives at or below \$5.50 a day*	94.9%

*2011 PPP

Source: World Bank

Many households in Mali rely on cotton production. In the cotton zone, the CMDT has established categories of income for producers (categories A to D). The category is very generally linked to the number of hectares of cotton. Category A producers have about four oxen, four plows, a cart or a tiller, and more than 15 hectares; Category B producers have between 5 to 15 hectares, two oxen, and one cart; Category C producers have one ox, one cart, and 1 to 5 hectares; while Category D producers have no cart, no ox, and maybe one hectare. Very generally, it is the categories A and B which have more income and access to electricity. Farmers organized around cotton are also accustomed to taking credit.

Focus group participants in Koutiala highlighted the importance of cotton to the local economy, indicating that they have financial means after the sale of cotton (typically from the months of November to May). Other crops provide income supplements, such as peanuts and fruit trees. In more remote villages, the population is increasingly dispersed, and income is much lower. However, households in larger villages often have access to solar, and use solar panel systems to drive small productive use activities such as mobile phone charging, thus raising incomes and climbing the access to energy tiers to use of larger solar products more quickly than has been observed in some other countries.

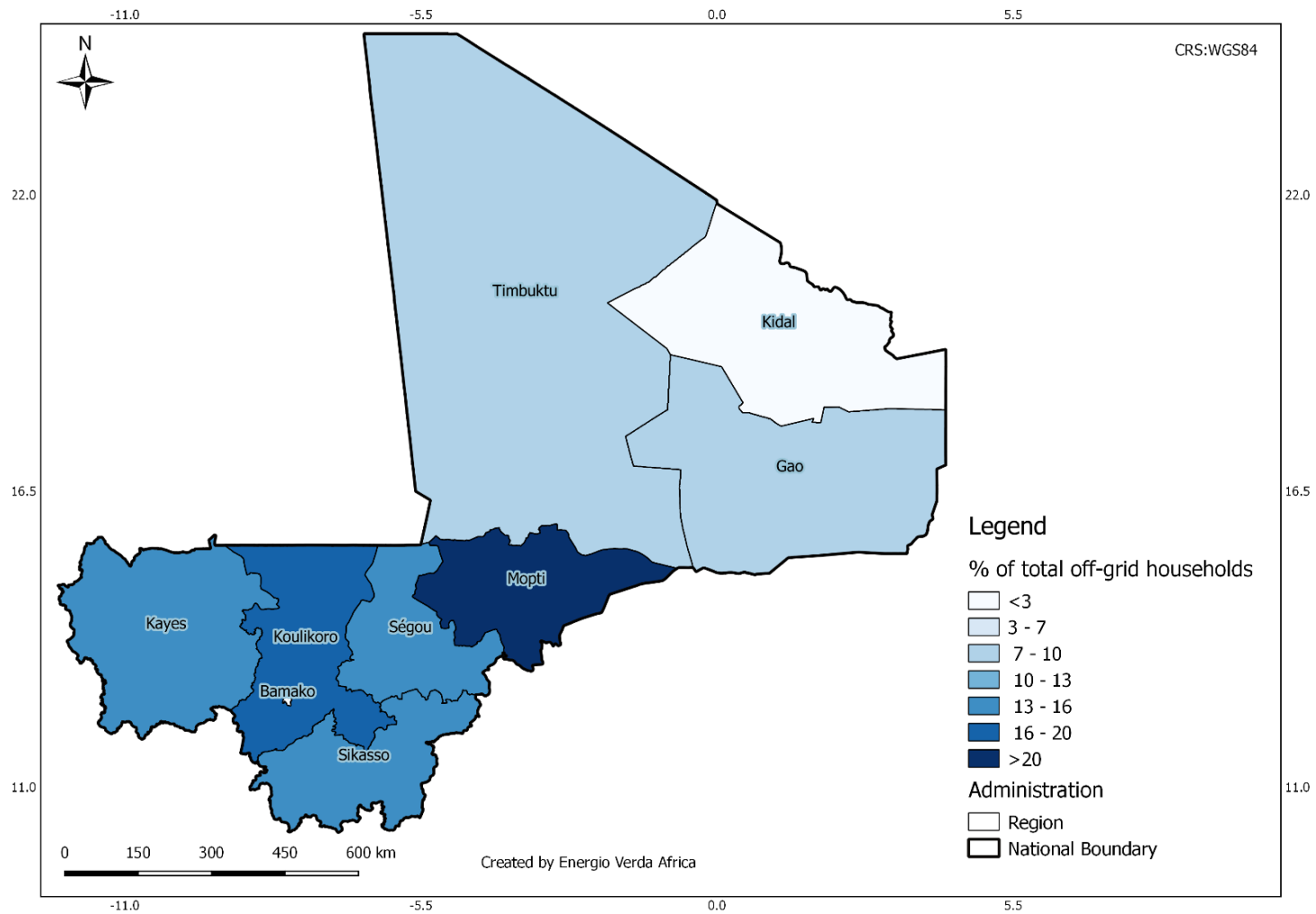
➤ **Geographic Components of the Solar Market**

The total number of off-grid households and their geographic distribution can change 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 16-19**) 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 16-19**), while the total size of the OGS market will decrease slightly over time, the distribution of off-grid households across the country will remain similar through 2030.

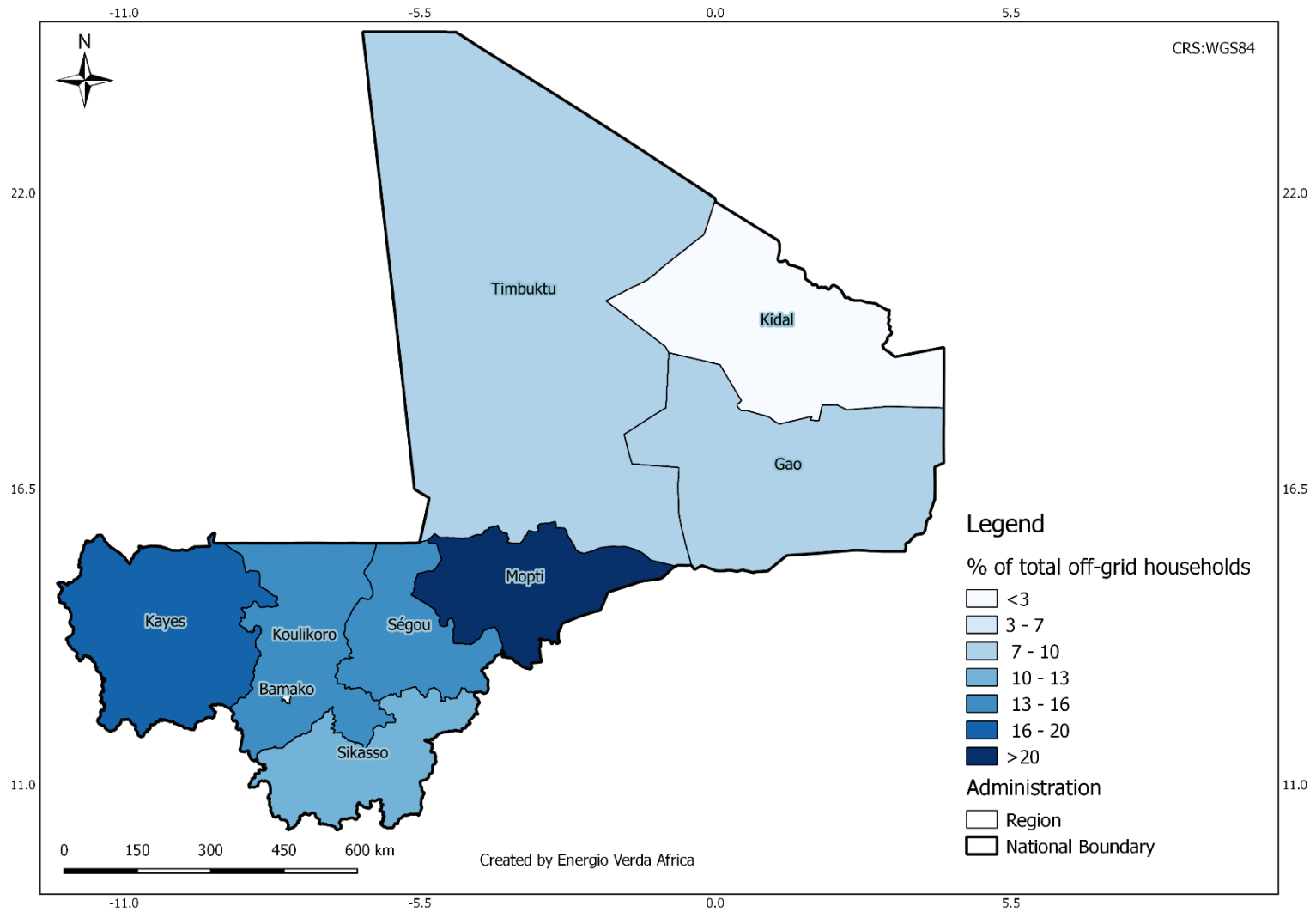
Figure 16: Distribution of Potential Off-Grid Households by Region, 2023¹³³



Source: Energio Verda Africa GIS analysis

¹³³ See Annex 1 for more detail, including data sources.

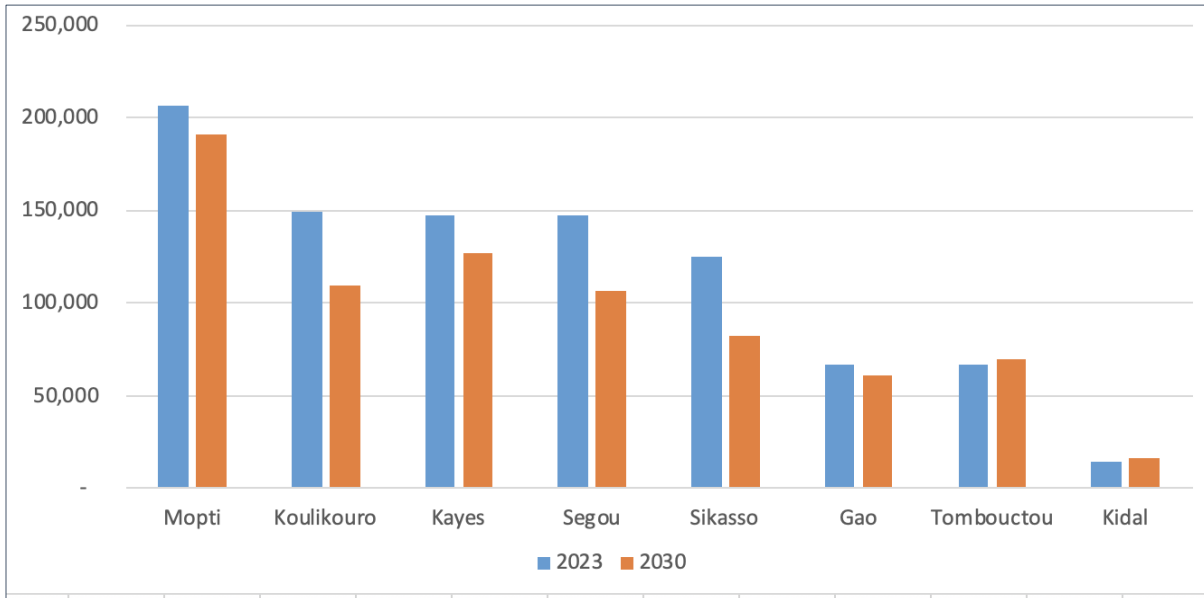
Figure 17: Distribution of Potential Off-Grid Households by Region, 2030¹³⁴



Source: Energio Verda Africa GIS analysis

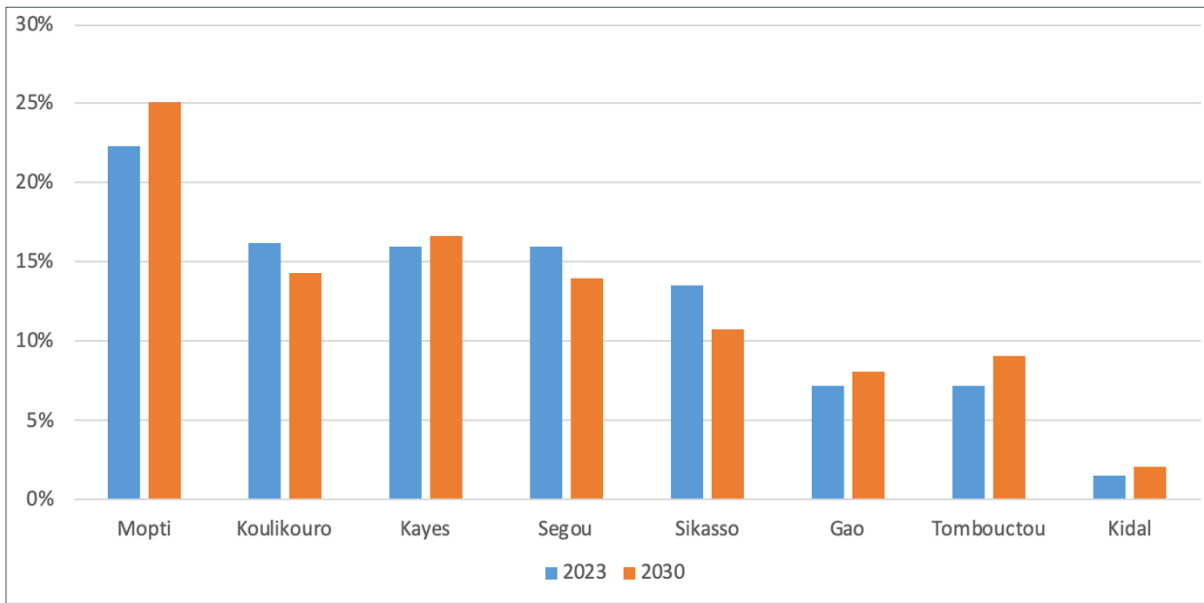
¹³⁴ See Annex 1 for more detail, including data sources.

Figure 18: Estimated Number of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

Figure 19: 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, common sources of electricity used in off-grid rural households include diesel generators, solar panels, and battery or solar flashlights. FGD participants reported that most villages no longer use kerosene, candles or even battery driven torches, preferring instead solar lanterns.

The following costs of common energy devices were provided by FGD participants:

- Batteries: CFA 200-300
- Solar flashlight: CFA 1,500 – 2,000 (last for about six months, made in China)
- Lagazel solar torch with panel: CFA 22,000 with phone charging; CFA 12,000 for lighting only – very durable, water resistant

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

These tiers are defined in **Table 13**. Establishing an average monthly household expenditure for each energy tier using common rural technologies shows how household income level aligns with energy tiers. Secondly, it provides a basis to compare these costs to solar products that can offer an equivalent level of service by energy tier. This in turn reveals potential household savings by switching to solar products, as shown in **Figure 20** and **Table 14**.

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

Table 12: Rural Energy Technology and Costs¹³⁵

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	\$0.29	\$2.00	\$4.64	\$2.13	\$4.95	\$2.49	\$5.77
Cell Phone Charging	Done at a charging station	-	8	\$0.17	\$0.00	\$1.36	\$0.00	\$1.45	\$0.00	\$1.69
Smart Phone Charging	Done at a charging station	-	16	\$0.17	\$0.00	\$2.72	\$0.00	\$2.90	\$0.00	\$3.38
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	\$0.29	\$0.00	\$2.32	\$0.00	\$2.48	\$0.00	\$2.88
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	\$1.07	\$50.00	\$4.28	\$53.37	\$4.57	\$62.16	\$5.32
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	30	\$1.24	\$100.00	\$37.20	\$106.80	\$39.71	\$124.31	\$46.24

Source: African Solar Designs analysis

¹³⁵ Data from FGDs, field surveys and various published data sources.

Table 13: Typical Tier-Based Energy Costs

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Typical Monthly Cost (USD) 2018	Typical Monthly Cost (USD) 2023	Typical Monthly Cost (USD) 2030
Tier 0 No electricity	<ul style="list-style-type: none"> Characterized by complete lack of electricity services Many cash-poor consumers are in this situation part of each month when they don't have money to buy dry cells or charge phones 	<ul style="list-style-type: none"> Rely solely on kerosene, wood and other fuel sources for cooking and lighting 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty
Tier 1 Range: 1 to 20 Wh/day	<ul style="list-style-type: none"> Access to one torch powered by dry cell batteries One cell phone powered by charging service 	<ul style="list-style-type: none"> One battery-powered light requires dry cell replacement on weekly basis One cell phone charged 8 times per month 	\$6.00	\$6.40	\$7.46
Tier 1.5 Range: 20 to 100 Wh/day	<ul style="list-style-type: none"> Access to one torch and one lantern each powered by dry cells One cell phone powered by charging service Radio powered by dry cells 	<ul style="list-style-type: none"> Two battery-powered light points require dry cell replacement on weekly basis One cell phone charged 8 times per month Radio dry cells replaced two times per month 	\$12.96	\$13.83	\$16.11
Tier 2 Range: 55 to 500 Wh/day	<ul style="list-style-type: none"> One torch and two lanterns powered by dry cells One cell phone and one smart phone powered by charge service Radio DC TV 	<ul style="list-style-type: none"> Three battery light points require dry cell replacement on weekly basis One cell phone charged 8 times per month and one smart phone charged 16 times per month TV/Radio powered by lead acid battery recharged once per week 	\$22.28	\$23.78	\$27.70
Tier 3 Range: 500 to 2500 Wh/day	<ul style="list-style-type: none"> Five lighting points Multiple cell/smart phones AC radio and music system AC TV 	<ul style="list-style-type: none"> Generator powers a set of appliances 	\$37.20	\$39.71	\$46.24

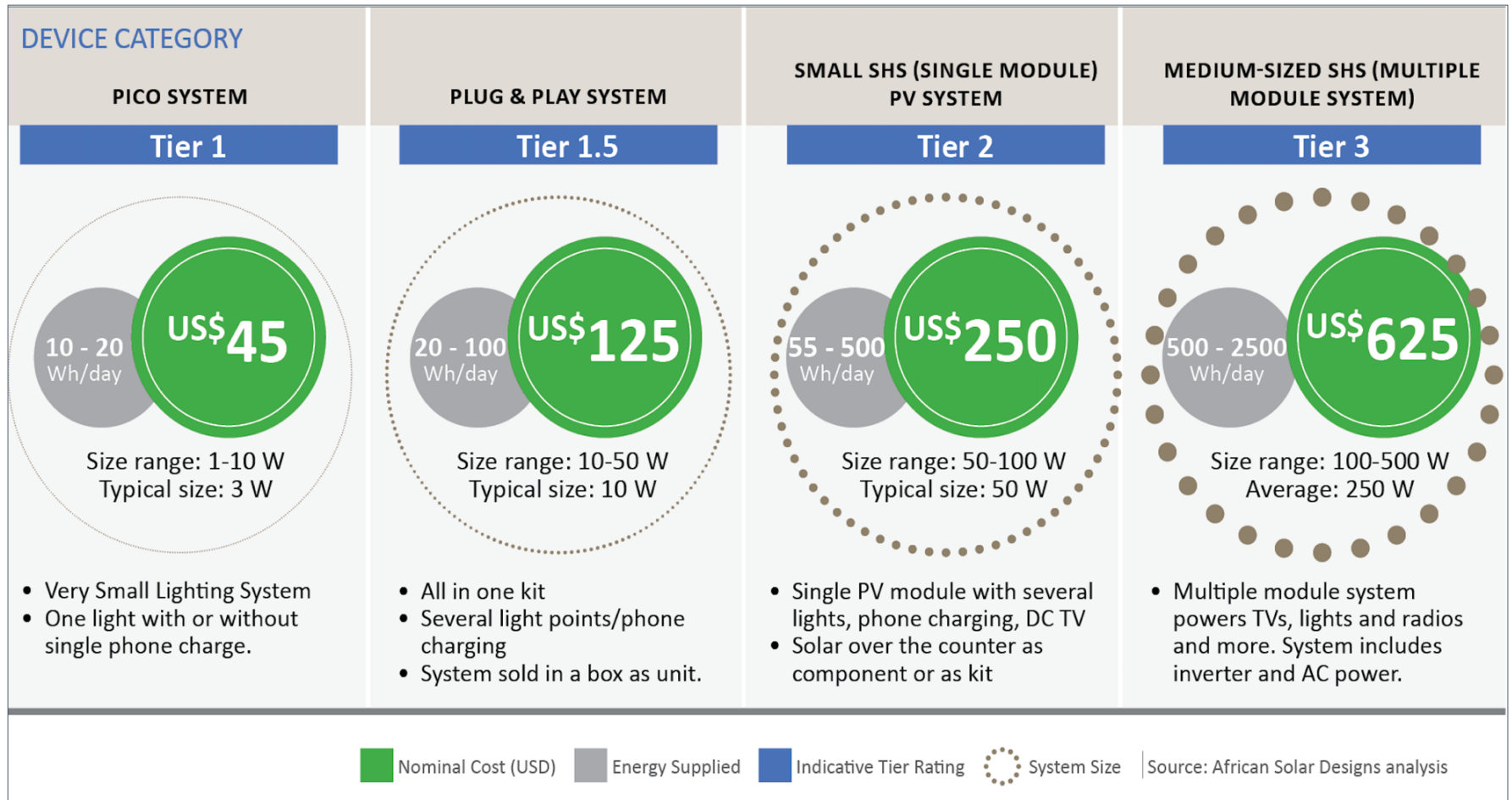
Source: African Solar Designs analysis

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

➤ **Household Solar PV System Types**

Solar PV systems can provide lower cost and higher levels of service than existing dry cell, phone charging and generator options. In order to model how solar systems can meet existing energy use categories, levels of service and ability to pay, four types of household solar systems are configured to match the tier-based demands of off-grid communities. The system descriptions, energy outputs, prices, tier ratings and target consumer groups are listed in **Figure 20**.

Figure 20: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

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

Focus group participants emphasized the widespread use of solar across Mali, estimating that about 70 to 90% of the population use solar torches / lamps (of various qualities). Participants emphasized that usage is widespread even in rural villages and that many women and even poor households have access to solar torches. Household use of solar has developed quickly, away from candles, kerosene and even battery-operated torches, to solar lanterns and larger kits. Phone charging in villages is offered as a service for CFA 25-100. Others expressed diverse household demand for the use of solar energy:

- Household water pumping
- Small scale vegetable and fruit drying – preservation for household consumption
- Milling
- Refrigeration
- Ice making

As household income increases, solar power is used for TVs or solar refrigerators. About 15 to 20% of the population has equipment with multiple solar panels (described as wealthier households with means).

➤ **Sales areas**

Solar products are more accessible and thus prevalent in large villages rather than remote areas, where both population and demand for products are increasingly dispersed. According to feedback from focus group participants, the most active sales regions are urban and semi-urban areas such as Koutiala, Mpepassa, Molobala, Konseguela, Kayes, Koulikoro, Sikasso, etc. These districts are also more dynamic, with more electrical equipment (refrigerators, televisions, telephones) than in small villages. Products of varying quality are widely available. However, some households are still unable to access solar products due to the technology's cost.

The prices of solar equipment have dropped significantly in recent years as more companies have entered the country's off-grid market to provide a range of OGS equipment and services. For example, the 'fee-for-service' business model, which is currently being deployed in the market, requires a monthly contribution from the user to cover the costs of maintenance or replacement of used equipment.

Focus group participants indicated that the region of Kayes is more developed in solar energy compared to other regions of Mali, a dynamic that is linked to private actors more than to public initiatives. In the north, prior to the instability that has arisen in recent years, people obtained solar panels from Algeria. Regional insecurity has forced roads to be cordoned off, limiting this access. In other areas, such as Mopti, access is also complicated due to availability of equipment, financing, technicians, information etc.

➤ **Pricing**

While some FGD participants indicated that prices of solar products have become more affordable in recent years, others commented that solar products were still expensive, noting that lamps can cost CFA 17,500 (USD 30) for high quality equipment, compared to low quality lamps that can be purchased for CFA 3,000 (USD 5).

➤ **Rural Electrification Hybrid System Project (SHER)**

The SHER project is distributing 2W and 5W lamps free of charge in 100 schools and 50 community-based infrastructures in all parts of the country. Out of 10,000 lamps to be distributed, about 6,000 have been distributed as of the end of 2018.

➤ **Maintenance and Quality**

FGD participants highlighted that the market is flooded with inexpensive low-quality products. They also pointed out that there is limited access to firms providing professional installation and maintenance on OGS products and systems. Sales are generally made based on the financial resources of the buyer, rather than a real assessment of the household’s needs.

Installation and the cost of high-quality batteries have become a major challenge for users of solar products, who can replace their batteries as often as every six months. Lead acid batteries are not commonly used and lithium batteries are available but quite expensive. Recycled batteries are of low quality and do not last long. Poorly installed systems can also limit battery life through improperly wired connections to appliances.

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

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

Table 14: Energy Expenditure of Different Income Groups

Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	\$25.41	\$144.82	10%	\$14.48
2nd Quintile of Population	\$38.43	\$219.04	10%	\$21.90
3rd Quintile of Population	\$51.45	\$293.27	10%	\$29.33
4th Quintile of Population	\$71.46	\$407.31	10%	\$40.73
Highest Quintile of Population	\$131.17	\$747.65	10%	\$74.76
2023 Scenario				
Lowest Quintile of Population	\$30.93	\$176.31	10%	\$17.63
2nd Quintile of Population	\$46.78	\$266.67	10%	\$26.67
3rd Quintile of Population	\$62.64	\$357.04	10%	\$35.70
4th Quintile of Population	\$87.00	\$495.88	10%	\$49.59
Highest Quintile of Population	\$159.69	\$910.22	10%	\$91.02
2030 Scenario				
Lowest Quintile of Population	\$36.10	\$205.79	10%	\$20.58
2nd Quintile of Population	\$54.61	\$311.26	10%	\$31.13
3rd Quintile of Population	\$73.11	\$416.72	10%	\$41.67
4th Quintile of Population	\$101.54	\$578.78	10%	\$57.88
Highest Quintile of Population	\$186.38	\$1,062.39	10%	\$106.24

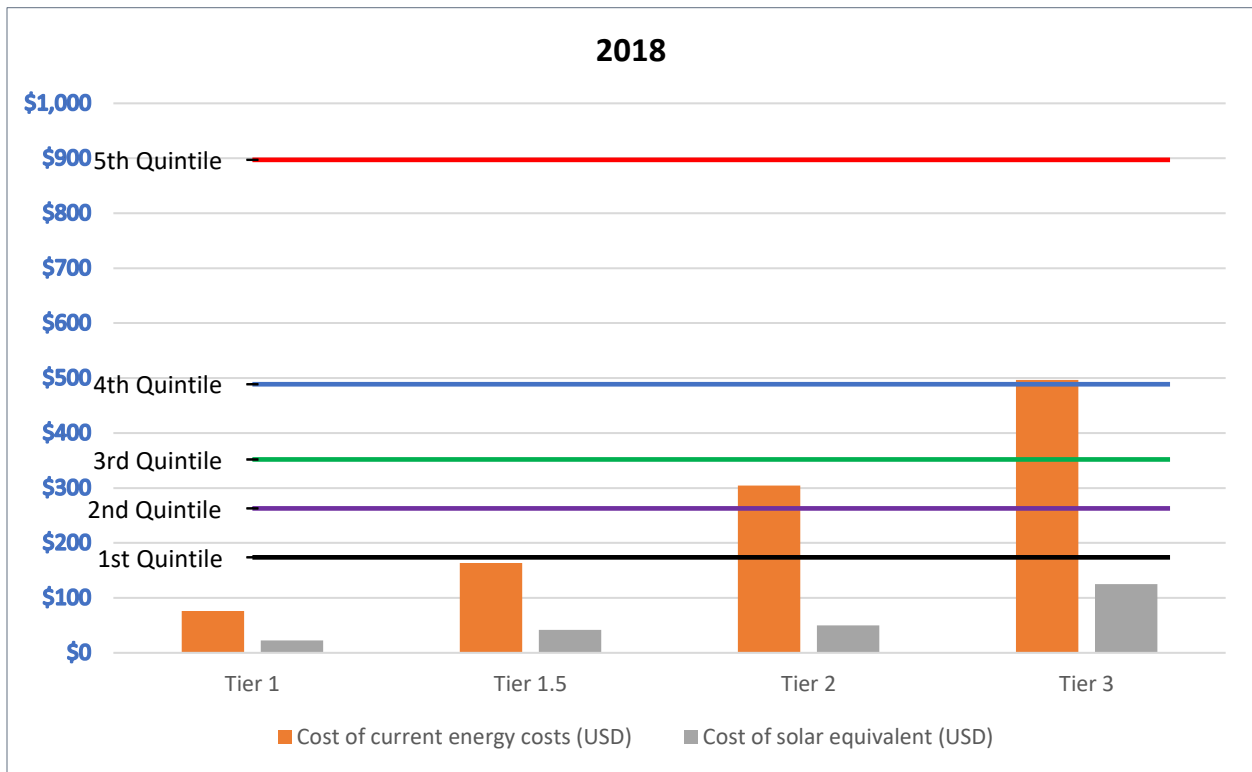
Source: African Solar Designs analysis

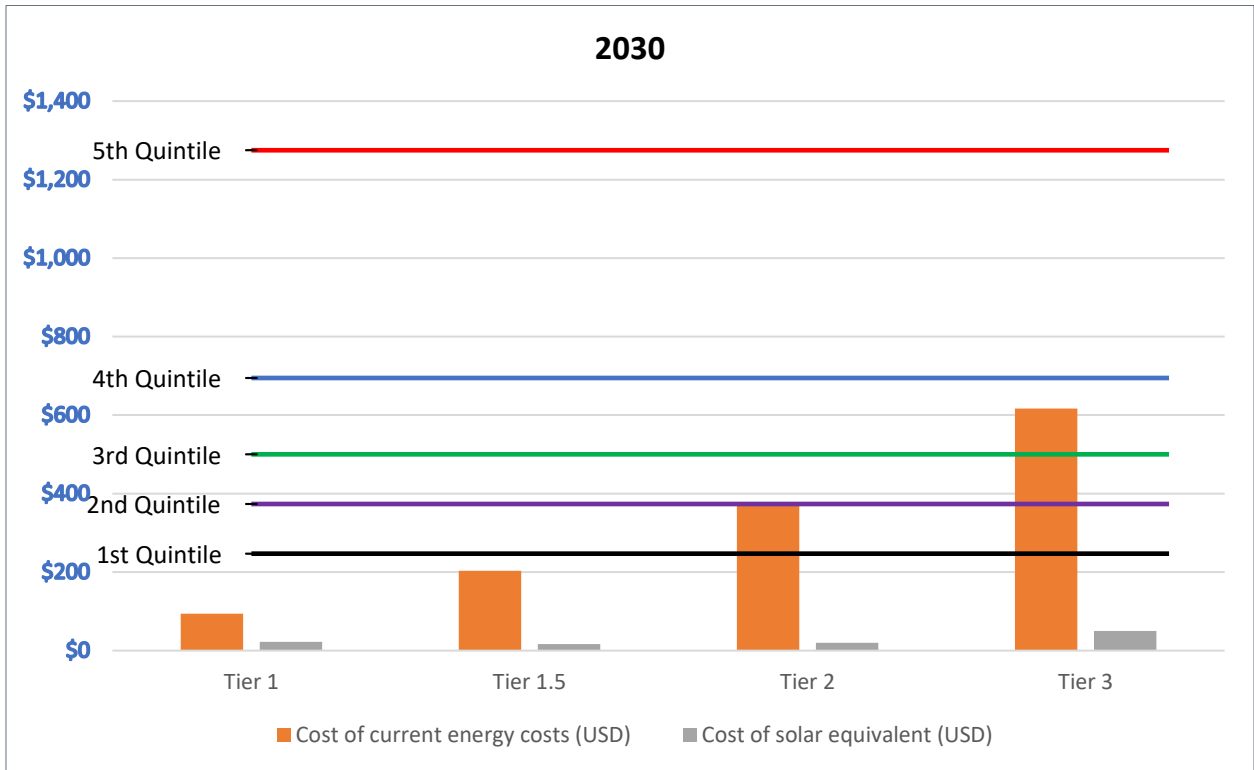
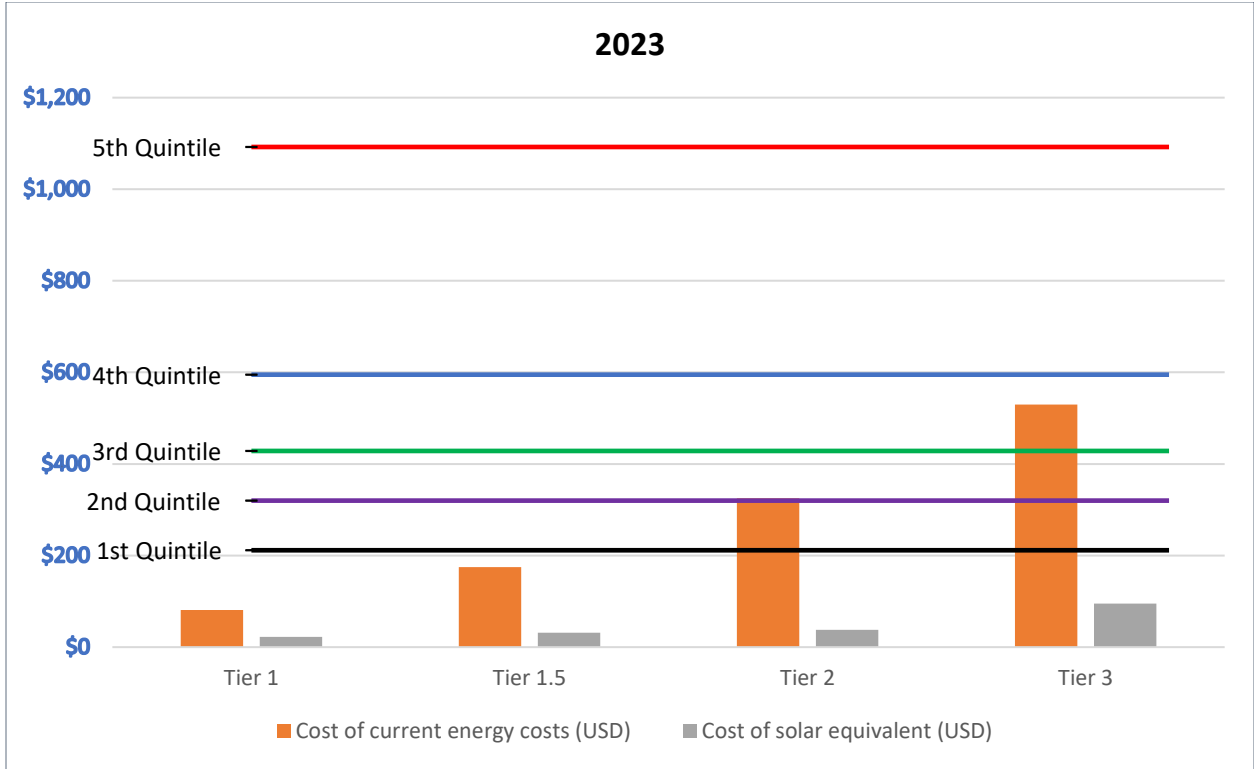
Figure 21 summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including

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





Source: African Solar Designs analysis

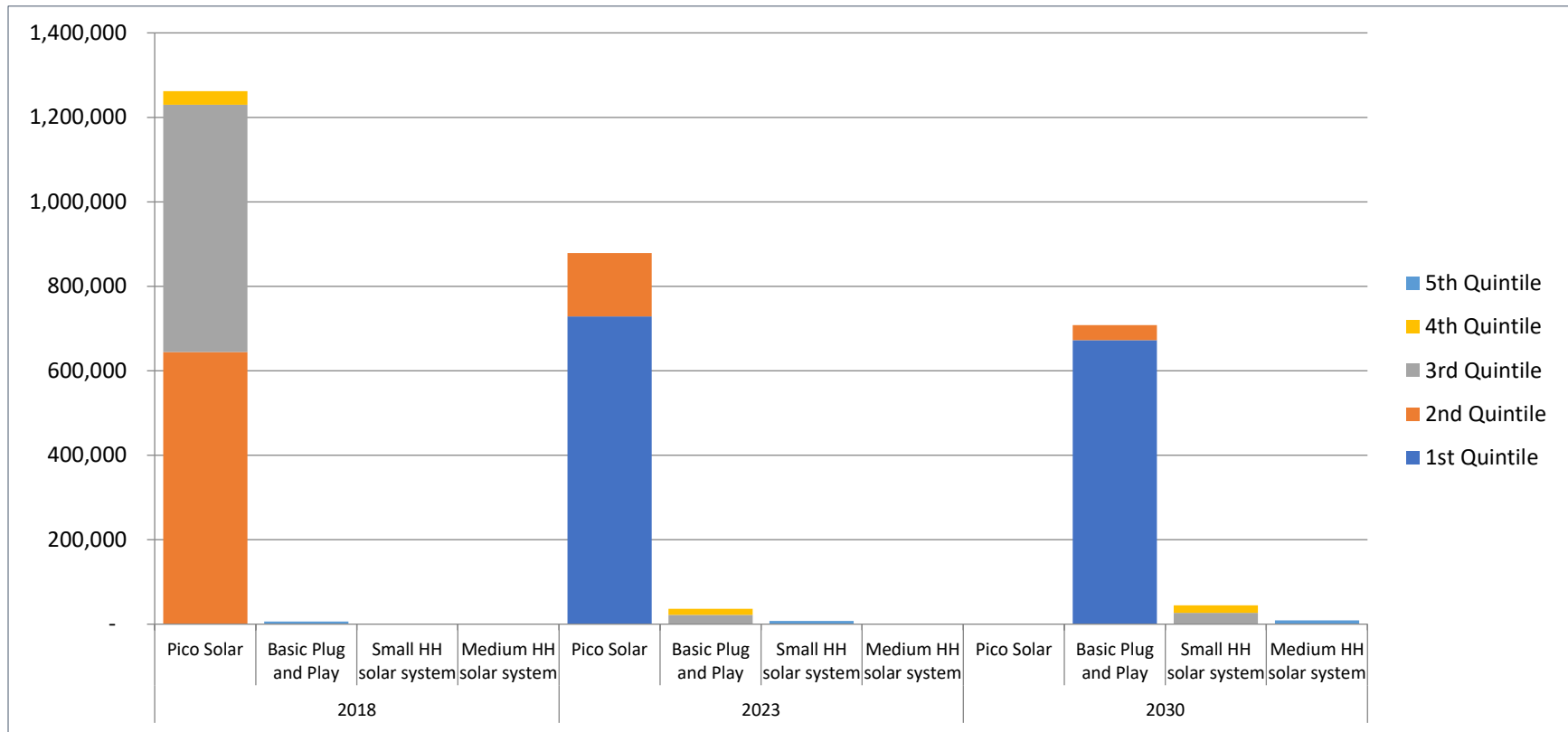
2.1.3 The Market for Household Devices without Consumer Finance

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

Based on the income quintiles and corresponding estimated current energy expenditure, in the 2018 scenario, all households without electricity access except those in the lowest income quintile can afford at least one OGS system unfinanced. Affordability increases significantly over time. However, the need for financing solutions for the lower income quintiles is clear.

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

Figure 22: Estimated Number of Households Able to Afford Cash Purchase of OGS Systems by Income Group



Source: African Solar Designs analysis

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

Table 15: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	631,078	1,893	\$28,398,506
Basic Plug and Play	2,169	22	\$271,082
Small HH solar system	0	0	\$0.00
Medium HH solar system	0	0	\$0.00
Total	633,247	1,915	\$28,669,588
2023 Scenario			
Pico Solar	439,407	1,318	\$19,647,852
Basic Plug and Play	12,142	121	\$1,151,395
Small HH solar system	1,457	73	\$276,335
Medium HH solar system	0	0	\$0.00
Total	453,006	1,512	\$21,075,582
2030 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	236,056	2,361	\$11,749,758
Small HH solar system	8,960	448	\$891,947
Medium HH solar system	1,792	448	\$445,974
Total	246,808	3,257	\$13,087,679

Source: African Solar Designs analysis

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

- The most common type of systems which the market can afford on a cash basis are pico systems. Based on available income figures Tiers 1.5, 2 and 3 solutions are less viable for the vast majority of the population in the near term. However, this picture changes significantly with the introduction of financing.
- The model does not adequately address highest quintile and actual sales in the market. Note that the analysis does not predict purchases of Tier 3 equipment and it does not reflect what is happening at the extreme high end of the market. Because the analysis divides the population into relatively wide quintiles, it does not adequately address the very small portion of apex rural (and peri-urban) customers that now use generators.
- Given the widespread use of both pico solar products, plug and play systems and panel systems described in the previous section, there is reason to be optimistic about solar market size and potential beyond what is captured in this model. Seasonal income for wealthier cotton farmers, for example, is being used to make large purchases of solar products in cash without the need for financing.

2.1.4 The Financed Market for Off-Grid Solutions

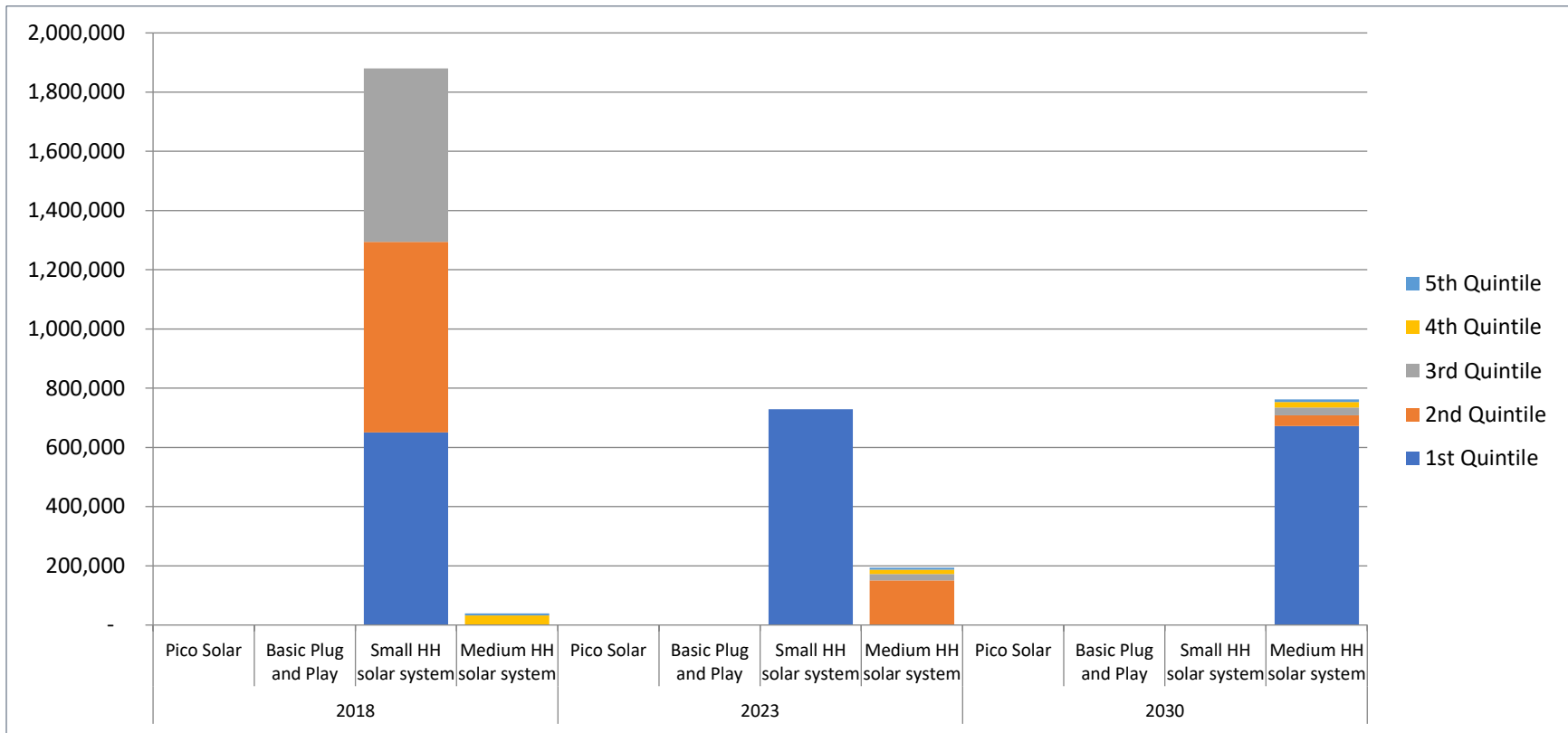
➤ Financial Model

In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with a 24% p.a. interest rate¹³⁶ and a 24-month term. The financial model assumes that the households would be willing to save for three months of their current energy expenditure to cover a small upfront deposit of 10% of the system and their current energy expenditure would be used to pay the monthly installments.

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

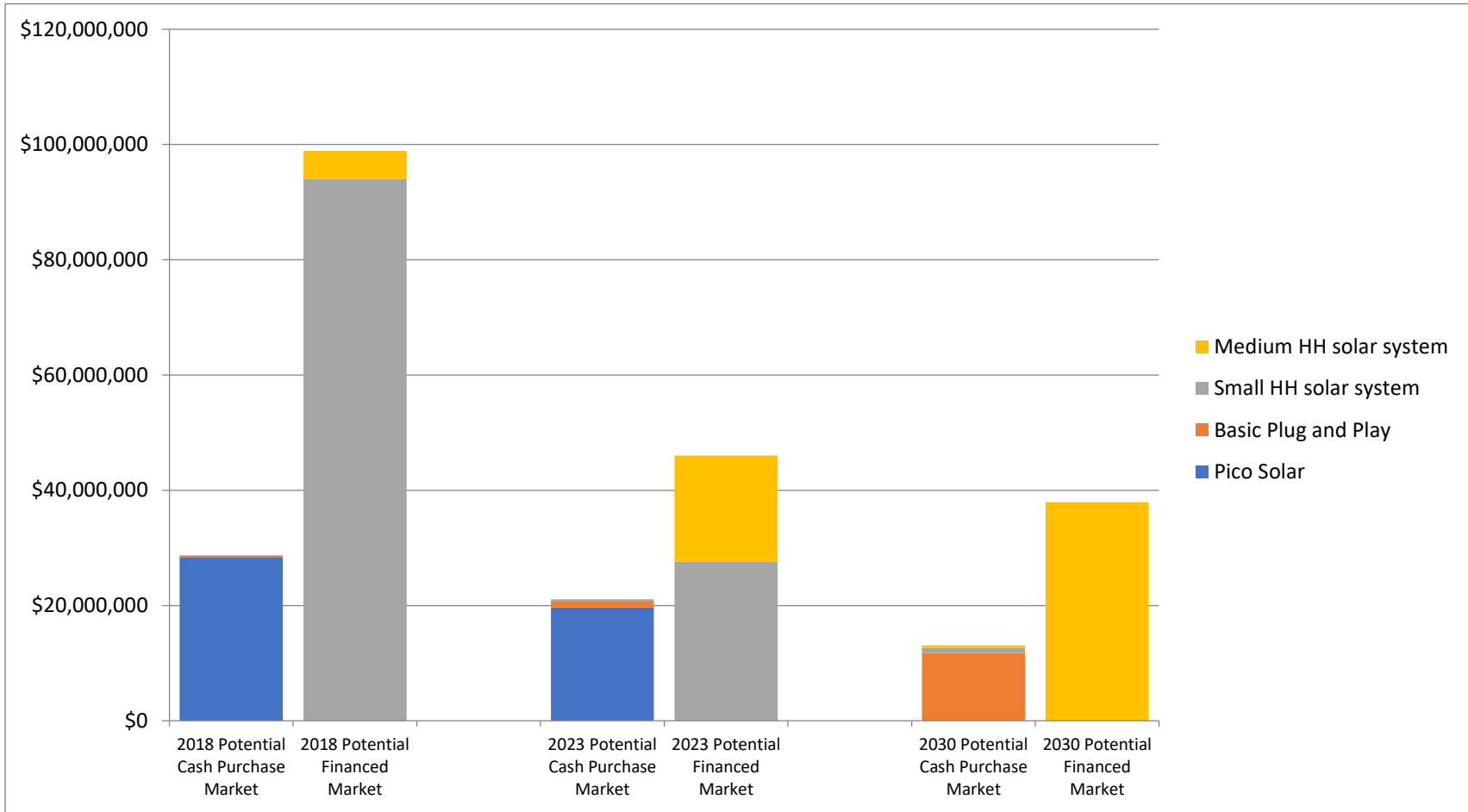
¹³⁶ Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): <http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf>

Figure 23: Estimated Number of Households Able to Afford Financed OGS Systems by Income Group



Source: African Solar Designs analysis

Figure 24: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

In 2018, without financing, 1,268,662 households (66.1% of households without electricity access) in the country could afford an OGS system. However, with financing, 1,919,258 households (100% of households without electricity access) could afford an OGS system as the 650,596 households without access in the lowest income quintile are enabled to acquire at least one OGS system. Consequently, the annualized potential market size increases from USD 28,669,588 to USD 98,890,560 mainly due to the fact that the households are enabled to purchase larger systems (**Figure 24**).

The least-cost electrification 2023 scenario calculates that 922,524 households could be electrified by stand-alone systems. Under this scenario, all the households without electricity access have the ability to acquire at least one OGS system, however, financing enables them to acquire the larger systems. The annualized potential market size increases from USD 21,075,58 to USD 46,031,833 (**Figure 24**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems would be 761,925. Under this scenario as well, all the households without electricity access have the ability to acquire at least one OGS system, however, financing enables them to acquire the larger systems. The annualized potential market size therefore increases from USD 13,087,679 to USD 37,925,117 (**Figure 24**).

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

Table 16: Estimated Financed Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	376,044	18,802	\$94,011,092
Medium HH solar system	7,807	1,952	\$4,879,468
Total	383,851	20,754	\$98,890,560
2023 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	145,702	7,285	\$27,633,469
Medium HH solar system	38,803	9,701	\$18,398,364
Total	184,505	16,986	\$46,031,833
2030 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	0	0	\$0.00
Medium HH solar system	152,385	38,096	\$37,925,117
Total	152,385	38,096	\$37,925,117

Source: African Solar Designs analysis

2.1.5 Consumer Perceptions, Interest and Awareness

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

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

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

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

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

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

2.2 Demand – Institutional

2.2.1 Overview of Institutional Market Segment

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

2.2.2 Analysis of Institutional Market Segment Demand

Table 17 shows the estimated annualized cash market potential for institutional users in Mali. This estimation is calculated using available GIS data, secondary research, and primary source field data. The analysis is based on available information from planned expansion of the sectors and typical usage patterns and costs of existing systems in the country. There was insufficient GIS data available to properly estimate the market size; as a result, per capita comparisons were made with similar countries to analyze certain sectors as described below.¹³⁷

Table 17: Indicative Total Cash Market Potential for Institutional Sector¹³⁸

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	890	1,335	\$3,336,563
	Medium power pumping system	624	2,496	\$6,239,500
	High power pumping system	200	2,000	\$5,001,250
	Subtotal	1,714	5,831	\$14,577,313
Healthcare	Health post (HC1)	140	35	\$87,750
	Basic healthcare facility (HC2)	27	41	\$102,375
	Enhanced healthcare facility (HC3)	16	66	\$163,800
	Subtotal	183	142	\$353,925
Education	Primary schools	500	250	\$749,775
	Secondary schools	54	104	\$258,960
	Subtotal	554	354	\$1,008,735
Public lighting	Public lighting (excluding street lighting)	375	187	\$561,825
TOTAL		2,826	6,514	\$16,501,798

Source: African Solar Designs analysis

¹³⁷ See **Annex 2** for more details.

¹³⁸ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

➤ **Water Supply**

Table 18: Key Assumptions for Water Supply Sector Analysis

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

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

As GIS data was not available to conduct the analysis, a per capita comparison made using data from Niger¹³⁹ identified off-grid potable water points such as boreholes and wells that could be electrified by stand-alone systems. Based on these assumptions, the estimated annualized cash market potential for the water supply sector is presented in **Table 19**.

Table 19: Estimated Cash Market Potential for Water Supply¹⁴⁰

Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	890	1,335	\$3,336,563
Medium power	624	2,496	\$6,239,500
High power	200	2,000	\$5,001,250
Total	1,714	5,831	\$14,577,313

Source: African Solar Designs analysis

➤ **Healthcare**

Table 20: Key Assumptions for Healthcare Sector Analysis

Sector	System Sizes	Key Assumptions
Healthcare	<ul style="list-style-type: none"> HC1: Dispensary health post (300 W) HC2: Basic health facility (1,500 W) HC3: Enhanced health facility (4,200 W) 	A per capita comparison identified a total of 1,560 off-grid healthcare facilities that could be electrified by stand-alone systems

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

¹³⁹ Niger was grouped in the same category as Mali; See **Annex 2** for more details

¹⁴⁰ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

As GIS data was not available to conduct the analysis, a per capita comparison made using data from Niger¹⁴¹ identified off-grid health facilities categorized according to their size (HC1, HC2, and HC3) that could be electrified by stand-alone systems.¹⁴² 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 21**). The assumptions of system size below are based on the services offered at each of these facilities.

Table 21: Healthcare Facility Categorization and Electricity Demand¹⁴³

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

Based on these assumptions, the estimated annualized cash market potential for health facilities is presented in **Table 22**. The distribution of potential off-grid health facilities is shown in **Figure 25**.

Table 22: Estimated Cash Market Potential for Healthcare Facilities¹⁴⁴

Type of Facility	Units	kW Equivalent	Cash value (USD)
Health post (HC1)	140	35	\$87,750
Basic healthcare facility (HC2)	27	41	\$102,375
Enhanced healthcare facility (HC3)	16	66	\$163,800
Total	183	142	\$353,925

Source: African Solar Designs analysis

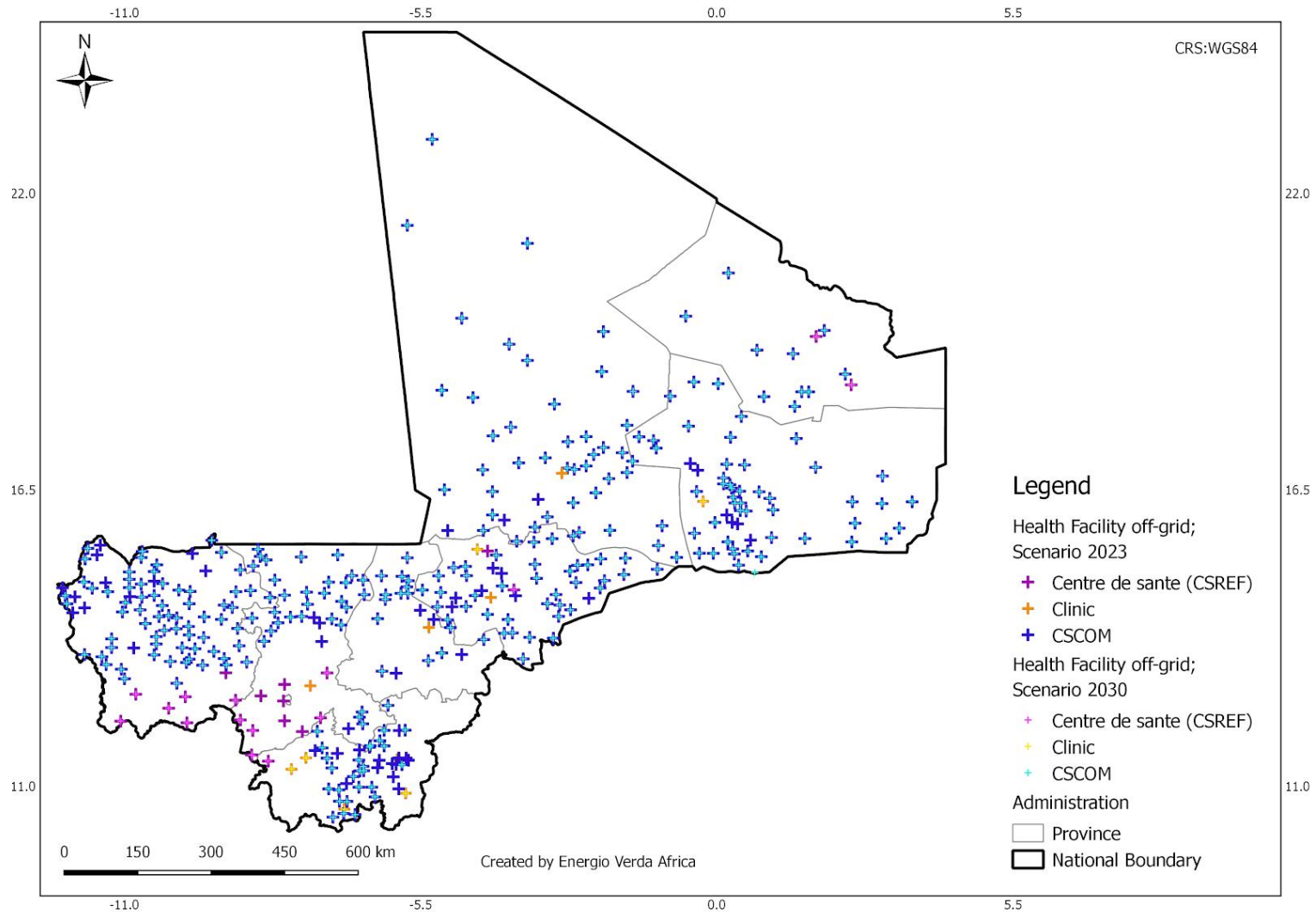
¹⁴¹ Niger was grouped in the same category as Mali; See **Annex 2** for more details

¹⁴² NOTE: This represents a small subset of the overall health infrastructure in the country; See **Annex 1** for more details.

¹⁴³ "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

¹⁴⁴ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

Figure 25: Distribution of Potential Off-Grid Healthcare Facilities, 2023 and 2030¹⁴⁵



Source: Energio Verda Africa GIS analysis

¹⁴⁵ Displaying identified facilities with known location (given coordinates) only; see **Annex 1** for more details, including data sources.

➤ **Education**

Table 23: Key Assumptions for Education Sector Analysis¹⁴⁶

Sector	System Sizes	Key Assumptions
Education	<ul style="list-style-type: none"> Elementary schools (500 W) Secondary schools (1,920 W) 	A per capita comparison identified a total of 9,997 off-grid primary schools and 1,079 off-grid secondary schools that could be electrified by stand-alone systems

The education sector analysis considered the electricity needs of off-grid primary and secondary schools.¹⁴⁷ These include lighting, ICT (computers, tablets etc.), communication (phone charging), laboratories and staff housing. The size of a school and number of students determines the amount of energy it requires. As GIS data was not available to conduct the analysis, a per capita comparison made using data from Niger¹⁴⁸ 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 24).

Table 24: Education Center Categorization and Electricity Demand¹⁴⁹

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

Source: GIZ; African Solar Designs analysis

Based on these assumptions, the estimated annualized cash market potential for primary and secondary schools is presented in Table 25. The distribution of potential off-grid primary and secondary schools is shown in Figures 7-8 in Section 1.2.2.4.

Table 25: Estimated Cash Market Potential for Primary and Secondary Schools¹⁵⁰

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	500	250	\$749,775
Secondary school	54	104	\$258,960
Total	554	354	\$1,008,735

Source: African Solar Designs analysis

¹⁴⁶ 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).

¹⁴⁷ 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.

¹⁴⁸ Niger was grouped in the same category as Mali; See Annex 2 for more details

¹⁴⁹ "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ_2016_Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

¹⁵⁰ 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 26: Key Assumptions for Public Lighting Sector Analysis

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

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

Table 27: Estimated Cash Market Potential for Public Lighting¹⁵¹

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	375	187	\$561,825

Source: African Solar Designs analysis

2.2.3 Ability to Pay and Access to Finance

Financing for institutional off-grid systems in Mali 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.¹⁵²

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.

¹⁵¹ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁵² 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 Mali. 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.

Given that agricultural activities make up 38% of GDP in Mali and employ nearly 80% of the population,¹⁵³ the sector is critical to the country’s growth. However, value-added agriculture is limited by low productivity, post-harvest crop losses, under-developed markets and vulnerability to climate change. Cotton and cereals lead agricultural production with sub-sectors such as shea butter, mangoes, peanuts, cashews, livestock, poultry and fishing, representing significant opportunities that can lead to economic and food security. The Malian government and donors have set goals to modernize and equip the sector through increased investment to support the sector’s value chains.¹⁵⁴ Hence, solar powered applications can play an important role in boosting agricultural productivity.

The services sector is another key contributor to GDP (40%) and has been benefitting from a boost in domestic demand despite constraints such as limited energy access and a lack of finance. On average, firms in Mali struggle with poor and/or inconsistent electricity service.¹⁵⁵ It is important to note that 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

¹⁵³ “Mali: Agriculture, forestry, and fishing, value-added (% of GDP),” <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=ML>

¹⁵⁴ “Feed the Future: Mali Small-Scale Irrigation Project,” USAID and KfW:

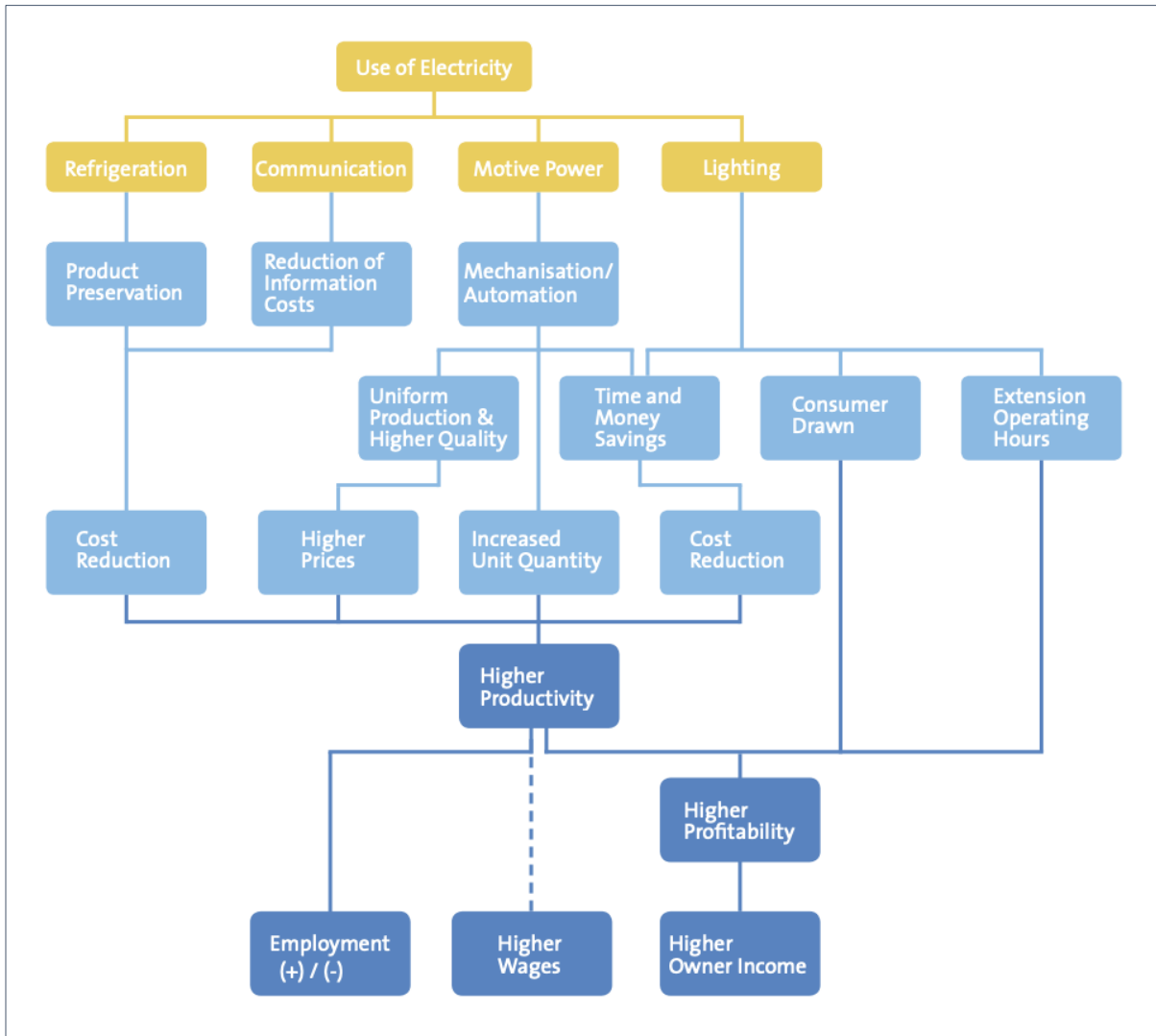
https://www.usaid.gov/sites/default/files/documents/1860/USAID_AEG_-_KfW_Irrigation_Fact_Sheet_-_FTF_-_Nov_16_FINAL.pdf

¹⁵⁵ “World Bank Enterprise Surveys,” World Bank (2016):

www.enterprisesurveys.org/~media/GIAWB/EnterpriseSurveys/Documents/CountryHighlights/Mali-2016.pdf

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 26**).

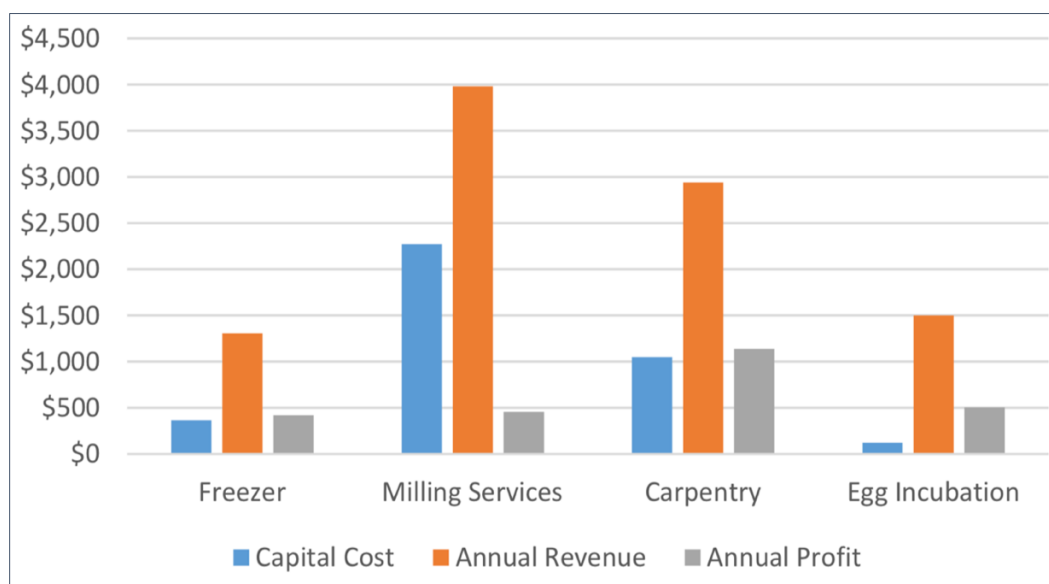
Figure 26: Pathways from Electricity to Income Generation¹⁵⁶



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

¹⁵⁶ 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 27: Analysis of Cost, Revenue and Profit for Various Off-Grid Productive Use Applications¹⁵⁷



NOTE: Annual profit does not include recovery of cost capital

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

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

Table 28: Overview of Productive Use Applications

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

Source: African Solar Designs

¹⁵⁷ "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 areas in Mali, especially in the south (agriculture) and north (pastoralism) regions of the country. Some activities already exist in Koutiala and electrified activity zones in Konseguela and Yorosso.

2.3.2 Analysis of Productive Use Market Segment Demand

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

Table 29: Indicative Total Cash Market Potential for Productive Use Sector¹⁵⁸

Productive Use Sector		Units	kW Equivalent	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	191	48	\$119,125
	Value-added Applications			
	Irrigation	78,611	9,433	\$51,097,222
	Milling	355	2,307	\$5,767,405
	Refrigeration	375	2,060	\$5,150,063
	Subtotal	79,341	13,800	\$62,014,690
Connectivity Applications	Phone Charging	13,515	5,406	\$11,649,582
TOTAL		93,047	19,254	\$73,783,397

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

➤ **SME Applications for Village Businesses**

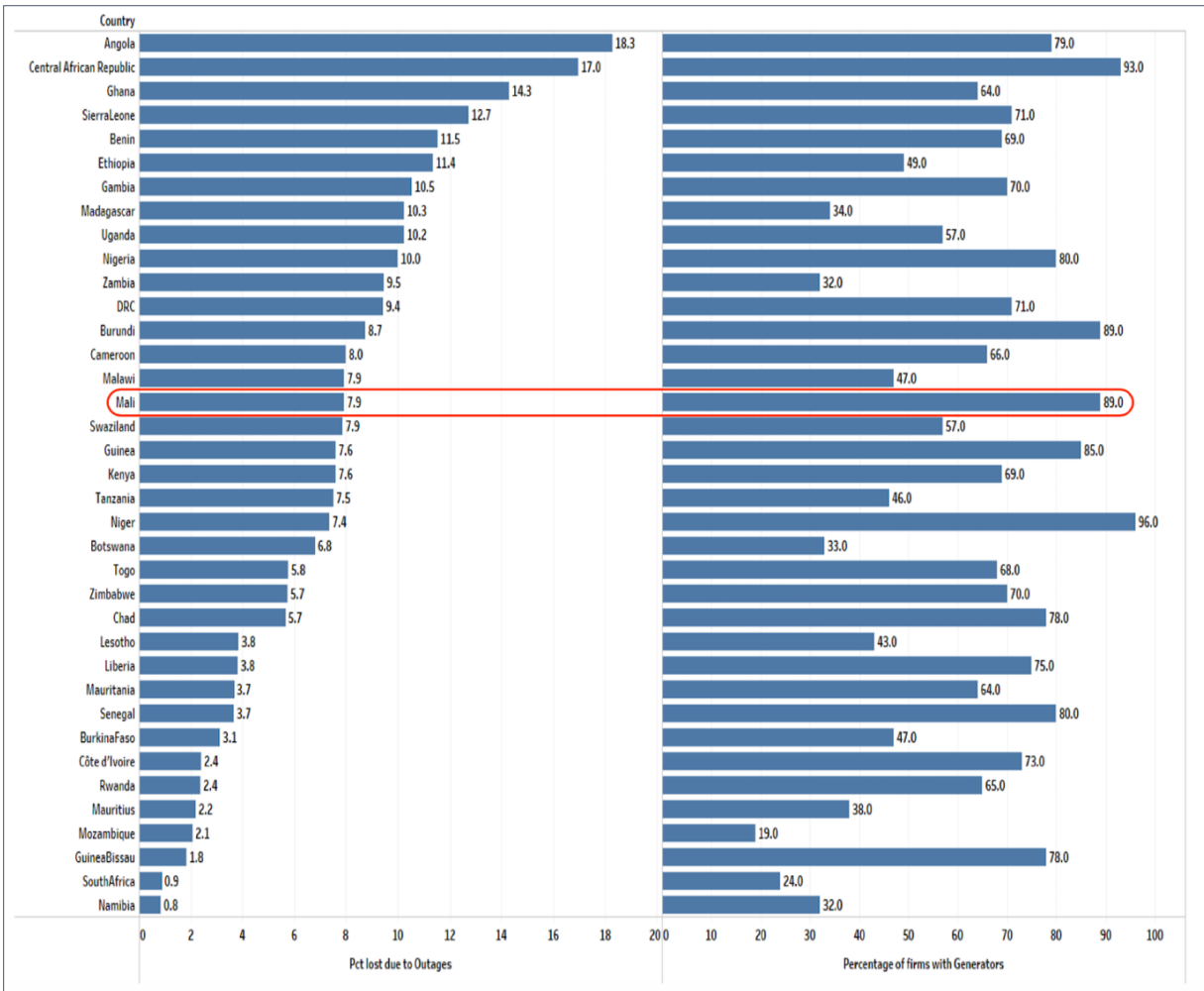
Access to solar powered appliances can have a wide-ranging impact on SMEs, many of which would otherwise rely on diesel generators to power their enterprises. Close to 33% of SMEs in emerging markets use fossil fuel powered generators in order to address energy insecurity.¹⁵⁹ For ECOWAS countries, independent power generation via fossil fuel powered generators is especially prevalent.¹⁶⁰ Electricity supply to Malian firms has significantly worsened in the last decade resulting in annual business sales losses of 7.9% and an increase in the percentage of firms that use generators (**Figure 28**).

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

¹⁵⁹ 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>

¹⁶⁰ Ibid.

Figure 28: Percentage of Sales Lost due to Power Outages and Percentage of Firms with Generator¹⁶¹



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

¹⁶¹ 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.¹⁶²

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 199,125 (**Table 30**).

Table 30: Estimated Cash Market Potential for SMEs – Barbers and Tailors¹⁶³

No. of SMEs with Constrained Access to Finance ¹⁶⁴	Units	kW Equivalent	Cash Value (USD)
953	191	48	\$119,125

Source: World Bank; African Solar Designs analysis

➤ **Value-Added Applications**

Agricultural practices, especially for smallholder farmers, can benefit from a wide range of off-grid solar technologies. Cold rooms and ice production are valuable investments for economies engaged in aquaculture. Solar refrigeration, cooling and processing equipment would enable traders and livestock farmers to sell dairy products. Solar drying of cocoa and palm oil processing are productive use applications that would greatly benefit rural farmers in countries where these products contribute to export revenues. Government efforts continue to prioritize cotton’s value chain due to its importance as an export. The ‘Programme de developpement strategique de la filiere coton’ (2013-2018) was initiated in order to increase cotton production and establish ginning factories.¹⁶⁵ Mali’s cotton value chain is not directly incorporated into this analysis; rather, cotton production is integrated into the assessment of the size of Mali’s irrigation market.

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

¹⁶² 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

¹⁶³ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁶⁴ “MSME Finance Gap,” SME Finance Forum: <https://www.smefinanceforum.org/data-sites/msme-finance-gap>

¹⁶⁵ “Country Sheet on Food and Agriculture Policy Trends,” FAO (July 2017): <http://www.fao.org/3/a-i7617e.pdf>

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. In Mali, rain-fed farming is widely practiced and only one-third of irrigable land is under cultivation. A variety of public sector donor institutions and government have provided substantial support to irrigation efforts.¹⁶⁶ This analysis focused instead on a small-scale private sector driven approach and estimated the market potential for off-grid solar pumping systems to support smallholder farmers.

Solar pumping systems vary in their wattage depending on the area of land irrigated, the depth of water abstracted and the quality of the soil and crops among other factors.¹⁶⁷ 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 Mali are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 29**).

It is important to note Malian farmers may be discouraged from making long-term irrigation investments on their land due to unclear land tenure rights because of competing claims under customary land laws.¹⁶⁸ Additionally, climate change and competing demands by pastoralists and farmers create tension over changing demands for land with productive potential.

In analyzing the available market for solar-powered irrigation, this market scoping exercise focused exclusively on smallholder farmers and solar water pumping irrigation technologies to address their needs. In doing so, this analysis took into consideration the emerging experience with small-scale productive use pumping in East Africa. Small pumps of 80 Wp-150 Wp (e.g. Futurepump and SunCulture) make up the bulk of sales, while larger-sized pumps (e.g., Grundfos) are also frequently marketed to address differing water access and crop conditions.

Table 31 presents the estimated annualized off-grid solar cash market potential for smallholder value-added solar irrigation applications in Mali, which has an estimated cash value of USD 51 million (see **Annex 2** for more details).

Table 31: Estimated Cash Market Potential for Value-Added Applications – Irrigation¹⁶⁹

Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation	Units	kW Equivalent	Cash Value (USD)
471,667	78,611	9,433	\$51,097,222

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

¹⁶⁶ “Feed the Future: Mali Small-Scale Irrigation Project,” USAID and KfW:

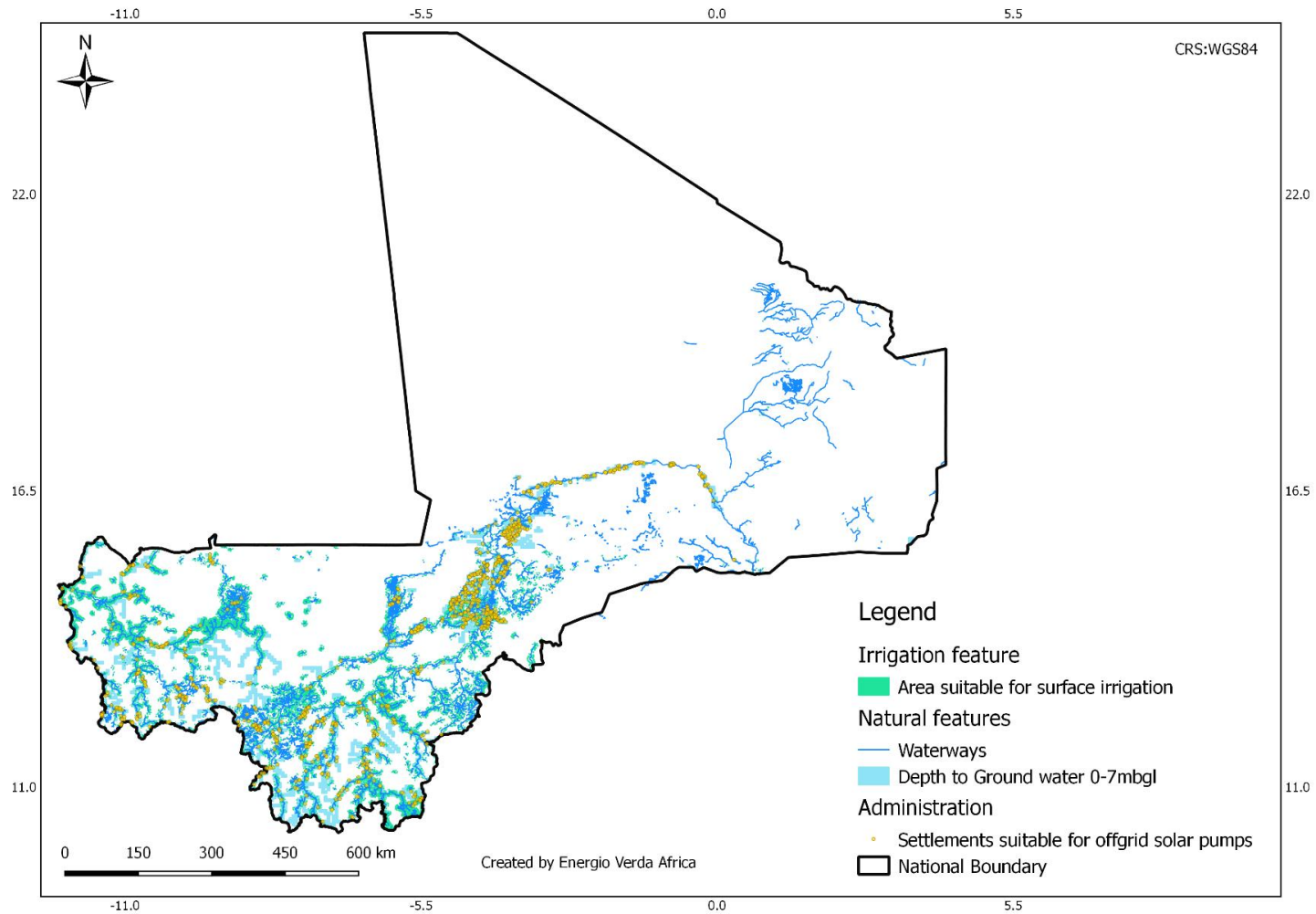
https://www.usaid.gov/sites/default/files/documents/1860/USAID_AEG_-_KfW_Irrigation_Fact_Sheet_-_FTF_-_Nov_16_FINAL.pdf

¹⁶⁷ See GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS

¹⁶⁸ “Country Sheet on Food and Agriculture Policy Trends,” FAO (July 2017): <http://www.fao.org/3/a-i7617e.pdf>

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

Figure 29: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps¹⁷⁰



Source: British Geological Survey, Bureau of Statistics; ESA Climate Change Initiative; Humanitarian Data Exchange (HDX); Energio Verda Africa GIS analysis

¹⁷⁰ 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>; Settlements provided by the Humanitarian Data Exchange, 2016.

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 32 presents the estimated annualized off-grid solar market potential for smallholder value-added solar grain milling applications in Mali, which has an estimated cash value of USD 5.7 million (see **Annex 2** for more details).

Table 32: Estimated Cash Market Potential for Value-Added Applications – Milling¹⁷¹

Estimated No. of Solar Mills	Units	kW Equivalent	Cash Value (USD)
7,098	355	2,307	\$5,767,405

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 33 presents the estimated annualized off-grid solar market potential for smallholder value-added solar refrigeration applications in Mali, which has an estimated cash value of USD 5.1 million (see **Annex 2** for more details).

Table 33: Estimated Cash Market Potential for Value-Added Applications – Refrigeration¹⁷²

Off-Grid Market Centers	Units	kW Equivalent	Cash Value (USD)
7,491	375	2,060	\$5,150,063

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

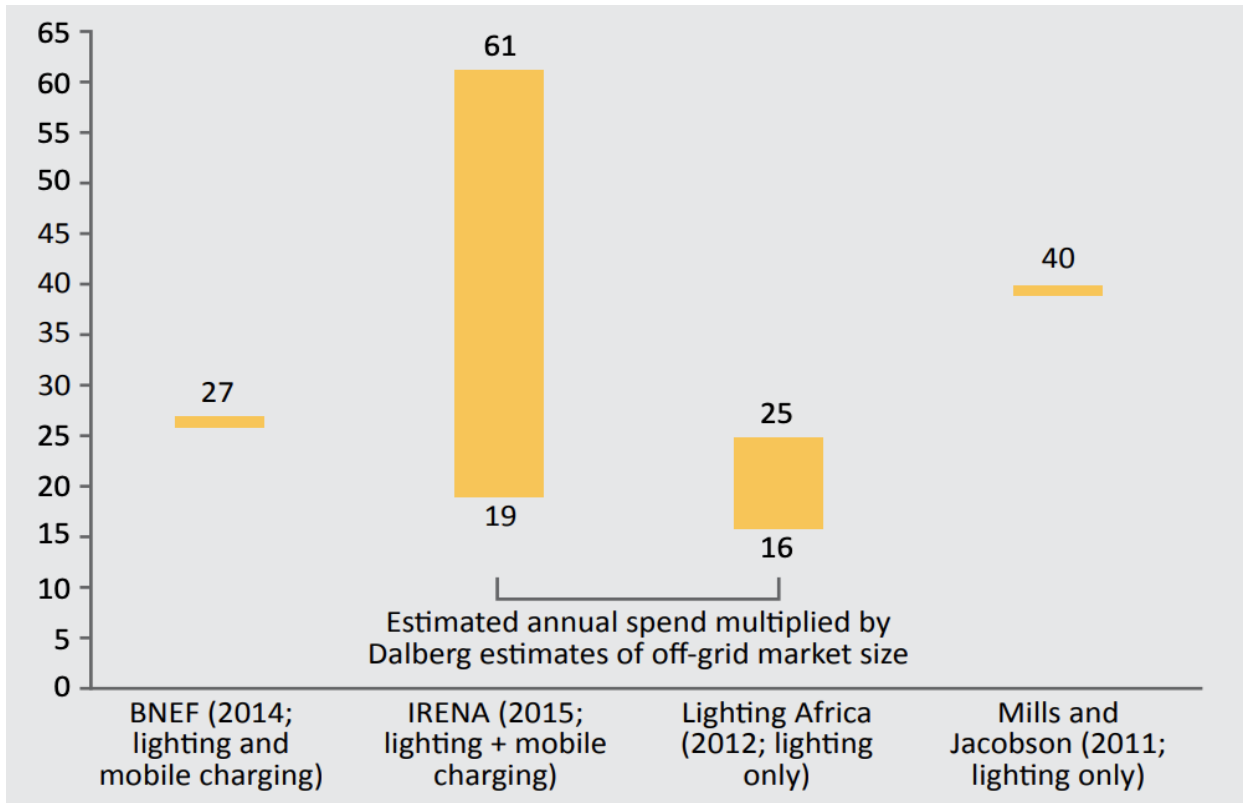
Ultimately, the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry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

➤ **Connectivity Applications**

Mobile phone charging stations/kiosks make up a critical segment of off-grid solar demand, as the market for solar phone charging is expected to grow significantly in the near-term. Household rates of mobile phone ownership often greatly exceed rates of electricity access, while households spend a significant share of income on lighting and phone charging (**Figure 30**). Increasingly, OGS devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

¹⁷¹ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
¹⁷² Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

Figure 30: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging¹⁷³



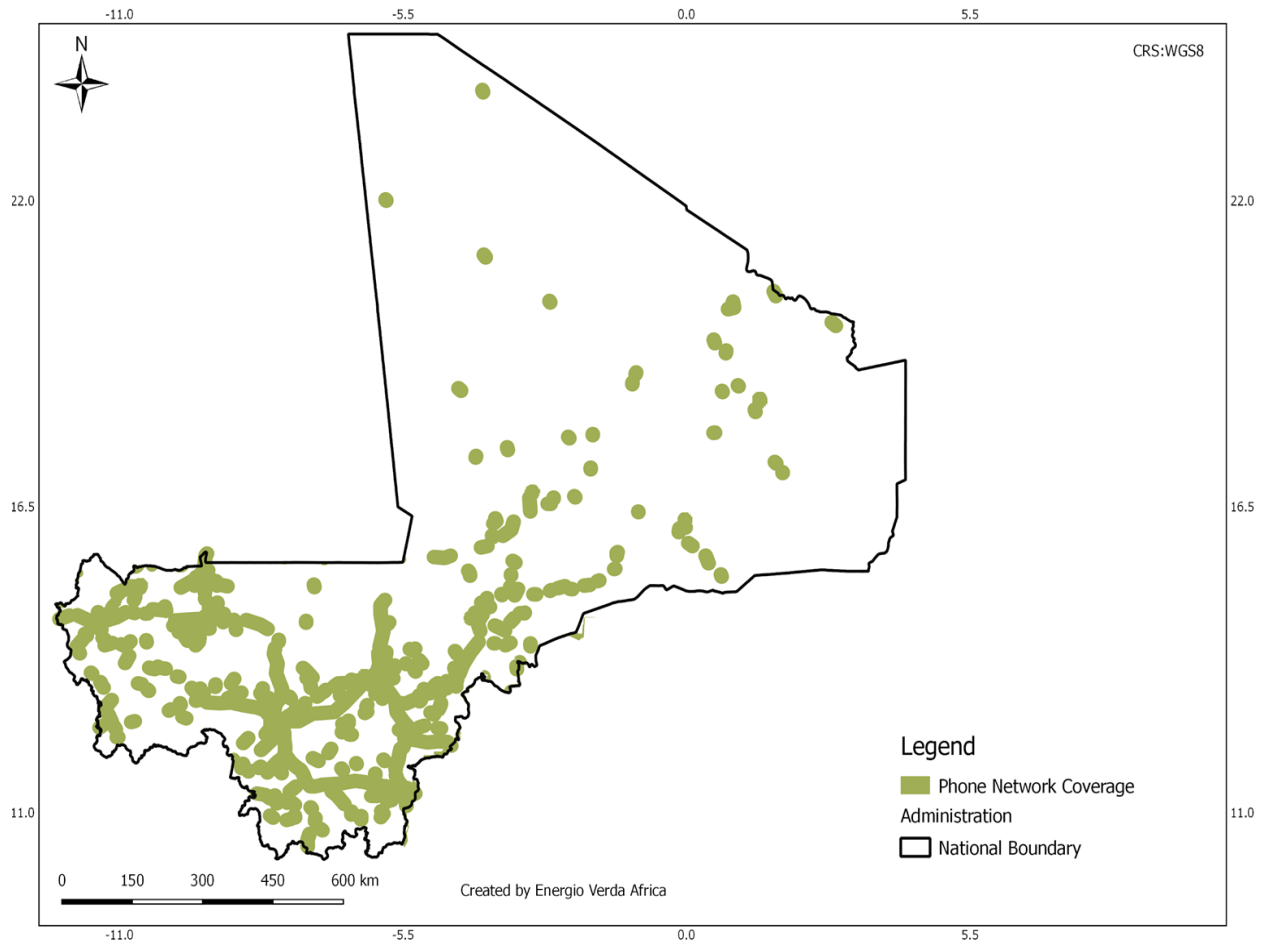
NOTE: Figures in Billion USD

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

Figure 31 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 14**).

¹⁷³ “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 31: Mobile Phone Network Geographic Coverage¹⁷⁴



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 34** presents the estimated annualized cash market potential for off-grid solar mobile phone charging enterprises in Mali, which has an estimated cash value of USD 11.6 million (see **Annex 2** for more details).

Table 34: Estimated Cash Market Potential for Mobile Phone Charging Enterprises¹⁷⁵

Mobile Subscribers ¹⁷⁶	Rural Population (%) ¹⁷⁷	Units	kW Equivalent	Cash Value (USD)
11,400,000	59.3%	13,515	5,406	\$11,649,582

Source: GSMA; World Bank; African Solar Designs analysis

¹⁷⁴ See **Annex 2** for more details.

¹⁷⁵ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁷⁶ “The Mobile Economy: Sub-Saharan Africa,” GSMA, (2017):

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

¹⁷⁷ 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 Mali. 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:

- Despite public and donor-led interventions to lower financial constraints, firms in rural areas still struggle to access financing solutions. Malian firms with a bank loan or line of credit increased from 17% in 2010 to 26% in 2016, however the value of collateral required also increased drastically thus shutting out a lot of small businesses.¹⁷⁸ FGDs also indicated a preference in dealing with micro-lending institutions compared to traditional banks.
- There is also a high degree of skepticism regarding the reliability and quality of solar powered appliances in the current market, and as such, more should be done to raise awareness and set appropriate standards for solar products. Discussants particularly pointed out having to travel to Bamako in search of better-quality equipment.
- Further, most companies cannot afford the up-front cost of solar solutions. A potential solution to this could be to implement consignment schemes to allow distributors to better engage retailers for solar appliances and power systems.

¹⁷⁸ World Bank Enterprise Survey (2016):

<http://www.enterprisesurveys.org/~media/GIAWB/EnterpriseSurveys/Documents/CountryHighlights/Mali-2016.pdf>

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Mali, 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 35**.

Table 35: Solar Company Tier Classification

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

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

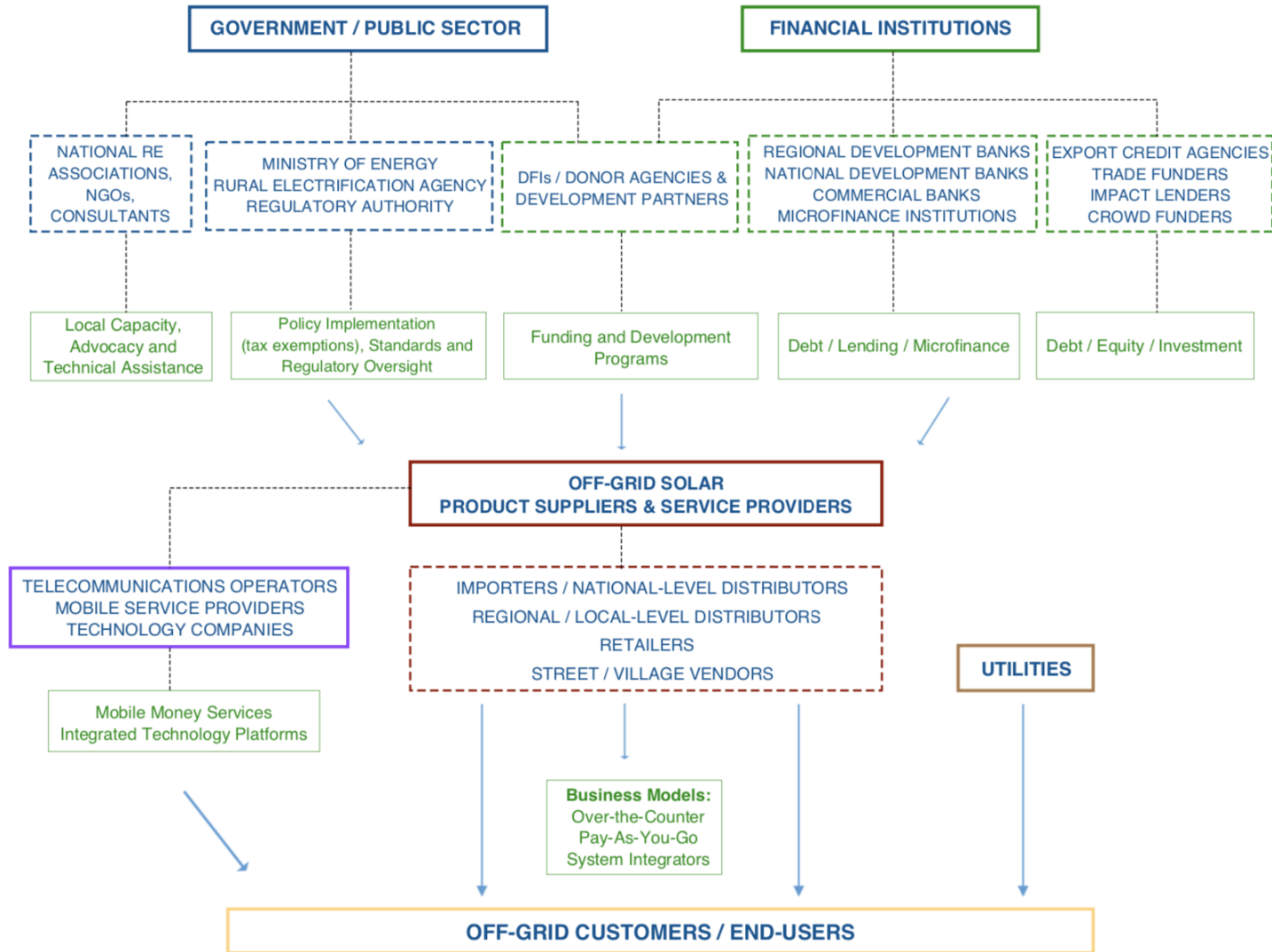
2.4.1 Overview of Commercial Market for Solar PV Equipment

The off-grid solar supply chain in Mali is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 32**). Mali’s solar market is in a period of rapid growth as it is among the largest markets in the region, along with Nigeria, Ghana, Cameroon, and Senegal. In rural areas, notably in Koutiala, purchases of OGS products increase according to the seasonal income of the population (e.g. in the cotton and mining sectors).

The environment and opportunity for solar companies in Mali is improving. A wide range of products and systems are 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. The solar market is made up of a diverse set of actors, includes a solar training body (Solektra Academy) and a favorable regulatory environment where solar equipment is exempt from import taxes. Rural households make up the main market for OGS products in the country, as demand for modern lighting products and household electrical appliances grows. Nevertheless, urban households, both electrified and non-electrified, may play an even larger role as the commercial driver of the market as they tend to have greater ability to afford OGS products and systems. Despite higher levels of grid connectivity in Bamako and its surrounding urban areas, power supply is often not sufficient, continuous, or reliable (**Figure 2**), further supporting expanded use of solar PV equipment by this consumer segment.

While formal companies play an important role in the development of Mali’s solar industry, the informal sector still accounts for a significant share of the overall market. Local stakeholders and focus group participants emphasized the need for a regulatory framework to address the issue of low-quality, uncertified products flooding the market. Access to finance (working capital) for suppliers and awareness raising in rural areas beyond the geographic coverage of companies were also cited as barriers to market growth.

Figure 32: 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.¹⁷⁹ 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 2017.¹⁸⁰

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.¹⁸¹

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 33**. 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.

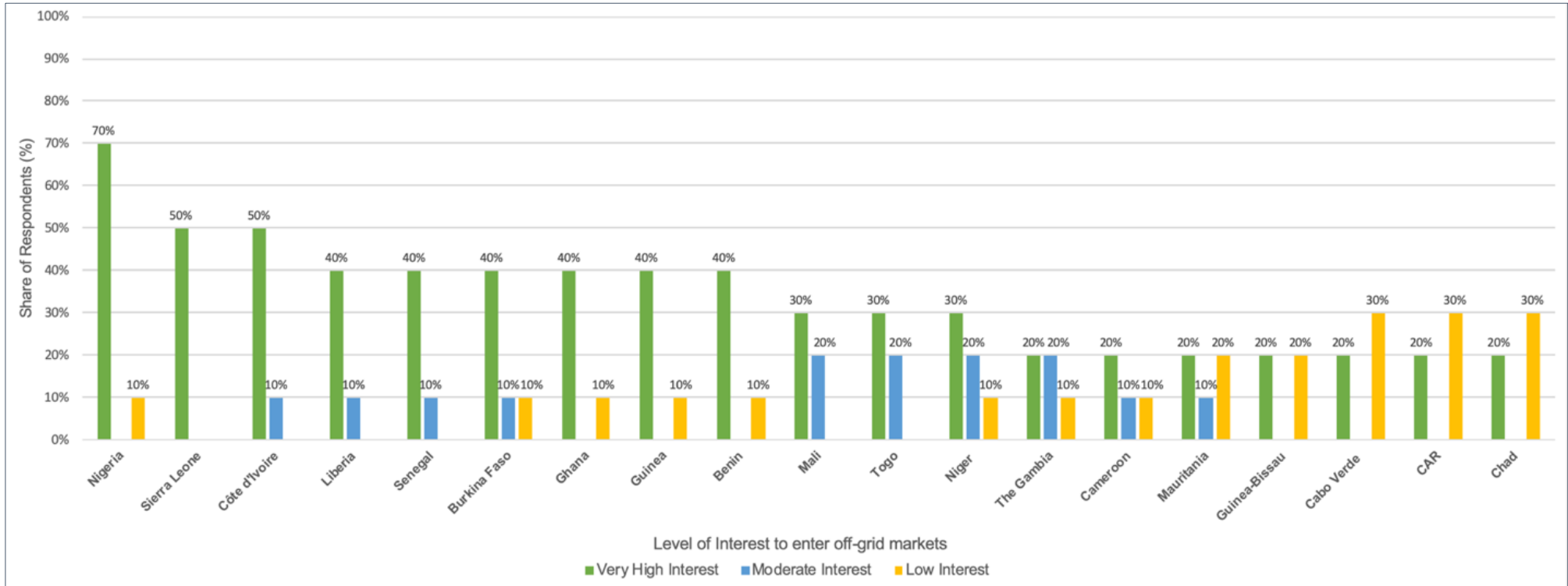
¹⁷⁹ “Off-Grid Solar Market Trends Report, 2018,” Dahlberg Advisors and Lighting Africa, (January 2018):

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

¹⁸⁰ Ibid.

¹⁸¹ “Insights from Interviews with Off-Grid Energy Companies,” ECREEE, (June 2018).

Figure 33: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers¹⁸²



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

¹⁸² 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 Mali

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 more than 50 companies operating in Mali’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 Mali were Tier 1 companies and members of the Solar Professionals Association (Association Professionnelle Solaire, APES).

The country’s major international and regional companies, including Baobab+, Yeelen Djiguima, Yeelen Kura, Oolu Solar, Total Awango, Orange Energie, and Afrika Solar among others, mainly distribute pico solar lamps, plug and play systems and single module SHS. Total Awango, Access, MES International and Oolu Solar are working with AMADER’s rural electrification initiative. Horonya is the only local assembler of solar panels in the country, while Yeelen Djiguima and Afrika Solar also make their own solar equipment locally (in neighboring country Burkina Faso and in Mali). Most local companies have developed international partnerships to grow and specialize in their core business and offer PAYG consumer financing options to end-users.

Yeelen Djiguima¹⁸³ has been distributing Lagazel Kalo pico lamps that are manufactured in Dédougou (Burkina Faso), close to the Malian border and distributed through existing networks of associations and cooperatives. The company offers both the fee-for-a-service model and PAYG consumer financing to their customers. Yeelen Kura was established by French and Dutch utilities EDF and NUON in 1997 and is 100% owned by Dutch Rural Energy Foundation FRES. With financing from the EU, the company distributes solar kits in the regions of Koutiala and Sikasso.¹⁸⁴ Afrika Solar, a Malian and French-based solar startup launched in 2015, uses recycled material to make its own small-scale pico solar lamps.

Further to the market landscape, Oolu Solar is a regional (Senegalese) company operating in Mali, selling pico solar, plug and play systems and SHS, mainly using the PAYG business model. Large international players include French petroleum company Total Awango and French telco Orange Énergie, entered the West African and opened operations in Mali in 2018.¹⁸⁵ The company has partnered with UK off-grid energy provider BBOXX to provide pico solar lamps and single modular SHS through its Orange money PAYG system. Total has partnered with U.S. off-grid energy company d.Light to launch its Awango product series, distributed through Total gas stations network in West Africa.¹⁸⁶ Baobab+ is a branch of French group Baobab that utilizes the group’s microfinance distribution network – Microcred – to reach household users in Bamako. The company has access to international funding and utilizes the PAYG business model.

¹⁸³ “Les lampes Lagzel disponibles à Bamako avec l’appui de la Fondation Antenna,” Lagazel, (January 2018):

<http://www.lagazel.com/single-post/2018/01/17/Les-lampes-LAGAZEL-disponibles-à-Bamako-avec-lappui-de-la-Fondation-Antenna>

¹⁸⁴ “Qui sommes-nous?” Yeelen Kura, (December 2018): <http://www.yeelenkura.com/index.php/qui-sommes-nous>

¹⁸⁵ “Enabling Digital Africa with Orange Énergie,” Mobile World Live, (2018): <https://www.mobileworldlive.com/m360-2018-africa/enabling-digital-africa-with-orange-energy/>

¹⁸⁶ “Etat des lieux du PayGo solaire en Afrique : acteurs, marchés, investissements, produits et tendances,” Innogence Consulting, (2018): <https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Etat-Des-Lieux-Du-PayGo-Solaire-en-Afrique.pdf>

Solar companies operating in Mali have developed a variety of business models to provide services to the off-grid market. Most are manufacturer representatives and distributors for international brands and have also formed partnerships with telecommunications companies and PAYG providers and other local distribution channels (e.g. rural association and cooperatives networks, microfinance networks) to sell their products. Many of these companies make use of PAYG consumer finance, while Yeelen Kura has developed the fee-for-a-service renting system. Companies typically offer installation, operation, and post-sales maintenance services for the products they sell to customers.

Start-up/early-stage companies in Mali (e.g. Yeelen Kura, Horonya, Atlas Electronique, Soninkara Solaire) offer pico solar, SHS, single and multiple modular systems to various market segments. These companies are mainly retailers, but also operate along different segments of the supply chain, including as manufacturer representatives/distributors (e.g. Atlas Electronique) and wholesalers (Horonya and Soninkara Solar Electro). They mainly utilize cash over-the-counter sales as their dominant transaction model.

➤ **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.

Using reports published by GOGLA, some basic market information is presented in **Table 36** and **Table 37**. It is important to note that this data only includes figures from GOGLA-affiliated companies and certified product sales and is therefore not fully representative of off-grid solar market activity in Mali.

Table 36: Total Sales Volume and Cash Revenue for Stand-alone Systems in Mali, 2016-17¹⁸⁷

Sales Volume / Revenue	2016	2017	Total
Total Volume of Products Sold (Units)			
Total Volume of Products Sold	41,601	73,211	114,812
Pico Solar	35,361	68,818	104,179
SHS	6,240	4,393	10,633
Total Cash Sales Revenue (USD)			
Total Cash Sales Revenue	\$1,095,169	\$3,023,285	\$4,118,454
Pico Solar	\$1,051,362	\$2,600,025	\$3,651,387
SHS	\$43,807	\$423,260	\$467,067

Pico solar products categorized as 0-10W

SHS products categorized as >10W

Table 37: Cash and PAYG Sales Volume and Revenue for Pico Solar Products, H1 2018¹⁸⁸

Sales Volume / Revenue	Cash	Share (%)	PAYG	Share (%)	Total
Total Sales Volume Mali	16,448	100%	no data	-	16,448
Total Sales Volume West Africa	194,521	65%	104,520	35%	299,041
% of Total Sales Volume in West Africa	8.5%	-	-	-	5.5%
Total Sales Revenue Mali	\$443,729	100%	no data	-	\$443,729
Total Sales Revenue West Africa	\$14,972,591	50%	\$15,008,999	50%	\$29,981,590
% of Total Sales Revenue in West Africa	3%	-	no data	-	1.5%

NOTE: H1 = First half of year

Source (Tables 36-37): GOGLA, Lighting Global and World Bank; GreenMax Capital Advisors analysis

- 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.
- In 2016-2017, 114,812 units were sold in Mali for a total cash sale revenue of over USD 4.1 million. Sales volume and revenue figures nearly doubled between 2016 and 2017.
- The Malian market was the fourth largest market in terms of sales volume and revenue over this period in the West Africa region. Mali was only behind Nigeria, Burkina Faso, and Benin.

¹⁸⁷ "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/resource_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/resource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

¹⁸⁸ "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

➤ **Main Solar Products and Components**

Table 38 lists the brands of common solar products and components in Mali. The list does not include non-certified brands that are also common in the country’s grey market.¹⁸⁹

Table 38: Off-Grid Solar Products and Components in Mali

Systems	Companies
Distributors of Pico solar & plug and play system	Total Awango, Access, Afrika Solar, Yeelen Djiguima; Yeelen Kura
Single module distributors	Oolu Solar, Total Awango, Access, Orange Energy, Yeelan Kura, Atlas and Soninkara Solaire
Multiple module system distributors	Diawara Solar, Sinergie, ZED, SEEBa, SEECO, Malisol, Aircom, Sonikara, Access, Kama, Yandalux, Emicom, Horonya, Yeelen Kura, Atlas
Very large system supplier	Yeelen Kura, Horonya, Atlas, Soninkara Solaire
Products/Components	Brands
Pico/plug & play system	D.light, Lagazel (Burkina Faso), Bramax (China), Primax (China), France Solar (China), Atlas (China)
Solar panels	Solar World, Yara (Mali brand), Diarra (Mali brand), Bosch (Germany), Germany (Germany), Chine Solar (China), Atlas (China)
Inverter	Power Inverter (China)
Lead Acid Battery	Hoppecke (France), BK (China/Taiwan), Super Power (China), Delta Solar (China), Boya (China), Atlas (China) – Boya and BK noted to sell the largest volumes of batteries

Source: Stakeholder interviews

➤ **Market Prices**

Table 39 presents average prices for off-grid systems and components in Mali’s solar market. As sales volumes continue to grow rapidly, prices of solar products for consumers are comparable to and often lower than prices in more mature markets.

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

Off-Grid System / Component	Price range (USD / per unit)
Pico solar	\$7-\$51
Solar Module (300W-250W)	\$95-\$260
Inverter (> 350W)	\$12-\$775
Lead Acid Battery (30Ah-200Ah)	\$17-\$260

Source: Stakeholder interviews

➤ **Importation Clearance Processes**

For the importation of solar products two government agencies are involved in Mali: Rural Electrification Agency AMADER – only for solar equipment not already listed under the list of Decree No. 2014-0816 / P-RM, from October 27, 2014 – and the Renewable Energy Agency AER-Mali. Solar equipment is exempt from VAT and certain taxes (see Decree No. 2014-0816 / P-RM, from October 27, 2014 on the suspension of the collection of VAT, duties and taxes on renewable energy equipment for imports. This exemption is valid for 5 years and regularly renewed. Other taxes, however, remain in place – the community levy, the

¹⁸⁹ 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.

Community Solidarity Levy, and the Statistical Fee. For a company like Oolu Solar, taxes can represent around FCFA 1.2 million (about USD 2,000) for 1,500 PAYG solar systems.

It takes less than a month for goods to be imported from Senegal (Dakar) to the Malian border and an additional two to five days for customs clearance procedures. There is no need for a government agency to approve equipment already identified in the decree's list mentioned above, unless the agency is directly involved in the importation process or when the equipment is not in this list (e.g. solar televisions).

2.4.4 Overview of Business Models

➤ **Company Approach to Market**

While there is growing diversification of players in Mali, including international distributors and a local assembler, some solar companies have evolved from a traditionally integrated business models to form partnerships with manufacturers, telecommunications companies, PAYG service providers, financial institutions etc., which has allowed them to specialize in their core business while externalizing other activities and services. While many companies have been in business for several years (Yeelen Kura, Sinergie), there are also many recent entrants to the market (i.e. those with less than ten years – mostly less than five years of experience, including Baobab+, Oolyu Solar, Orange Énergie, Total Awango, Yeelen Djiguima). Yeelen Kura, created in 1997, has been operating in Mali's OGS market since 2001.

While some companies continue selling a wide range of products, many have started to specialize in order to focus on specific consumer segments, especially households. For other solar companies, their most important clients are large institutional groups such as institutions, NGOs, public health facilities and schools. Many firms utilize PAYG financing to target low-income households and base of the pyramid customers. Yeelen Kura has launched the Fee-for-a-service renting business model in the region of Koutiala and Sikasso. Companies that only use cash/over-the-counter sales are typically retailers selling low-quality solar products without a warrantee, including a lot of hardware shops in Bamako.

➤ **Business Models**

There are four main business models used in the market (**Table 40**), 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 informal and formal components. Many traders simply offer solar products over-the-counter. Formal sector solar companies also stock modules, batteries and balance of system and offer them over-the-counter to do-it-yourselfers and agents.
- **System integrators** handle large systems and projects. They design, procure and install systems which range from high-end residential sites, to institutional power to mini-grids. Local integrators represent international solar, inverter and battery brands with whom they partner with on projects.
- **Plug and play and pico suppliers** cooperate with many of the major OGS brands to distribute products in the country. Sellers of plug and play systems target customers who can afford more than simple pico lanterns (products are usually sold through PAYG).
- **PAYG** is used widely in Mali and continues to grow. Under this business model, suppliers are gradually building up client bases and are quickly evolving to develop credit mechanisms that fit with local income patterns. Margins are made from subscriptions of thousands of consumers who buy systems through created accounts. The task of installation and after sales services is undertaken by agents. Common products sold include plug and play systems that are fully designed.

Table 40: Overview of Off-Grid Solar Business Models

Business Model	Strategy and Customer Base	State of Development
Over-the-counter solar market	<p>Formal: Retailers in Mali 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. In Mali, Yeelen Djiguima also offers door-to-door sales of solar products.</p> <p>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.</p>	<p>Mature commercial market</p> <p>Early stage commercial development</p>
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. In Mali, a majority of companies deal with social and institutional customers and utilize the procurement model.	Mature commercial market
Plug and Play system supplier	These suppliers distribute equipment to retailers' projects, rural agents, community groups and over-the-counter. Traders of plug and play often sell these devices as part of other businesses.	Early stage commercial development
PAYG Sales	PAYG companies seek to implement the rent-to-own payment-based models used successfully in other countries. The business model is data-driven and relies on mobile money services and a network of agents to meet last-mile customers. Innovative OGS PAYG collaborations between shop-owners, mobile-operators and other larger local businesses are being tested. The PAYG business model is utilized widely and is growing quickly in Mali.	Early stage commercial development

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

➤ **Company Financing**

While many companies utilizing consumer finance, including the PAYG model, to sell off-grid products and systems on credit (sometimes with lengthy repayment periods), it can become difficult for companies to finance their operations and grow their business. In addition to financing customer payment options, suppliers also require significant working capital to purchase high-quality equipment, build-up and renew inventory, buy 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 companies in Mali are self-financed with cash flow covered by shareholders and founders and from on-going business transaction, while some are supported by FI/MFI loans, donor funding/grants and CSR as well as international partners' equity, but these resources are generally limited to Tier 2 and Tier 3 companies. The lack of financing, and more specifically of working capital, was nonetheless mentioned as one of the key barriers preventing the market to grow by focus group discussion stakeholders.

While large international companies operating in the country have access to loans, equity and other international funds to finance their growth and development, many local companies in Mali are unable to raise funds to expand their business. In Mali, local financiers have started to develop an appetite for the renewable energy and solar sectors. Local SME financing exist in Mali, through the Revolving Fund for Employment (FARE) and renewable energy credit lines are also availed to solar companies, although with high interest rates (typically at 10 to 12%). Letters of credit given are provided by some banks to guarantee payment by the solar enterprises to their suppliers SME financing is available for some companies to support businesses in their growth phase. Companies make use of cash-flow/credit line financing against the signed contracts with major commercial clients, large NGOs or donors.

Feedback from industry stakeholders stressed the importance of guarantees for clients who do not pay cash. They also indicated that AER had launched a loan energy initiative in partnership with banks, but the program did not succeed as costs were too high for solar enterprises, procedures were too lengthy (6 months between the beginning of the project and approval by the bank and the actual installation of solar systems) and participation was low among solar suppliers.

When importing, companies are exposed to considerable foreign exchange (FX) risks because they must cover costs of equipment in foreign currency. When projects are delayed, during seasonal low-income periods or when products are delayed in port, dealers must bear FX losses. The development of consumer financing arrangements allows the growth of the solar market because distributors do not have to take all finance risks and can plan with commercial or MFI financing to grow their business. When distributors are availed credit terms by large solar suppliers, they usually avail consumer finance to their final customers.

➤ **Evolving Business Models**

As a nascent solar market, Mali presents a fertile ground for new business model innovations. New models will require partnerships between developers, solar distributors, telco companies, commercial finance and the retail sector. One of the results of the FGD discussions was a list of potential partnerships that can be explored to enhance existing and new business models (**Table 41**).

Table 41: Evolving Off-Grid Solar Business Models

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

2.4.5 The Role of Non-Standard Players in the Market

Stakeholder interviews and FGDs were not able to assess overall market volume. 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 GoM or formal projects.

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

2.4.6 Equipment Quality and the Impact of Uncertified Equipment

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

Interviewed stakeholders in Mali indicated that low-quality does not only involve informal players but also formal players. While most hardware stores could also sell low-quality and non-certified products – e.g. most pico solar lamps are Chinese brands that are short-lived – solar panels distributed under local brands often prove to be low quality products. Quality control was one of the major areas requiring significant support to build the solar industry.

Over 50% of the suppliers who were surveyed cited counterfeit products as a significant barrier to market growth. Poor-quality and/or counterfeit products negatively impact the entire market by creating a misperception about product quality, which in turn undermines consumer confidence in solar equipment. Moreover, grey-market traders significantly undercut the prices of registered businesses who are still subject to taxes and import duties. Low prices of over-the-counter products make compliant products uncompetitive as many customers opt to buy non-compliant goods that are cheaper. Feedback from focus group meetings indicated that there is a lack of control at the equipment level in Mali, while the technical specifications listed on the products can be false. They suggested to establish certified labels for a wider range of products, as the Lighting Global certification is specific to Pico solar lanterns but does not cover other equipment. Stakeholders suggested that there is a role for the recently created Renewable Energy Agency of Mali (AER) and for the Solar Professionals Association (APES), to assist in enforcement of standard and monitor quality control of equipment through mediation efforts between regulatory bodies, market players and consumers.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

Mali'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.

In Mali, the Solektra Academy supports solar PV market development, installation and maintenance through relevant training. However, localized technical capacity is still not sufficient, concentrated mainly in Bamako, and technicians lack necessary qualifications. As a result, focus group participants indicated that Malian players have to seek technical support from foreign stakeholders.

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

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

2.4.8 Capacity Building Needs of the Supplier Market Segment

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

- While the industry's largest players have access to various sources of financing, local financing is largely not affordable to support the sector's development; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations.
- Reasons for denied finance by financial institutions included lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion.
- Knowledge, technical capacity and expertise is possessed by few professionals in the industry working for large established solar companies; the majority of technicians lack the training, expertise or knowledge necessary to adequately service the market.
- Low geographic coverage is an issue, as Bamako concentrates most of active solar players, while solar companies are lacking in rural areas (Yeelen Kura has a quasi-monopoly in Koutiala and Sikasso).
- Lack of consumer awareness, knowledge and understanding of solar systems was noted to be a major

barrier to market growth.

- High cost of equipment and low-quality control. There is a need to improve regulations and develop framework to ensure price control (avoiding price fluctuation), product quality and address issues of low-quality products that compete with certified products sold by formal companies.
- Some of Mali’s solar players are members of the Solar Professionals Association (APES), but interviewed stakeholders noted that the association was not very active, even dysfunctional, whereas APES should have a major role in promoting off-grid solar players interest and lobbying GoM.

Table 42 presents various areas of support and associated capacity building for the OGS supply chain in Mali. Attention should be given to the following:

- **Importers/Suppliers:** Suppliers needs financial support to grow their business. In addition to supporting suppliers, financing should also be made available to end-users to enable them to purchase OGS systems.
- **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.
- **Financial institutions:** Stakeholders in Mali believe that training should not be limited to technicians and solar players but should extend to local FIs and MFIs to improve their overall knowledge of the solar industry, business models and corresponding financing arrangements and products.
- **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 42: Capacity Building and Technical Assistance for the OGS Supply Chain in Mali¹⁹⁰

Area of Support	Description	Rationale
Tax exemptions on solar technology	<ul style="list-style-type: none"> Effective and consistent implementation of solar products import duty clearance 	<ul style="list-style-type: none"> Costs of solar products are inflated by import duties; costs are passed on to customers, making solar less affordable.
Quality control/certification agency	<ul style="list-style-type: none"> Ensure that imported products are suitable/relevant to the local context 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Supplier and consumer education and benefit awareness campaigns, targeting both segments, distributors and retailers, with a focus on rural populations 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Concessionary credit line so financial institutions can access liquidity for solar market lending; create frameworks that avail loans to solar companies (small household systems, larger PV installations, and mini-grids), pilot with aim of scaling out 	<ul style="list-style-type: none"> Long inventory financing periods present a key challenge to growth for solar lantern and solar home system distributors High upfront financing requirements present a key challenge to distributors of larger PV systems (including pumps)
Credit guarantee scheme for inventory financing	<ul style="list-style-type: none"> Private sector lending portfolio is de-risked through guarantees and effect loss sharing agreements to cover irrecoverable inventory loans 	<ul style="list-style-type: none"> De-risking encourages private sector lending to solar sector Initial security until the proof case of economic viability of lending to solar businesses has been established
Market entry and expansion grants	<ul style="list-style-type: none"> Combination of upfront grants and results-based financing to invest in infrastructure and working capital 	<ul style="list-style-type: none"> Significant upfront investment to build distribution network and source inventories to serve household market
Technical assistance	<ul style="list-style-type: none"> Help solar companies set up technology platforms for PAYG Incubation and acceleration of early-stage businesses Capacity building for solar technicians to enable installation and O&M of equipment Assess rural communities needs to inform the right business model case by case Capacity building for suppliers in rural areas Capacity building for local FIs 	<ul style="list-style-type: none"> 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

¹⁹⁰ 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 Mali, 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 43 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 43: Barriers to Off-Grid Solar Market Growth in Mali

Market Barrier	Description
Demand¹⁹¹	
Consumers are unable to afford solar systems	<ul style="list-style-type: none"> • Low-income consumers, particularly in rural areas, lack of access to finance • Purchasing solar products of all varieties among end-consumers remains relatively low.
Lack of initial funding by HHs, businesses and institutions for the initial capital investment	<ul style="list-style-type: none"> • Relatively high costs of OGS systems (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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • A sustainable approach to O&M is critical for long-term success
Supply	
Technical capacity	<ul style="list-style-type: none"> • Technical skills lack through the supply chain within the sector, affecting both the upstream, midstream and downstream, thus adversely affecting the ability of the sector to pick up and grow. Majority of the firms decry lack of adequate number of technicians to support the downstream side of the market
Transportation costs	<ul style="list-style-type: none"> • High transportation costs of inventory deter new entrants; devices and equipment are shipped either from China or from Europe, creating long delivery lead times of up to three months and long inventory holding times once products have arrived in country • Typical supplier payment terms are 30% upon placement of the production order and the remaining 70% upon shipment before any cargo has even left its port of origin. • Transport by container would reduce the costs dramatically; however, this requires purchases in bulk, which local solar distributors aren’t able to make without financing

¹⁹¹ 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	<ul style="list-style-type: none"> A lack of investment into the sector prevents growth; this is due to perceived high risks resulting primarily from lack of track record of sales Solar distributors have limited alternative financing options. Solar suppliers are unwilling to provide trade financing while commercial financiers in Mali, including banks and MFIs, are currently not positioned to service the financing requirements of solar distributors.
Company finance	<ul style="list-style-type: none"> Entrants into the sector require significant working capital, which is not readily available Equity investments are needed into the local distribution/sales companies. It is quite easy to obtain debt financing and other loans once the solar companies have sufficiently grown and reached the “level of interest” of the larger funds; however, until the number of customers and sales volumes are reached, they need some equity investors to share higher risks with the original founders of the companies
Informal sector competition and market spoilage	<ul style="list-style-type: none"> Several informal entrepreneurs have taken advantage of high import duties by illegally importing low-quality solar products ranging from solar lanterns to larger home installations Black-market traders are able to significantly undercut the prices of registered businesses who are still subject to high taxes and import duties These products are largely low-grade, failure-prone counterfeits with short lifespans Damaged perceptions of solar systems durability and reliability hinders market uptake
Lack of data	<ul style="list-style-type: none"> No clear figures on the actual needs, actual usage or experience of consumers The data for the private market players on the available opportunities is very limited and not concise due to fragmented data
High ‘transaction costs’ for solar installations	<ul style="list-style-type: none"> Cash-flow and bureaucratic hurdles for the local suppliers Sales and O&M services in remote areas can be costly, especially for small businesses

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

2.5.2 Drivers of Off-Grid Solar Market Growth

Table 44 is a summary of the key drivers of OGS market growth in the country.

Table 44: Key Drivers of Off-Grid Solar Market Growth in Mali

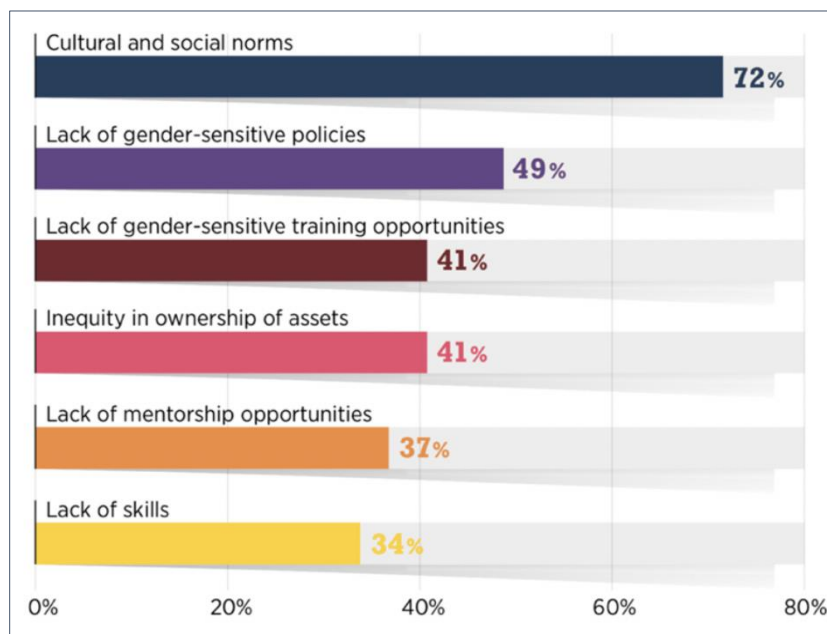
Market Driver	Description
Strong off-grid electricity demand	<ul style="list-style-type: none"> Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	<ul style="list-style-type: none"> The Government is viewed by sector players as forward-leaning and action-oriented, creating and supporting momentum and positive attention for the solar sector, which helps attract substantial and sustained investment to the market
Increased utilization of PAYG	<ul style="list-style-type: none"> While Mali’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	<ul style="list-style-type: none"> Local OGS suppliers are actively engaged in efforts to improve / reform the sector, accept new business models and strategies and take measures to attract external investment
Strong donor/NGO presence	<ul style="list-style-type: none"> The presence and wide range of donor-funded activities in the country’s off-grid sector provides confidence that the market will continue to receive financial and policy support to develop

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

2.5.3 Inclusive Participation¹⁹²

Given that the off-grid market is only beginning to emerge in Mali, 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 34**). 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.¹⁹³

Figure 34: 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.¹⁹⁴ 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.¹⁹⁵

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,

¹⁹² See **Annex 4** for more details

¹⁹³ “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

¹⁹⁴ “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

¹⁹⁵ “Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development,” UN Women, (2018): <http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2018/sdg-report-fact-sheet-sub-saharan-africa-en.pdf?la=en&vs=3558>

technicians, and part time and full-time employees and entrepreneurs.¹⁹⁶ Women also have unique social networks that typically offer greater access to rural households, which can be important to deploying energy access solutions.

Despite these opportunities, women are typically not part of key decision-making processes at nearly all levels of society. Women tend to have limited access to land and capital, as these are often determined by traditional and religious customs that remain deeply rooted in patriarchal traditions. Women also have more difficulty accessing finance due in part to lack of collateral required to guarantee payment and often resort to obtaining loans from money lenders who charge exorbitant interest rates.¹⁹⁷

The gender analysis undertaken in Mali 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)¹⁹⁸
- 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 Mali’s energy and off-grid sectors. Moreover, AMADER has created a joint Gender and Energy Program in partnership with the UN and the World Bank called ‘SHER’ (Hybrid Rural Electrification Project), aimed at increasing access to productive energy for women in rural areas. The AFREA Gender and Energy Programme also supported the assessment of gender specific energy needs in the areas electrified by AMADER followed by an action plan for integrating gender in the agency’s projects. Another related gender mainstreaming initiative is under the UNDP Multifunctional Platform.

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 Mali.¹⁹⁹

¹⁹⁶ “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

¹⁹⁷ See **Section 3.2** for more details.

¹⁹⁸ 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**.

¹⁹⁹ “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/>

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 (**Section 3.2**), including a summary of any off-grid solar lending. **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 6-12 months duration to finance inventory purchases. Yet, such loans are hard to come by for developing off-grid enterprises. Since equipment purchase arrangements are usually denominated in hard currency, loans also in hard currency over such short tenors are often acceptable. Trade finance from export credit agencies (ECAs) and private trade funders may also provide good solutions, but these lenders are often unwilling to finance orders under a few million USD or EUR in value.

➤ **Asset-Based or Receivables Financing**

Once stand-alone solar system providers achieve a portfolio of operating PAYG or LTO installations, the system assets and revenues from customer payments can be used to leverage debt financing to fund business activities and expansion. Typically, a Special Purpose Vehicle (SPV) is established to house the asset portfolio, which is sold by the solar provider to lenders. This form of financing has been widely deployed in East Africa and is also increasingly available in West Africa through a variety of regionally focused specialized debt funds that are focused on portfolio financings in the range of USD 1-10 million.²⁰⁰

➤ **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.²⁰¹

²⁰⁰ 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.

²⁰¹ 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 Malian banking sector has experienced significant growth in recent years, but access to finance remains low for large segments of the population. Although the economy has recovered from the political instability in 2012-2013, ongoing security challenges have prevented the Government from providing basic services in certain areas, which has in turn increased the cost of doing business and negatively impacted the overall investment climate. Despite measures taken by local authorities to address these issues, security risks have delayed broader financial market reforms.

As a member of the West African Economic and Monetary Union (WAEMU, or Union Économique et Monétaire Ouest Africaine, UEMOA), Mali shares a currency with seven other countries in the economic community, the West African CFA Franc, which is pegged to the euro. FIs in Mali are regulated by the Central Bank of West African States (Banque Centrale des États de l'Afrique de l'Ouest, BCEAO) and supervised by the WAEMU Banking Commission. Within this macroeconomic environment, Mali has experienced relatively low rates of inflation and low interest rates, especially compared to non-WAEMU countries. Between 2009 and 2014, the average inflation rate for WAMEU countries was approximately 1%, while the average inter-bank interest rate during the same period was about 4%.²⁰²

The Malian financial sector is dominated by banking institutions and consists of 13 commercial banks and three non-bank FIs, including a leasing company and two guarantee funds – one for mortgage loans and the other for the private sector/SMEs. **Table 45** lists all of the banks and non-bank FIs operating in the country as of 2017 and includes the market shares of each institution, highlighting the concentrated market structure of the banking sector, with the top three banks controlling nearly half of the market.²⁰³

The microfinance sector is made up of 101 licensed MFIs, of which 33 are in operation. MFIs play an important role in the overall financial market as they service nearly the same number of consumers as commercial banks, albeit with a smaller share of overall assets (the 10 largest MFIs account for 3% of total assets of the financial system). The sector is supervised and regulated by the banking commission of the BCEAO, although only 10 of the operating MFIs are large enough to be subject to regulatory requirements.²⁰⁴

Over the last decade, government and public ownership in the Malian banking sector has reduced drastically, as banks that are majority held by foreign private shareholders now control nearly 90% of deposits and loans.²⁰⁵ This dynamic can largely be attributed to an increased presence of WAEMU banks operating across the region. Mali's largest bank, Banque de Développement du Mali (BDM), is following a similar approach. The bank has established subsidiaries in neighboring Côte d'Ivoire and Burkina Faso and is ranked 12th among all commercial banks in WAEMU, holding 2% of the assets of the regional banking system and 3.9% of provisional overall net income.²⁰⁶

²⁰² "The Landscape for Impact Investing in West Africa: Understanding the current trends, opportunities and challenges," Dalberg and Global Impact Investing Initiative, (December 2015):

https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

²⁰³ "Financial Sector Assessment Program – Development Module: Mali," World Bank, (December 2015):

<https://openknowledge.worldbank.org/bitstream/handle/10986/24269/Mali000FinanciOr0assessment0program.pdf?sequence=1&isAllowed=y>

²⁰⁴ MFIs that have deposits or credits greater than CFA 2 million are subject to the Article 44 of the law 007-06-2010.

²⁰⁵ Ibid.

²⁰⁶ "Rapport annuel de la Commission Bancaire de l'UMOA – 2017," Commission Bancaire - Union Monétaire Ouest Africaine, (2017):

https://www.bceao.int/sites/default/files/2019-01/Rapport_Annuel_CB_2017.pdf

Table 45: Financial Institutions in Mali²⁰⁷

Institution	Total Capital (CFA million)	Capital Allocation			Total Balance Sheet (CFA million)	Network (# of branches)	Number of Accounts	Market Share (%)
		National		Foreign				
		Public	Private					
Commercial Banks								
Banque de Developement du Mali (BDM)	25,000	10,228	2,688	12,084	708,491	130	175,057	16%
Banque Malienne de Solidarite (BMS)	34,595	7,805	25,955	835	695,206	47	243,732	16%
Ecobank-Mali	10,000	-	659	9,341	532,618	33	147,553	12%
Banque Nationale de Developement Agricole (BNDA)	26,522	9,674	-	16,848	469,862	51	280,824	11%
Bank Of Africa (BOA)	15,450	-	5,646	9,804	457,396	61	262,386	10%
Banque Internationale pour le Mali (BIM SA)	10,006	1,052	3,852	5,102	399,352	83	273,848	9%
Banque Sahelio- Saharienne pour l'Investissement du Commerce Internatioale (BSIC)	10,000	2,500	2,399	5,101	242,095	15	84,183	5%
Banque Atlantique (BA)	22,000	-	9,899	12,101	304,484	25	61,250	7%
Coris Bank Internatioanle (CBI)	11,000	1,100	-	9,900	205,957	7	7,738	5%
Banque Commerciale du Sahel	14,300	475	5	13,820	138,778	19	28,570	3%
Banque pour le Commerce et l'Industrie du Mali (BCI-Groupe)	12,500	-	-	12,500	125,186	2	417	3%
Banque Internationale pour le Commerce et l'Industrie du Mali (BICIM)	10,000	-	1,500	8,500	114,202	1	5,468	3%
Orabank Côte Divoire Succursale du Mali	-	-	-	-	69,311	12	15,972	2%
Subtotal	201,373	32,834	52,603	115,936	4,462,938	486	1,586,998	
Non-Bank Financial Institutions								
Fonds de Garantie pour le secteur prive	5,961	3,950	2,011	-	23,796	1	-	61%
Societe Africaine de Credit Auto mobile – Alios Finance, Succursale du Mali	-	-	-	-	9,213	1	-	24%
Fonds de Garantie Hypothécaire du Mali	3,036	2,537	499	-	5,755	1	-	15%
Subtotal	8,997	6,487	2,510	-	38,764	3	-	
TOTAL	210,370	39,321	55,113	115,936	4,501,702	489	1,586,998	

Source: UEMOA

²⁰⁷ "Rapport annuel de la Commission Bancaire de l'UMOA – 2017," Commission Bancaire - Union Monétaire Ouest Africaine, (2017): https://www.bceao.int/sites/default/files/2019-01/Rapport_Annuel_CB_2017.pdf

As of 2017, Malian FIs accounted for the fourth largest share (12.7%) of the WAEMU market (**Table 46**).²⁰⁸

Table 46: Market Share of FIs in WAEMU, 2017

Country	Number of Commercial Banks	Number of Non-Bank Financial Institutions	Total Balance Sheet (CFA million)	Market Share (%)
Benin	15	0	3,486,329	9.8%
Burkina Faso	13	4	5,198,407	14.7%
Côte D'Ivoire	28	2	11,095,578	31.2%
Guinea-Bissau	5	0	245,921	0.7%
Mali	13	3	4,501,702	12.7%
Niger	12	1	1,572,520	4.4%
Senegal	25	4	6,788,590	19.1%

Source: UEMOA

According to a number of financial indicators, the Malian banking sector has grown rapidly in recent years, well above the average for Sub-Saharan Africa.²⁰⁹ The sector is predominantly owned by foreign shareholders, most of which are based in Africa. Moroccan banks have the largest presence with majority shareholdings in four banks and own half of total assets, while WAEMU banks are the second largest group, controlling three banks. The sector is moderately concentrated, with the top three banks controlling approximately half of deposits and loans.²¹⁰

➤ **Banking Industry Financial Soundness Indicators**

Assets-Based Indicators: Malian commercial banks are plagued by weak asset quality due to high volumes of nonperforming loans (NPLs) that average 19.3%, well above the WAEMU average of 15.3%. Though performance varies among banks, these rates have slightly declined from a high of 25.4% in 2009. About 30% of NPLs can be described as ‘legacy’ NPLs, which considerably increase the total volume. High NPLs represent a significant challenge for the banking sector and can in part be attributed to ongoing political instability and conflict in the country.²¹¹

To address this issue, the IMF has suggested that commercial banks reduce non-collateralized NPLs and non-operating assets (NOAs) in the banking system that were not fully developed by June 2018 in order to maintain financial system stability.²¹² As of 2017, NPLs are still high at 16% of total loans (**Figure 35**).

²⁰⁸ “Rapport annuel de la Commission Bancaire de l’UMOA – 2017,” Commission Bancaire - Union Monétaire Ouest Africaine, (2017): https://www.bceao.int/sites/default/files/2019-01/Rapport_Annuel_CB_2017.pdf

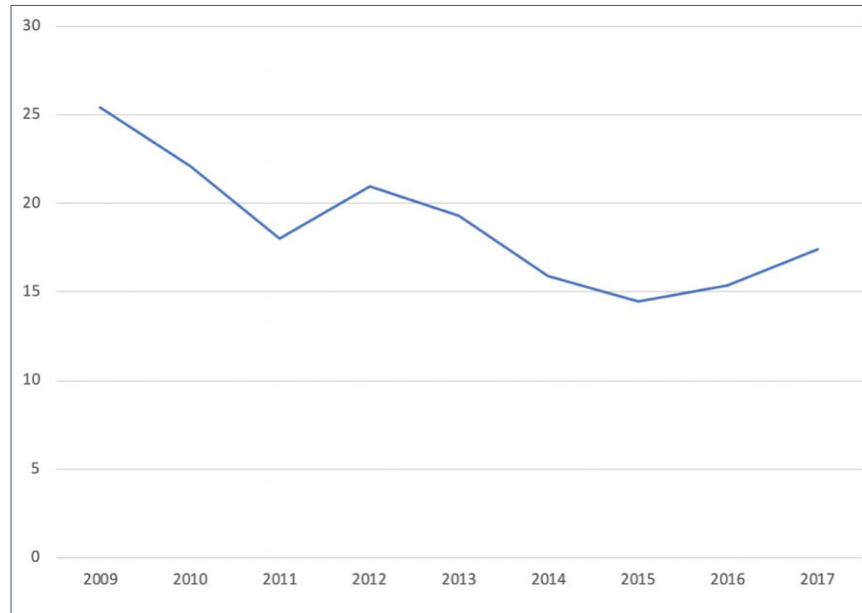
²⁰⁹ “Global Financial Development Report, 2015-2016: Long-Term Finance,” World Bank, (2016): <http://documents.worldbank.org/curated/en/955811467986333727/Global-financial-development-report-2015-2016-long-term-finance>

²¹⁰ “Financial Sector Assessment Program – Mali: The Banking System and Credit to the Economy,” World Bank (December 2015): <https://openknowledge.worldbank.org/bitstream/handle/10986/24269/Mali000FinanciOr0assessment0program.pdf?sequence=1&isAlowed=y>

²¹¹ “Financial Sector Developments and Stability in ECOWAS,” West African Monetary Agency (June 2017): <http://amao-wama.org/wp-content/uploads/2018/05/Financial-Stability-Final-Version-English-for-Publication.pdf>

²¹² “Mali: IMF Country Report No. 18/360,” International Monetary Fund, (December 2018): <https://www.imf.org/en/Publications/CR/Issues/2018/12/12/Mali-Tenth-Review-under-the-Extended-Credit-Facility-Arrangement-and-Request-for-Waiver-of-46457>

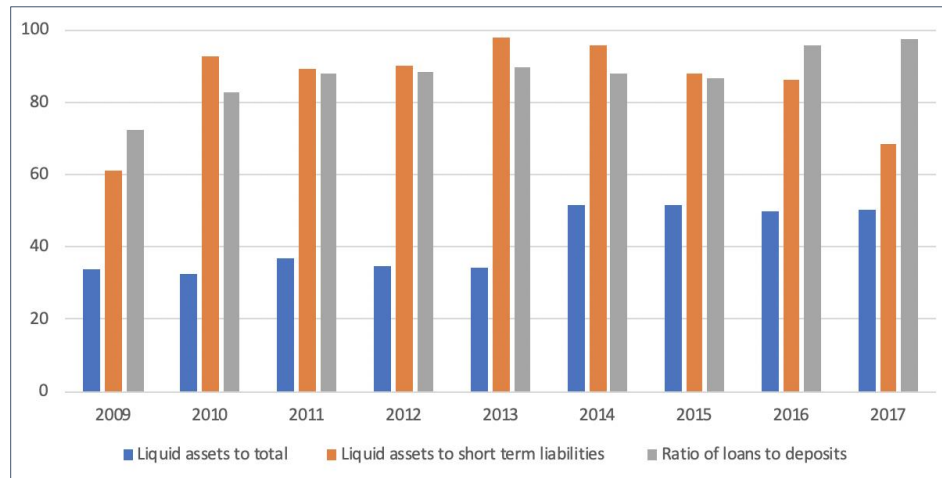
Figure 35: Banking Sector Non-Performing Loans to Total Loans (%)



Source: International Monetary Fund

Banking sector liquidity has tightened due to deposit shortfalls.²¹³ Lending rates have also expanded more rapidly than deposit mobilization in recent years. Since 2009, deposits have grown by 47%, while loans have increased by 64% (Figure 36). Banks have generally been able to maintain a satisfactory liquidity ratio as a result of injections of liquidity by the BCEAO, while competition for deposits has increased.²¹⁴

Figure 36: Banking Sector Liquidity Indicators (%)



Source: International Monetary Fund

²¹³ World Bank Financial Sector Assessment Program, 2015.

²¹⁴ "Mali: IMF Country Report No. 18/142," International Monetary Fund, (May 2018): <https://www.imf.org/en/Publications/CR/Issues/2018/05/31/Mali-Selected-Issues-45922>

Capital-Based Indicators: Overall, the banking sector is adequately capitalized and profitable, although performance varies widely among banks. As of 2017, the average bank capital adequacy ratio (CAR) remained above the WAEMU norm of 11.5% (**Table 47**).²¹⁵

Table 47: Banking Sector Capital Adequacy Indicators

Indicator	2014	2015	2016	2017
Regulatory capital to risk-weighted assets	14.5%	14.8%	14.7%	13.7%
Regulatory Tier 1 capital to risk-weighted assets	13.1%	13.4%	13.2%	12.3%
Capital Net worth in % of Assets	7.1%	7.4%	7.3%	7.3%

Source: International Monetary Fund

Income and Performance-Based Indicators: Malian banks are moderately profitable, with an overall return on assets (ROA) of 1% and return on equity (ROE) of 14.6% in 2017, although returns have declined since a peak in 2014 of 16% (**Table 48**).²¹⁶

Table 48: Banking Sector Income and Expense Indicators

Indicator	2012	2013	2014	2015	2016	2017
Return on Assets (ROA)	1.3%	1.2%	1.1%	1.1%	1.1%	1%
Return on Equity (ROE)	12.5%	14.1%	16%	14%	14.8%	14.6%

Source: IMF²¹⁷

➤ **Distribution of Credit by Sector**

Like other WAEMU member countries, the economy in Mali is generally underfunded. Commercial banks are often unable to meet the financial needs of customers and businesses for loans. Between 2012 and 2018, the largest share of credit has gone to the tertiary sector (**Figure 37**). Despite contributing 40% of GDP and employing roughly 65% of workers, the agricultural sector has consistently received under 5% of overall private sector credit, and most of that is concentrated in the cotton sector.²¹⁸

²¹⁵ "Mali: IMF Country Report No. 18/142," International Monetary Fund, (May 2018):

<https://www.imf.org/en/Publications/CR/Issues/2018/05/31/Mali-Selected-Issues-45922>

²¹⁶ "Bankers without Borders: Global Financial Development Report, 2017-2018," World Bank Group, (2018):

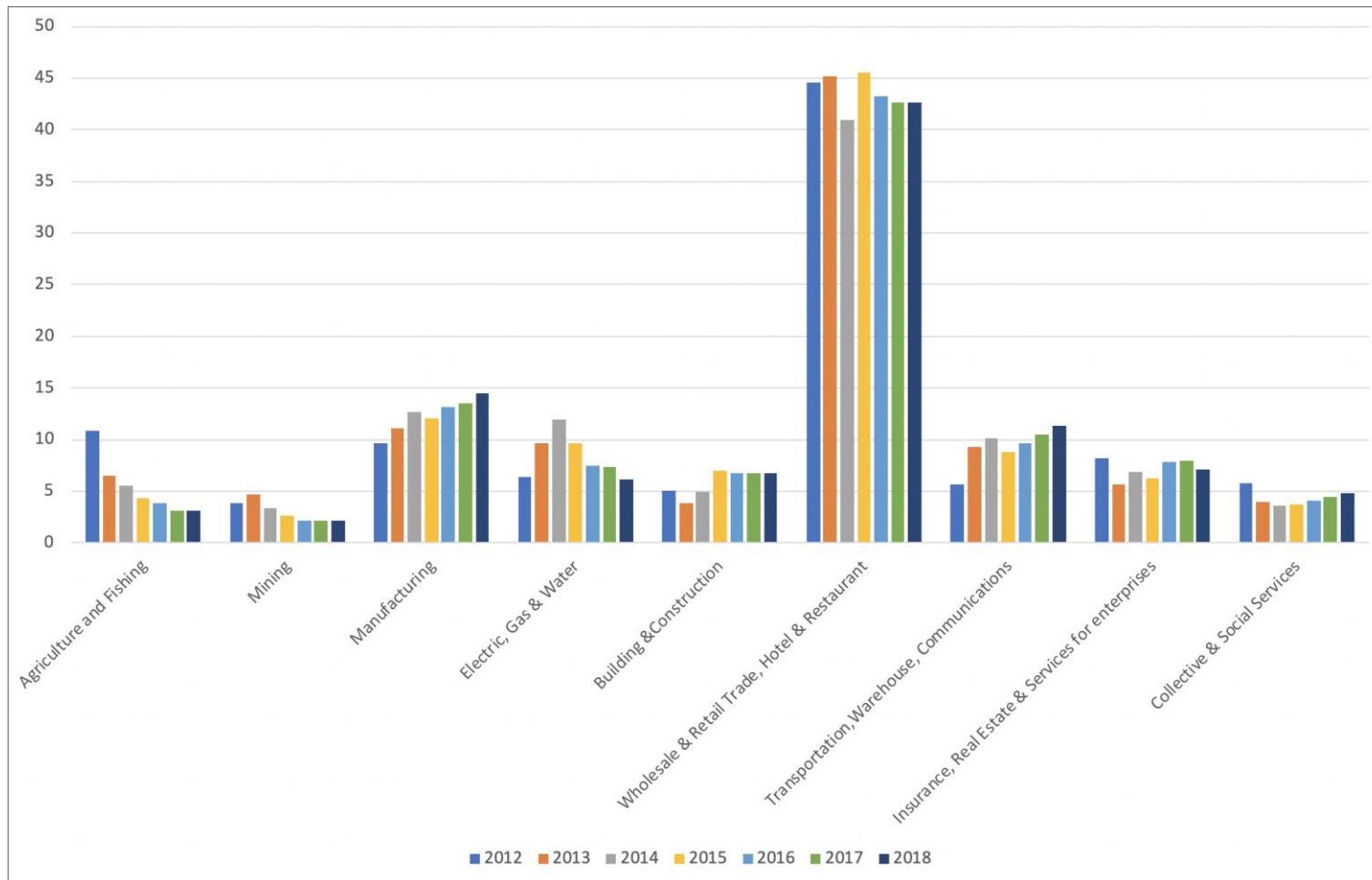
<https://openknowledge.worldbank.org/bitstream/handle/10986/28482/9781464811487.pdf>

²¹⁷ "Mali: IMF Country Report No. 18/360," International Monetary Fund, (December 2018):

<https://www.imf.org/en/Publications/CR/Issues/2018/12/12/Mali-Tenth-Review-under-the-Extended-Credit-Facility-Arrangement-and-Request-for-Waiver-of-46457>

²¹⁸ "Financial sector profile: Mali," Making Finance Work for Africa: <https://www.mfw4a.org/index.php?id=89>

Figure 37: Distribution of Credit by Sector (%)



Source: World Bank

3.2.2 Financial Inclusion

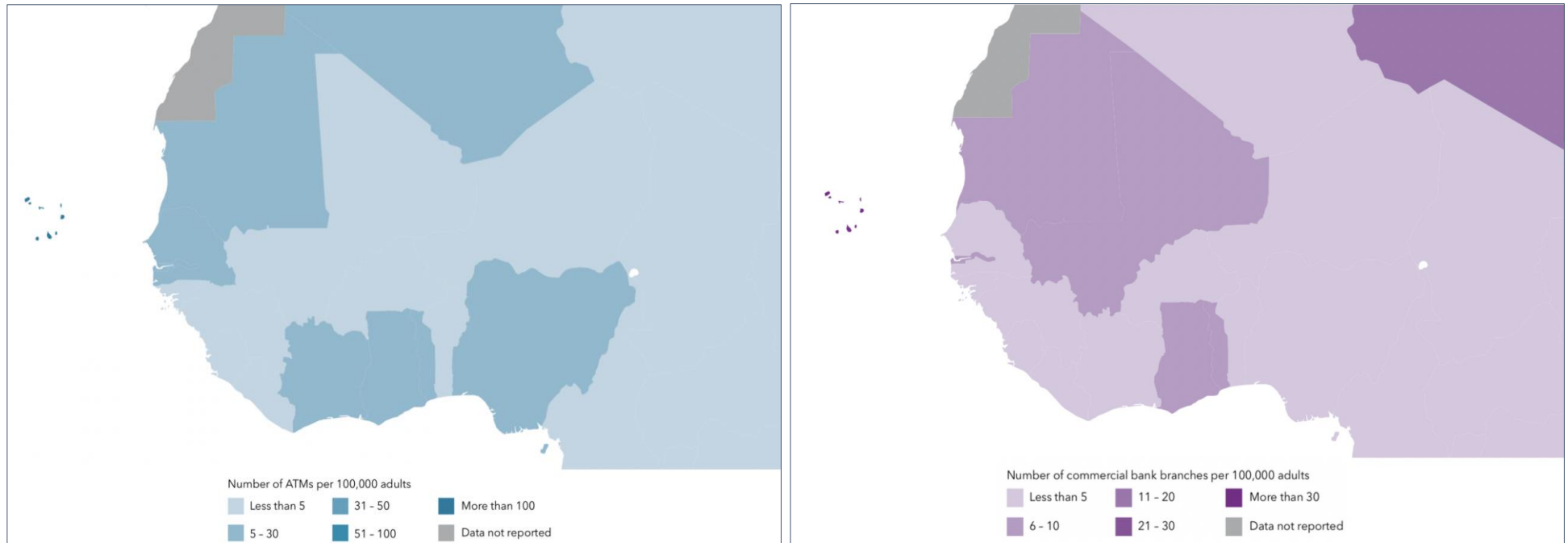
➤ Access to Financial Services

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 38**).²¹⁹ 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%.²²⁰ Many countries across the region, including Mali, have also seen a sharp increase in mobile money account ownership (**Figure 39**) and transaction volume (**Figure 40**).

²¹⁹ “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

²²⁰ Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., “The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution,” World Bank, (2017): <http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf>

Figure 38: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017²²¹

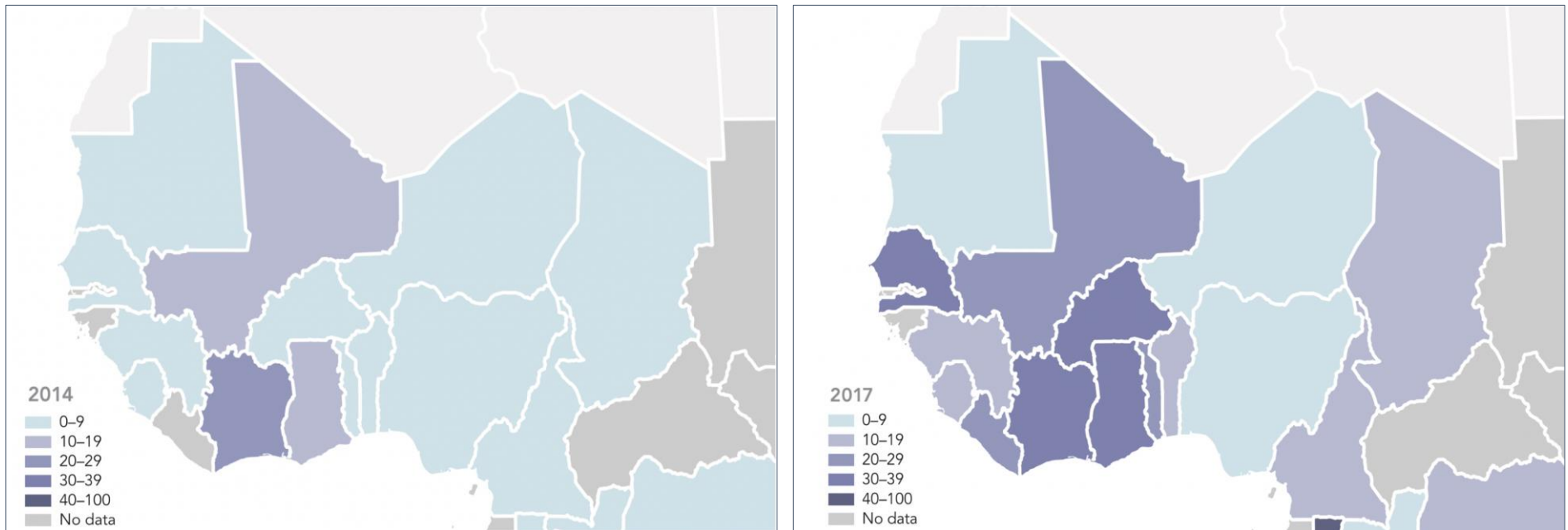


Source: International Monetary Fund

Figure 38 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.

²²¹ International Monetary Fund – Financial Access Survey: <http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&slid=1460054136937>

Figure 39: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017²²²



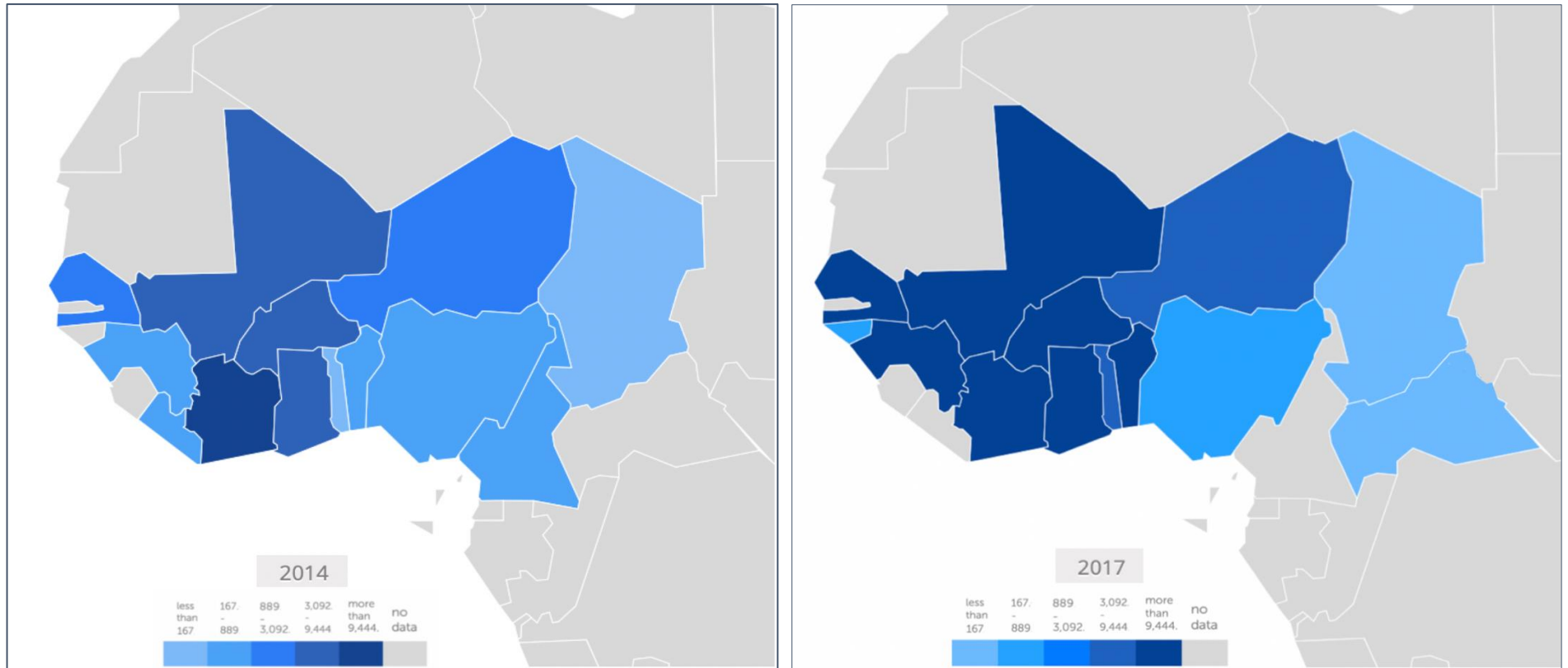
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 39 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.

²²² Demirguc-Kunt et al., 2017.

Figure 40: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017²²³



NOTE: Maps exclude Cabo Verde (no data)

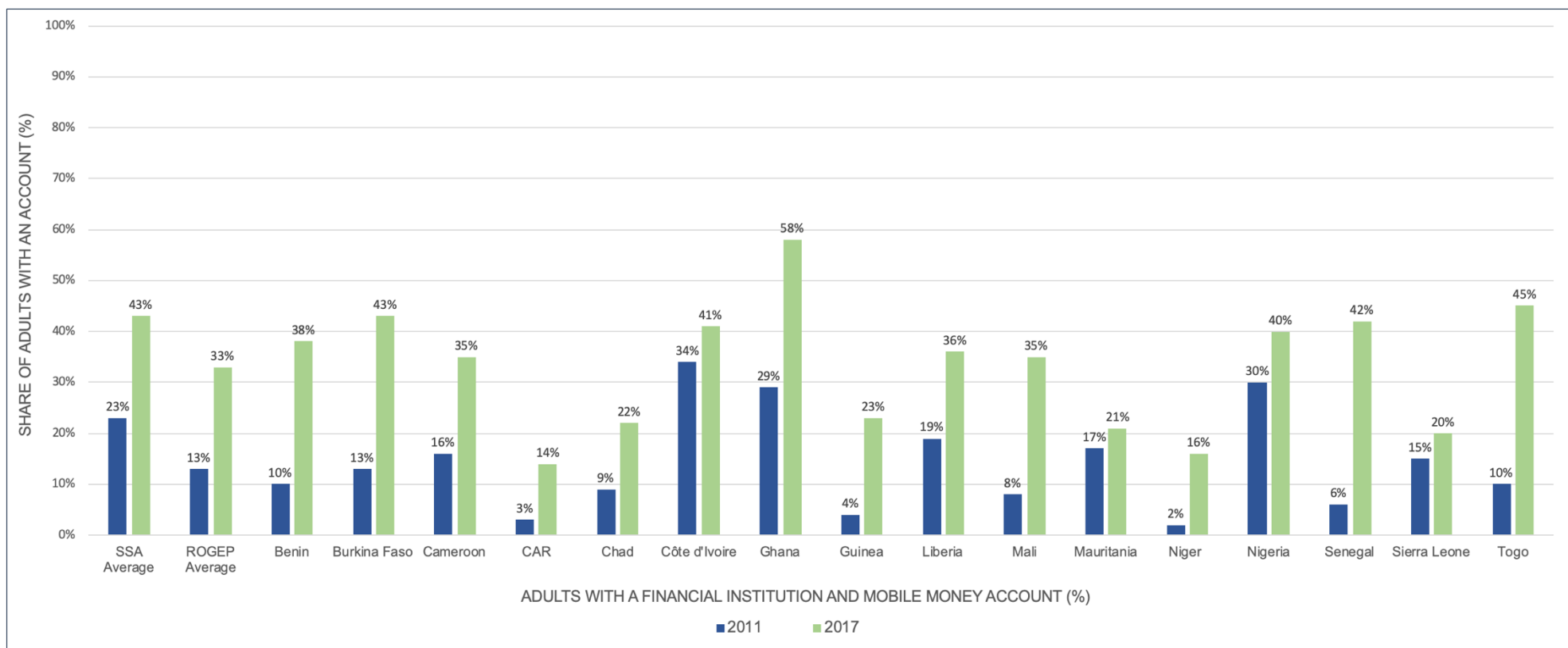
Source: International Monetary Fund

Figure 40 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.

²²³ International Monetary Fund – Financial Access Survey: <http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&slid=1460054136937>

In 2017, 35% of Mali’s adult population had an account at a financial institution or with a mobile money service provider, up from 8% 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 41).

Figure 41: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017²²⁴



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

²²⁴ Demirguc-Kunt et al., 2017.

Mali's high poverty levels and vast territory make financial inclusion a challenge; an estimated four out of five Malian citizens living in rural areas do not have access to finance. The low level of financial inclusion and credit to the private sector can be largely attributed to a weak legal, judicial and regulatory framework for the financial sector.²²⁵ The GoM and regional authorities are taking steps to remediate these factors through the establishment of the following initiatives and policies.²²⁶ These steps include:

- **A regional, private Credit Information Bureau (BIC)** to improve the secured transactions framework, and regulatory reforms.
- **Broadening of existing services** from basic payment services to a more comprehensive menu of remittance, savings, credit, and insurance products.
- **Accelerating change by shifting from cash to digital platforms**, including government payments, such as wages, other government-to-person (G2P) payments such as pensions, and social transfers and person to government (P2B) flows such as fees and taxes.
- **A guarantee fund to promote access to finance for SMEs:** The Private Sector Guarantee Fund is a new Non-Bank Financial Institution that will offer partial risk guarantees to banks and financial institutions for loans to SMEs.²²⁷
- **A United Nations-IFAD-funded rural microfinance program** was set up to improve the access of around 500,000 low-income rural Malians to financial service.²²⁸
- **Promote financial inclusion by expanding access to digital financial services:** With the fast growth in mobile money, there is an opportunity to bring financial services to Mali's rural areas that are not accessible through traditional banking services. The high penetration of mobile phones in Mali has created an opportunity for Malians. Currently, WAEMU has a bank-led model for mobile financial services, but regional authorities are expected to allow non-bank payment service providers in the near future. Orange Money, which currently operates under a licensed bank (BICIM), is the largest provider of mobile payments in Mali and intends to apply for a license as an electronic money provider.²²⁹

The Government of Mali also intends to build upon the financial inclusion policies that are being pursued at a regional level. In 2016-2017, the BCEAO, in partnership with the UN Capital Development Fund and the IMF, organized a series of high-level meetings of key West African policymakers to develop a regional policy and strategic framework to improve financial inclusion. Ultimately, the West African Monetary Union Council of Ministers adopted an action plan that aimed to expand access to financial services to 75% of the WAEMU adult population over a five-year period. The implementation of this strategy is expected to benefit from financial support from various DFIs as well as technical assistance from the World Bank.²³⁰

There are, however, gradual signs of improvement. In 2009, 7.4% of the country's adult population had a bank account. By 2013, the figure had increased to 12.4% of the adult population. As of 2017, access to financial services had improved considerably in Mali, with about one-third of the adult population having an account either at a financial institution or with a mobile money service provider. The country's rapid increase in financial inclusion is driven by the proliferation of mobile money services. In 2016, Mali

²²⁵ "Connected Women – Mapping the mobile money gender gap: Insights from Côte d'Ivoire and Mali," GSMA, (April 2017): https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/CW_Côte_Mali_gendergap_Phase2_V2_WEBOK.pdf

²²⁶ World Bank Financial Sector Assessment Program, 2015.

²²⁷ The Private Sector Guarantee Fund is commonly referred to as Fonds de Garantie pour le Secteur Prive (FGSP) in Mali.

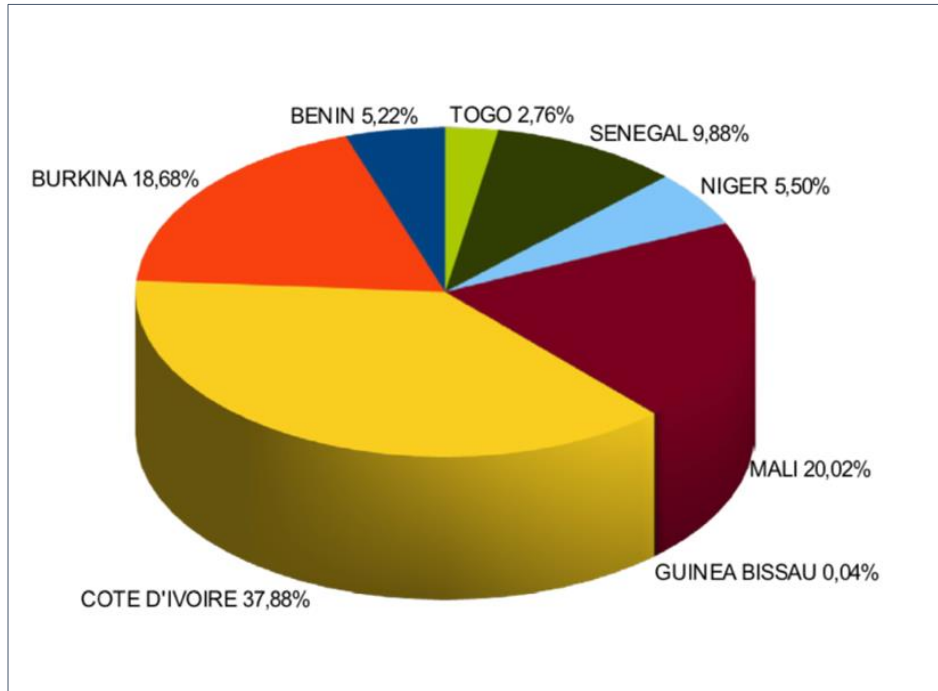
²²⁸ "Toward Greater Financial Inclusion in Mali," FAO, (October 2018): <http://www.fao.org/support-to-investment/our-work/by-area-of-work/area-of-work-detail/en/c/1158437/>

²²⁹ Sangaré, M., "Mobile Money and Financial Inclusion in Mali: What has been the Impact on Saving Practices?" University of Paris, (2014): <https://www.imtfti.uci.edu/files/docs/2015/Sangare%20IMTFTI%20Final%20Report.pdf>

²³⁰ "West African Economic and Monetary Union: Common Policies of Member Countries," International Monetary Fund, (April 2018): <https://www.imf.org/en/Publications/CR/Issues/2018/04/25/West-African-Economic-and-Monetary-Union-WAEMU-Common-Policies-for-Member-Countries-Press-45815>

represented the second largest mobile money market in the WAEMU zone, accounting for the second highest number of subscriptions (6.8 million) and 20% of mobile money transaction volume (**Figure 42**).²³¹

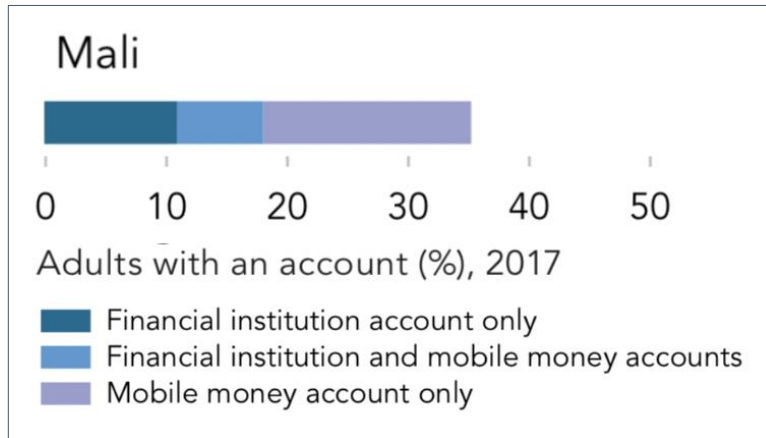
Figure 42: WAEMU Mobile Money Market – Share of Transaction Volume by Country, 2016



Source: BCEAO

In 2017, more adults in Mali had an account with a mobile money service provider than at a financial institution (**Figure 43**).²³²

Figure 43: Financial Institution Account Ownership



Source: World Bank Global Findex Database

²³¹ "Overview of Mobile Financial Services Data in the West African Economic and Monetary Union in 2016," BCEAO, (2016): https://www.bceao.int/sites/default/files/inline-files/3etat_des_services_financiers_uemoa_2016_anglais_.pdf

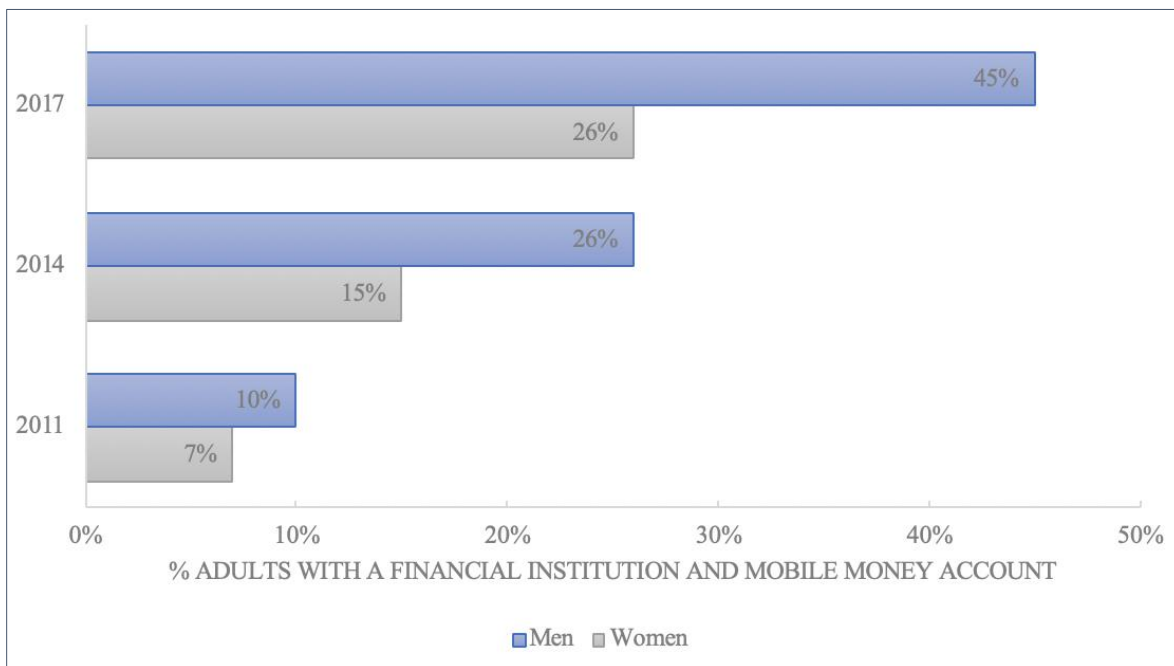
²³² Ibid.

➤ **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. In Mali, the gender gap is significantly higher at 19% (**Figure 44**), as women experience financial exclusion mainly due to low or irregular sources of income and limited access to land and credit. The country’s elevated levels of poverty, social and cultural norms, and lower levels of education and rates of literacy make it difficult for women to access and use financial services.²³³

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.

Figure 44: Financial Inclusion Gender Gap in Mali²³⁴



Source: World Bank Global Findex Database

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. Yet, despite the country’s overall progress, the gender gap in financial inclusion increased from 11% in 2014 to 19% in 2017. This discrepancy is well above the average for the West Africa and Sahel region (14%) and behind only Benin (20%) and Nigeria (24%).²³⁵

Widespread mobile phone ownership (**Figure 15**), rapidly growing mobile internet usage (**Figure 14**) and extensive network coverage (**Figure 31**), have led to the proliferation of mobile money services and

²³³ Demirguc-Kunt et al., 2017.

²³⁴ Ibid.

²³⁵ Ibid.

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 Mali. 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.

3.2.3 Commercial Lending Environment

The spread between lending and deposit rates in the Malian banking sector is among the highest in the WAEMU zone, indicative of the sector’s high credit risk.²³⁶ Less than 12% of SMEs have a loan or line of credit from a financial institution, as bank credit to the private sector remains low. Bank lending is concentrated in T-bills, direct investment into state owned enterprises, and large companies. Firms report that most investments (80% on average) are financed primarily from internal funds or retained earnings, while only 10% come from bank financing.²³⁷

➤ Maturity Structure of Bank Deposits and Credit

In 2016, short-term loans dominated the credit market, representing three-quarters of total loans, well above the WAEMU average of 46% in the same year.²³⁸ However, medium-term credit doubled from 20% in 2005 to nearly 40% in 2015. Typically, growth in longer-term maturities indicates growing market sophistication and economic prospects. Yet, despite the increase in medium-term credit, long-term credit has remained low (**Table 49**).²³⁹

Table 49: Maturity Structure of Bank Deposits

Deposits	2005	2015
Short-term	-20%	40%
Medium-term	20%	32%
Long-term	5%	3%

Source: Making Finance Work for Africa

Despite the recent improvements in performance, most Malian banks provide the private sector with short-term loans (**Figure 45**) due to challenges in contract enforcement and the secured transactions framework, which makes it difficult for banks to recover loans. This in turn has a secondary effect on the private sector, as firms then find it difficult to finance their longer-term investment needs due to higher interest rates and collateral requirements on loans, lack of long-term resources, and regulatory constraints. Another cause for the limited amount of long-term investments is that the majority of commercial bank loanable funds are sourced from other liabilities, such as lines of credit from the BCEAO and North African and European banks, instead of customer deposits. As a result, most bank loans are geared towards financing short-term activities for established businesses, while SMEs have difficulty obtaining access to credit.²⁴⁰

²³⁶ Demircuc-Kunt et al., 2017.

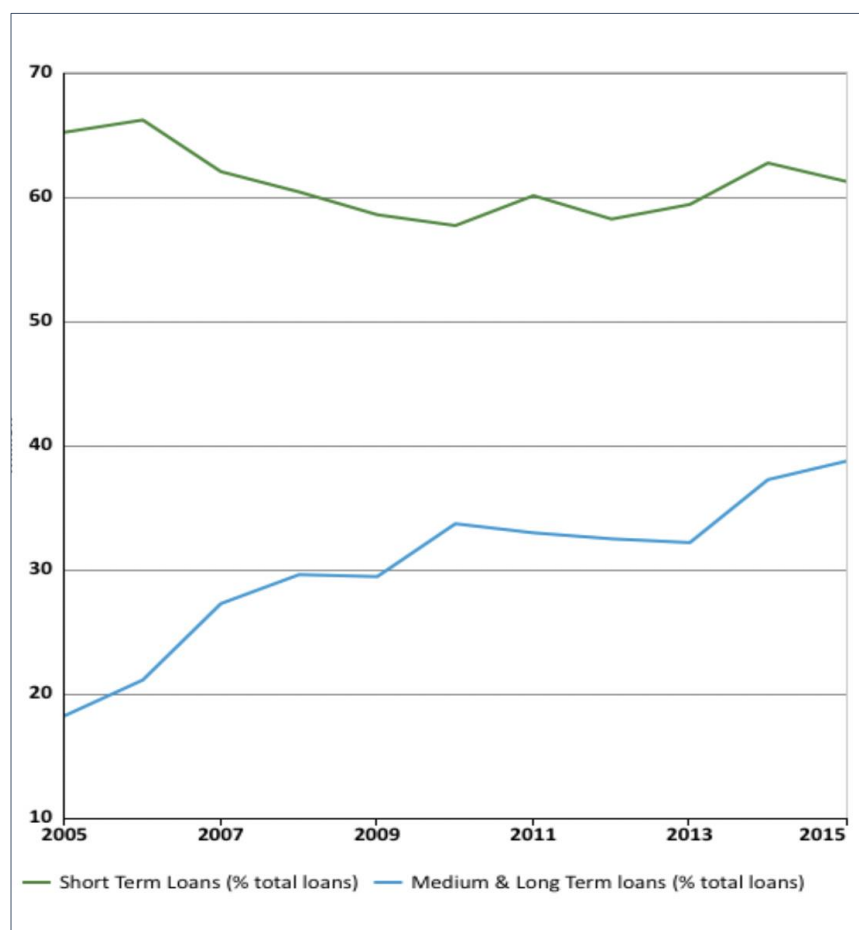
²³⁷ “Financial Sector Assessment – Development Module: Mali,” World Bank, (December 2015).

²³⁸ Ibid.

²³⁹ “Financial sector profile: Mali,” Making Finance Work for Africa: <https://www.mfw4a.org/index.php?id=89>

²⁴⁰ World Bank Financial Sector Assessment Program, 2015.

Figure 45: Maturity Structure of Bank Loans (% of total)



Source: African Development Bank

➤ Interest Rates

As a member state of WAEMU, Mali’s monetary policy is decided by the BCEAO. The BCEAO regional monetary policy is heavily dependent on two types of open market operations: (i) refinancing for one week, and (ii) refinancing for one month, allocated at variable rates.²⁴¹ In 2017, the weighted average rates for refinancing for one week and one month were around 3.75%. The BCEAO central benchmark rate, or central bank rate, has sustained around 2.5% since 2013, while the marginal lending rate, has hovered around 4.5% in recent years.²⁴²

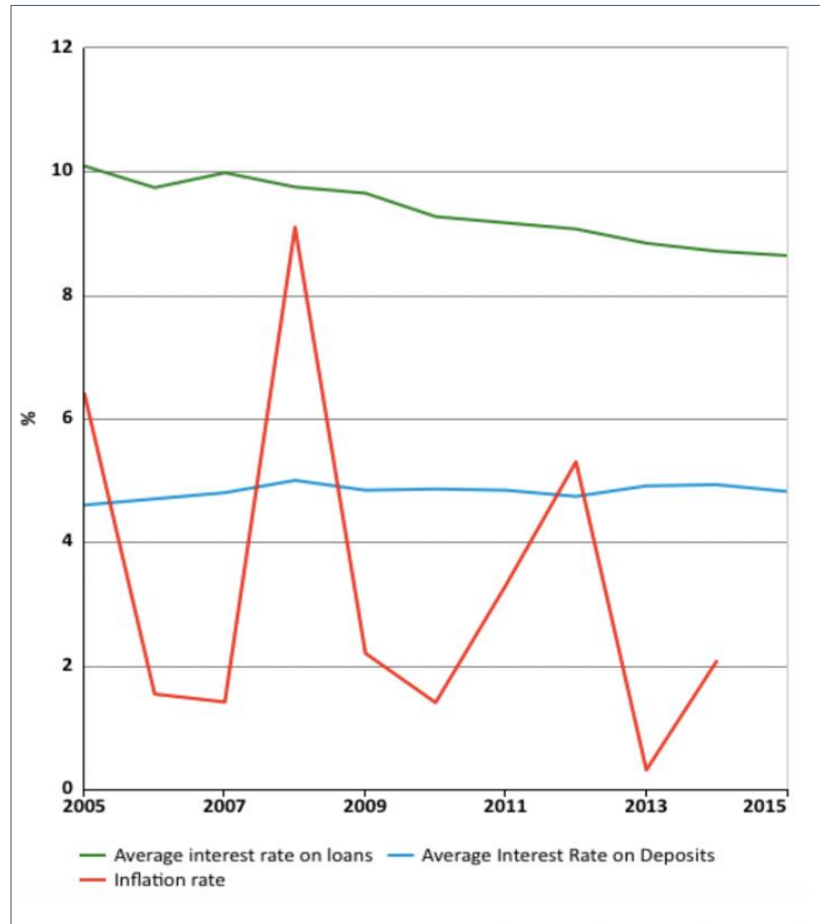
Between 2010 and 2015, Mali’s interest rate spread fell from 4.25% to 3.5%, before increasing to 4.50% in 2017.²⁴³ Over this period, Mali’s average interest rate on loans declined modestly, from 9.4% in 2010 to 8.6% in 2015, while the average deposit rate remained stable at around 4.8% (Figure 46).

²⁴¹ “West African Economic and Monetary Union: Common Policies of Member Countries,” International Monetary Fund, (April 2018): <https://www.imf.org/en/Publications/CR/Issues/2018/04/25/West-African-Economic-and-Monetary-Union-WAEMU-Common-Policies-for-Member-Countries-Press-45815>

²⁴² “Rapport Annuel de la Commission Bancaire de l’UMOA – 2017,” BCEAO, (2018): https://www.bceao.int/sites/default/files/2019-01/Rapport_Annuel_CB_2017.pdf

²⁴³ “Mali Interest Rate,” Trading Economics: <https://tradingeconomics.com/mali/interest-rate>

Figure 46: Interest Rates on Deposits and Loans Compared to Inflation



Source: African Development Bank

➤ **Foreign Exchange Market**

As a member state of WAEMU, Mali’s currency, the CFA franc, is pegged to the Euro. The BCEAO therefore follows the monetary policy of the European Central Bank, which effectively sets interest rates for the CFA franc zone. This pegged exchange rate system limits the ability of member states to quickly respond to shocks. At the same time, CFA zone countries survived the recent collapse of oil prices and commodities without suffering from currency collapse, inflation and fiscal distress like other West African countries.²⁴⁴ In general, the CFA franc monetary zone consistently outperforms other Sub-Saharan countries in terms of inflation rate and overall macroeconomic stability.

The CFA franc is backed by a guarantee from the French treasury for the convertibility of the CFA franc into Euros at the fixed exchange rate at the Paris Stock Exchange.²⁴⁵ This provides stability and credibility to the currency. The common currency also expedites trade by removing foreign exchange between member states. This includes the eight members of WAEMU as well as the six countries in the Economic and

²⁴⁴ Cappola, F., “In Africa: Understanding the CFA Franc and its Foreign Exchange Rate Impact,” <https://www.americanexpress.com/us/foreign-exchange/articles/cfa-franc-and-its-foreign-exchange-rate-impact/>

²⁴⁵ Hallet, M., “European Economy: The role of the Euro in Sub-Saharan Africa and in the CFA franc zone,” European Commission Directorate-General for Economic and Financial Affairs, (2008): http://ec.europa.eu/economy_finance/publications/pages/publication13478_en.pdf

Monetary Community of Central Africa (Communauté Economique et Monétaire de l’Afrique Centrale, CEMAC). On a regional level, there are plans to implement a single currency across all of West Africa by 2020, although there are many hurdles to overcome before this degree of macroeconomic convergence can be achieved.²⁴⁶

Table 50 shows the official exchange rate of CFA to USD between 2013 and 2018.

Table 50: Official Exchange Rate (CFA-USD)²⁴⁷

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

Source: International Monetary Fund

➤ **Collateral Requirements**

A common problem in the West African Economic and Monetary Union is poor judicial processes regarding collateral registry and recovery, as well as a lack of available credit information about the borrower. Hence, most commercial banks require high amounts of collateral in order to mitigate consumer credit risk. As a result, a majority of firms in the country are unable to obtain loans due to high costs of credit, insufficient funds offered, the short maturity of the loans, and/or the amount of required collateral. Collateral requirements for a loan in Mali vary widely, from 50% up to 120%. Banks seek assets such as landed property, cash and inventory, and personal guarantees as collateral.²⁴⁸

➤ **Banking Supervision**

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

The central bank also implemented regulations to improve its ability to enforce existing regulations. The instructions focused on how to set up internal audit systems, compliance audit systems and provisional administration for BICs. The provisions also defined the sanctions applicable to BICs and established the amounts required to set up a special reserve to ensure their long-term viability. Reporting systems and procedures were also put in place to ensure that financial statements of credit institutions were reliable and also prepared in a timely manner.²⁴⁹ Mali adopted these regulations in 2016.

²⁴⁶ Liedong, T., “Could West Africa introduce a single currency?” CNN, (August 8, 2017):

<https://www.cnn.com/2017/08/08/africa/single-currency-west-africa/index.html>

²⁴⁷ International Financial Statistics (IMF): <http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B>

²⁴⁸ Stakeholder interviews, 2018.

²⁴⁹ “2016 Annual Report,” Banque Centrale des Etats de l’Afrique de l’Ouest (BCEAO), https://www.bceao.int/sites/default/files/2017-12/2016_annual_report_2.pdf

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 Mali’s off-grid solar market (see **Section 1.2.2.1**), these funds have largely 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.

In 2015, several banks in Mali signed an agreement with the Ministry of Energy to support the dissemination of individual solar kits throughout the country under the Projet Prêt Energie Renouvelable from 2015 to 2017. The banks that participated in the project were Banque Atlantique, Bank of Africa, BDM, BMS, BICIM, BIM, BNDA, BSIC, and Ecobank.²⁵⁰

3.2.4.1 Programs Supporting Financial Institutions in Off-Grid Solar Lending

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

SUNREF is a credit line provided by AFD for financial institutions and their clients that aim to fund clean energy projects. SUNREF includes TA and credit facilities to provide banks with the necessary long-term financing to overcome financial barriers met by project sponsors. The program is open to companies seeking to obtain easier access to green finance and banks seeking to develop their green finance portfolios. In 2014, Orabank, Société Générale and AFD signed a partnership agreement to launch SUNREF’s West Africa program, which makes a EUR 30 million (CFA 19.6 billion) credit line available to banks in the WAEMU (Benin, Burkina Faso, Côte d’Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo).²⁵¹

3.2.4.2 Key Barriers to Off-Grid Solar Lending

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

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

➤ **Maturity Structure of Bank’s Funding**

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

²⁵⁰ Dechaine, Canard, “Production d’Energies Renouvelables : Dix Banques Passent au Vert,” maliweb.net, (October 2015) : <https://www.maliweb.net/economie/energie-du-mali/production-denergies-renouvelables-dix-banques-passent-au-vert-1205712.html>

²⁵¹ SUNREF: <https://www.sunref.org/en/sunref-elue-meilleure-solution-financiere-pour-lenergie-durable-en-afrique-de-louest/>

➤ **Low Private Sector Credit**

Commercial bank credit to the private sector remains weak and continues to constrain development of the OGS sector. As described in **Section 3.2.2**, access to finance remains a key barrier in the country. The use of bank loans for working capital and investment is extremely low. This hinders solar companies from investing in the growth of their business and expansion of their operations.

➤ **Lack of Credit History/ High Collateral Requirements**

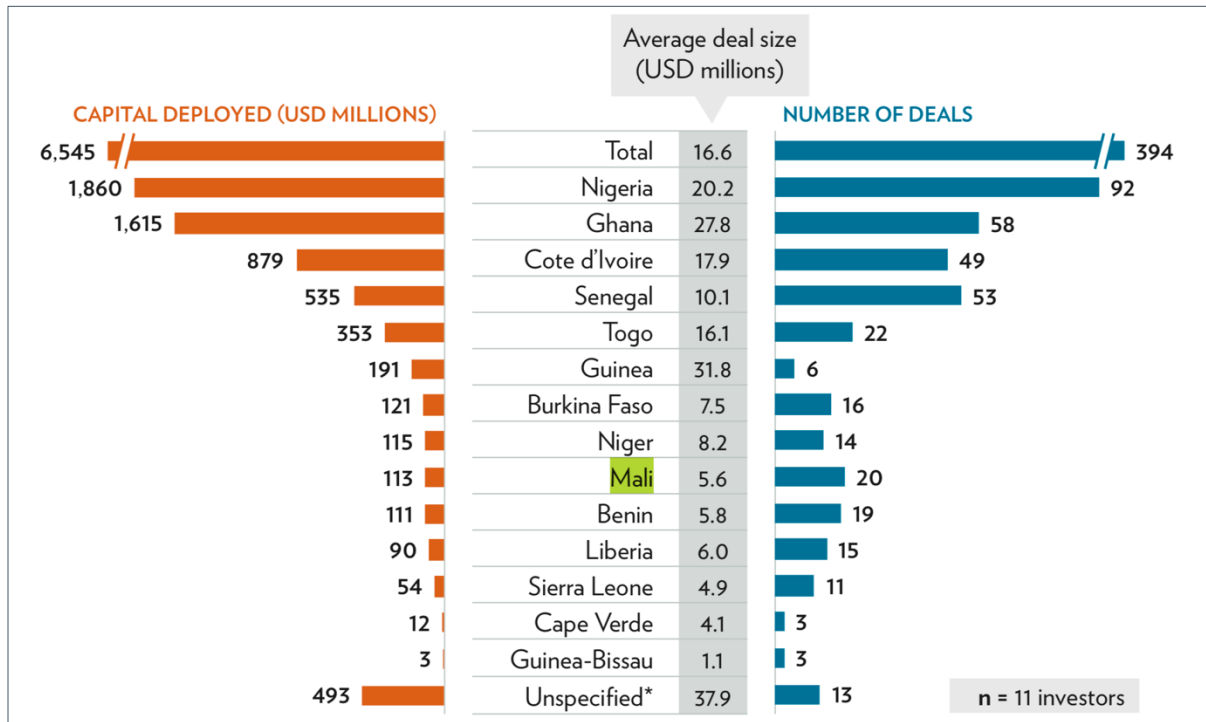
As described in **Section 3.2.3**, consumers in Mali face stringent collateral requirements. Many consumers also lack basic financial literacy and knowledge about the terms and conditions of financial products and therefore struggle to obtain loans. The lack of credit history/track record and the weak balance sheet of most off-grid solar enterprises is a critical barrier that often prevents these firms from meeting the collateral requirements of banks. When compared to domestically-owned enterprises, foreign-owned firms are typically more likely to obtain financing. All of the interviewed commercial banks indicated that credit guarantees would be necessary to encourage lending to the off-grid sector.

3.3 Financial Institutions²⁵²

3.3.1 Development Finance Institutions

Between 2005 and 2015, Mali received a total of USD 113 million in DFI funds with an average deal size of USD 5.6 million; the amount comprised under 2% of the total DFI investment across West Africa over this period (**Figure 47**).²⁵³

Figure 47: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Apart from the above-mentioned AFD/PROPARCO SUNREF program, DFI programs that are relevant to the off-grid solar sector in Mali 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.²⁵⁴

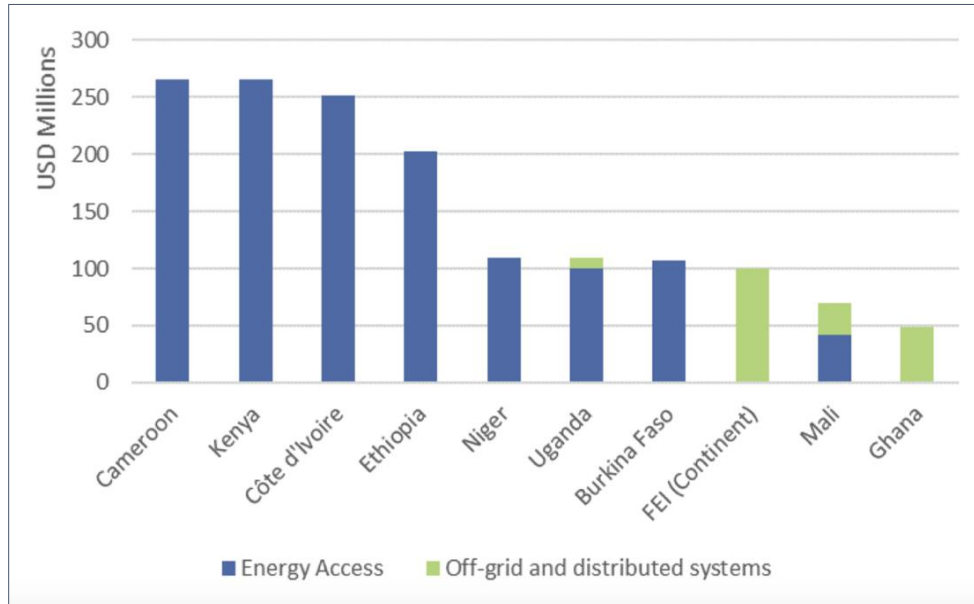
²⁵² Excluding commercial banks, which are reviewed in detail in **Section 3.2**.

²⁵³ "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

²⁵⁴ "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 launch of the FEI in 2016 led to a significant increase in AfDB financing for distributed renewable energy throughout Sub-Saharan Africa. Mali received approximately USD 60 million in energy access financing from AfDB between 2014 and 2017 (**Figure 48**).

Figure 48: Distribution of AfDB Energy Access Financing in Sub-Saharan Africa, 2014-2017²⁵⁵



Source: Oil Change International and Friends of the Earth U.S.

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.²⁵⁶ The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d’Ivoire, Ghana and Nigeria.²⁵⁷

➤ **International Finance Corporation (IFC)**

In June 2018, the IFC announced it had invested USD 60 million in a regional risk-sharing facility to support Bank of Africa Group’s lending to SMEs in eight African countries, including Mali. Half of the facility is earmarked for women-run businesses, and for climate-related improvements, such as energy efficient equipment upgrades, small solar systems, and climate-smart agricultural supply chains. IFC’s investment will cover up to 50% of the risk on these SME loans.²⁵⁸

²⁵⁵ 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>

²⁵⁶ Facility for Energy Inclusion – Off-Grid Energy Access Fund: <https://www.ogefafrika.com>

²⁵⁷ “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/>

²⁵⁸ “IFC Invests in Bank of Africa to Expand SME Lending in Eight Countries,” International Finance Corporation, (4 June 2018): <https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/947B76E4C106A246852582A200440E1C?OpenDocument>

3.3.2 Economic Development Finance Institutions

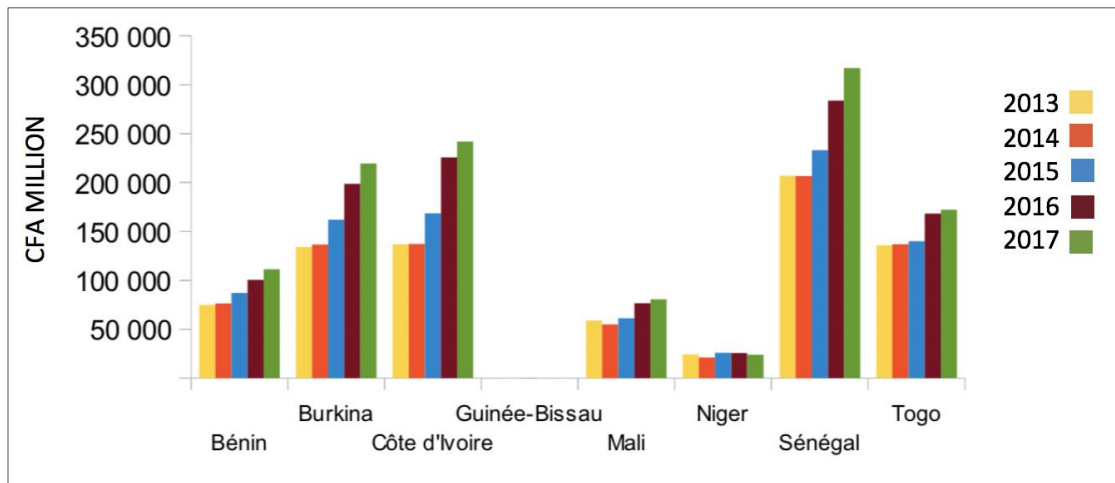
➤ **Banque Nationale de Développement Agricole (BNDA)**

BNDA Development Bank is among the most active financial institutions in Mali’s energy sector, having financed several electricity network extensions and solar projects. The bank recently provided financing for the Akuo Kita Solar 50 MW Solar IPP project in Mali, with additional financing from the West African Development Bank and Emerging Africa Infrastructure Fund. The institution also partnered with AER-Mali to deliver solar kits under the “Projet Prêt Energie Renouvelable,” implemented from 2015-2017. BNDA’s familiarity with the clean energy sector allows for financing of projects in the form of a loan at rates that are reasonable.²⁵⁹

3.3.3 Microfinance Institutions

The microfinance sector in the WAEMU region was formally organized under the Regulatory Program for Mutual Support (Programme d'Appui à la Réglementation des Mutuelles d'Epargne et de Credit, PARMEC), which authorized BCEAO to regulate MFIs through the WAEMU Banking Commission. MFIs with deposits greater than CFA 2 billion (USD 3.4 million) are regulated under PARMEC, while all others are governed through local institutions. As of 2017, there were over 650 MFIs active in WAEMU countries, with 13 million individuals as direct beneficiaries.²⁶⁰ **Figure 49** and **Figure 50** below illustrate trends in MFI deposits and loans, respectively, in WAEMU between 2013 and 2017. Mali has witnessed a gradual increase in MFI deposits and loans over the period.

Figure 49: Microfinance Deposits in WAEMU



Source: BCEAO

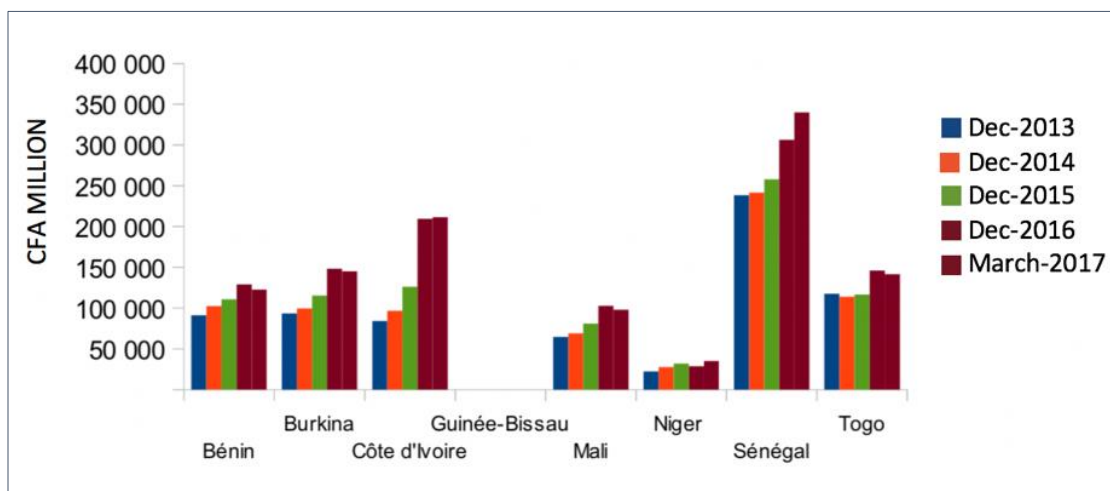
²⁵⁹ “Akuo Solar secures financing for 50MW solar project in Mali,” PV Tech, (January 2018):

<https://www.pv-tech.org/news/akuo-solar-secures-financing-for-50mw-pv-project-in-mali>

²⁶⁰ “Situation du Secteur de la Microfinance dans L’UMOA au 31 Mars 2017,” BCEAO (2017):

https://www.bceao.int/sites/default/files/2017-11/situation_de_la_microfinance_a_fin_mars_2017_1.pdf

Figure 50: Microfinance Loans in WAEMU



Source: BCEAO

Mali’s microfinance sector faces significant challenges in terms of overall resources, access to financing, supervision, and asset quality. As of 2016, the sector faced a high rate of non-performing loans, particularly among its rural clients. That year, the total amount of credits in the MFI sector was estimated at CFAF 93 billion (4.2% of the financial system), of which CFAF 27.9 billion was deployed in rural areas (30% of loans in the MFI sector and 1.3% of the financial system). Most of these rural loans are contracted for agricultural purposes. Meanwhile, deposits accounted for CFAF 68.5 billion (2.7% of the financial system), of which CFAF 12.3 billion came from rural areas (0.5% of the financial system).²⁶¹ In 2017, the Malian MFI sector accounted for 8.2% of the total balance sheet in the WAEMU zone (Table 51).

Table 51: MFI Sector Financial Indicators, 2017

	Total Balance Sheet (CFA million)	Market Share
Mali	136,447	8.2%
WAEMU	1,670,904	-

Source: UEMOA

3.3.4 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.²⁶² 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.²⁶³

²⁶¹ “Mali: IMF Country Report No. 18/142,” International Monetary Fund, (May 2018):

<https://www.imf.org/en/Publications/CR/Issues/2018/05/31/Mali-Selected-Issues-45922>

²⁶² Demircuc-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>

²⁶³ 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

Much like in other African states, there is a large informal financial sector in Mali (**Figure 51**). 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 World Bank’s Findex survey suggests that between 2011 and 2014, borrowing from FIs decreased slightly while borrowing from family or friends increased over the period (**Figure 52**).

3.3.5 Crowd Funders

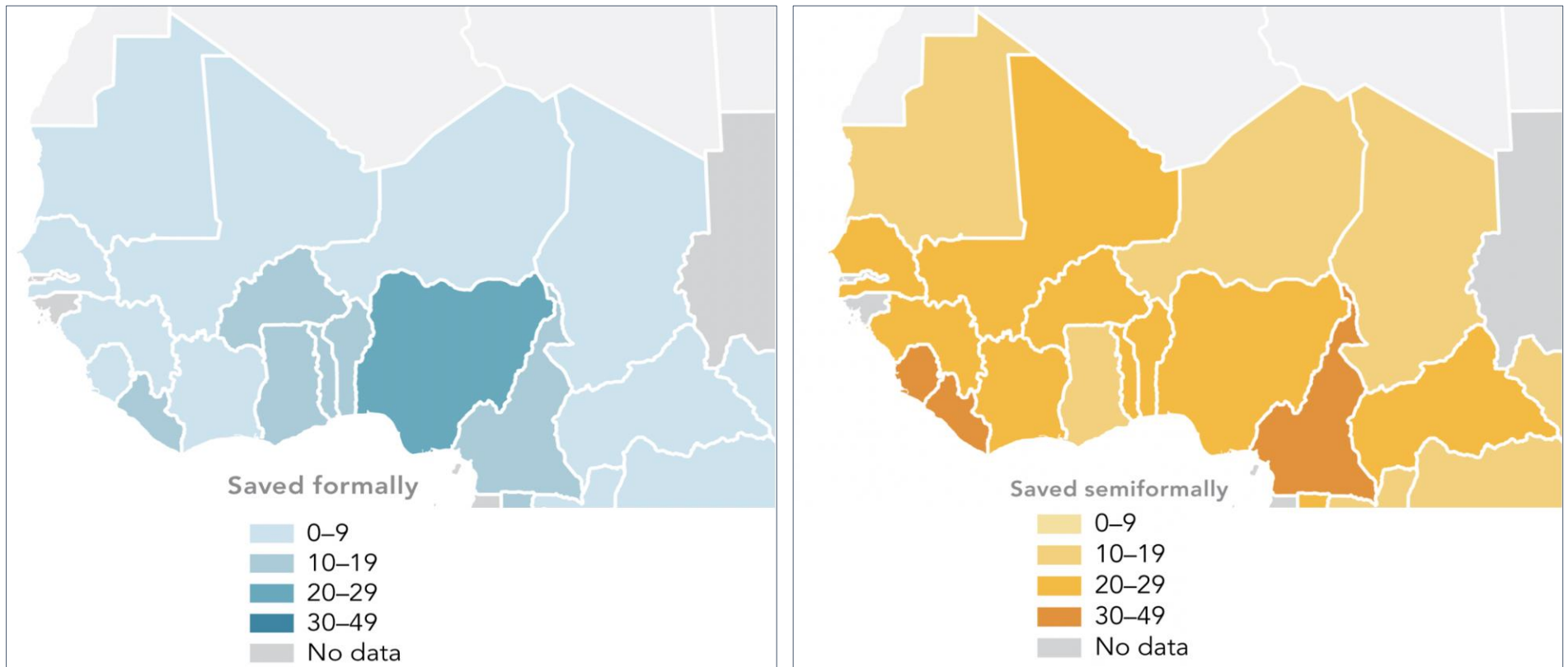
Crowdfunding in Mali has been limited. Although the demand for capital continues to grow, crowdfunding remains a challenging source of financing for SMEs. Across Africa as a whole, crowdfunding amounted to USD 70 million in 2015 – less than 1% of global crowdfunding.²⁶⁴ Moreover, roughly 75% of the capital raised by African start-up companies in 2017 was raised in Kenya, Nigeria, and South Africa.²⁶⁵ 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. In 2019, BBOXX and Trine raised EUR 6 million in funding – in what is the largest crowd-funded debt raise in the history of solar energy in Africa to date. The collaboration between Trine and BBOXX will accelerate BBOXX’s installation of pay-as-you-go solar home systems in Kenya, Rwanda, Togo, the Democratic Republic of Congo, **Mali**, Senegal and Guinea.²⁶⁶

²⁶⁴ “Crowdfunding in Emerging Markets: Lessons from East African Startups,” World Bank (2015): <https://www.infodev.org/infodev-files/crowdfunding-in-east-africa.pdf>

²⁶⁵ Disrupt Africa: <https://www.siliconcape.com/disrupt-africa-funding-report-2017/>

²⁶⁶ “BBOXX / Trine Crowdfunding Initiative Hits Milestone,” Alternative Energy Africa, (March 5, 2019): https://ae-africa.com/read_article.php?NID=9848

Figure 51: Share of Adults Saving in the Past Year (%), 2017²⁶⁷



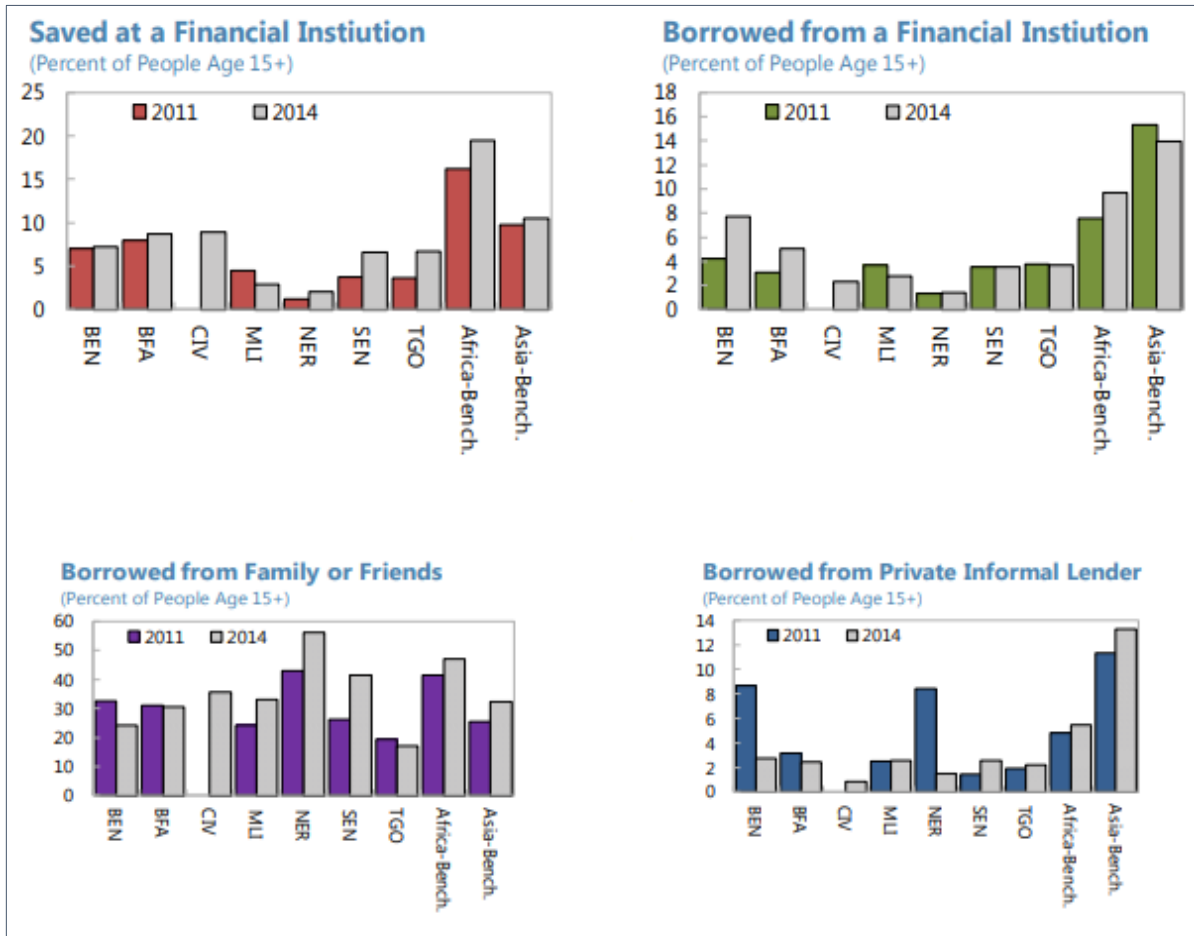
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 51 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 Mali.

²⁶⁷ Demircuc-Kunt et al., 2017.

Figure 52: Informal Financial Sector Indicators in WAEMU, 2011-2014²⁶⁸



Source: International Monetary Fund

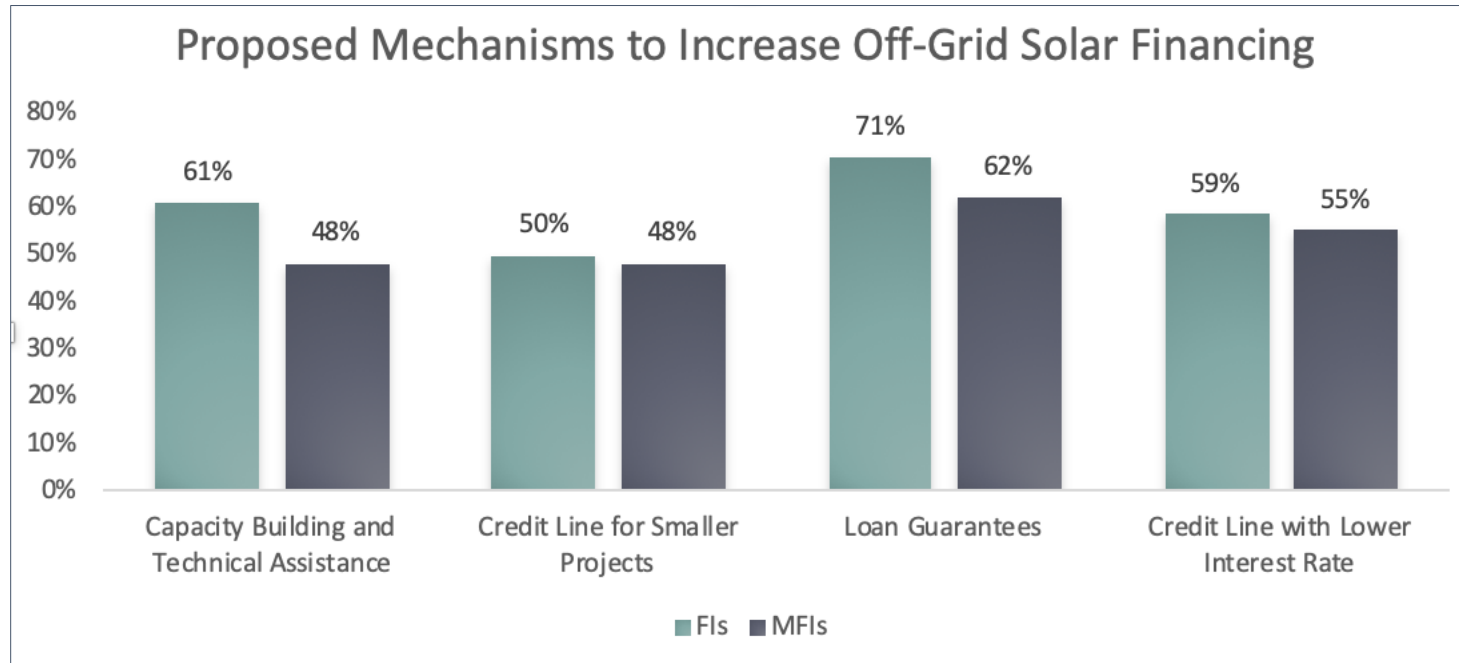
²⁶⁸ "West African Economic and Monetary Union," International Monetary Fund, (2016): https://www.imf.org/~media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/scr/2016/_cr1698.ashx

3.4 Summary of Findings

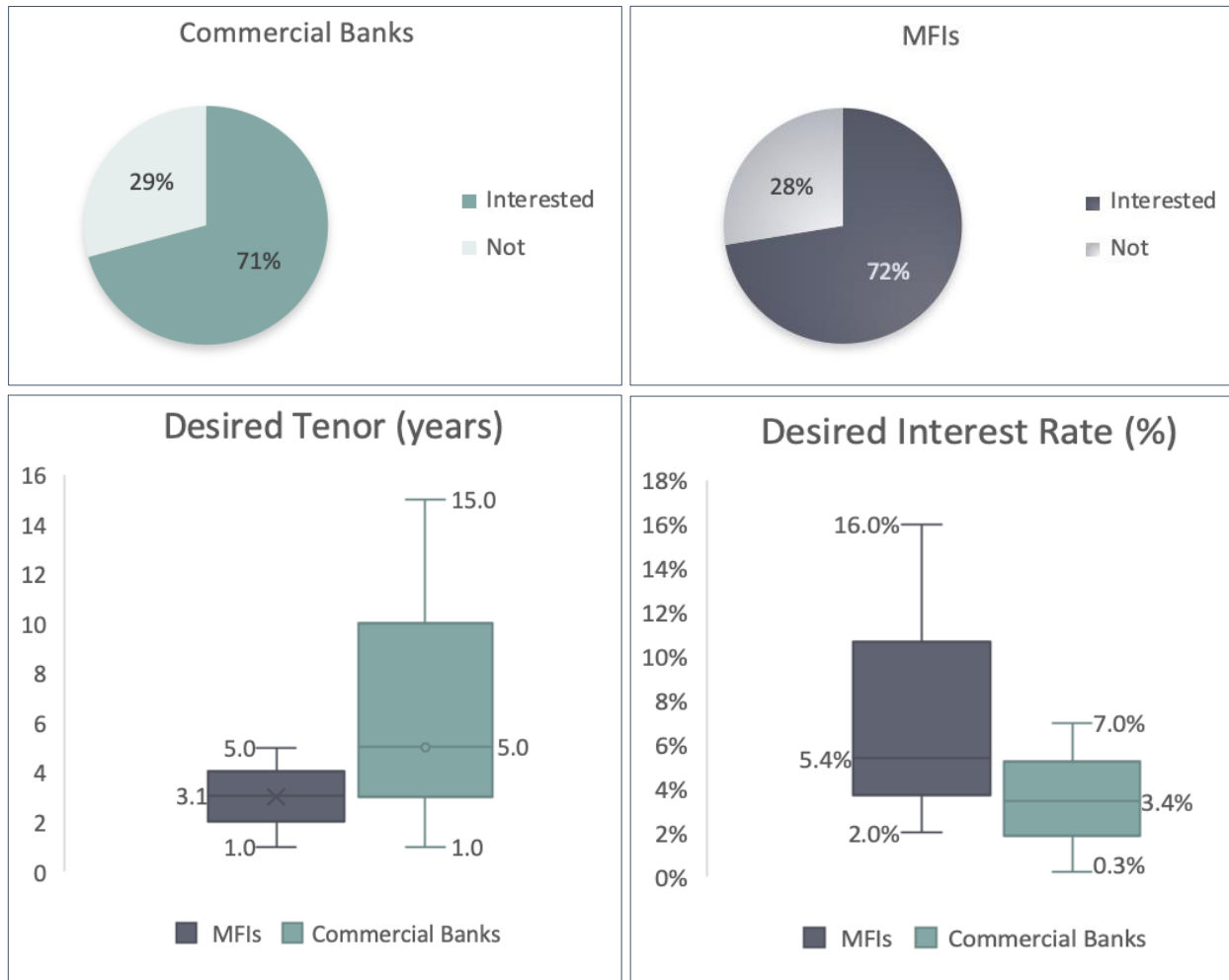
- **Opportunity for ROGEP Credit Lines:** Malian banks lack access to funding with the interest rates and tenors required to make off-grid solar projects attractive to end-users and SMEs. Local currency cost of capital remains very high for FIs, which in turn results in prohibitively high pricing for typical loans. Furthermore, loans are usually short-term, as customer deposits (mostly short-term) remain the largest source of funding for banks. This dynamic severely constrains OGS market growth. Stakeholder interviews revealed that there is indeed an opportunity for ROGEP credit lines to provide liquidity to local commercial banks and MFIs to support lending to the off-grid solar sector.
- **Local Currency and Pricing:** Most loans to off-grid enterprises and all loans for consumer purchases of stand-alone solar devices must be denominated in local currency. However, taking up hard currency denominated credit lines presents challenges for local lenders who would have to bear the FX risk. This risk is somewhat mitigated in Mali, however, as the CFA franc is pegged to the euro, which shields it from volatile currency fluctuations. As a result, even after pricing in a hedge to cover this risk, many hard currency denominated credit lines can stay attractive, as the all-in cost of capital to local FIs is manageable to provide competitive offers to borrowers.
- **Collateral Requirements:** The collateral requirements of commercial banks in Mali are extremely high, particularly for small firms. Moreover, lenders already in the space are deeply constrained from originating loans where the borrower cannot meet these requirements. Hence, the use of third-party *pari-passu* guarantees as an alternative form of collateral would enable banks to extend loans to borrowers without such high collateral requirements. Accordingly, many of the interviewed commercial banks emphasized the need for partial credit guarantees to encourage lending to the OGS sector (50% coverage is helpful; 70-80% coverage could be transformative). However, pricing from most available third-party guarantors can be in the range of 3%+ per annum, which some lenders view as too high to remain competitive. This creates an opportunity for ROGEP to either provide low-cost guarantees directly or to subsidize the premiums offered by existing third-party guarantors such as GuarantCo, Afrexim and Africa Guarantee Fund.
- **Risk Perception of New Lenders:** In order to attract additional lenders into the off-grid solar market segment, there is need for strong, reasonably priced credit enhancement mechanisms. In order to cover “market entry” risks for lenders unwilling to enter this market, guarantee instruments that cover first loss are needed. However, first-loss coverage, while necessary for attracting new lenders to the off-grid sector, does not address the key issue of collateral and is therefore likely insufficient on its own to stimulate growth in FI engagement unless coupled with third-party guarantee coverage.
- **Technical Assistance:** A well designed TA intervention is critical to accelerating OGS lending in the country. Stakeholder interviews revealed the following key areas of support: training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of stand-alone solar firms and projects; extensive due diligence support to qualify products and approve vendors; and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. The TA intervention should build upon previous and existing programs (e.g. SUNREF) to avoid duplication of efforts. Special attention should also be paid to offering advisory services on the side of the stand-alone solar enterprises. Lenders opine that these entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

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

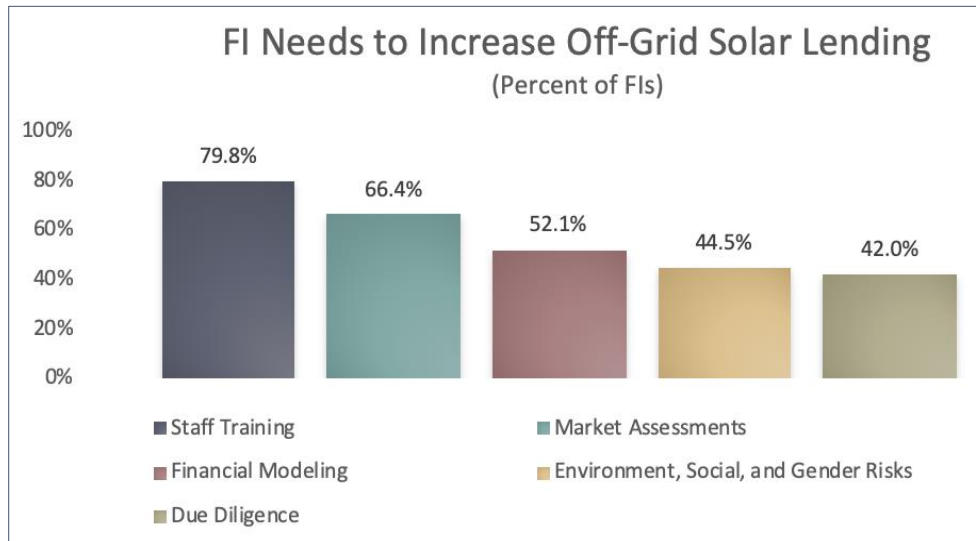
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from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



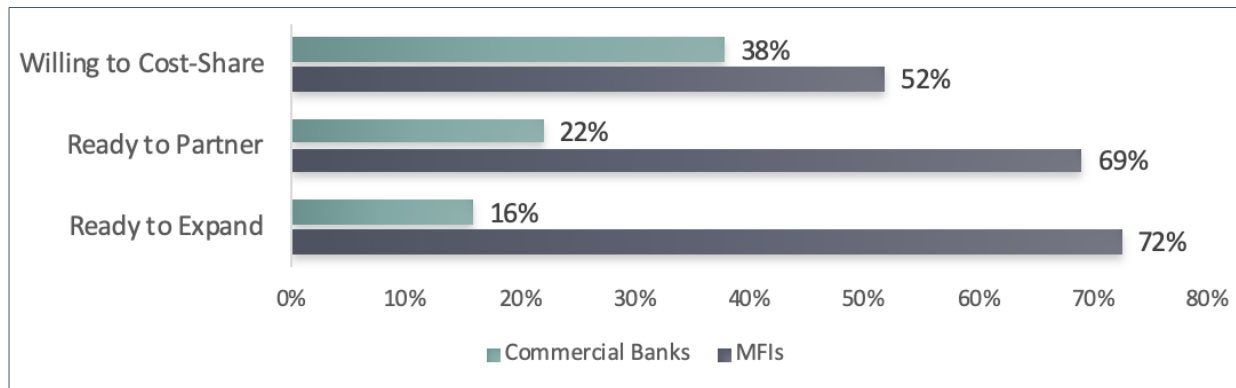
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy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



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



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



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

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 network²⁶⁹ (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)²⁷⁰ and outside the buffer area established for the electrification by grid extension
- Are located within areas that have a population density of more than 350 people per km² (as defined by Eurostat for rural areas)²⁷¹, plus an additional 50 people per km² for greater feasibility of mini-grids²⁷² and are within 1 km²⁷³ of a social facility (education center or health facility) and existing mini-grids of 2018.

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

1.2. Categorization/definition of settlements: Scenario 2030

1.2.1. *Electrification by grid extension* – settlements which are located within 15 km of the current electrical grid network (average distance mentioned by energy utilities in West Africa) or within 5 km of planned future line extensions²⁷⁴

²⁶⁹ NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

²⁷⁰ 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

²⁷¹ <http://ec.europa.eu/eurostat/web/rural-development/methodology>

²⁷² Identified in discussions with different international mini-grid developer.

²⁷³ Preferred maximum distance for mini-grids from discussions with different international developer.

²⁷⁴ 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.²⁷⁵

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

1.3. Definition of un-electrified settlements within grid areas

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

- Within the main grid line zones (see buffer zones for *electrification by grid extension* above)
- Outside 15 km night-lights of buffered areas to capture the densification within 5 years
- Within areas of low population density (less than 350 people per km²)

1.4. Determination of population per settlement

A key component of the least-cost analysis was the number of people living in each settlement (city, town, village, hamlet) of a given country. While there are different publicly available sources of information on total population (e.g. World Bank demographic data), a more granular view of the population distribution was necessary to perform the geospatial analysis.

Another difficulty was the identification of locations of settlements. The exact location of each settlement (with given coordinates) was not available / accessible in many of the countries. As a result, the least-cost analysis had to revert to other studies of population distribution – such as the population distribution developed by WorldPop. WorldPop utilizes a range of geospatial datasets to develop accurate population data:

“New data sources and recent methodological advances made by the WorldPop program now provide high resolution, open and contemporary data on human population distributions, allowing accurate measurement of local population distributions, compositions, characteristics, growth and dynamics, across national and regional scales. Statistical assessments suggest that the resultant maps are consistently more accurate than existing population map products, as well as the simple gridding of census data.”²⁷⁶

A Voronoi polygon analysis²⁷⁷ 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 3.0%²⁷⁸ was applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses.

²⁷⁵ 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.

²⁷⁶ <https://www.worldpop.org>

²⁷⁷ To learn more about Voronoi polygons, see wikidot: <http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons>

²⁷⁸ <https://data.worldbank.org/indicator/SP.POP.GROW?locations=ML>

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)	≤ 6km distance	≥ 6km distance	≥ 6km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	Grid map from DNE, Nov 2015 ²⁷⁹
Electricity grid network (planned)	Future network planned to be built (HV & MV lines)	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	Grid map from DNE, Nov 2015 ²⁸⁰
Mini-grids	Existing mini-grids in 2018 from AMADER from two programmes (SHER and KfW) ²⁸¹	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	AMADER, 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 ² ²⁸²	≥ 350 people per km ²	≤ 350 people per km ²	Not considered	Not considered	Not considered	WorldPop, 2020
Settlements	Settlement layer giving location of settlements across Mali (cities, towns, villages, hamlets)	Used	Used	Used	Used	Used	Used	Humanitarian Data Exchange (HDX), 2015 ²⁸³

²⁷⁹ Prepared by artelia for Ministère de l'Énergie et de l'Eau; georeferenced by EVA.

²⁸⁰ Ibid.

²⁸¹ Mini-grids from the programmes PERSHY, PESDR and PHARE were not available for the analysis (exact locations unknown).

²⁸² 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>

²⁸³ Data extracted from Direction Nationale de l'Administration Territoriales (DNAT) and l'Institut national de la statistique (INSTAT)

ECREEE: OFF-GRID SOLAR MARKET ASSESSMENT AND PRIVATE SECTOR SUPPORT FACILITY DESIGN

Social facility: education centers	Education centers with GPS coordinates (kindergarten, school, college and university); Indicator of active local economy	Not considered	≤ 1km distance ²⁸⁴	≥ 1km distance	Not considered	Not considered	Not considered	OpenStreetMap (OSM), 2018
Social facility: health centers	Centre de santé (CSREF), clinics and hospitals (CSCOM); Indicator of active local economy	Not considered	≤ 1km distance ²⁸⁵	≥ 1km distance	Not considered	Not considered	Not considered	OSM, 2018
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 ²⁸⁶

²⁸⁴ Preferred maximum distance for mini-grids from discussions with different international developer.

²⁸⁵ Preferred maximum distance for mini-grids from discussions with different international developer.

²⁸⁶ <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 Bamako and Koutiala 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,²⁸⁷ multiplied by electricity access rates from the International Energy Agency (IEA),²⁸⁸ 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.

²⁸⁷ World Bank Open Data, 2017: <https://data.worldbank.org/>

²⁸⁸ 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 Mali, the number of off-grid households by income quintile was derived. For this, a percentage of off-grid households by quintile was assumed, as follows:

Quintile	% Off-Grid
Highest 20%	1%
Fourth 20%	5%
Third 20%	90%
Second 20%	99%
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.”²⁸⁹ Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.²⁹⁰ 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:

²⁸⁹ 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).

²⁹⁰ 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 = $([\text{Capital system cost}/\text{average system life in years}] + [\text{Monthly operating cost} * 12])$

1.3.6 The **potential market size** for each solar tier was then calculated by multiplying the number of off-grid households per quintile that will be willing to pay for each solar tier by the cost of each system (system cost is based on representative data from Mali, as shown in 2.2.5).

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

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

1.3.8 The interest rate for consumer finance was conservatively estimated to be 24% p.a., based on the interest rate cap for Microfinance Institutions in WAEMU countries.²⁹¹

2023 and 2030 Household Demand Scenario: Assumptions

1. The GIS analysis²⁹² estimated that by 2023, 25.5% of the population will be grid connected, 49.2% will be connected by mini-grids while 25.3% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 50.4% of the population will be grid connected, 32.6% will be connected by mini-grids while only 17.0% 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 analysis), the households in the quintiles with the highest income will be given

²⁹¹ Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): <http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf>

²⁹² See Annex 1 for GIS methodology

priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest four quintiles were assumed to have only 1%, 2%, 3%, and 21% off-grid households respectively, while the lowest quintile was assumed to have 100% off-grid households. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 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 75% 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%	3%	3%
Second 20%	21%	4%
Lowest 20%	100%	75%

2. Inflation rates for Mali: According to the IMF World Economic Outlook data, inflation in Mali is estimated to be at 2.2% 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 1.022.
3. Based on a 3% population growth rate from the World Bank²⁹³ and the population density dataset used in the study, the estimated total population will be 20,762,464.10 in 2023 and 25,535,211.98 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 74.7% in 2023 and 83.0% in 2030
5. To estimate GDP, it was assumed that the current annual GDP growth rate of 5.3% will be maintained through 2023 and 2030:

Parameter	2023	2030
Population	20,762,464 (GIS estimate)	25,535,211 (GIS estimate)
GDP (constant 2010 USD)	\$19,266,821,632	\$27,657,229,602

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,²⁹⁴ 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

²⁹³ <https://data.worldbank.org/indicator/SP.POP.GROW?locations=BJ>

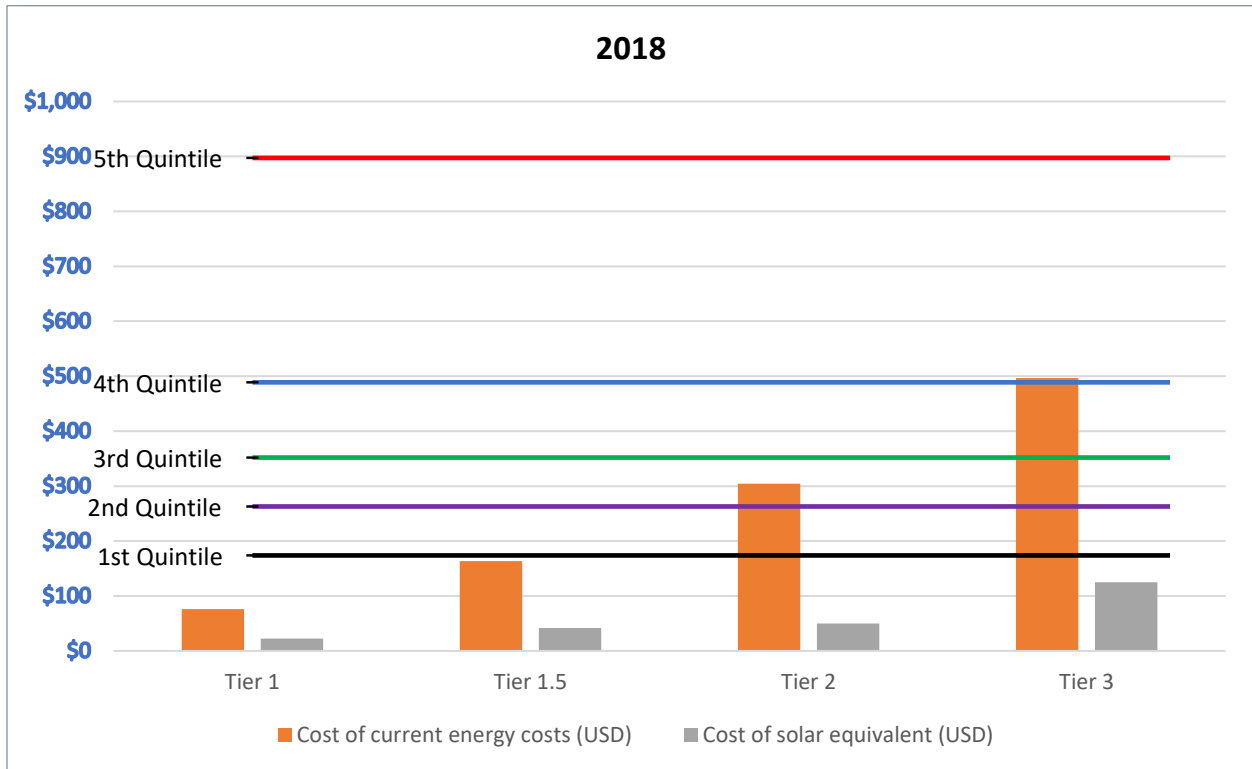
²⁹⁴ "Off-Grid Solar Market Trends Report 2018," Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

that the annual price decrease will be maintained at this level through 2030 (annual cost reduction factor of 0.89).

8. It was assumed the maximum interest rates in Mali will stagnate at the current rate of 24% or possibly decline.

Household Cost Savings and Affordability Calculation

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



- This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. The same analysis was also completed for the 2023 and 2030 scenarios.
- Both the annual costs of current energy technologies and equivalent solar solutions considered the capital cost of each unit as well as the operating cost over the average lifetime of a unit.
- These costs were compared with a 10% monthly energy budget for households of different income quintiles. The analysis did not assess affordability for a cash vs. financed purchase over time.

2. INSTITUTIONAL DEMAND

2.1 Country Categorization

To assess institutional sector demand, the ROGEP countries were grouped into four categories based on income and population density, which are two key factors that influence the number of public service institutions in a given country. The countries were categorized as follows:

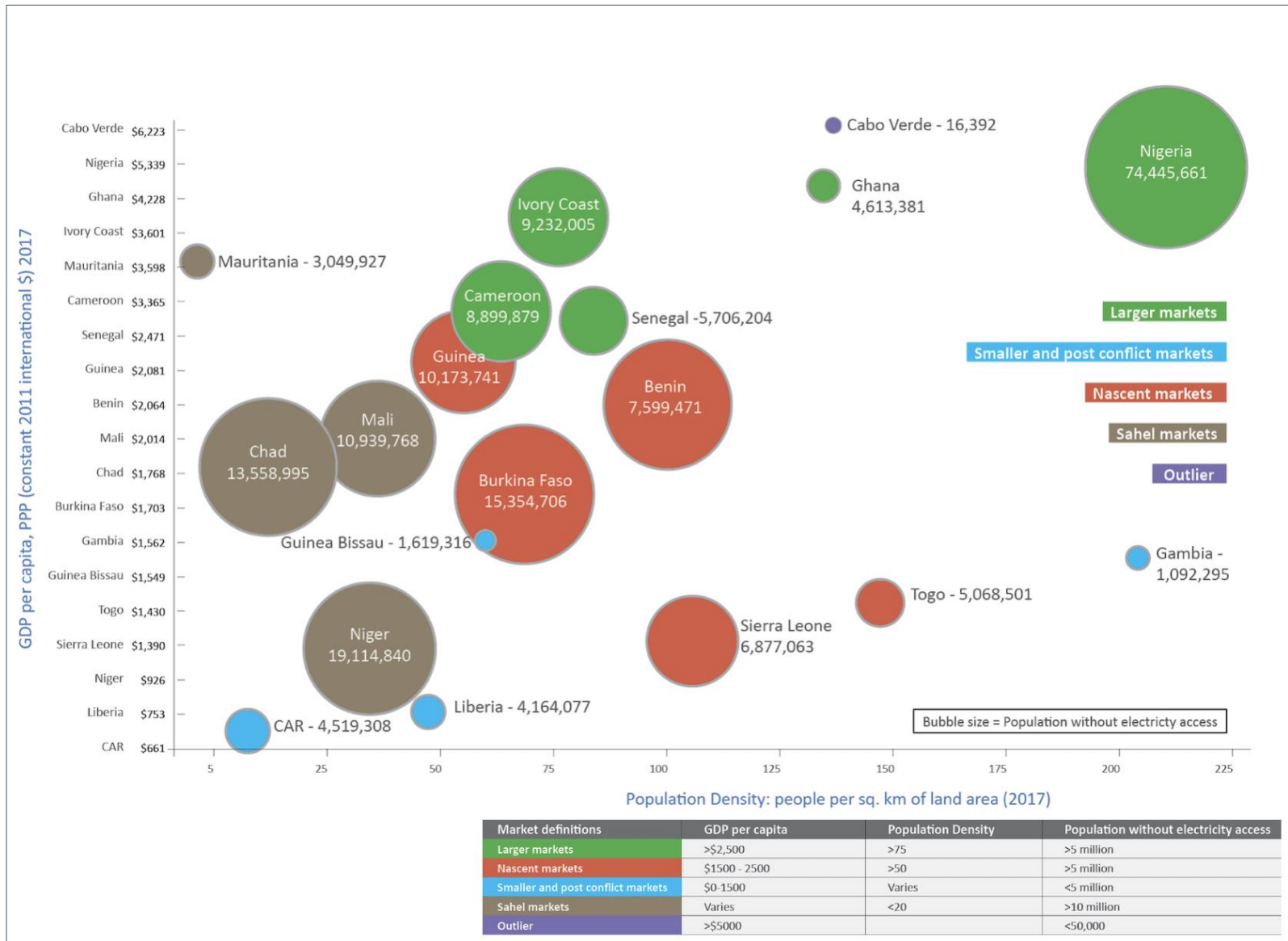
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	Category 2: Low-income / high population density	Category 3: High-income/ low population density	Category 4: High-income / high population density
Niger Burkina Faso Chad Mali Guinea Guinea-Bissau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

These categories were used to address data gaps, as obtaining accurate and comprehensive data on the number of off-grid public institutions in many of the countries was challenging. Where data was not available, per capita assumptions based on data from similar countries in the same category were used. The following countries were used as reference countries for each category:

Category 1	Guinea, Liberia, Niger
Category 2	Benin, Sierra Leone
Category 3	Côte d'Ivoire
Category 4	Ghana

Categories are defined as follows (and illustrated in the figure below):

- Low population density: <95 people per square km of land area
- High population density: >95 people per square km of land area
- Low income: <\$2,200 GDP per capita
- High income: >\$2,200 GDP per capita



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.²⁹⁵ The solar PV sizing factor is based on the peak sun hours available across most of Africa.

²⁹⁵ "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 ²⁹⁶	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

²⁹⁶ Cost per watt derived from African Solar Designs analysis and from IRENA:
<https://www.irena.org/publications/2016/Sep/Solar-PV-in-Africa-Costs-and-Markets>

Institutional Sector Market Sizing Calculations:

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

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

Healthcare						
# of healthcare facilities	X		X		=	Estimated Annualized Off-Grid Solar Market Potential for Healthcare Sector
HC 1		Cost per tier 3 system (\$625)		Divided by system lifetime of 5 years		
HC 2		Size of solar system in Watts (1500W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		
HC 3		Size of solar system in Watts (4200W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		

Education						
# of schools	X		X		=	Estimated Annualized Off-Grid Solar Market Potential for Education Sector
Primary		Size of solar system in Watts (500W)		Cost per watt (\$3) divided by system lifetime of 20 years		
Secondary		Size of solar system in Watts (1920W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		

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

2.4 Data Collection Approach by Institutional Market Segment

MALI			
Water Supply	Healthcare	Education	Public Lighting
Per capita assumption	Per capita assumption	Per capita assumption	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Mali 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:²⁹⁷

- 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.

²⁹⁷ 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 ²⁹⁸	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) ²⁹⁹	X	=	Smallholder Irrigation Potential (hectare) ³⁰⁰	Divided by 0.3 ³⁰¹	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	\$650 (cost of solar pumping kit) ³⁰²	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 cropland³⁰³ adjacent to permanent surface water sources. As identified by experts in a study in Zambia³⁰⁴ and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure 29** is a map of the cropland within a 5 km distance from permanent surface water.

²⁹⁸ “MSME Finance Gap,” SME Finance Forum: <https://www.smefinanceforum.org/data-sites/msme-finance-gap>

²⁹⁹ AQUASTAT – Food and Agriculture Organization: <http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en>

³⁰⁰ 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

³⁰¹ 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/>

³⁰² 120W solar pumping kit: <https://futurepump.com/futures-bright-farmers-kenya/>

³⁰³ “Prototype Land Cover Map over Africa at 20m Released,” Esa, (February 2018): <https://www.esa-landcover-cci.org/?q=node/187>

³⁰⁴ “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) ³⁰⁵	X	70% ³⁰⁶	X	50% ³⁰⁷	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor ³⁰⁸	=	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 ³⁰⁹	X	5,500 W ³¹⁰	X	\$2.50 per watt	Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Refrigeration

3.3 PUE Applications for Connectivity/Mobile Phone Charging Enterprises

The market sizing calculation for solar-powered phone charging enterprises was based on each country’s mobile phone penetration rate (number of unique subscribers), rural population rate, and the average costs of OGS phone charging appliances (\$862, 5-year system life, 400 W system).

Mobile Phone Charging Enterprises							
# of Mobile Phone Subscribers in 2017 ³¹¹	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

³⁰⁵ Food and Agriculture Organization: <http://www.fao.org/faostat/en/#data/RF>

³⁰⁶ Assumption that 70% of crops are milled

³⁰⁷ Assumption that 50% of milled crops are processed at smallholder farmer level

³⁰⁸ 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/>

³⁰⁹ <https://www.citypopulation.de>

³¹⁰ 5.5kW solar powered refrigeration system – See: <https://www.deutschland.de/en/solar-powered-coldhubs-nigeria>

³¹¹ “The Mobile Economy, Sub-Saharan Africa,” GSMA Intelligence, (2017):

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

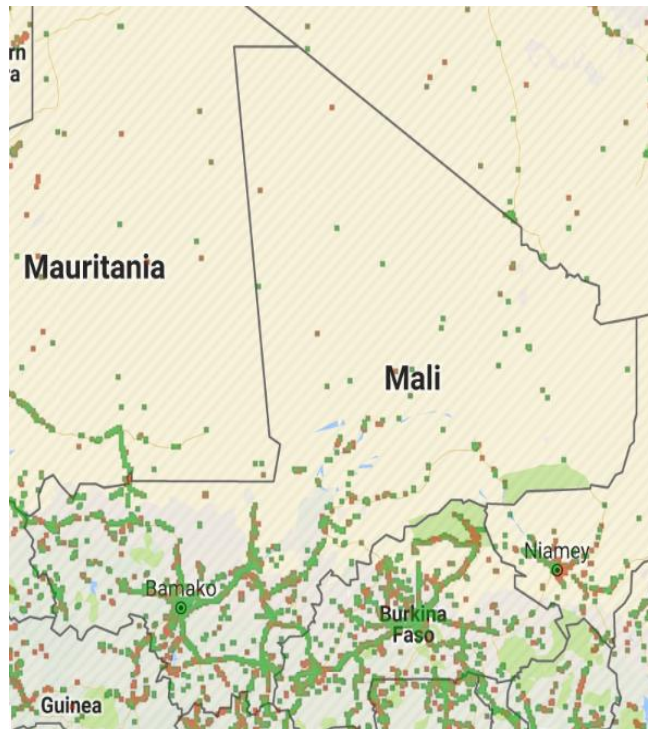
* Indicative Costs for Phone Charging Appliances³¹²

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 31**). 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

³¹² "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 Cotonou in Bamako and Koutiala in June-July 2018
- Survey of 15 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- GOGLA semi-annual sales reports³¹³
- 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 Mali is included below:

1	Access
2	Afrika Solar
3	Aircom
4	Arepel
5	Atlas Électronique
6	Baobab+
7	Desse Connstruction
9	Diawara Solar Energy (Ibi Group)
10	Egec-Foula Travail
11	Elcom
12	Emicom
13	Etablissement Sidi Haïdara
14	Faro
15	General Solaire Distribution
16	Geotechnologie
17	Groupe Horonya (Horonya Electronique And Horonya Solar)
18	Gte
19	Hydrosahel
20	Irri Mali
21	Kama
22	Kingui Solaire
23	Mali Electric Service International
24	Mali Invest
25	Malisol

³¹³ “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

26	MES International
27	Ngoulee Commerce Général Quincaillerie Solaire
28	Ndoul Holding (N.D.H-Sarl) Ex Ecogaz
29	Ntigi Solaire
30	Oolu Solar
31	Orange Énergie
32	Quincaillerie Étoile
33	Quincaillerie Tidiane Diagouraga
34	Sabe
35	Sami
36	Seeba
37	Seeco
38	Silene Mali
39	Solektra International Mali
40	Solconcept
41	Somimand
42	Soninkara Solar Electro
43	Sory Keita Solaire
44	Sinergie Sa
45	SSD Yeelen Kura
46	THIAM ENERGIE SOLAIRE
47	TME-Mali
48	Total Awango
49	Toubac
50	Yandalux Mali / Avelux Mali
51	Yeelen Djiguima
52	Zénith Energie et Développement (ZED-SA)

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT

Data collection under Task 3 included a combination of desk research, collaboration with local experts, and extensive stakeholder engagement with key officials and representatives from local and regional commercial banks, microfinance institutions and other development banks and agencies in Mali. 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.³¹⁴

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.³¹⁵ 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?

³¹⁴ The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.

³¹⁵ The survey was adapted based on the type of FI that was being interviewed (commercial banks, MFIs, Regional Development Banks)

- Is the bank interested to explore a credit line with ROGEP? What size of credit line would the bank be comfortable launching with initially?
- Does the bank feel that it would need a third-party guarantee in order to reduce risk enough to make loans to off-grid enterprises? If so, would it be enough if a guarantor were to cover 50% of losses on par with the bank? Or will the bank need the guarantor to take the first 10-20% of losses in an off-grid loan portfolio?
- What pricing does the bank consider to be fair and affordable for third party pari-passu guarantees? For first loss coverage?
- Has the bank had experience with any of the following as guarantors on the bank's loans: Africa Guarantee Fund, Africa Trade Insurers, Afrexim Bank, GuarantCo, IFC, USAID DCA? Has their pricing been fair and affordable? Does the bank have any preference in working with one over the others?
- To engage in lending to the off-grid market segments, would Technical Assistance be helpful? What types of TA would be most useful? Outside consultants to help design specific loan products and underwriting guidelines for the off-grid sector? Outside consultants to develop deal flow and conduct due diligence? Training of bank credit department and account representative personnel? Direct funding to the bank to develop marketing and promotional materials and hire staff?
- Does the bank adhere to and is in compliance with all aspects of the Basel II and III accords?
- Does the bank adhere to and have implemented controls for the Equator Principals and the World Bank/IFC Environmental and Social Standards?

ANNEX 4: GENDER ASSESSMENT

1. Context and Purpose of the Gender Analysis

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

Women in energy-poor households are at substantially higher risk of illness attributable to indoor air pollution and solid fuel (biomass) use.³¹⁶ 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.³¹⁷

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.³¹⁸ 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.³¹⁹ 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.³²⁰

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).³²¹ Mauritania is also implementing a national policy to address this issue – the National Strategy of Institutionalization of Gender (la Stratégie Nationale d'institutionnalisation du genre).

³¹⁶ "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>

³¹⁷ 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>

³¹⁸ "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>

³¹⁹ Ibid.

³²⁰ "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/>

³²¹ "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 Bamako in June 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Mali 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

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 mainstreaming³²² (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 Mali

Structural inequalities and gender discrimination against women and girls persist in Mali, 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 Mali ranks 182 out of 189 countries in the index.³²³

2.2 Gender and Poverty

Poverty remains widespread in Mali, affecting about half of the population. Poverty rates are higher in rural areas where a large share of the country’s poor population lives. According to UNDP statistics, 75.9% of the labor force is considered working poor at PPP USD 3.10/day.³²⁴ HDI indicators and income levels are comparatively lower for women, who constitute a disproportionate share of the country’s poor population.

2.3 Gender, Human Capital and Economic Empowerment

2.3.1 Education, Skills Development and Training

While Mali has made some improvements in gender parity in rates of access to primary education, there are many troubling signs in the education sector as gaps still persist between men and women in primary education as well as higher education (see **Figure 10**). Only 7.3% of adult women in the country have attained some level of secondary education compared to 16.4% of men.³²⁵ An estimated 59% of boys of secondary school age are out of school compared to 71% of girls of the same age.³²⁶ Across the entire sector, there are huge disparities between the poorest and the richest youth in terms of access to education. This trend remains consistent in literacy rates among the country’s youth and adult populations, as just 25% of the country’s female adult population is literate, compared to 43% of the adult male population.³²⁷

³²² **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.

³²³ “UN Human Development Reports: Gender Inequality Index (GII),” UN Development Programme, (2018): <http://hdr.undp.org/en/composite/GII>

³²⁴ “UN Human Development Indicators: Mali,” UN Development Programme, (2018): <http://hdr.undp.org/en/countries/profiles/MLI>

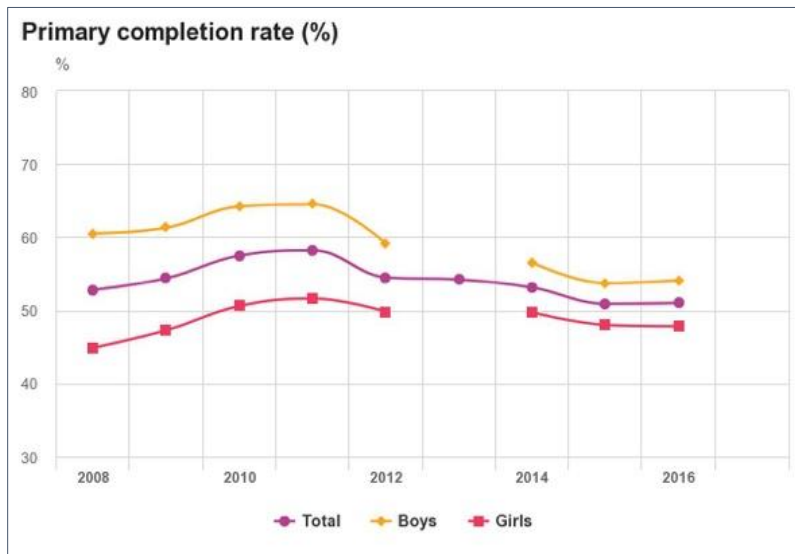
³²⁵ Ibid.

³²⁶ “Mali: National Education Profile, 2014 Update,” Education Policy and Data Center, (2014):

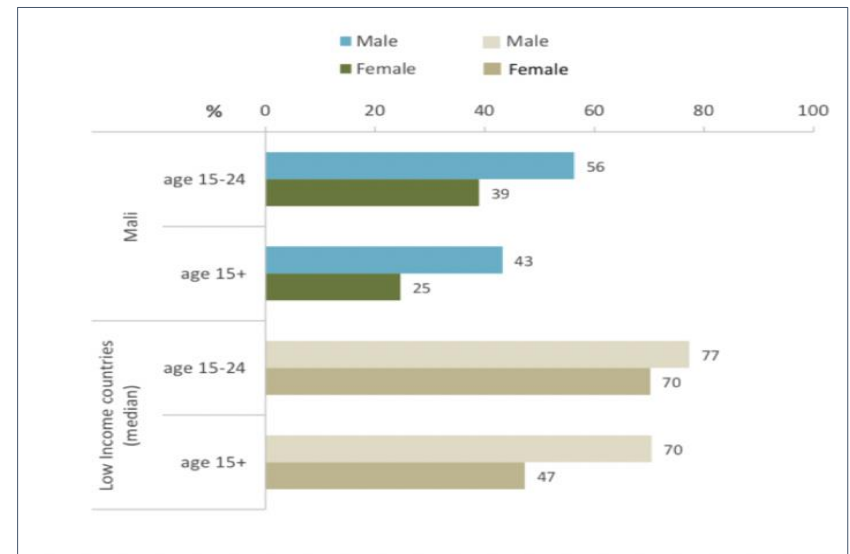
https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Mali.pdf

³²⁷ Ibid.

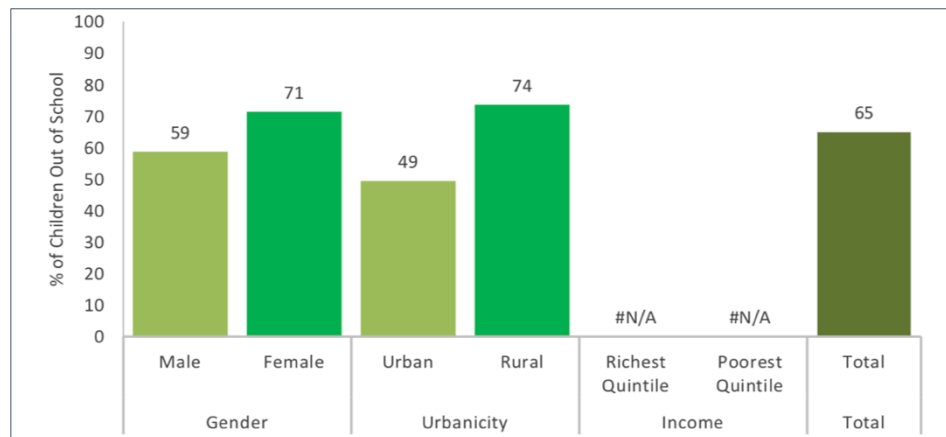
Primary School Completion Rate



Literacy Rates Among Youth and Adult Populations

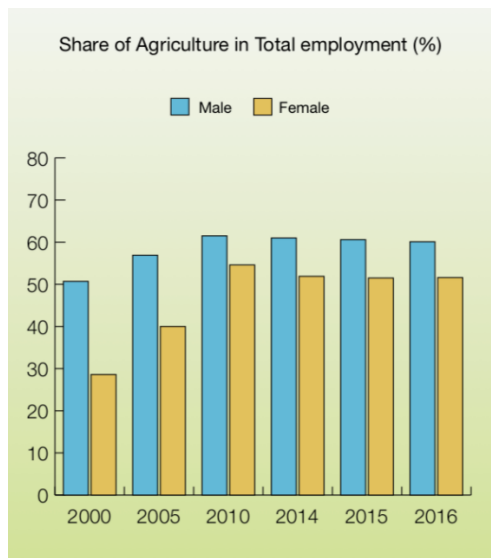


Percentage of Children of Secondary School Age (12-18) Out of School



Source: UNESCO Institute of Statistics

According to the UN, as of 2017, only 25.7% of women in Mali had an account at a financial institution or with a mobile money service provider.³²⁸ 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 subsistence agriculture.³²⁹



Source: African Development Bank

2.3.2 Fertility Rates and Reproductive Health

As of 2017, the fertility rate in Mali remain high, at about five children per woman. The country also has a high maternal mortality rate; for every 100,000 live births, 587 women die from pregnancy related causes. An estimated 17.2% of women have an unmet need for family planning.³³⁰

2.3.3 Participation and Decision-Making

Socio-cultural perspectives in Mali remain male-dominated, as conventional gender roles continue to hold women back. This is reflected in household decision-making, which often plays a role in restricting the rights and empowerment of women. These dynamics are also present in the rates of representation of women in the labor market as well as in leadership positions in business and government. Although women’s level of participation in the economy is growing, they still lag behind men, with an adult labor force participation rate of 60.8% compared to 82.5% for men.³³¹ As of 2017, women held only 8.8% of the country’s seats in parliament.³³²

³²⁸ “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

³²⁹ “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

³³⁰ “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

³³¹ “UN Human Development Indicators: Mali,” UN Development Programme, (2018): <http://hdr.undp.org/en/countries/profiles/MLI>

³³² Ibid.

2.4 Gender Policy, Institutional and Legal Framework in Mali

2.4.1 Gender Mainstreaming initiatives by the Government

The Government of Mali 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.

In 2010, the Government adopted a National Gender Policy (PNG) and its first National Plan of Action (2011-2013) as a framework for promoting gender equality in all sectors and at all levels of society. Mali has a robust gender policy that includes planning and budget for gender activities across 15 priority ministries/sector, including those involved in the management of public employment – the Ministries of Labour and Public Service, Education, Health, State Reform and Justice.

The 1992 Constitution of Mali establishes equality between women and men and prohibits discrimination on the basis of gender. The GoM 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. The Ministry for the Advancement of Women, Children and the Family is in charge of managing the country’s gender mainstreaming efforts. Mali has also implemented quotas in its political party platforms to increase the participation of women in the public sector.³³³

Mali has also made attempts to address gender-equality in the energy sector. As part of this process, the Government has established Gender Focal Unit within AMADER that aims to integrate gender considerations into the activities of each department and staff member are more sensitized on gender issues.

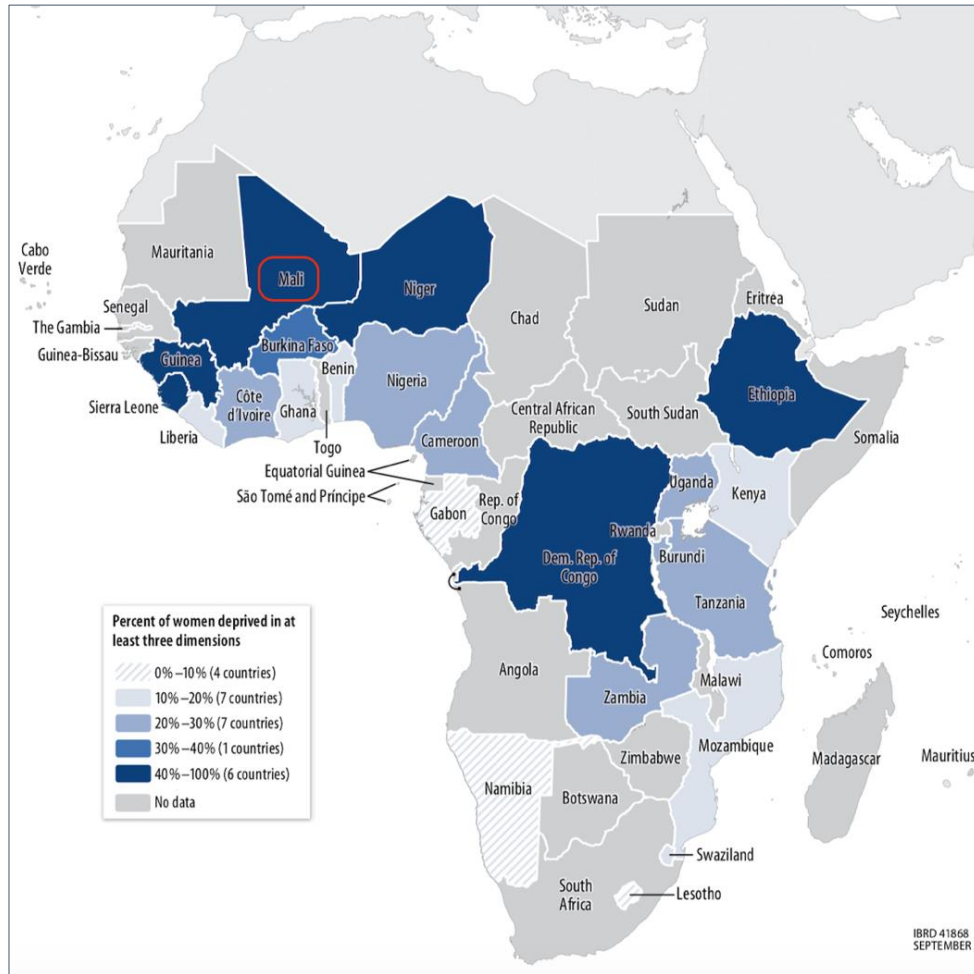
2.4.2 Gaps in the Gender Policy/Legal Framework

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. Mali’s legal system consists of statutory, customary, and religious laws, leading to contradictions and inconsistencies among the three.

These gender dynamics are worse among rural populations and poorer segments of the population. Illiteracy remains substantially higher among women, women suffer more from violence (especially domestic violence), and they are more curtailed in their access to information and decision making. While multiple deprivation characterizes life for a sizable share of African women, rates are significantly higher in West Africa and the Sahel – with Mali ranking among the six worst nations in Africa.

³³³ Women participation in Politics, www.iknowpolitics.org

Socioeconomic Deprivation of Women in Africa³³⁴



Source: The World Bank Group: Poverty in a Rising Africa

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.³³⁵

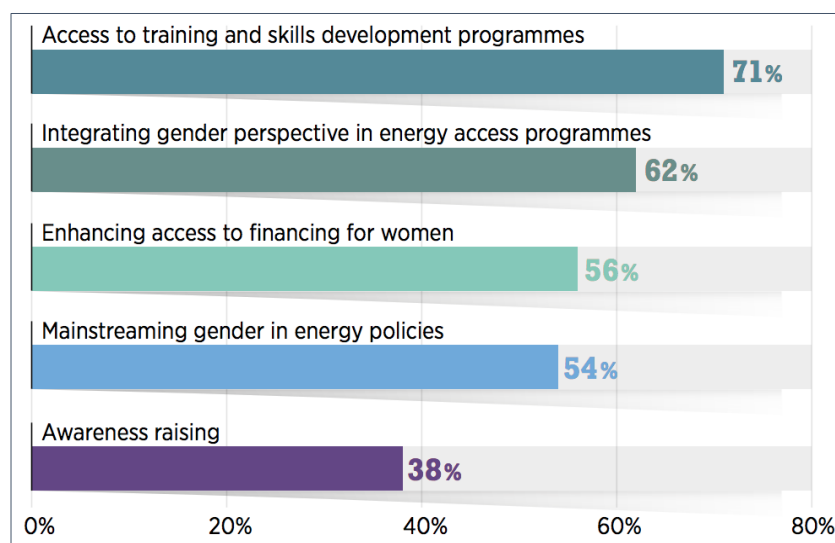
In seeking solutions to improve women’s engagement in energy access, a 2018 IRENA survey found that access to necessary technical, business or leadership skills development programs was the single most important measure that could be taken. Over half of survey respondents also highlighted the need to integrate gender perspectives in energy access programs as well as enhanced access to finance.³³⁶

³³⁴ “Poverty in a Rising Africa: Africa Poverty Report,” The World Bank Group, (2016): <https://www.un.org/africarenewal/sites/www.un.org.africarenewal/files/Poverty%20in%20a%20Rising%20Africa%20Overview.pdf>

³³⁵ “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

³³⁶ Ibid.

Measures to Improve Women’s Engagement in Energy Access



Source: International Renewable Energy Agency

In addition to the measures highlighted in the figure above, below is a list of additional policy recommendations that could further improve gender equality in Mali’s energy sector.³³⁷

- Take measures to close the gender gap in access to education, particularly in higher levels of education
- Implement a quota system to increase the number of women employed in government’s energy ministry and ensure that women are part of decision-making processes in the energy sector
- Implement policy and budgetary measures to support programs that aim to raise awareness and promote opportunities for women as energy customers, suppliers, financiers, and educators
- Commission studies to collect, synthesize and publish gender-specific/sex-disaggregated data on women’s energy access and usage to inform (i) public policy development to improve rates of access for women; and (ii) private sector on potential customer needs (e.g. clean cooking technologies, productive use of energy applications etc.)
- Undertake a “gender audit” of the energy sector and develop a gender action plan to inform long-term policy objectives targeting gaps in the existing framework and promoting inclusive participation (e.g. by adding gender categories to policies and projects and accounting for gender impacts in strategic planning).
- Establish a Gender Focal Point or Unit within key local institutions in order to administer targeted gender policies and programs (to replicate the national Gender Focal Unit within AMADER)
- 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.³³⁸

³³⁷ 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

³³⁸ “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



A retail market for off-grid solar products in Bamako, Mali.



GreenMax Senior Consultant, Baptiste Flipo (second from right), with ROGEP focus group participants in Koutiala, Mali, in July 2018.



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