WORLD BANK GROUP

ECREEE

TOWARDS SUSTAINABLE ENERGY

REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

CÔTE D'IVOIRE REPORT

JULY 2019

GreenMax Capital Advisors

Energio Verda
Renewable Energy for Development

ASD

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ABBREVIATIONS & ACRONYMS

AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ANARE-CI	Autorité Nationale de Régulation de l'Électricité en Côte d'Ivoire (National Authority of Regulation of Electricity in Ivory Coast)
ASD	African Solar Designs
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
BFA	Banque pour le Financement de l'Agriculture (Bank for Financing Agriculture)
BHCI	Banque de L'Habitat de Côte d'Ivoire Habitat Bank of Côte d'Ivoire
BIC	Bureaux d'Information sur le Crédit (Credit Information Bureaus)
BOAD	Banque Ouest Africaine de Développement (West African Development Bank)
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAR	Capital Adequacy Ratio
CCGT	Combined-Cycle Gas Turbine
CDC-CI	Caisse des Dépôts et Consignation Côte d'Ivoire (Caisse Deposits and Consignment Ivory Coast)
CEADIR	Climate Economic Analysis for Development, Investment and Resilience
CFA	Communauté Financière Africaine (African Financial Community)
CIE	Compagnie Ivoirienne d'Électricité (Ivorian Electricity Company)
CIE-ENERGIES	Société des Énergies de Côte d'Ivoire (Energy Company of Ivory Coast)
CIPREL	Compagnie Ivoirienne de Production d'Électricité (Ivorian Electricity Production Company)
CNCE	Caisse Nationale des Caisses d'Epargne (National Savings Bank)
COD	Cash-on-Delivery
COGES	Comité de Gestion (Management Committee)
DFI	Development Finance Institution
DG	Director General
DFID	Department for International Development (UK)
EBID	ECOWAS Bank for Investment and Development
ECA	Export Credit Agency
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ECOWREX	ECOWAS Observatory for Renewable Energy and Energy Efficiency
ECREEE	ECOWAS Center for Renewable Energy and Energy Efficiency
EIB	European Investment Bank
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUR	Euro
EVA	Energio Verda Africa
FAO	Food and Agricultural Organization of the United Nations
FDI	Foreign Direct Investment
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion
FI	Financial Institution
FX	Foreign Exchange
GDP	Gross Domestic Product
GIS	Geographic Information System

GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GNI	Gross National Income
GoCI	Government of Côte d'Ivoire
GOGLA	Global Off-Grid Lighting Association
GSMA	Groupe Spéciale Mobile Association (Global System for Mobile Communications)
HC	Health Center
HH	Household
ICT	Information and Communications Technology
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LBTP	Laboratoire du Bâtiment et des Travaux Publics (Buildings And Public Work Laboratory)
LTO	Lease-to-Own
LNG	Liquefied Natural Gas
MFI	Microfinance Institution
MPEER	Ministère du Pétrole, de l'Energie et du Développement des Énergies Renouvelables (Ministry of Petroleum, Energy and Renewable Energy Development)
MTF	Multi-Tier Energy Access Framework
MW	Megawatt
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
NPL	Non-Performing Loan
O&M	Operations and Maintenance
OGE	Off-Grid Electric
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)
PANER	Plan d'Actions National des Energies Renouvelables (National Renewable Energy Action Plan)
PAYG	Pay-As-You-Go
PDER	Plan Directeur de l'Electrification Rurale (Rural Electrification Master Plan)
PEPT	Programme Electricité Pour Tous (Electricity for All Program)
PNIASE-CI	Programme National d'Investissement pour l'Accès aux Services Énergétiques en Côte d'Ivoire (National Investment Program for Access to Energy Services in Côte d'Ivoire)
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PRODERE	Programme Régional de Développement des Énergies Renouvelables et d'Efficacité Énergétique (Regional Program for the Development of Renewable Energy and Energy Efficiency)
PRONER	Programme National d'Electrification Rurale (National 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
SGBCI	Société Générale de Banques en Côte d'Ivoire (Societe Generale Ivory Coast)
SHS	Solar Home System
SEFA	Sustainable Energy Fund for Africa
SME	Small and Medium Enterprise
SPV	Special Purpose Vehicle
SRUC	Sector Reform and Utility Commercialization
SSA	Sub-Saharan Africa
SUNREF	Sustainable Use of Natural Resources and Energy Finance
TA	Technical Assistance
UEMOA/WAEMU	Union Économique et Monétaire Ouest Africaine / West African Economic and Monetary Union
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak
ZECI	Zola Energy Côte D'Ivoire

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KEY DEFINITIONS

ELECTRICITY ACCESS

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

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

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

OFF-GRID / STAND-ALONE SOLAR

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

- Pico solar/solar lanterns[5]
- Single module solar systems (DC)[6]
- Multiple module solar systems (AC)[7]
- Large solar systems (AC)[8]

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

[1] https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf
[2] https://www.iea.org/energyaccess/methodology/
[3] https://sustainabledevelopment.un.org/sdg7
[4] "Multi-Tier Framework for Measuring Energy Access," World Bank ESMAP: https://www.esmap.org/node/55526
[5] Typically less than 10 Wp; all-in-one lighting and/or phone charging; enables partial or full Tier 1 electricity access
[6] Typically 11-100 Wp; capable of powering a few appliances (lights, mobile phone charging, TV, radio, fan etc.); often referred to as a "plug-and-play" solar home system when components are sold as a set; enables full Tier 1 or higher electricity access
[7] Typically 101-500 Wp; capable of powering multiple appliances; requires small inverter
[8] Typically greater than 500 Wp; most often used to power a large home; requires large inverter

Multi-tier Matrix for Measuring Access to Household Electricity Supply

			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. Afford-ability					Cost of a standard consumption package of 365 kWh/year < 5% of household income		
	6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative	
	7. Health & Safety						Absence of past accidents and perception of high risk in the future	

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

WEST AFRICA AND THE SAHEL

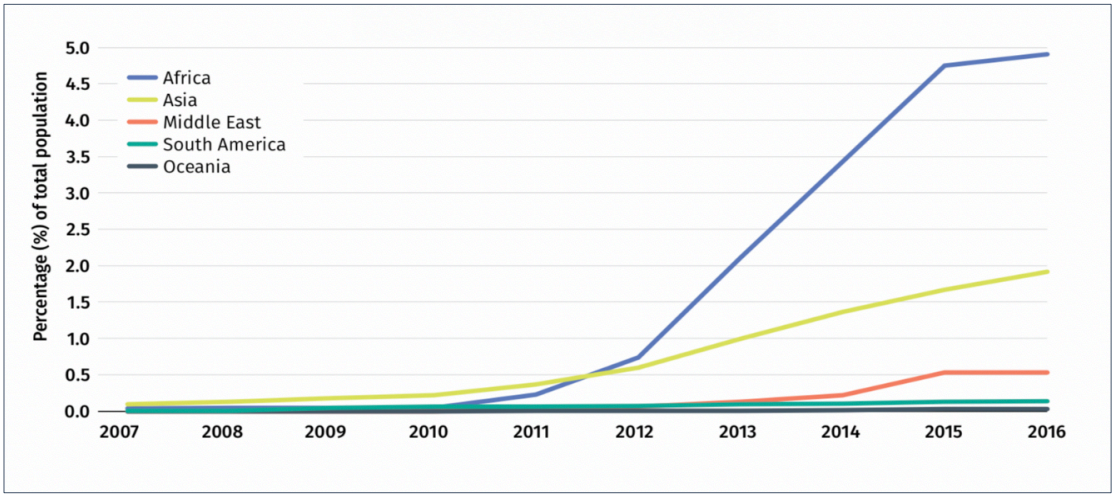
The term "West Africa and the Sahel" as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina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

EXECUTIVE SUMMARY

I. INTRODUCTION

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

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



Tier 1 access and above

Source: International Renewable Energy Agency

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

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

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

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

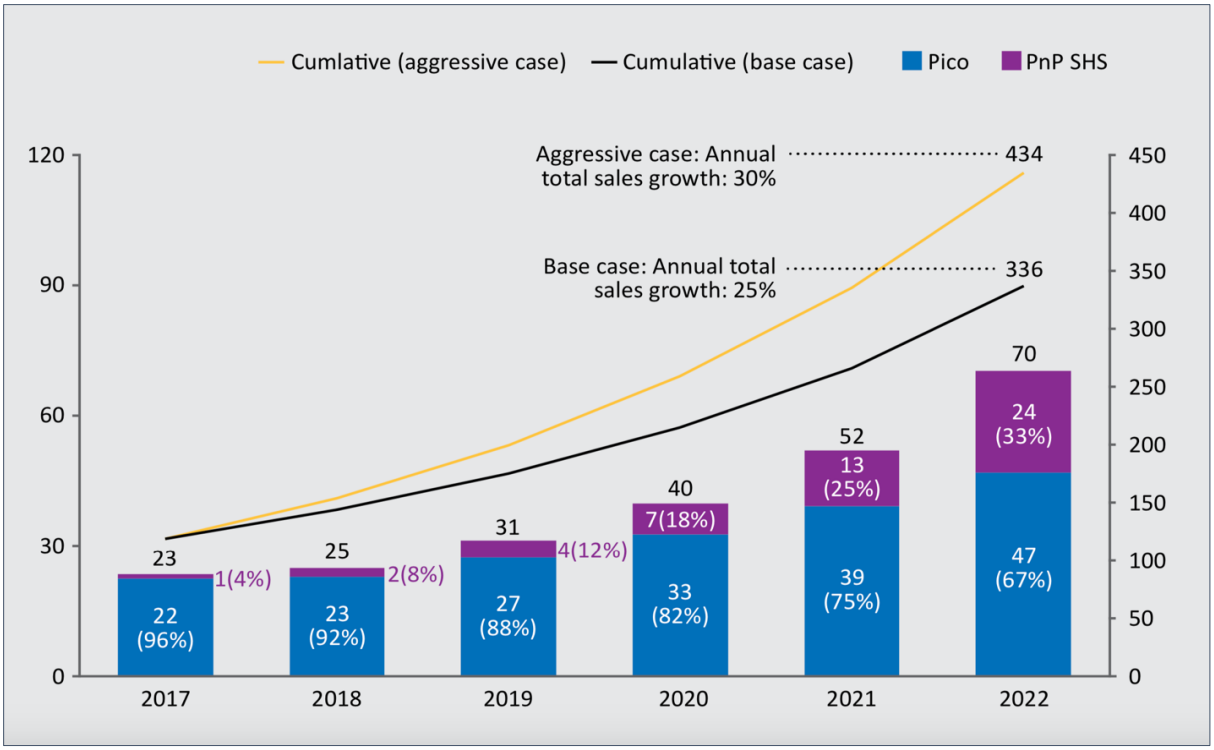
Until recently, diesel generators largely served as the expensive alternative both for rural electrification and for urban and peri-urban "bad grid" areas, where electricity was unreliable or only available for part of the day. However, the advent of decentralized renewable energy technologies, particularly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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

II. BACKGROUND AND CONTEXT OF THE ASSIGNMENT

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

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

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

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

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

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

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

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

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

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

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

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

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

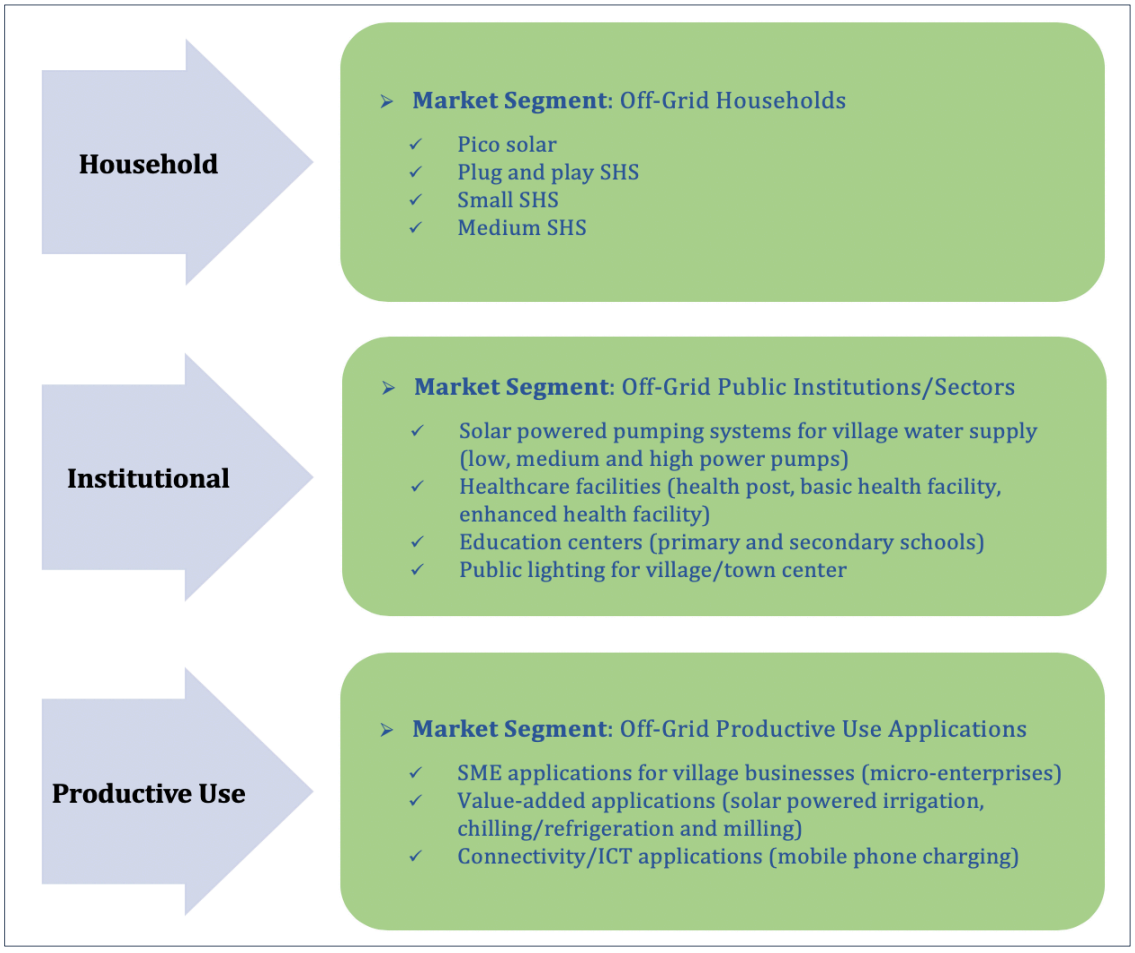
Section 2 estimates the potential market for off-grid solar products and systems by assessing potential demand from the household, institutional and productive use market segments (**Figure ES-3**), followed by an analysis of the supply chain. The household market sizing utilizes results from the least-cost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

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

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

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

Figure ES-3: Analyzed Off-Grid Market Segments



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

III. EXECUTIVE SUMMARY

Côte d'Ivoire is the largest economy in the West African Economic and Monetary Union (WAEMU) and was the second fastest growing country in Sub-Saharan Africa in 2017. The country's economic growth is driven by a robust services sector. This dynamic is not reflected in the country's employment structure, however, as two-thirds of the labor force remains in agriculture. Côte d'Ivoire is the largest producer and exporter of cocoa beans in the world. Agricultural processing of cocoa, coffee and palm oil contributes significantly to export revenues, while the cocoa sector alone accounts for 10% of GDP and about one-third of the country's exports.[24] More than half of the country's rapidly growing population lives in urban areas – Abidjan concentrates 20% of the population, 80% of formal employment, and 90% of businesses.

Access to electricity remains an ongoing challenge. In 2016, approximately one-third of the overall population – an estimated 9 million people – lacked access to electricity, with a significant disparity between rates of access in urban (88%) and rural (31%) areas.[25] Even where grid connections exist, power supply is often unreliable, with fewer than one-third of firms and half of households reporting reliable access to electricity when surveyed.[26] Off-grid electrification is a policy priority for the Government of Côte d'Ivoire (GoCI), which aims to achieve universal access by 2025. Currently, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing well, as evidenced by the country's 21-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017. In the 2017 RISE evaluation, Côte d'Ivoire ranked third in West Africa and the Sahel and was among the highest scoring countries in Africa.[27]

With support from ECREEE, the Government has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan (Plan d'Action National pour les Énergies Renouvelables, PANER). In 2014, the GoCI adopted the National Program for Investment in Energy Access Services (Le Programme National d'Investissement Pour l'Accès aux Services Energétiques en Côte d'Ivoire, PNIASE-CI), which identified the number of electrified localities and households with access to electricity. The Government subsequently launched the National Program for Rural Electrification, (Programme National d'Electrification Rurale, PRONER) in 2014 to align public and private resources and coordinate the development efforts necessary to expand electricity coverage to all localities and double the number of household connections. A key component of the Government's electrification strategy is the "Electricity for All" initiative (Programme Electricité Pour Tous, PEPT), which aims to provide electricity to around one million low-income households through rehabilitation and extension of the transmission network. State-owned CI-ENERGIES also developed a Rural Electrification Master Plan (Plan Directeur d'Electrification Rurale, PDER), which has set a target of universal access by 2025 through a combination of grid extensions and off-grid solar technology.

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 Côte d'Ivoire (**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 118.5 million. The productive use sector (USD 69.3M) makes up the majority of estimated demand, followed by the household (USD 39.6M) and institutional (USD 9.7M) sectors.

[24] "Côte d'Ivoire Macroeconomic Report," AFD, (2015): https://www.afd.fr/fr/les-enjeux-de-la-nouvelle-croissance-ivoirienne
[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

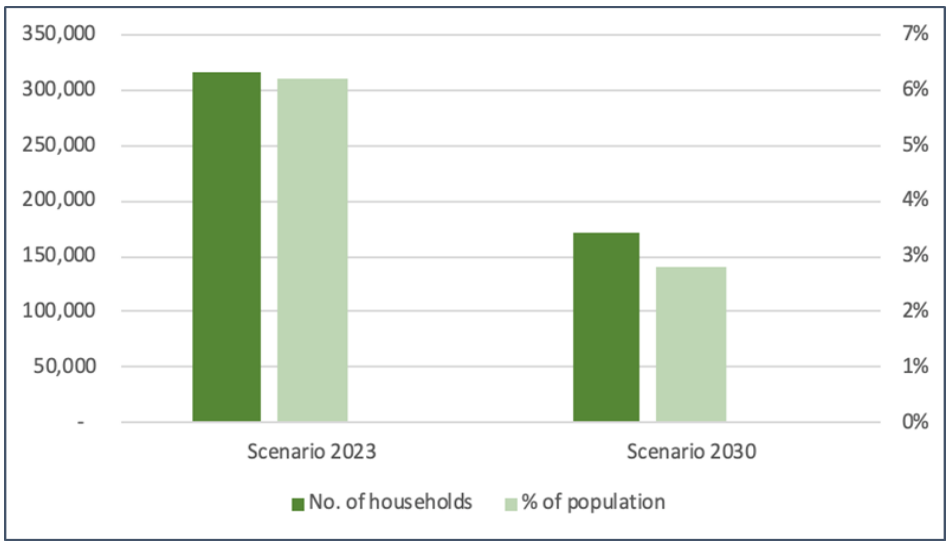
Figure ES-4: Indicative Total Cash Market Potential for Off-Grid Solar Products in Côte d'Ivoire, 2018

Source: African Solar Designs analysis

The least-cost electrification analysis found that by 2023, 13,938 settlements across Côte d'Ivoire (3,351,045 households) will be connected to the main grid, representing 65.5% of the population. By 2030, this figure will increase to 31,192 settlements (5,607,797 households), equivalent to 92,3% 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 6,159 settlements (316,016 households), representing 6.2% of the population in 2023, as suitable for stand-alone systems, decreasing to 3,112 settlements (170,879 households) and 2.8% of the population in 2030 (**Figure ES-5**). While the total size of the OGS market for households will decrease over time, it will also become more concentrated in the remote west region of the country, with the largest share of off-grid households located in the regions of Woroba, Zanzan and Bas-Sassandra in 2030. This has implications for long-term business models of the solar product market, which will need to consider broader distribution areas as the total number of households without access to electricity declines.

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



Source: Energio Verda Africa GIS analysis

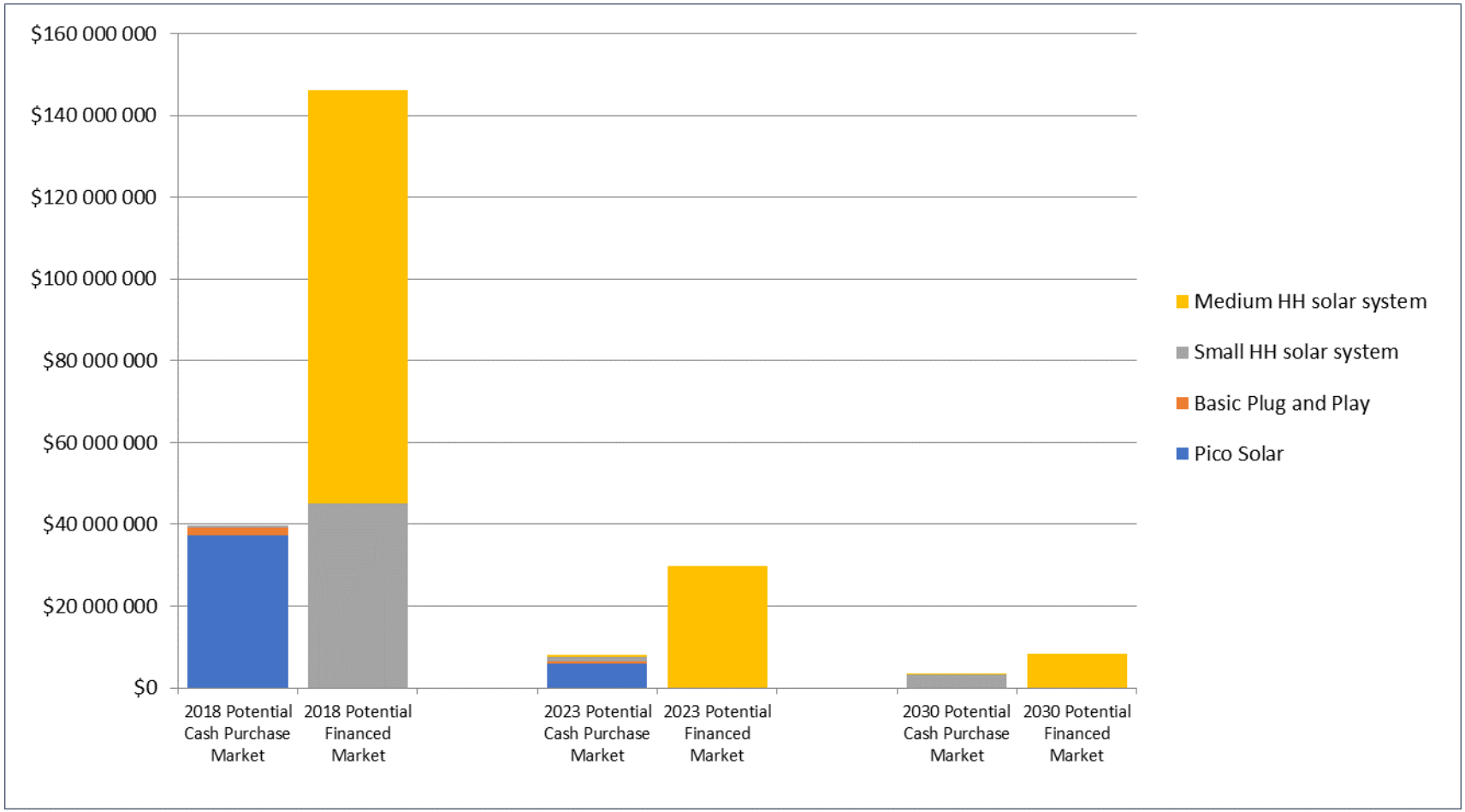
According to the analysis, the annualized off-grid solar cash market potential for the household sector in 2018 is USD 39.6 million, with the estimated market value more than tripling in size to USD 146.2 million with the addition of consumer financing (**Figure ES-6**). The most common types of systems the market can afford on a cash basis are pico solar and small plug and play systems; however, this changes significantly with the introduction of financing (**Figure ES-7**).

Based on an analysis of income levels of the country's population and corresponding estimated energy expenditures, households across all income quintiles can afford at least one OGS system unfinanced. However, financing enables many more consumers to acquire systems and those already in the market to afford larger systems.

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

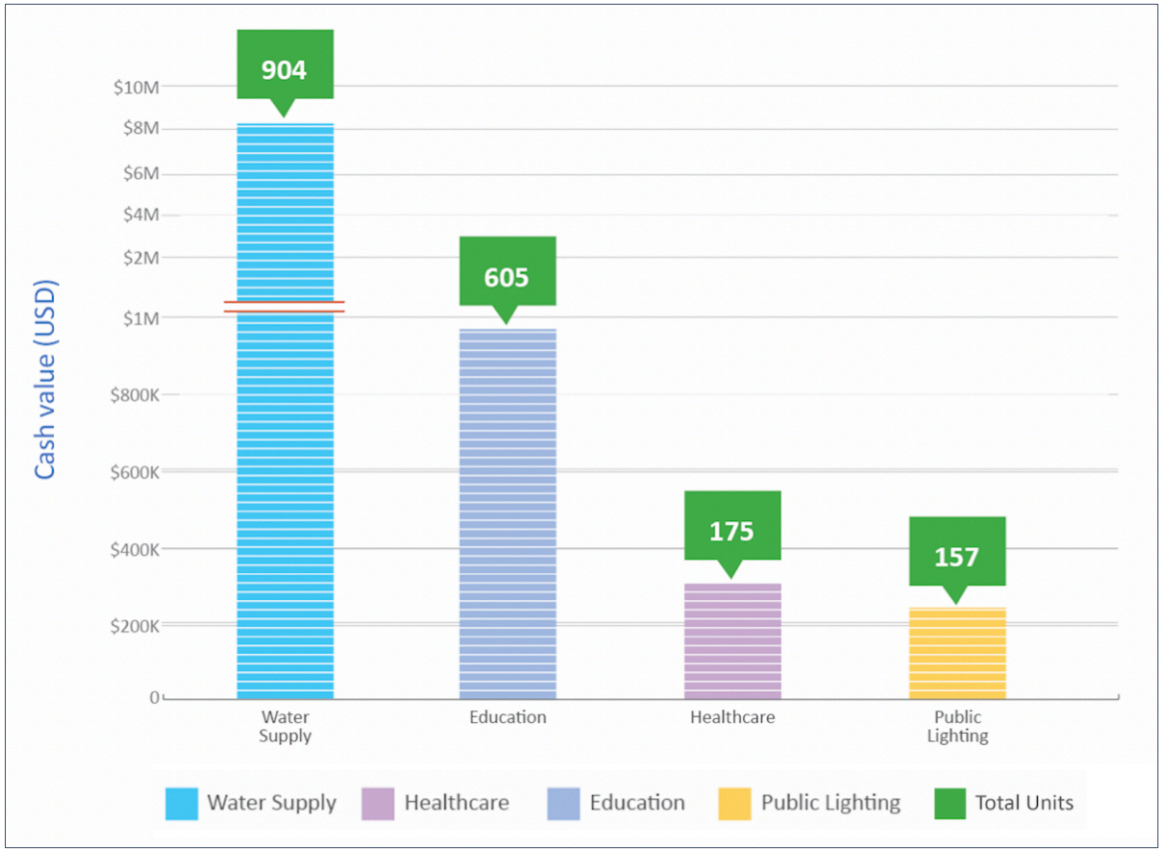
Source: African Solar Designs analysis

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

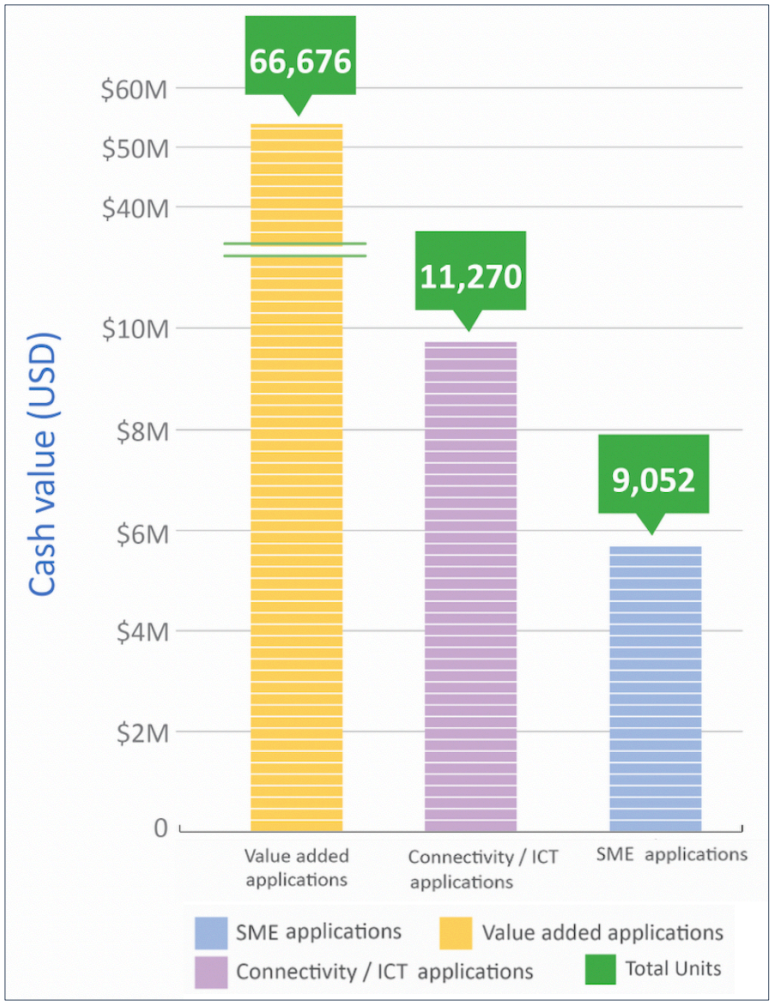


Source: African Solar Designs analysis

The estimated annualized cash market potential for Côte d'Ivoire's public/institutional sector in 2018 is USD 9.7 million (**Figure ES-8**). The institutional market segment with the largest potential is water supply (USD 8.2M), followed by education (USD 956K), healthcare (USD 297K) and public lighting (USD 236K). 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 69.3 million (**Figure ES-9**). The estimated demand from value-added applications represents most of the PUE market potential (USD 53.9 M), followed by applications for connectivity (USD 9.7M) and SMEs (USD 5.6M).

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



Source: African Solar Designs analysis

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

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

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

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

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

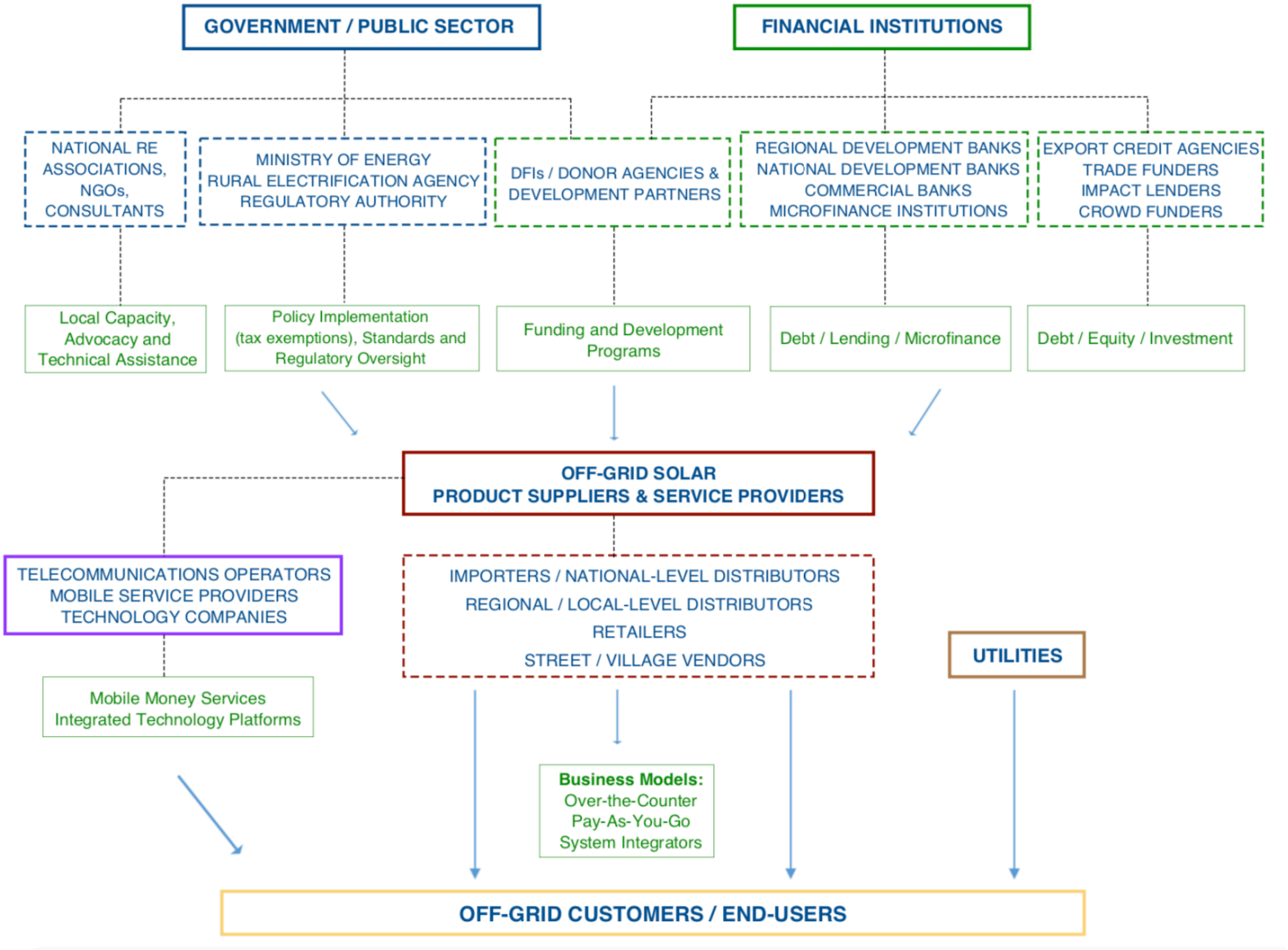
For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realties, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely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

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

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

Côte d'Ivoire'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 Côte d'Ivoire:

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

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

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

In Côte d'Ivoire, 28 commercial banks operate mainly in urban areas, leaving many rural and low-income people and businesses with limited access to financial services. Although access to banking and financial services through formal institutions remains limited, Côte d'Ivoire 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, 41% of the country's adult population had an account at a financial institution or with a mobile money service provider, up from 34% in 2014. In 2017, Côte d'Ivoire had among the highest rates of financial inclusion in West Africa and the Sahel, 8% above the regional average but slightly below the average for Sub-Saharan Africa. Despite this improvement in overall access, there is still a significant gender gap in rates of access to financial services, as women in Côte d'Ivoire are 11% less likely than men to have an account at a financial institution or with a mobile money service provider.[28]

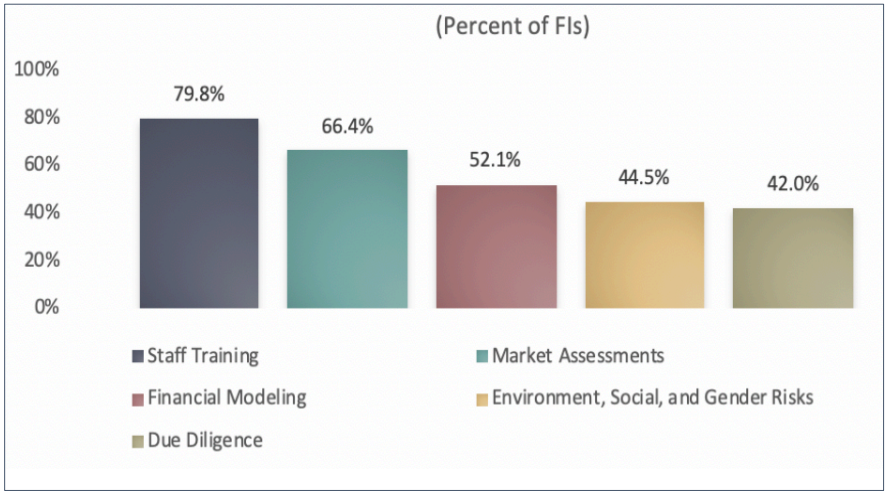
Expanding digital financial services, especially mobile money, can create new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. Moreover, mobile money technology also plays a critical role in the application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

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

While there are several donor and DFI-funded programs and initiatives that provide financing to support development of Côte d'Ivoire's off-grid solar market, these funds have not been channeled through local commercial banks or MFIs. ROGEP is therefore a pioneering initiative in the country, as it endeavors to boost OGS lending via engagement with local financial partners. Local FIs are increasingly becoming more aware of the opportunities in the off-grid sector thanks to donor-funded initiatives such as AFD's Sustainable Use of Natural Resources and Energy Finance (SUNREF) West Africa program and the recently completed USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR) program.

According to the Task 3 survey of financial institutions in Côte d'Ivoire and across the region,[29] 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 (such as CEADIR and 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

[29] 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 Côte d'Ivoire, 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.[30]

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**).[31]

[30] "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
[31] Ibid.

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

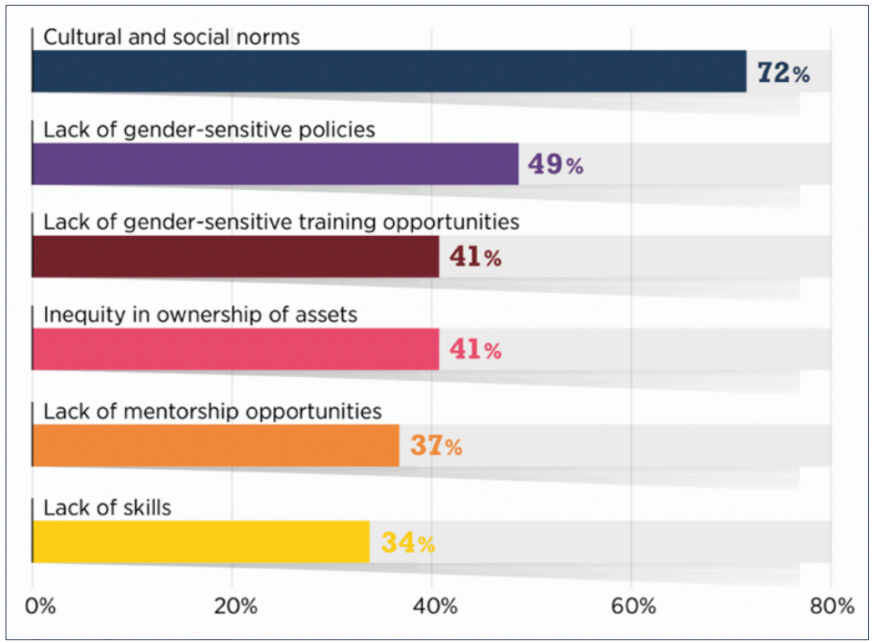
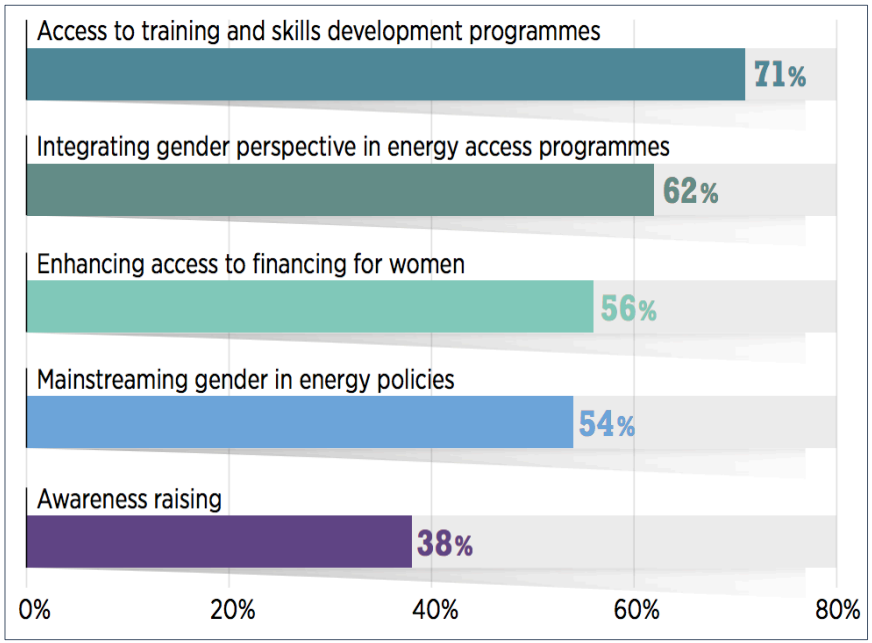


Figure ES-13: Measures to Improve Women's Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in Côte d'Ivoire 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 Côte d'Ivoire.[32]

[32] "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 Côte d'Ivoire (**Section 1.1**). This is followed by an overview of the country's existing energy sector (**Section 1.2**), with a focus on the status of energy access, including an assessment of both the on-grid and off-grid markets, a least-cost electrification analysis and a review of gender policies. **Section 1.3** examines national energy policy and regulation vis-à-vis the off-grid solar market, including detailed analysis of the existing framework for stand-alone systems[33] in Côte d'Ivoire 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

Côte d'Ivoire is the largest economy in the West African Economic and Monetary Union (WAEMU) and continues to experience high rates of economic growth after emerging from more than a decade of civil conflict and political instability.[34] Côte d'Ivoire was the second fastest growing country in Sub-Saharan Africa in 2017, due in part to favorable agricultural conditions and improved terms of trade. The country's GDP grew at a rate of 7% in 2017, driven by structural public investment and a robust services sector.[35] More than half of the country's rapidly growing population lives in urban areas – Abidjan concentrates 20% of the population, 80% of formal employment, and 90% of businesses.[36] In 2017, Côte d'Ivoire's services sector (energy, communications, transportation, financial services and trade) contributed to half of GDP, with industry accounting for approximately 30% of GDP and agriculture making up the balance. This dynamic is not reflected in the country's employment structure, however, as two-thirds of the labor force remains in agriculture. Côte d'Ivoire is the largest producer and exporter of cocoa beans in the world. Agricultural processing of cocoa, coffee and palm oil contributes significantly to export revenues, while the cocoa sector alone accounts for 10% of GDP and about one-third of the country's exports.[37]

Table 1: Macroeconomic and Social Indicators

Population	24.3 million
Urban Population	55% of total
GDP	USD 37.43billion
GDP growth rate	7.6%
GNI per capita*	USD 1,580
Unemployment rate	9.4% (2013 est.)
Poverty rate	46.3% (2015)
Urban / rural poverty	35.9% / 56.8%
Currency	West African CFA franc (CFA)
Official language	French
Natural resources	Agricultural (cocoa, coffee, sugar, palm oil, cashews); ores (gold, copper, manganese, bauxite)

* World Bank Atlas method (current USD)[38]
All figures from 2017 unless otherwise indicated
Source: AfDB and World Bank

[33] 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
[34] "Côte d'Ivoire Country Report," World Bank, (2018): http://documents.banquemondiale.org/curated/fr/610761516612734143/pdf/121663-WP-P165646-FRENCH-Final-ECONOMIC-UPDATE-6%C3%A9-EDITION-imprimable-PUBLIC.pdf
[35] "Côte d'Ivoire Economic Outlook," African Development Bank, (2018): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf
[36] "Reimagining Ivorian cities," World Bank, (September 2016): http://www.worldbank.org/en/country/Côtedivoire/publication/reimagining-ivoirian-cities
[37] "Côte d'Ivoire Macroeconomic Report," AFD, (2015): https://www.afd.fr/fr/les-enjeux-de-la-nouvelle-croissance-ivoirienne
[38] "World Bank Open Data: Côte d'Ivoire," World Bank, (2017): https://data.worldbank.org/country/Côte-divoire

1.2 Energy Market

1.2.1 Energy Sector Overview

The energy sector in Côte d'Ivoire has been managed by Compagnie Ivoirienne d'Électricité (CIE) since the early 1990s. In 2013-14, the Government of Côte d'Ivoire (GoCI) undertook a series of reforms to liberalize the power market. CI-ENERGIES (Société des Energies de Côte d'Ivoire), a government-owned company, supplies electricity as a vertically integrated monopoly and enters into Power Purchase Agreements (PPAs) with Independent Power Producers (IPPs) as the sole transmission and distribution operator. Rural electrification falls under the joint purview of CIE and state-owned CI-ENERGIES. Liberalization of the distribution and retail sectors is expected in 2020 after CIE's existing concession agreement with the Government expires.[39]

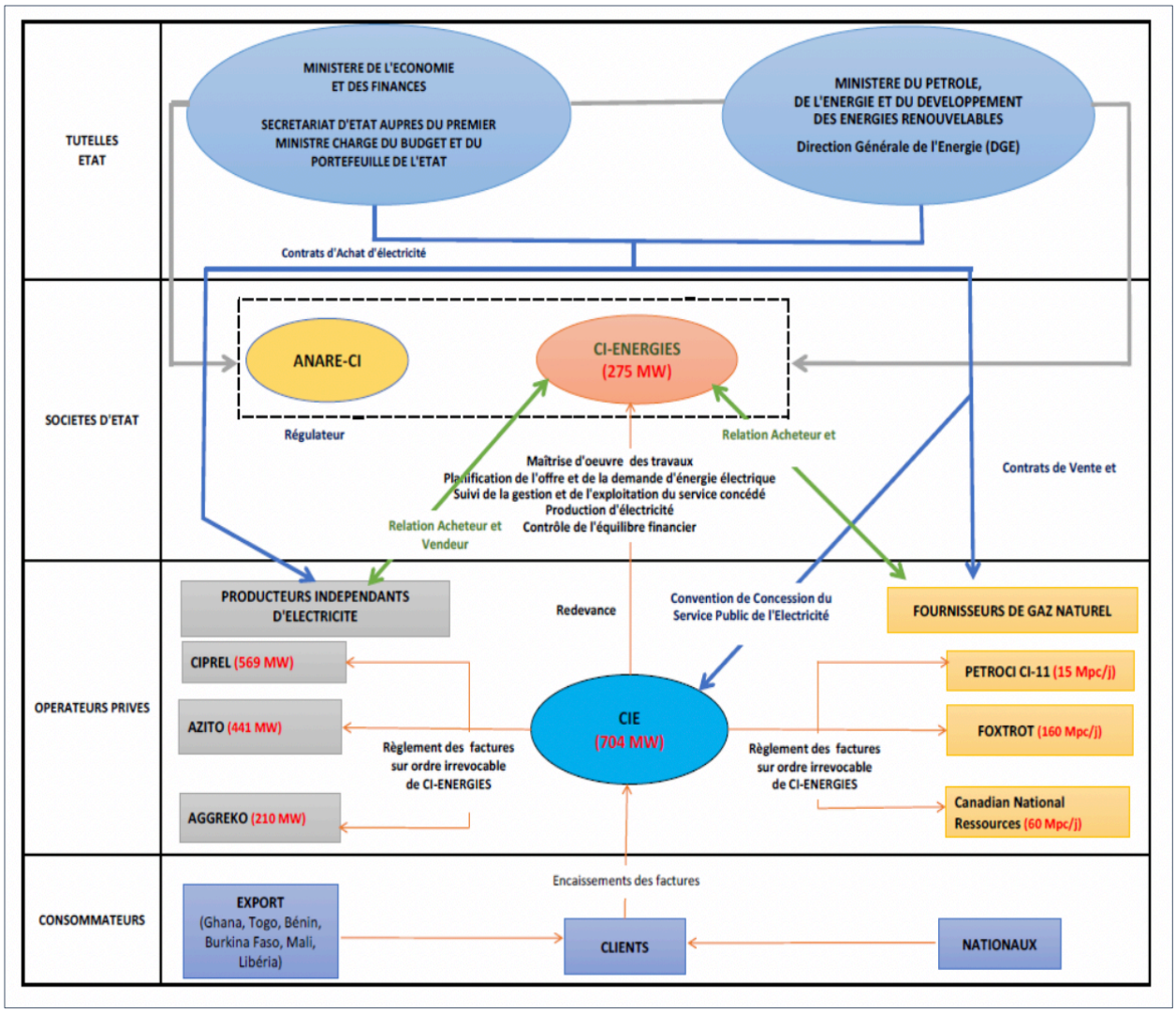
Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Ministry of Petroleum, Energy and Renewable Energy Development (Ministère du Pétrole, de l'Energie et du Développement des Énergies Renouvelables, "MPEER")	• Ministry responsible for implementing national energy policy and coordinating all energy sector programs and activities
Director General of Energy (Direction Générale de l'Energie)	• Entity within MPEER responsible for overseeing all electrification and energy sector development in the country
CI-ENERGIES (Société des Énergies de Côte d'Ivoire)	• State-owned company that responds to MPEER and manages the energy sector, including (i) energy planning; (ii) project management and development; (iii) asset and cash flow management; and (iv) rural electrification • Managing preparation and administration of Rural Electrification Master Plan (Plan Directeur d'Electrification Rurale, "PDER")
CIE - Côte d'Ivoire Electricity Company (Compagnie Ivorienne d'Électricité)	• Private utility company responsible for electricity production, transmission and distribution throughout the country • Operates and maintains both hydro and thermal plants under concession agreements with the state • In its role as the grid operator, CIE is responsible for (i) network extensions, maintenance and electrification; and (ii) regional transmission of power to neighboring countries
ANARE-CI (Autorité Nationale de Régulation du secteur de l'Electricité de Côte d'Ivoire)	• Independent regulatory authority responsible for (i) supervising compliance with all energy laws and regulations by utility operators and IPPs; (ii) proposing electricity tariffs to the state as well as tariffs to access the national grid; (iii) dispute settlement; (iv) protecting the collective interest of electricity consumers; and (v) providing advice and assistance to all electricity operators
CIPREL (Compagnie Ivorienne de Production d'Électricité), Azito Energie and Aggreko	• Private IPPs operating 569 MW, 441 MW and 210 MW of thermal production in the country, respectively, together accounting for more than half of the country's power production in 2017.

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

[39] "Côte d'Ivoire Country Profile," ClimateScope, Bloomberg New Energy Finance, (2017): http://global-climatescope.org/en/country/Côte -ivoire/#/enabling-framework

Figure 1: Institutional Overview of the Energy Sector



Source: CI-ENERGIES

1.2.2 Electricity Access: *Grid and Off-Grid*

In 2016, approximately one-third of the overall population in Côte d'Ivoire – an estimated nine million people – did not have access to electricity, with a significant disparity in rates of access between urban (88%) and rural (31%) areas.[40] Off-grid electrification has therefore been a policy priority, with the Government aiming to achieve universal access by 2025.

1.2.2.1 Off-Grid Market Overview

In 2012, with support from ECOWAS, the GoCI developed and adopted the National Program for Investment in Energy Access Services (Le Programme National d'Investissement Pour l'Accès aux Services Energétiques en Côte d'Ivoire, "PNIASE-CI"), which focused on identifying and measuring the

[40] "Energy Access Outlook, 2017: From Poverty to Prosperity," IEA, (2017): https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

level of energy access in the country by examining the proportion of electrified localities and households with access to electricity.[41] The Government subsequently launched the National Program for Rural Electrification, (Programme National d'Electrification Rurale, PRONER) in 2014 to align public and private resources and coordinate the development efforts necessary to expand electricity coverage to all localities and double the number of household connections. A key component of the Government's electrification strategy is the "Electricity for All" (Programme Electricité Pour Tous, PEPT) initiative, which aims to bring electricity access to around one million low-income households over the next five years through a combination of rehabilitation and extension of the transmission network as well as a subsidy mechanism that eliminates the high cost for rural households to connect to the distribution grid.

These Government-led electrification efforts have been largely successful. PEPT has already established 300,000 connections to the grid. From 2011-2016, there was a 59% increase in the number of localities electrified and a 20% increase in the national coverage rate (ratio of localities electrified compared to the total number of localities in the country).[42]

Following a new policy in 2014, state-owned CI-ENERGIES began developing a Rural Electrification Master Plan (Plan Directeur d'Electrification Rurale, PDER) to electrify all of the country's rural areas. The plan called for the electrification of all localities with at least 500 households by 2018 and to achieve universal access by 2025, utilizing a combination of grid extensions and distributed solar technology. Under PDER, CI-ENERGIES estimates that a total of 96 localities are eligible for off-grid electrification through mini-grids. A program is already in place to provide solar-diesel hybrid solutions to 49 of these areas with funding from WAEMU and the European Union (EU) ENERGOS-2 program. As the Master Plan did not account for smaller localities, an off-grid strategy utilizing micro-grids and solar kits is being developed for the electrification of more than 3,000 remaining settlements and villages throughout the country.[43] In addition to public sector initiatives, several private solar companies are also operating the country's off-grid market (see **Section 2.4.3**).

Outside of the household connections, there has been relatively limited off-grid market activity in Côte d'Ivoire. As of 2017, ANARE-CI identified 48 isolated power plants totaling about 5 MW that are operating in rural areas.[44] These are mostly small thermal plants, with the exception of seven solar-diesel hybrid mini-grids operating in the north-east region of Zanzan, which were part of a pilot project funded by the EU and the United Nations Industrial Development Organization (UNIDO) to generate solar electricity in targeted productive use communities.[45]

[41] "SE-for-All Action Agenda: Côte d'Ivoire," ECREEE, (2015): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/CO%CC%82TE_D%E2%80%99IVOIRE_Agenda_d%E2%80%99Action_de_L%E2%80%99initiative_Energie_Durable_Pour_Tous.pdf

[42] "Electrification Rurale de Côte d'Ivoire," CIE-ENERGIES, (March 2017): http://www.ecreee.org/sites/default/files/documents/news/08_Côte_divoire_rural_electrification_masterplan.pdf

[43] "1st National Workshop: Promoting Private Investments in Autonomous Solar Systems in West Africa and the Sahel," Abidjan, Côte d'Ivoire, ECREEE, (3 May 2018)

[44] "Côte d'Ivoire: Energy Sector," Africa-EU Renewable Energy Cooperation Programme (RECP), (2017): https://www.africa-eu-renewables.org/market-information/Côte -divoire/energy-sector/

[45] "Promoting renewable energy-based grids in rural communities for productive uses in Côte d'Ivoire," UNIDO, (2016): https://www.unido.org/sites/default/files/2016-09/GFIVC12005-100186_TE_report-2016_0.pdf

1.2.2.2 Demand and Supply/Generation Mix

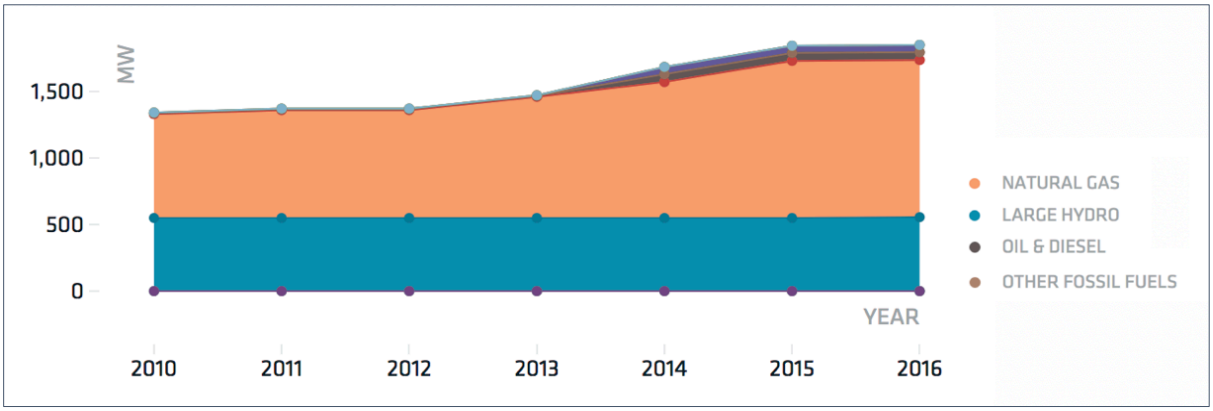
With an installed generation capacity of 2,199 MW, Côte d'Ivoire's is the third largest electricity producer in West Africa behind Ghana and Nigeria. The country's power supply is dominated by gas-fired generation and large hydropower (**Figure 2** and **Table 4**),[47] contributing to about 60% and 40% of installed capacity, respectively. Three private IPPs – CIPREL, Azito Energie, and Aggreko – account for approximately two-thirds of the country's installed generation capacity.[48]

Table 3: Electricity Sector Indicators, 2017[46]

Installed Capacity	2,199 MW
Thermal	1,320 MW
Hydropower	879 MW
Renewable (non-hydro)	-
National electrification rate (2016)	64%
Urban electrification rate	88%
Rural electrification rate	31%
Population without access	9.2 million
Households without access	1.7 million
Electrification target	Universal access by 2025

Source: IEA, USAID Power Africa and World Bank

Figure 2: Installed Generation Capacity



Source: ClimateScope, Bloomberg New Energy Finance

Like many countries in Sub-Saharan Africa, Côte d'Ivoire is struggling to provide sufficient power generation capacity to meet rising demand. The country's rapidly growing economy and increasing electrification have contributed to a steady increase in domestic electricity consumption, with demand growing at a rate of more than 10% per year since 2011 and growth expected to continue at more than 7% per year through 2025.[49] In response, the Government is partnering with private IPPs to significantly increase the country's installed capacity, with a target of reaching 4 GW of electricity generation by 2020.

To meet this target, the GoCI intends to add new hydroelectric, thermal and renewable energy capacity, while also expanding the capacity of existing power plants. In late 2017, the Government commissioned the 275MW Soubré Hydroelectric Power Plant, while plans were also announced to increase generation at the CIPREL (350 MW) and Azito (280 MW) CCGT plants. The country's first Liquefied Natural Gas (LNG) terminal is under construction in the port of Abidjan; LNG imports would bolster domestic gas

[46] See **Section 2.1** for more details on households/population without access to electricity.
[47] "Côte d'Ivoire Power Africa Fact Sheet," USAID, (2018): https://www.usaid.gov/powerafrica/Côte -divoire
[48] "Côte d'Ivoire: Energy Sector," Africa-EU Renewable Energy Cooperation Programme (RECP), (2017): https://www.africa-eu-renewables.org/market-information/Côte -divoire/energy-sector/
[49] "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," IFC, (2018): https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aadc01b4/IFC-Côte_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES

supplies and reduce the need to burn costly and environmentally damaging diesel and heavy fuel oil.[50] Utility-scale biomass and solar technology projects will increase the share of clean energy in the generation mix. In its Nationally Determined Contribution (NDC), released in 2016, Côte d'Ivoire set a target to generate 42% of electricity from renewable energy by 2030 **(Table 4)**.

Table 4: Current and Planned Installed Capacity[51]

Installed Capacity (MW)	2017	2030 (planned)
Thermal – gas	1,320	2,548
Thermal – coal	-	1,400
Hydro	879	1,891
Solar	-	420
Biomass	-	500
Total Installed Capacity (MW)	**2,199**	**6,759**
Total thermal	1,320	3,948
Total renewable energy	879	2,811

Source: IFC

Electricity tariffs are set by the Ministry of Petroleum, Energy and Renewable Energy and regulated by ANARE-CI. Tariffs are structurally low in Côte d'Ivoire due to the cheap gas environment, but also vary widely based on social class and usage. CIE sells power to on-grid consumers at an average tariff of approximately USD 0.13/kWh (**Table 5**). Recent attempts to increase electricity tariffs were quickly abandoned amid social unrest.

Table 5 : Average Electricity Tariffs and Projections[52]

Year	2016	2017	2018	2019	2020
Total average tariff / kWh	CFAF 68.2 (USD 0.11)	CFAF 70.1 (USD 0.12)	CFAF 73.0 (USD 0.13)	CFAF 75.5 (USD 0.13)	CFAF 77.3 (USD 0.14)

Source: CIE

Concerning asset sales, the **Table 6** provides a breakdown of the prices for solar stand-alone kits utilizing pay-as-you-go (PAYG) and cash sales in Côte d'Ivoire (for a plug-and-play solar kit).

Table 6: Stand-alone Solar Costs by Payment Method

Payment Method	Price (CFA franc)	Price (USD)
Initial fee	15,000	28
Monthly fee	5,000	10
Total cost in 3 years	195,000	350
Cash payment	140,000	250

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

[50] "Côte d'Ivoire on schedule to meet Ouattara's target of 4GW of electricity generation by 2020," African Energy, (13 December 2017): https://www.africa-energy.com/live-data/article/c%C3%B4te-d%E2%80%99ivoire-schedule-meet-ouattara%E2%80%99s-target-4gw-electricity-generation-2020

[51] "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," IFC, (2018): https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aadc01b4/IFC-C%C3%B4te_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES

[52] "Tarifs d'électricité," CIE, (2018): http://www.cie.ci/particuliers/vos-consommations/tarifs-electricite

1.2.2.3 Transmission and Distribution Network

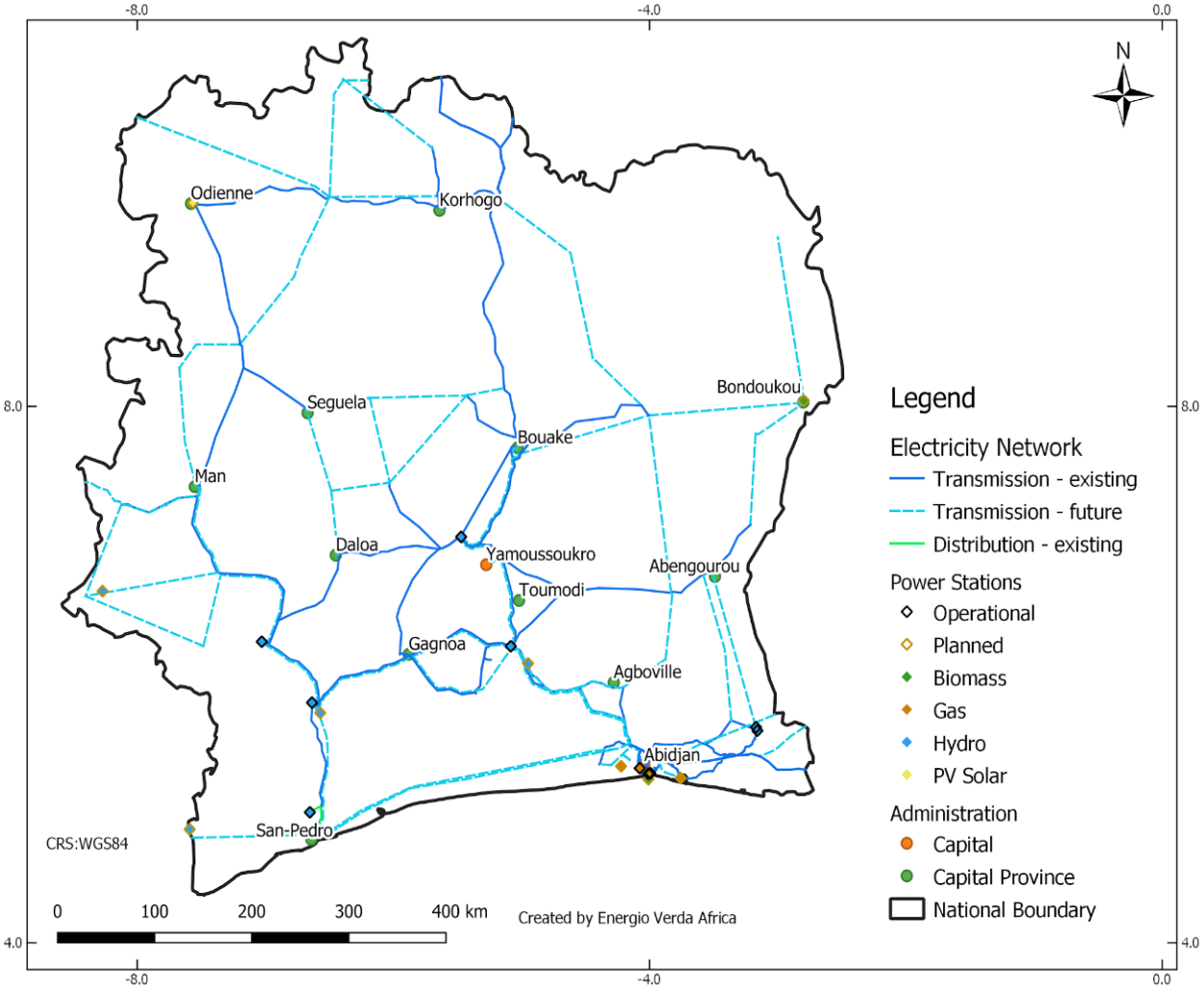
Côte d'Ivoire's electricity grid is relatively extensive compared with other countries in the region, covering close to half of the country's villages and nearly 80% of the population **(Figure 3**).[53] Despite the high penetration of coverage, the rate of rural electricity access remains low, which can largely be attributed to the high upfront cost of grid connection.[54] In response, the GoCI is eliminating high connection costs for rural end-users under its PEPT initiative.

Overall, a significant gap exists between the infrastructure needs of the power sector and the availability of resources to invest in grid maintenance and extension to rural areas. As a result, the country's electricity network is overloaded, unreliable and in need of significant investment, with average transmission and distribution losses as a percentage of power output estimated at 22% in 2017.[55] The poor status of the grid remains a major constraint to long-term development; recent studies undertaken by CIE and the Government estimate that more than USD 3 billion of investment will be required over the next decade to address the country's needs in transmission, urban distribution and rural electrification.[56] With little interest from the private sector and a lack of public funds, in order to meet its electrification objectives, the GoCI is mobilizing financial support from a range of DFIs, including the World Bank, AfDB, the French Development Agency (Agence Française de Développement, AFD), the EU, the West Africa Development Bank (Banque Ouest Africaine de Développement, BOAD) as well as bilateral assistance from China. CIE-ENERGIES has announced several grid extension initiatives under PDER, as grid extension and rehabilitation will be the primary methods the country will utilize to achieve universal access by 2025, with supplemental mini-grid and stand-alone solar system initiatives to support communities that cannot be reached by the distribution network (**Figure 4**).[57]

As a member of the West African Power Pool (WAPP), Côte d'Ivoire is a net exporter of electricity, with net power exports equivalent to about 10% of the country's overall production in 2016.[58] Côte d'Ivoire currently has existing grid connections with Benin, Burkina Faso, Ghana, and Togo; the country's export commitments to other WAPP countries will expand with the expected 2020 completion of the Côte d'Ivoire-Liberia-Sierra Leone-Guinea transmission line.[59] Côte d'Ivoire is well positioned to become a major trading hub as the WAPP moves towards a unified regional electricity market providing reliable and affordable energy to its member states.[60]

[53] "Côte d'Ivoire Electricity Transmission and Access Project: Project Appraisal Document," World Bank, Energy and Extractives Global Practice, (2017): http://documents.worldbank.org/curated/en/450031491098454445/pdf/CÔTE -DIVOIRE-PAD-03132017.pdf
[54] "Côte d'Ivoire Power Africa Fact Sheet," USAID, (2018): https://www.usaid.gov/powerafrica/Côte -divoire
[55] "Côte d'Ivoire: Energy Sector," Africa-EU Renewable Energy Cooperation Programme (RECP), (2017): https://www.africa-eu-renewables.org/market-information/senegal/energy-sector/
[56] "Côte d'Ivoire Electricity Transmission and Access Project," The World Bank, (2017): http://documents.worldbank.org/curated/en/450031491098454445/pdf/CÔTE-DIVOIRE-PAD-03132017.pdf
[57] "Access to Electricity," CIE Energies, (2017): http://www.cinergies.ci/acc%C3%A8s-%C3%A0-l-%C3%A9lectricit%C3%A9.html
[58] "Côte d'Ivoire: Energy Sector," Africa-EU Renewable Energy Cooperation Programme (RECP), (2017): https://www.africa-eu-renewables.org/market-information/senegal/energy-sector/
[59] "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," IFC, (2018): https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aadc01b4/IFC-C%C3%B4te_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES
[60] "West African Power Pool", WAPP, (2018): http://icc.ecowapp.org

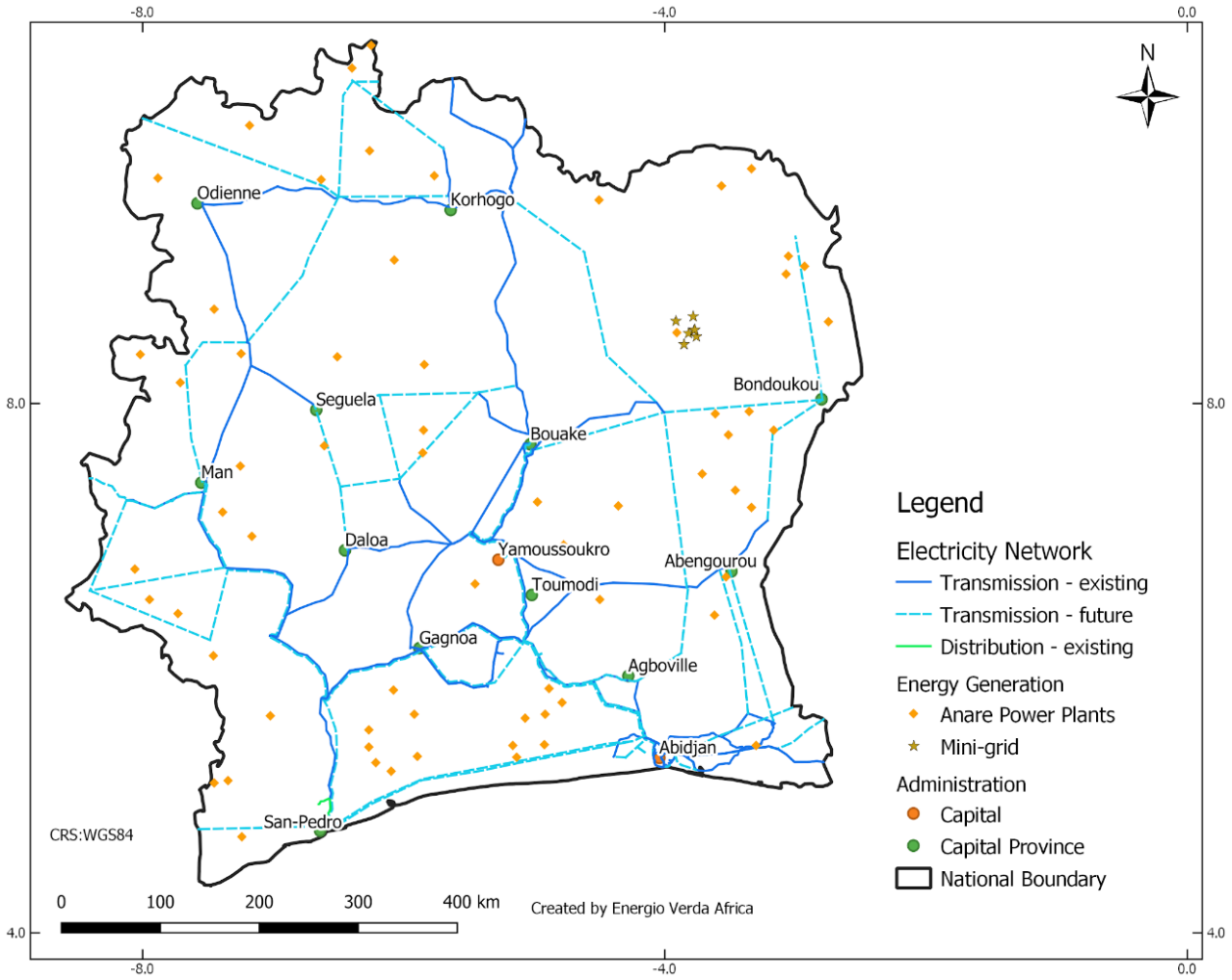
Figure 3: Electricity Transmission and Distribution Network[61]



Source: Energio Verda Africa GIS analysis

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

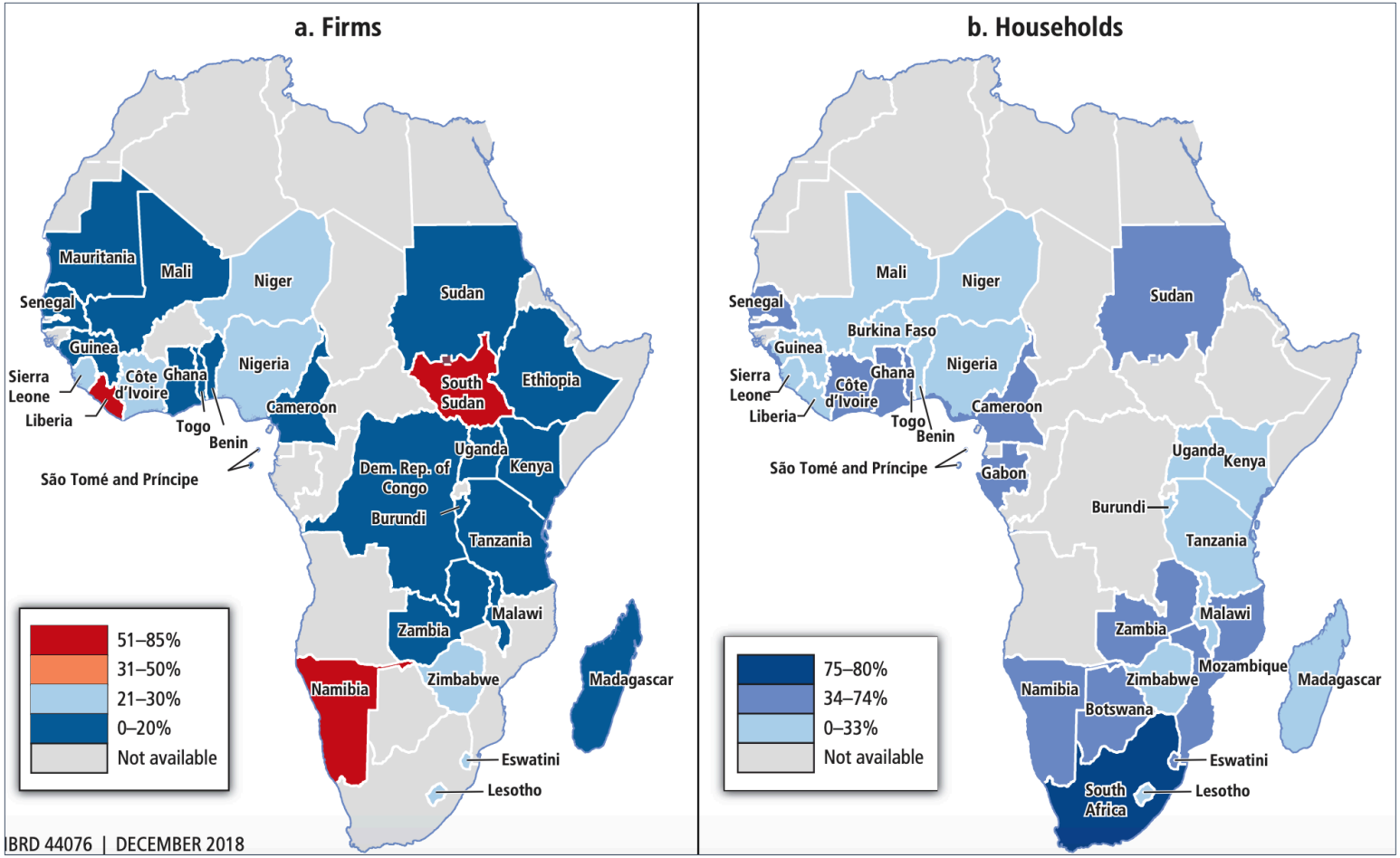
Figure 4: Power Plants and Mini-Grids[62]



Source: Energio Verda Africa GIS analysis

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

Figure 5: Access to Reliable Electricity by Firms and Households in Africa[63]



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

The maps in **Figure 5** illustrate the share of firms (Panel a) and households (Panel b) reporting access to a reliable supply of electricity. In Côte d'Ivoire, fewer than one-third of surveyed firms and about half of surveyed households reported having reliable access to electricity.

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

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 Côte d'Ivoire through 2023 and through 2030 ("Scenario 2023" and "Scenario 2030").[64] 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 Côte d'Ivoire 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 Côte d'Ivoire based on their proximity to electrical infrastructure, population density or nodes of economic growth.

For the scenario 2023 analysis, it is assumed that widespread densification of the existing electrical grid will enable settlements within 5 km of existing grid lines to connect to the grid (according to WAPP densification plans).[65] Beyond this area, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km^2) and have active local economies, evidenced by the presence of social facilities and by their proximity to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km^2) or far from the national grid – are considered candidates for off-grid stand-alone systems.

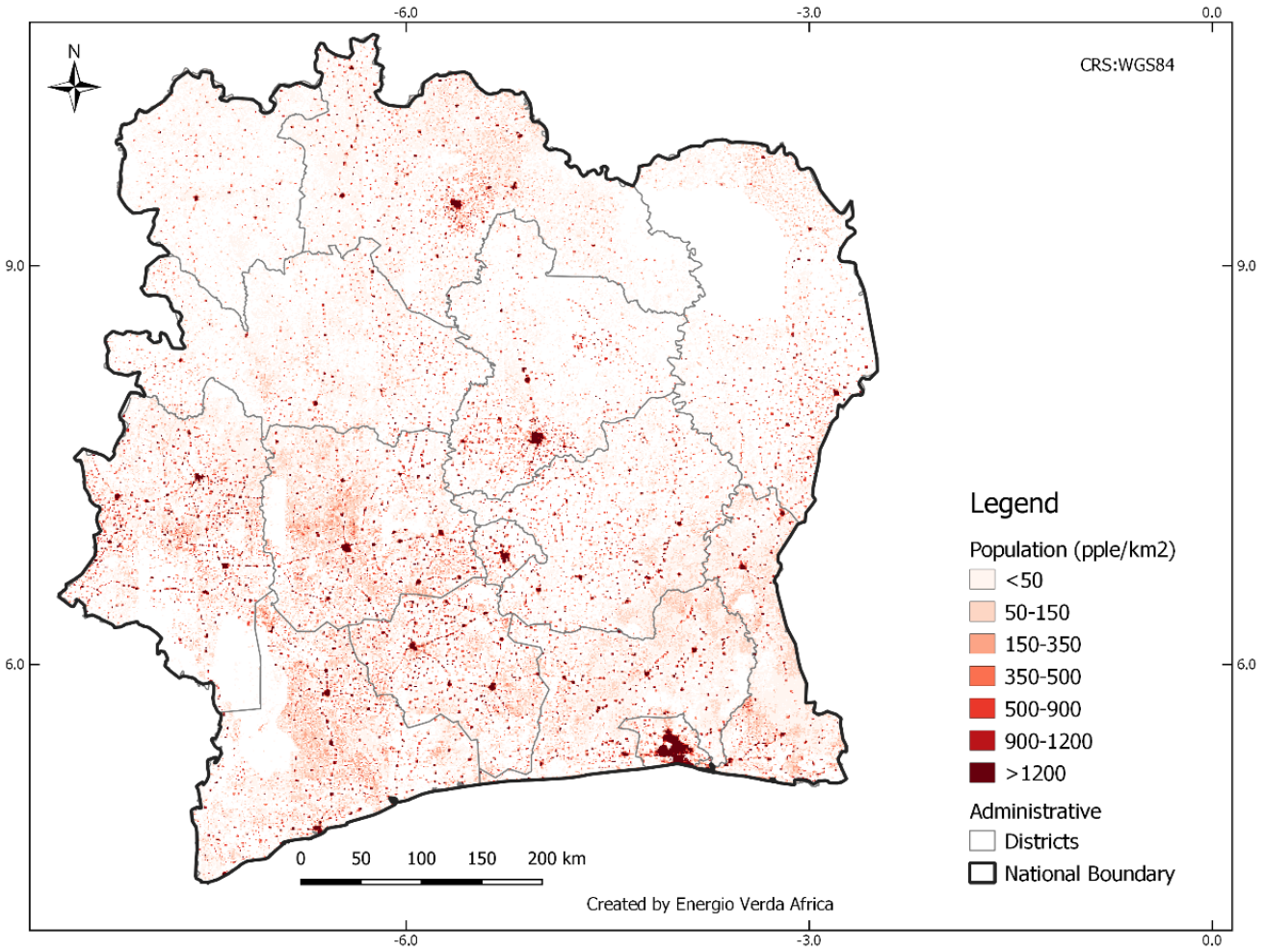
For the scenario 2030 analysis, it is assumed that the grid and the reach of grid densification efforts will extend far beyond the existing network. Hence, settlements that are within 15 km of current lines (average densification distance announced by utilities across West Africa in a 10-year timeline in personal interviews) and 5 km of future planned line extensions (high voltage lines only were available for the analysis) 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 2023 analysis, as well as within 15 km of economic growth centers – airports, mines and urban areas. All other settlements are considered candidates for off-grid stand-alone systems.

Given the lack of low voltage distribution line data, it is necessary to approximate areas where un-electrified settlements in close proximity to the grid exist. The analysis therefore focuses on settlements that are within 5 km of the high and medium voltage network, but that are located beyond 15 km of areas with night-time light emissions (indicative of electrification). Settlements in areas of low population density (below 350 people/km^2) that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within the scenario 2023.[66]

Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 2.5%[67] was applied to the geospatial analysis to project population figures for the scenario 2023 and 2030 analyses.[68] **Figure 5** shows population density across the country, which served as the basis for this analysis.

[64] NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to GoCI electrification targets for 2030
[65] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[66] Note that this analysis was performed for scenario 2023 but not for scenario 2030 due to uncertainties regarding population densities being too high over such a long timeframe
[67] "World Bank Open Data: Côte d'Ivoire," World Bank, (2017): https://data.worldbank.org/indicator/SP.POP.GROW
[68] See **Annex 1** for more details on the approach and methods used

Figure 6: Population Density, 2015[69]



Source: Energio Verda Africa GIS analysis

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

- **Results**

Table 7 summarizes the results of the least cost electrification analysis. **Figure 6** and **Figure 7** illustrate the distribution of settlements according to least-cost electrification options under scenarios 2023 and 2030, respectively. The number of households was estimated by using the average household size for the country (5.4 persons/household).[70]

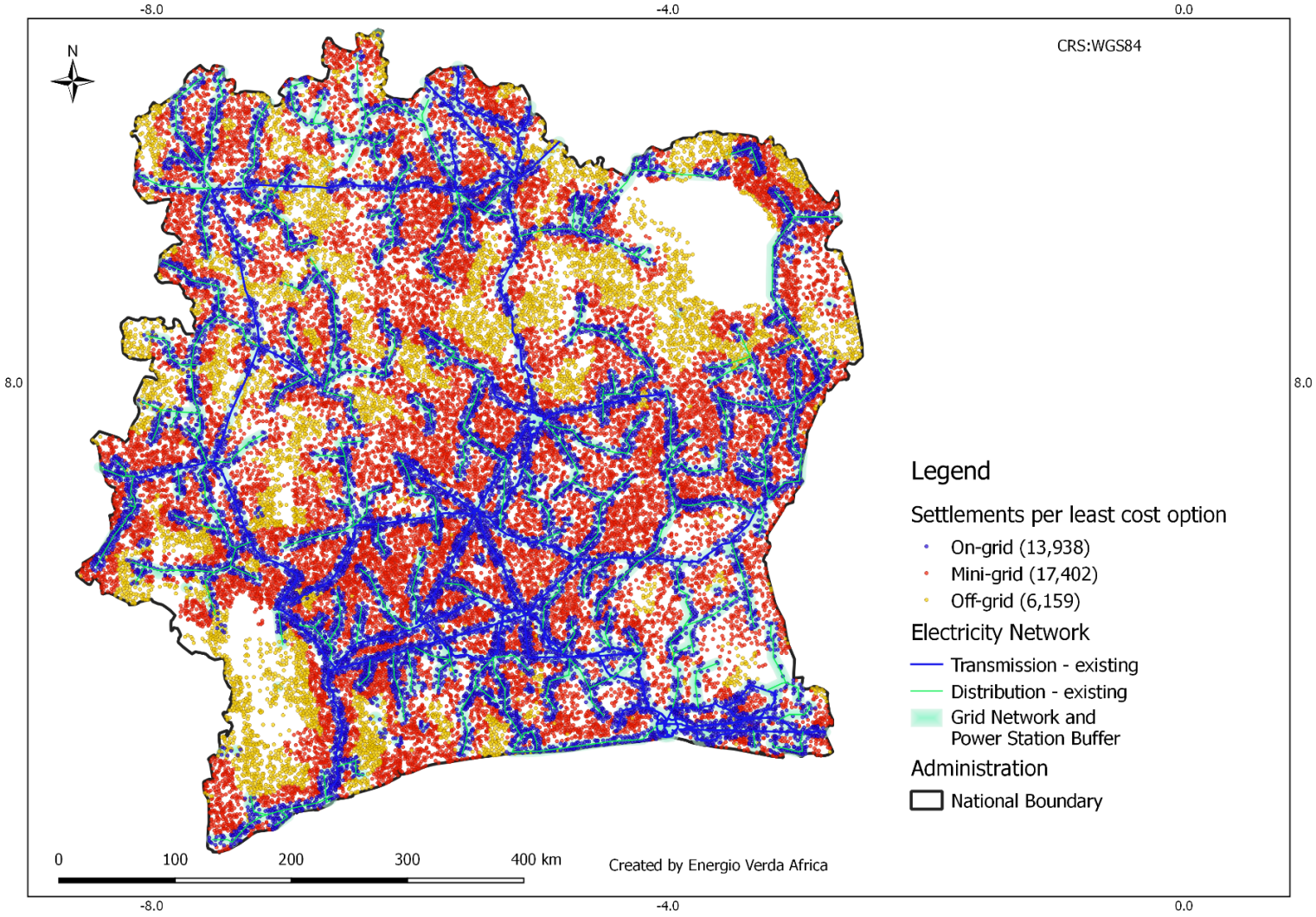
Table 7: Results of Least-Cost Electrification Analysis

Scenario	Indicator	Least-Cost Electrification Option			Grid Vicinity		
		Grid extension	Mini-grid	Off-grid stand-alone systems	Under-grid un-served	Total under-grid	Total outside grid vicinity
Scenario 2023	Number of settlements	13,938	17,402	6,159	606	14,544	22,955
	% of settlements	37.2%	46.4%	16.4%	4.2%	38.8%	61.2%
	Total population	18,095,642	7,811,582	1,706,487	100,853	18,196,495	9,417,217
	% of population	65.5%	28.3%	6.2%	0.6%	65.9%	34.1%
	Number of households	3,351,045	1,446,589	316,016	18,676	3,369,721	1,743,929
Scenario 2030	Number of settlements	31,192	3,195	3,112	Not calculated	31,192	6,307
	% of settlements	83.2%	8.5%	8.3%	Not calculated	83.2%	16.8%
	Total population	30,282,102	1,619,175	922,749	Not calculated	30,282,102	2,541,924
	% of population	92.3%	4.9%	2.8%	Not calculated	92.3%	7.7%
	Number of households	5,607,797	299,847	170,879	Not calculated	5,607,797	470,727

Source: Energio Verda Africa GIS analysis

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

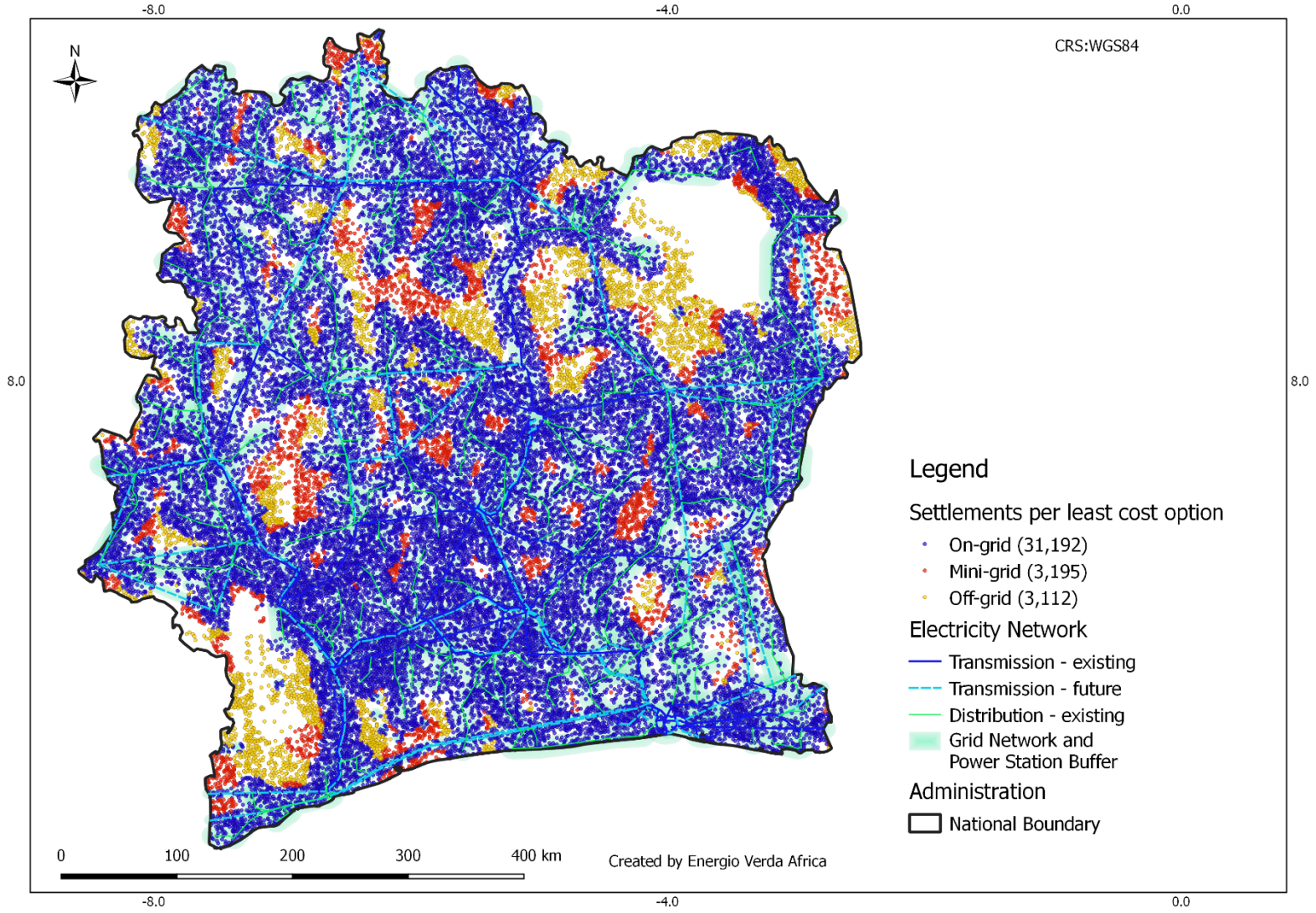
Figure 7: Distribution of Settlements by Least-Cost Electrification option, 2023[71]



Source: Energio Verda Africa GIS analysis

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

Figure 8: Distribution of Settlements by Least-Cost Electrification option, 2030[72]



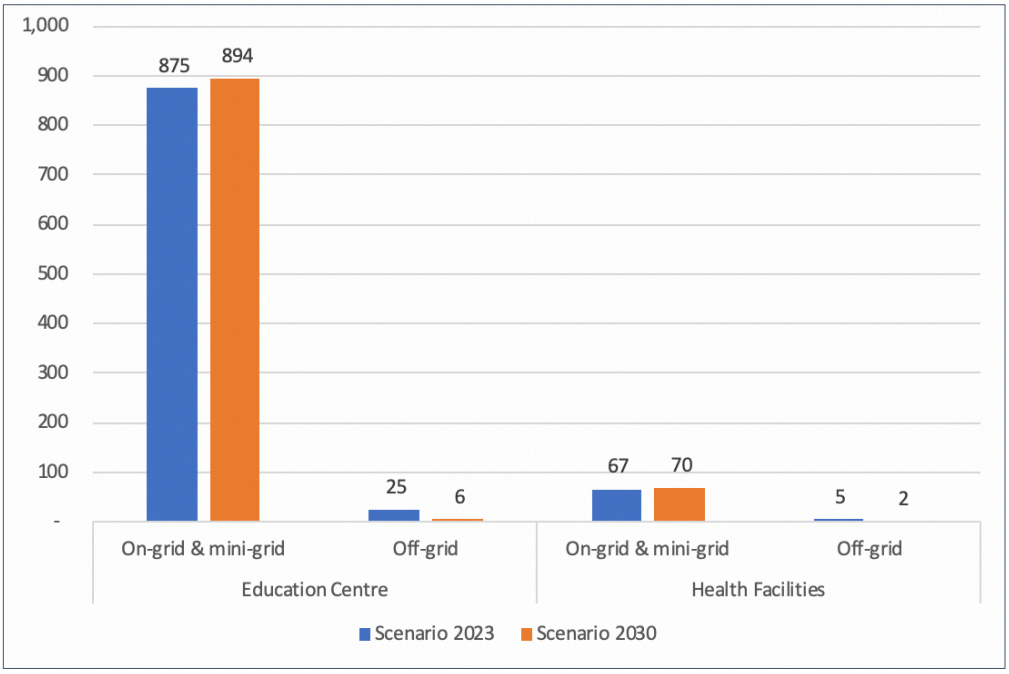
Source: Energio Verda Africa GIS analysis

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

The analysis also covered the education centers and health facilities that will remain in off-grid areas during the analyzed timeframes. The number of education centers and health facilities cannot be seen as comprehensive as not all were available for the geospatial analysis (institutions with known coordinates); a total of 900 education centers and 72 health facilities were analyzed. Of the 900 education centers, 360 are located in the Abidjan area and 305 in the Bouake area and will potentially be connected to the main grid in both scenarios.

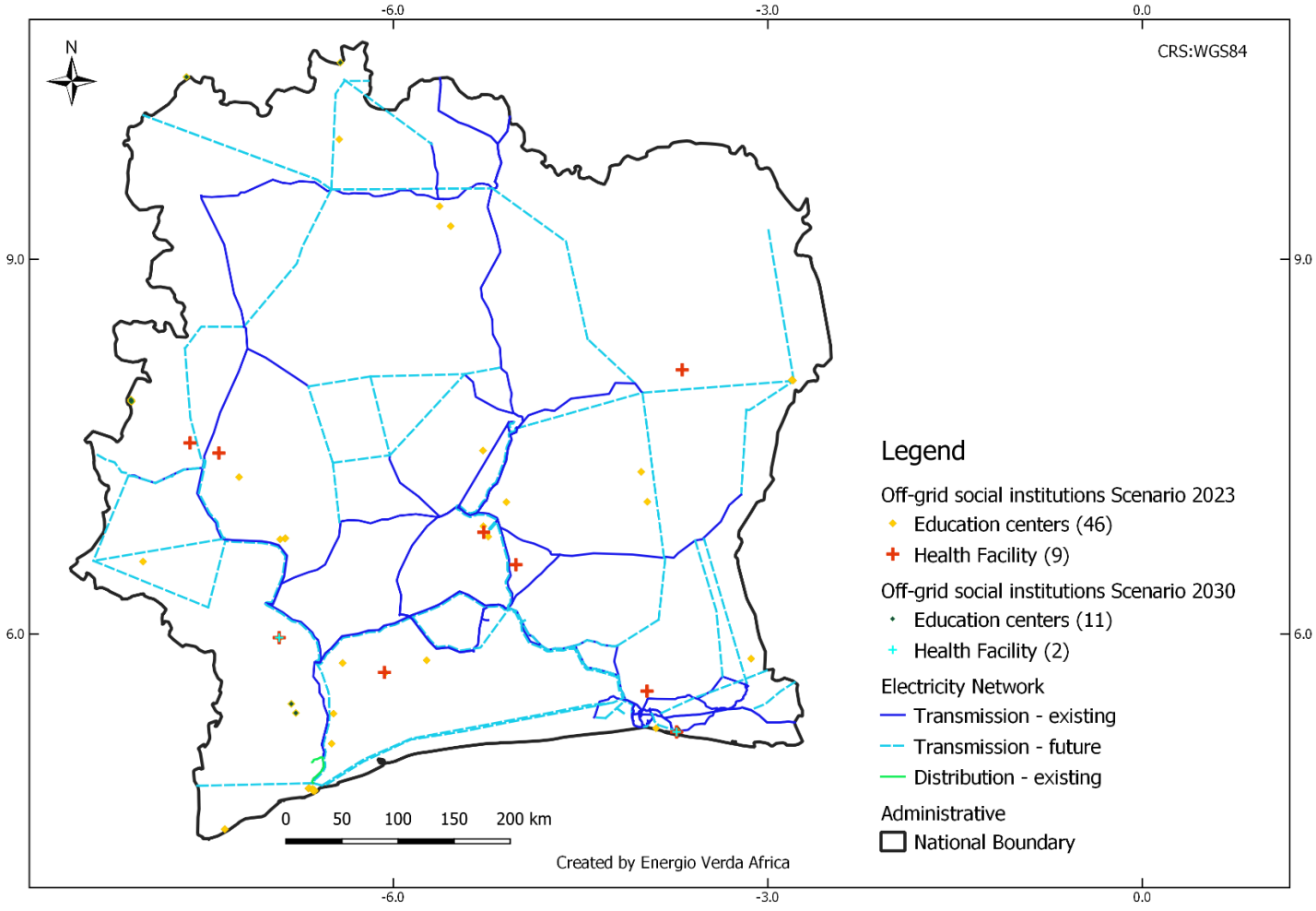
Figure 9 summarizes the number of these education centers and health facilities that may be electrified (on-grid and mini-grid) or suitable for off-grid stand-alone solutions in the scenarios 2023 and 2030. **Figure 10** illustrates the distribution of potential off-grid facilities across the country under the two scenarios.

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



Source: Energio Verda Africa GIS analysis

Figure 10: Distribution of Potential Off-Grid Social Facilities, 2023 and 2030[73]

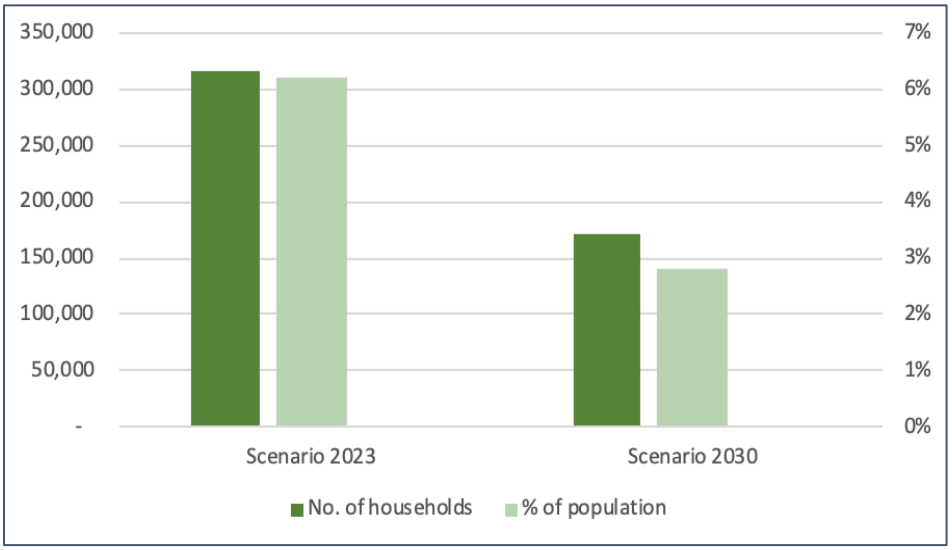


Source: Energio Verda Africa GIS analysis

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

According to the geospatial analysis, by 2023, 13,938 settlements across Côte d'Ivoire (3,351,045 households) will be connected to the main grid, representing 65.5% of the population. By 2030, this figure will increase to 31,192 settlements (5,607,797 households), equivalent to 83.2% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030. Not all settlements in close proximity to electricity lines will connect to the main grid, largely due to the low density of these areas (dispersed settlements with a density below 350 people/km^2). By 2023, an estimated 606 settlements located under the grid will meet these criteria (or 4.2% 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 17,402 settlements (1,446,589 households), or 28.3% of the population, decreasing to 3,195 settlements (299,847 households), or 4.9% 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 6,159 settlements (316,016 households) and 6.2% of the population in 2023, decreasing to 3,112 settlements (170,879 households) and 2.8% of the population in 2030 **(Figure 11**).

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



Source: Energio Verda Africa GIS analysis

The analysis indicates that the off-grid stand-alone market has the potential to grow significantly. An estimated 47,487 settlements have the potential for mini-grid solutions. The off-grid market has even greater potential. According to figures published by the Global Off-Grid Lighting Association (GOGLA),[74] an estimated 54,431 off-grid stand-alone solar PV products (pico solar and solar home systems) have been

[74] "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

sold in Côte d'Ivoire as of the end of 2017 (see **Section 2.4.3**). The least-cost analysis estimates that more than 2.5 million households in 2023 are suitable for stand-alone solutions.

In its SEforALL National Renewable Energy Action Plan (Plan d'Actions National des Energies Renouvelables, PANER), the GoCI envisions a relatively limited share of the population will gain electricity access through off-grid systems (**Table 8**). The findings of the least-cost analysis suggest that the Government may need to consider increasing the utilization of off-grid solutions (a combination of mini-grids and stand-alone 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 8: Estimated Share of Population Served by Off-Grid Systems[75]

Share of population with access to off-grid systems powered by renewable energy (%) *	2020 (target)	2030 (target)
	3%	2%

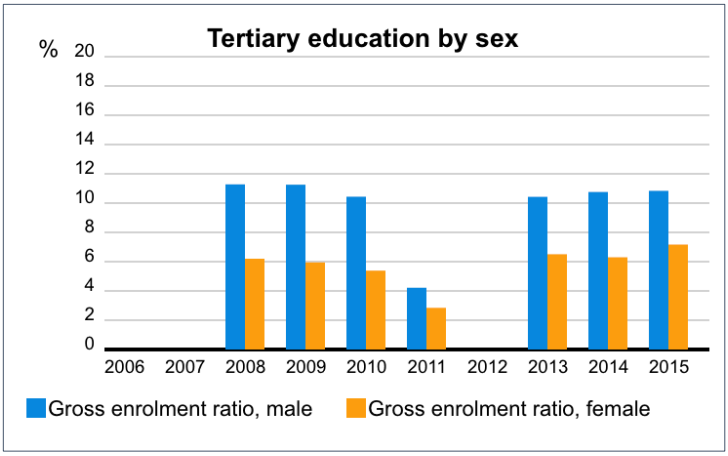
* Estimate includes both mini-grids and stand-alone systems

Source: SEforALL National Renewable Energy Action Plan

1.2.2.5 Inclusive Participation[76]

Inclusive participation in Côte d'Ivoire 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. Côte d'Ivoire performs poorly in the United Nations Development Programme (UNDP) Gender Inequality Index, which measures several indicators to assess levels of gender inequality in the areas of health, access to education, economic status and empowerment.[77] Female participation in education, particularly higher education, remains disproportionately low (**Figure 12**).[78] While gender discrimination is widespread, these issues tend to be more pronounced in rural areas of the country.

Figure 12: Rates of Enrollment in Tertiary Education



Source: UNESCO Institute for Statistics

[75] "Plan d'Actions National des Énergies Renouvelables (PANER): CÔTE D'IVOIRE," Ministère du Pétrole et de l'Energie, (2016): http://se4all.ecreee.org/sites/default/files/plan_dactions_national_des_energies_renouvelables_paner_-_Côte_divoire.pdf

[76] See **Annex 4** for more details.

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

[78] "Côte d'Ivoire 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. In 2007, the President issued the Solemn Declaration of Côte d'Ivoire on Equality of Chances, Equity and Gender (Déclaration solennelle de la Côte d'Ivoire sur l'égalité des chances, l'équité et le genre), which intended to introduce a 30% quota for female candidates in country's elections. This measure was formally adopted as a policy in 2009 as the National Policy for Equalities for Chances, Equity and Gender (Politique Nationale de l'Egalité des Chances, l'Equité et le Genre). A National Council for Women and the Observatory for Equity and Gender was also established to support equality for women in the public and private sectors.

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

1.2.3 Key Challenges

Some of the key energy sector challenges facing Côte d'Ivoire include (but are not limited to) the following:

- **Investment in Grid Extension and Maintenance**: Economic growth and corresponding increases in electricity demand are putting pressure on power supply – a mismatch that will continue to burden the electricity transmission and distribution network that needs maintenance and investment to reduce losses and expand access to meet the long-term objectives of PDER.

- **Electricity Tariffs:** Côte d'Ivoire subsidizes electricity tariffs for low-income consumers, providing electricity to poorer households below the cost of supply with funds from the GoCI and the country's utilities through a range of residential and commercial consumers who pay higher electricity rates. While this subsidization scheme has made power affordable for most residential consumers (particularly low-income households), commercial users pay significantly higher electricity tariffs – approximately 20% higher than residential tariffs (**Figure 13**).[79] Attempts to restructure tariffs have been met with protest, as electricity costs have become a social and political issue; the Government was forced to cancel a proposed rate increase in 2016 following public unrest.[80]

- **Utility Financial Performance**: Without cost-reflective tariffs in place, CIE-ENERGIES does not generate enough revenue and must rely on foreign assistance to invest in the country's power infrastructure.[81]

- **Imbalanced Energy Mix:** The country's power sector is overly reliant upon natural gas and large hydropower, technologies that are susceptible to price volatility and climatic conditions, respectively. While private investment continues to support gas projects, there is comparatively very little investment in non-hydro renewable energy, which cannot compete with cheaper baseload power in the country's existing regulatory environment. The off-grid sector is even less of a factor in the country's long-term electrification plans (**Table 4**).

[79] "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

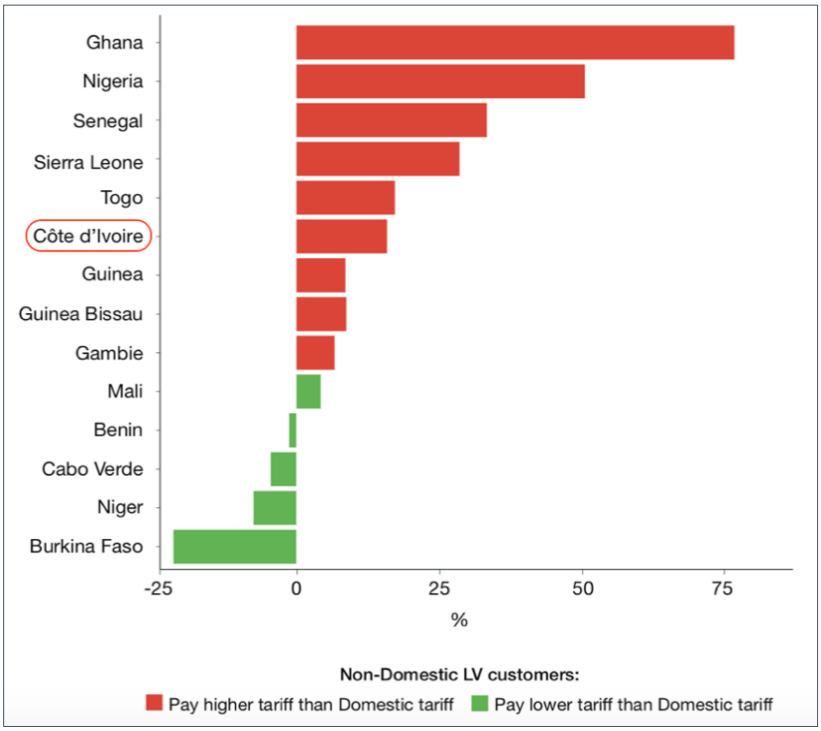
[80] "Côte d'Ivoire: Energy Sector," Africa-EU Renewable Energy Cooperation Programme (RECP), (2017): https://www.africa-eu-renewables.org/market-information/senegal/energy-sector/

[81] "Scheme to expand electricity access generate private sector opportunities in Côte d'Ivoire," Oxford Business Group: https://oxfordbusinessgroup.com/analysis/lights-schemes-seeking-expand-access-electricity-are-generating-opportunities-private-sector

- **Rural Electrification:** In its medium and long-term rural electrification planning, the GoCI has prioritized grid extension over development of mini-grids and stand-alone systems and ultimately seeks to extend the transmission grid to 100% of the population. This approach to electrification, however, limits public funds and resources available to provide support for stand-alone solar solutions that could accelerate electrification; less than 5% of an estimated USD 796 million in electrification costs through 2020 are to be spent on renewables and off-grid projects.[82] Moreover, the institutional market segment (i.e. schools and health clinics) faces budgetary and public finance considerations that constraint investment in stand-alone solar for these facilities.

- **Off-Grid Regulatory Framework:** Clarity is currently being sought on the regulatory approach for the off-grid sector and the Government's vision for these technologies either as provisional measures or as long-term energy solutions for the country.[83] Market liberalization is expected to extend to electricity distribution after CIE's concession agreement expires in 2020, which would allow private operators to enter the off-grid market. Until then, an uncertain regulatory environment may impede private investment to the sector.

Figure 13: Commercial Tariff in Excess of Residential Tariff in ECOWAS Countries, 2018



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

Source: ECOWAS Regional Electricity Regulatory Authority

[82] "Côte d'Ivoire Country Profile," ClimateScope, Bloomberg New Energy Finance, (2017): http://global-climatescope.org/en/country/Côte -ivoire/#/enabling-framework

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

- **Local Financial Institutions:**[84] Local financial institutions (FIs) and microfinance institutions (MFIs) lack sufficient internal capacity and credit appetite to invest in the renewable energy/off-grid sectors. This challenge is complicated as it arises mainly from the risk perceptions of FIs, which influence whether efforts should be made to develop strategies and customize financial products to target a nascent market, where there is often limited knowledge of technologies, market characteristics and historical data on portfolio credit performance. There are also likely misperceptions about the potential size of these markets as well as doubts about the profitability of offering financial products in rural off-grid areas, where the creditworthiness of potential clients may be an issue. The renewable energy/off-grid space is particularly complicated given relatively high transaction costs and a comparatively unfavorable regulatory environment that exists in the country.[85]

- **Other challenges:** Successful development of the stand-alone solar sector will require more than just a financial support mechanism – the Government and 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 of the country's stand-alone solar PV market.

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

[85] 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

In Côte d'Ivoire, several policies and plans have been adopted or initiated by the Government to promote national electrification. In 2013, MPEER announced a national energy policy that aims to provide reliable and affordable energy to the population and transform the country into a power hub in West Africa. The specific objectives of the policy are to (i) progress towards financial sustainability; (ii) generate more electricity and better manage the demand; and (iii) improve production and distribution frameworks. Diversifying the energy mix (i.e. by increasing the share of renewable energy) is also a policy priority to ensure long-term energy security. The GoCI does not want a single source of energy to account for more than 60% of the system's total capacity.[86]

In its 2016-20 National Development Plan, the GoCI prioritized inclusive and sustainable growth, with a focus on public investment in infrastructure and electricity. In 2016, as part of its commitment to ECOWAS, Côte d'Ivoire adopted a National Action Plan for Renewable Energy (PANER) that aimed to increase the share of renewable energy in the electricity mix. The Government also made ambitious commitments in its NDC, agreeing to reducing its CO_2 emissions by 28% and setting a target to generate 42% of its electricity from renewable sources; with 26% for large and medium hydro and 16% for other renewable sources (solar and biomass) by 2030.[87] None of these policies, however, included specific provisions for off-grid development.

1.3.2 Integrated National Electrification Plan

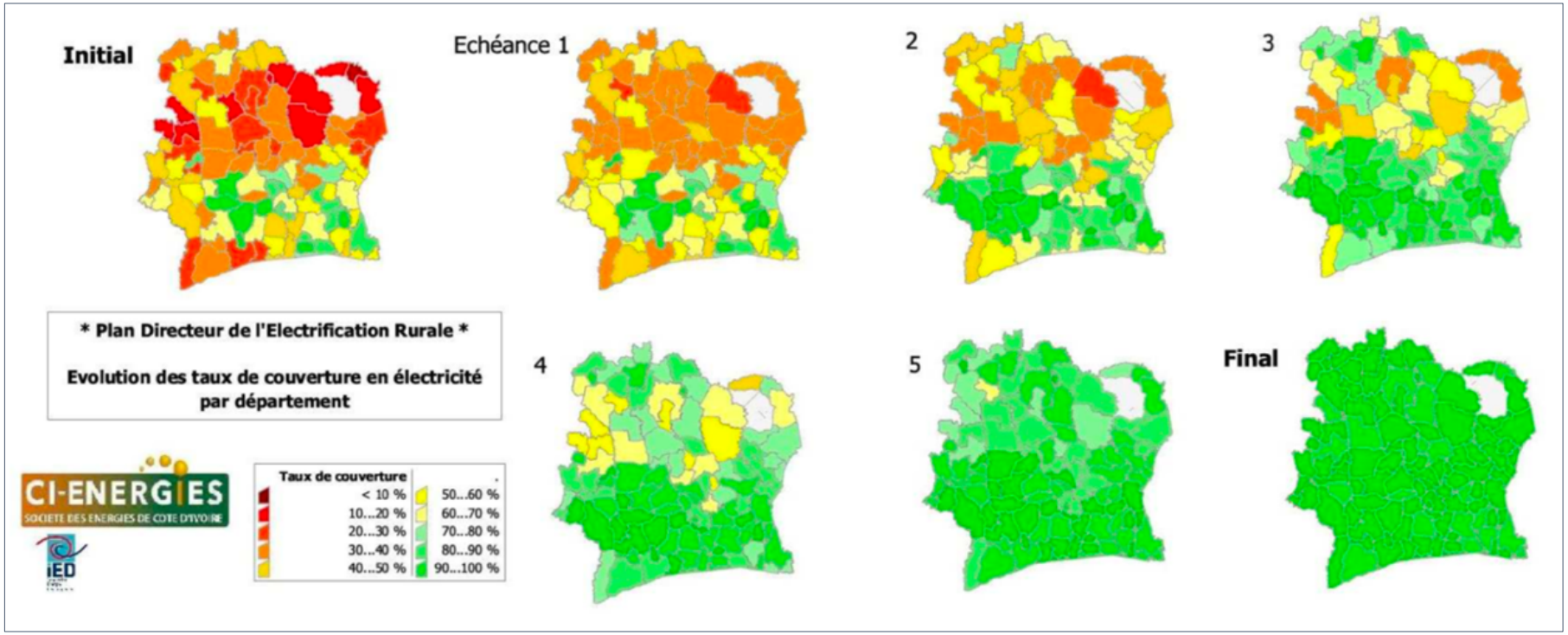
CI-ENERGIES, under the supervision of the DG of Energy and in collaboration with CIE, has developed and is now in the process of implementing a Rural Electrification Master Plan (PDER) for the country. The Master Plan utilizes a combination of grid extensions to larger localities of more than 500 households and off-grid solutions to electrify smaller communities throughout the country, with an overall objective of achieving universal access by 2025. Distribution network extensions will be large-scale and will require significant reinforcement of existing infrastructure; the entire Master Plan will be implemented in five phases over the course of the 15-year period (**Figure 14**). CI-ENERGIES estimates that PDER will require CFAF 575 billion (~USD 1.02 million) in investment during the period of 2015-2030.[88]

[86] "Interview of Amidou Traoré, Director-General, CI-Energies: Côte d'Ivoire Energy," Oxford Business Group, (2017): https://oxfordbusinessgroup.com/interview/unlocking-potential-amidou-traoré-director-general-ci-energies-prospects-energy-sector-both-national

[87] "Republic of Côte d'Ivoire: NDC Registry," United Nations Framework Convention on Climate Change, (2016): http://www4.unfccc.int/ndcregistry/Pages/Home.aspx

[88] "Plan Directeur d'Electrification Rurale de Côte d'Ivoire, PDER-CI," Final Report, CIE-ENERGIES (July 2015)

Figure 14: Rural Electrification Rates by Region, 2015-2030



Source: CI-ENERGIES, Plan Directeur d'Electrification Rurale de Côte d'Ivoire

1.3.3 Energy and Electricity Law

Much like in its electrification planning, the GoCI does not have a well-defined legal framework for stand-alone solar technologies. The Electricity Code of 2014 continued liberalization of Côte d'Ivoire's power market, a process that began in the mid-1980s when it became the first country in Sub-Saharan Africa to contract IPPs for power generation. The revised law extended liberalization to the power transmission, distribution, import and export market segments, keeping only the dispatching of power under state monopoly.[89] While the Electricity Code provides a basis for liberalizing the electricity sector, ongoing negotiations to extend CIE's distribution concession, as well as the need for secondary legislation, means that developers are not yet able to create commercial PPAs with third-party off-takers.[90] A 2016 Decree sets the terms and conditions for concession agreements for off-grid electricity operated by mini-grids and stand-alone systems, but these measures have not been implemented in practice to date.

1.3.4 Framework for Stand-alone Systems

Figure 15 is an overview of the key national policies, programs, laws and regulations pertaining to Côte d'Ivoire's framework for stand-alone systems. The gaps in this framework are addressed in **Section 1.3.5**.

To date, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing well, as evidenced by the country's 21-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017. In the 2017 RISE evaluation, Côte d'Ivoire ranked third in West Africa and the Sahel and was among the highest scoring countries in Africa (**Figure 16**).

[89] "Côte d'Ivoire Electricity Transmission and Access Project: Project Appraisal Document," World Bank, Energy and Extractives Global Practice, (2017): http://documents.worldbank.org/curated/en/450031491098454445/pdf/CÔTE -DIVOIRE-PAD-03132017.pdf

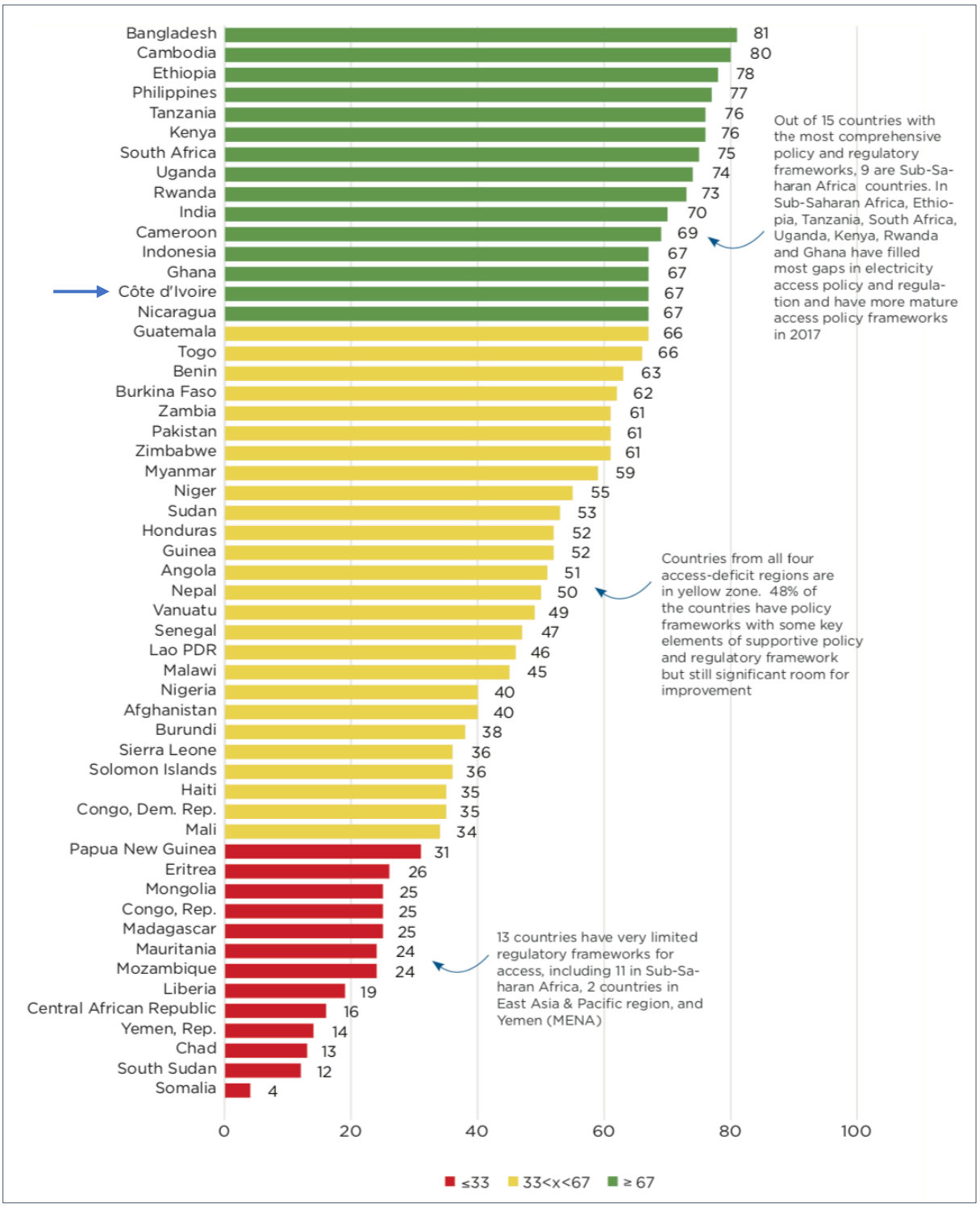
[90] "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," International Finance Corporation, (2018): https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aadc01b4/IFC-C%C3%B4te_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES

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

CÔTE D'IVOIRE			
	World Bank RISE 2017 Energy Access Score: 67 World Bank RISE 2015 Energy Access Score: 46	2017 ranking among West Africa and the Sahel (ROGEP) countries: 3rd	
Policy/Regulatory Support and Financial Incentives	**Specific national policies, laws and programs**		
	National electrification policy with off-grid provisions	√	PRONER
	Integrated national electrification plan	√	PDER
	Energy/electricity law with off-grid provisions	√	2016 Decree
	National programs promoting off-grid market development	√	PRONER
	Specific target for rural electrification	√	100% by 2025
	Financial incentives		
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	√	50% VAT reduction on solar equipment
	Standards and quality		
	Government-adopted international quality standards for stand-alone systems	x	
	Government-certified program for solar equipment installers	√	GIZ-funded solar PV training
	Consumer awareness/education programs	x	
	Concession Contracts and Schemes	√	2016 Decree
	Business Model Regulation	x	

√ = existing/implemented provisions in the current regulatory framework
X = no existing provisions
Source: World Bank RISE, Stakeholder interviews and GreenMax Capital Advisors analysis

Figure 16: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017[91]



Source: World Bank Regulatory Indicators for Sustainable Energy

[91] "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

Specific national rural electrification programs in Côte d'Ivoire include the Rural Electrification Program (PRONER), the "Electricity for All Program" (PEPT), and the Rural Electrification Master Plan (PDER). PRONER was launched by the Government in 2014 and aims to increase the penetration rate of electricity to 80% by 2020 and the coverage rate to about 100%. It also plans to maintain an electrification rate of 500 new localities (each with over 500 inhabitants) annually until 2020. The PEPT was also adopted in 2014 with the aim to establish 200,000 new grid connections to the grid per annum. The PDER, which came into effect in 2015, is the rural electrification plan designed to implement the strategic objectives outlined in PRONER. Although all of these programs have identified several locations that are deemed eligible for solar-diesel hybrid electrification, there is no regulatory framework in place for development of these off-grid systems.

1.3.4.2 Financial Incentives

In addition to the PEPT program's grid connection subsidy, solar equipment benefits from a five-year VAT reduction from 18% to 9%. Outside of these measures, most of the policy, regulatory and financial incentives in the electricity sector are directed towards supporting the country's huge natural gas market.

1.3.4.3 Standards and Quality

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

1.3.4.4 Concession Contracts and Schemes

Decree N° 2016-787 of 2016 sets the terms and conditions for concession agreements for off-grid electricity operated by mini-grids and stand-alone systems. These conditions include the possibility of having one or more concessionaires operating in the same geographic area. Additionally, the concessionaire's assets and those conceded by the Ministry of Energy will be the subject of a complete accounting inventory, drawn up at the expenses of the concessionaires themselves and transmitted to the MoE within three months of entry. In the case of installations carried out by the GoCI, the concessionaire is only remunerated for the operating service it provides.[92] While these legal provisions are in place, they have yet to be implemented in practice as the off-grid regulatory framework is still under development.

1.3.4.5 Specific Business Model Regulation

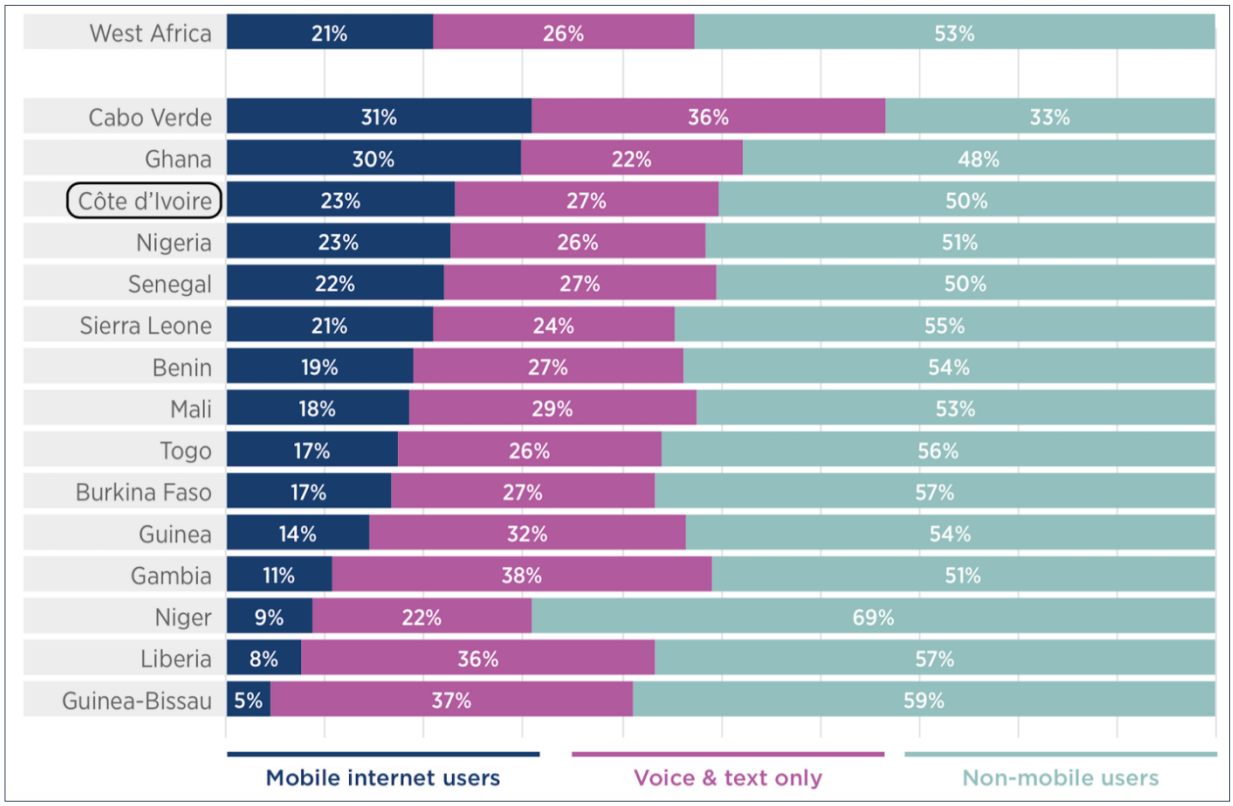
While ANARE's mandate as the electricity sector regulator covers concession areas, the off-grid market remains outside of its regulatory purview. As a first step to address this, PDER has established definitions of a national off-grid strategy for solar kits in terms of (i) capacity, (ii) components of the kit, (iii) expected performance, (iv) pricing of benefits and duration of payment, (v) utilization of mobile money operations and Pay-As-You-Go (PAYG) schemes; a contractual framework between the parties; and additional accompanying measures, incentives and exchanges of information.[93]

[92] "Fixant les Conditions Et Modalites D'exercise de L'activite de Production Associee a la Distribution et a la Distribution et a la Commercialisation de L'energie Eletrique Par Mini Reseau Ou Par Des Systemes Autonomes Indivuduels de Production D'energie Electrique," ANARE, Ministry of Petroleum and Energy, (2016): http://www.anare.ci/assets/files/pdf/loi_reglement/decret/Decret_n_2016-787_du_12_octobre_2016_fixant_les_conditions_et_modalites.pdf

[93] "Électrification Rurale de Côte d'Ivoire," CIE-ENERGIES, (March 2017): http://www.ecreee.org/sites/default/files/documents/news/08_Côte_divoire_rural_electrification_masterplan.pdf

The Government can take measures to support PAYG business models that have already been deployed by private solar companies engaged in the market. As was demonstrated in East Africa in recent years, the proliferation of mobile money platforms can rapidly facilitate energy access. Recent data suggests that there is an opportunity for the GoCI to bring together key stakeholders in the off-grid sector (solar providers, telecommunications companies etc.) to take advantage of the country's growing mobile internet usage (**Figure 17**) and high rates of mobile phone ownership in rural areas (**Figure 18**). Moreover, a transition to mobile broadband networks is gaining rapid momentum, with Côte d'Ivoire among the five largest markets in West Africa in terms of size and share of subscriber growth.[94]

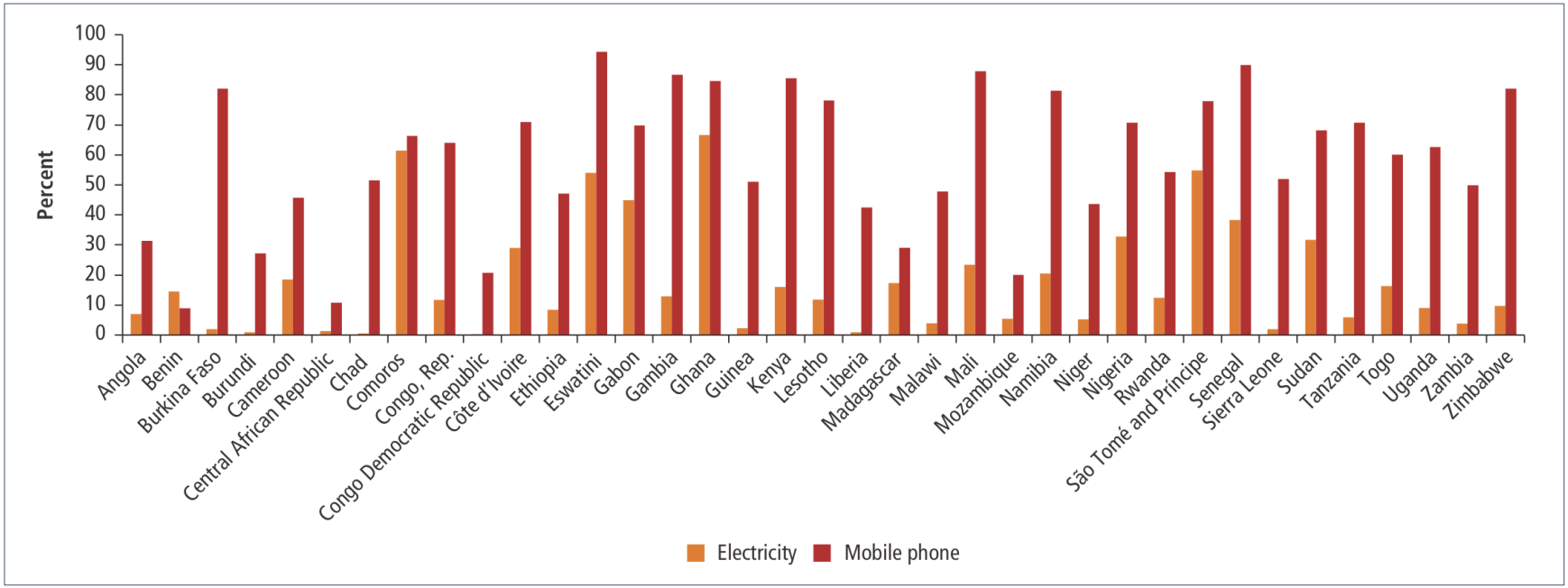
Figure 17: West Africa Mobile Internet Penetration Rates, 2017[95]



Source: GSMA Intelligence

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

Figure 18: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)[96]



Source: World Bank

[96] 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 DG of Energy and the electricity market regulator, ANARE-CI, 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. 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 9** identifies some of the policy/regulatory challenges facing off-grid market development in Côte d'Ivoire and the proposed mitigation measures/TA interventions to overcome these gaps.

Table 9 : Gaps in the Off-Grid Policy and Regulatory Framework[97]

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Specific National Policies, Laws and Programs	**A. Insufficient National Electricity / Electrification Policy** a. Main focus of policy is on national grid extension only b. Government is subsidizing fossil fuel electricity production	a. 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[98] b. Help Government analyze where fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives
	B. Insufficient Integrated National Electrification Plan a. Insufficient focus on or understanding of framework to support private sector participation	a. Help Government improve the existing planning framework under the Rural Electrification Program (PRONER) and corresponding Master Plan (PDER) to encourage private participation in mini-grid and stand-alone solar system options, including *inter alia* preparation of guidelines to enhance collaboration between Government and private companies, industry associations, and other relevant stakeholders to coordinate development of effective policy that is flexible and responsive to the needs of the market
	C. Insufficient Energy and Electricity Law	a. Help Government expand existing legal framework that is flexible and helps create appropriate incentives for private sector participation in off-grid market development (e.g. by expediting the process of electricity market liberalization)

[97] **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 Côte d'Ivoire (**Table 2**), including the Ministry of Petroleum, Energy and Renewable Energy Development (MPEER), the Director General of Energy (DGE), the Regulatory Authority (ANARE-CI), and the state-owned energy planning agency, CI-ENERGIES, among other national and local authorities.

[98] The Rural Electrification Master Plan (PDER) focuses primarily on grid extensions and does little to promote off-grid development

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
	D. Insufficient national policies, laws, programs and/or action plans targeting off-grid market development	
	a. No Lead Agency	a. Help Government establish a lead entity / Rural Electrification Agency that has a clear mandate to coordinate activities with the private sector, donor community and at national and local level in order to implement PDER and accelerate market growth to achieve energy access objectives
	b. Insufficient focus on or understanding of framework to support private sector participation	b. Help Government improve policy and regulatory framework to create appropriate incentives for private sector participation to expedite off-grid solar market growth, including *inter alia* preparation of procurement schemes and financing mechanisms designed to encourage PPP engagement in the off-grid sector
2. Financial Incentives (import duties, taxes, etc.)	**A. Insufficiently supportive financial incentives / tax regime**	a. Help Government expand existing financial incentives[99] to cover the entire off-grid stand-alone solar product supply chain, including batteries, inverters or other system components to provide necessary support to the industry b. Help Government establish a Special Task Force to (i) mitigate potential difficulties in customs clearance and import logistics, and (ii) oversee implementation of tax exemptions by coordinating with all agencies and regulatory bodies involved c. Help Government introduce appropriate grant and subsidy schemes (such as the PEPT household grid connection subsidy program) which require private funding matches and are predictable and not overly bureaucratic d. Help Government create PPP schemes[100] to share high project development and market entry costs particularly with developers in remote areas e. Help Government analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede development of clean energy solutions[101]
3. Standards and Quality	**A. Insufficient Market Data**	a. Help Government establish a Special Task Force (within MPEER, DGE, or CI-ENERGIES) responsible for collaborating with the private sector to compile and regularly update a database of critical off-grid market data (solar product imports, costs, sales volumes, resource potential etc., GIS data and other key indicators) that can be (i) utilized by policymakers to make informed electrification planning decisions based on accurate market information, and (ii) made easily accessible to interested off-grid developers, investors and other key industry stakeholders

[99] The GoCI has implemented a 50% reduction in VAT for solar equipment
[100] The GoCI has established the National Steering Committee for Public-Private Partnerships to coordinate all of the country's PPP initiatives
[101] The GoCI directs the majority of its financial incentives and regulatory support to the country's huge natural gas market

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
	B. Unclear / lack of quality standards	a. Help Government establish international quality standards for off-grid stand-alone solar products, including minimum technical standards (IEC Technical Specifications), warranties, required availability of and cost guidelines for post-sale services/O&M, and harmonization of equipment to expedite replacement of spare parts b. Help Government integrate standards with appropriate oversight agencies to ensure quality-verification procedures are in place to safeguard the reputation of licensed products and to in turn mitigate the detrimental impact of the counterfeit / inferior product market[102] c. Help Government implement a legal framework that provides protections for consumers and suppliers, including *inter alia* regulations that (i) require licensing for the sale and installation of solar equipment; (ii) prohibit the sale of certain brands or models; and (iii) enable companies or public authorities to prosecute those caught distributing counterfeit / inferior products that are not up to promulgated standards
	C. Lack of capacity of local technical sector (solar PV technicians, installers, services providers etc.)	a. Support establishment of technical certification and vocational training programs through government, private sector, and/or academia for installation and maintenance of stand-alone solar systems[103] b. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through MPEER, DGE, or CI-ENERGIES)
	D. Insufficient attention of private companies to environmental/social standards and community engagement	a. Assist private sector and/or civil society organizations to ensure environmental/social standards are in place b. Assist in development of strategies encouraging inclusive gender participation c. Support with the implementation of a repair and recycling framework for off-grid solar systems and equipment
	E. Insufficient public awareness	a. Support Government, trade associations and civic society organizations to develop and implement consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related national programs b. Support development and implementation of programs to educate consumers, retailers and distributors on benefits of quality certified solar products vs. counterfeit products

[102] The presence of poor quality, sub-standard products has resulted in reduced profit margin for the genuine licensed players in the industry (see **Section 2.4** for more details)

[103] In 2018, GIZ initiated a three-year program that includes €5 million for vocational education and training for RE for the private sector, including solar PV and specialized training for electricians to become RE specialists

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
4. Concession Contracts and Schemes	**A. Lack of clear and transparent licensing and permitting procedures**	
	a. Unclear procedures	a. Help Government develop clear licensing and permitting procedures[104]
	b. Insufficient communication and streamlining	b. Help Government develop improved systems for sharing and disseminating information to project developers and key stakeholders, including establishment of a "one-stop-shop" for national level permits and approvals and expediting of local permits
	B. Lack of experience/understanding of emerging concession and energy services schemes for off-grid providers	
	a. Need for understanding of different SHS concession schemes	a. Help Government understand all options and models for possibilities of granting geographic concessions to private operators of SHS[105]
	b. Need for understanding of emerging models for 'Integrated Private Utilities' or 'Energy Companies of the Future'	b. Help Government to understand and develop approaches to facilitate pilots of 'Integrated Private Utility' or 'Energy Company of the Future' schemes.[106]
	c. Public procurement or finance/budget laws that hamper deployment of energy services models for public facilities	c. Help Government develop procurement and public finance laws that will facilitate stand-alone solar system investment for public facilities (schools, health care facilities, etc.)
	d. Lack of standardized contracts for energy services provided by private system operators to public facilities	d. Help Government, trade associations or civic society organizations develop model bilateral PPA and Energy Services Contracts for small scale IPPs and ESCOs to sell power or deliver energy services to public facilities (i.e. schools, health care facilities) or deliver solar street lighting services to municipalities
	e. Insufficient protection for stranded investments	e. Help Government develop proper procedures and guidelines to protect against stranded investments from competition among all on-grid and off-grid rural electrification approaches[107]

[104] While legal provisions for off-grid development are in place, they have yet to be implemented in practice as the sector's regulatory framework is still under development

[105] 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.

[106] 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.

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

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
5. Business Model Regulation	A. Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers	a. Support capacity building of regulators, Government and other stakeholders on different pricing schemes offered by stand-alone solar system providers to improve understanding and avoid unnecessary interventions to regulate[108] b. Support regulators and off-grid enterprises to collaborate specifically on developing pricing schemes for productive use market segment[109] c. Support capacity building and foster linkages between off-grid solar companies and telecommunications companies/mobile money providers to help roll out technology platforms and PAYG business models[110]

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

[108] 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.

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

[110] The Rural Electrification Master Plan (PDER) includes provisions to implement a contractual framework between off-grid service providers and mobile/telecommunications companies as well as additional accompanying measures, incentives, and exchanges of information.

1.4 Development Initiatives

1.4.1 National Government Initiatives

The Government, through the MPEER, has put in place several key strategic plans and roadmaps to address rural electrification and development of the off-grid sector (**Table 10**). These key development plans are supported mainly by the World Bank, AfDB, the EU, BOAD and Exim Bank of China. The total investment needed is estimated to be USD 3.625 billion, with about 40% of commitments secured to date.[111]

Table 10: National Government Off-Grid Development Programs[112]

Project/Program	Timeline	Market Segment(s)	Description
National Program for Rural Electrification (Programme national d'électrification rurale, PRONER) Rural Electrification Master Plan (Plan Directeur d'Electrification Rurale (PDER)	2015-2025	Grid extension, mini-grid, pico solar, SHS	• The National Program for Rural Electrification (PRONER) and the corresponding Rural Electrification Master Plan (PDER), aim to increase electricity penetration and coverage rates by electrifying 100% of localities with over 500 inhabitants by 2020 and to achieve universal access by 2025 • Electrification will be achieved through a combination of grid extension and distributed solar/hybrid solar-diesel technologies • The scope of this policy encompasses all of the country's 8,523 localities – the majority of these will be electrified through grid extension, with a total of 96 areas identified as being eligible for solar-diesel hybrid solutions. • For smaller localities, an off-grid strategy utilizing micro-grid and solar kits is being developed for more than 3,000 remaining settlements and villages.[113] • It is estimated that PRONER will require USD 675M over a five-year period to achieve its objectives. • With no framework to govern the off-grid sector, electrification of the off-grid areas relies mainly on public or donor funding
"Electricity for All" Program (Programme Electricité Pour Tous, PEPT)	2014-2020	Distribution grid (connection subsidy)	• Add 200,000 new connections each year and 1 million by 2020 through a revolving fund to eliminate high upfront grid connection charges for households (down from $250 to $2); • By 2030, CIE-ENERGIES estimates that the PEPT Program will have connected 70% of the country's households to the grid • Interim PEPT indicates that the program has been successful, establishing 300,000 connections since 2015
National Action Plan for Renewable Energy (Plan d'Actions National des Energies Renouvelables, PANER)	2011-2020	Renewable energy capacity	• Action plan to inform national renewable energy strategy with objective of increasing share of RE in the electricity mix • Under Nationally Determined Contribution to UNFCCC, the GoCI committed to 42% overall share of RE in energy mix by 2030 • Current electricity pricing environment (cheap natural gas) will require significant policy/regulatory support to meet objective

[111] "Côte d'Ivoire Electricity Transmission and Access Project: Project Appraisal Document," World Bank, Energy and Extractives Global Practice, (2017): http://documents.worldbank.org/curated/en/450031491098454445/pdf/CÔTE -DIVOIRE-PAD-03132017.pdf

[112] "Electrification Rurale de Côte d'Ivoire," CIE-ENERGIES, (March 2017): http://www.ecreee.org/sites/default/files/documents/news/08_Côte_divoire_rural_electrification_masterplan.pdf; and "DEVELOPPEMENT DU SECTEUR DE L'ELECTRICITE DE LA CÔTE D'IVOIRE," CIE-ENERGIES, 2018

[113] "1st National Workshop: Promoting Private Investments in Autonomous Solar Systems in West Africa and the Sahel," Abidjan, Côte d'Ivoire, ECREEE, (3 May 2018)

Project/Program	Timeline	Market Segment(s)	Description
Transmission and Distribution Master Plans	2016-2020	Transmission and distribution grid; rural electrification	• Master plans prepared by CIE for power transmission and distribution (including assessment of urbanization, rural electrification and system atomization) • Each Master Plan defines investment selection criteria to meet domestic and regional (WAPP) demand and secure supply • Estimated investments of around USD 2 billion are necessary to improve electricity transmission infrastructure, USD 680 million for urban distribution improvements (including a new dispatching center in Yamoussoukro), and USD 675 million for rural electrification. • The key sources of funding for these initiatives include the World Bank, AfDB, BOAD, EU and China

1.4.2 DFI and Donor Programs

In addition to Government-led initiatives, there are a number of related Development Finance Institution (DFI) and donor-funded programs also supporting development of the off-grid sector Côte d'Ivoire (**Table 11**). The AfDB, the EU and the World Bank are the three largest financing partners involved in development of the off-grid sector in Côte d'Ivoire. On a bilateral level, the governments and development institutions of France, Germany, the United States and China are all involved in various capacity in the rehabilitation of Côte d'Ivoire's electricity sector and in supporting growth of its off-grid market. France (AFD) and China (Ex-Im Bank) are also both heavily invested in other large infrastructure and utility-scale energy projects.

Table 11: DFI and Donor-Funded Off-Grid Development Programs

Project/Program	Sponsor	Timeline	Market Segment(s)	Description
Multilateral Partner Initiatives				
AfDB loan to Zola Energy Côte D'Ivoire (ZECI), Joint-Venture between Off-Grid Electric (OGE) and EDF	AfDB, Société Générale (SocGen), Crédit Agricole Corporate and Investment Bank (Crédit Agricole CIB)	2018 - present	Solar home systems	• In June 2018, AfDB ZECI received local currency loan of CFAF 15.75 billion (approximately € 24M) arranged by local affiliates of Société Générale and Crédit Agricole • AfDB will provide a partial credit guarantee covering part of the guaranteed loan facility as a catalyst
ENERGOS (Phase II)	European Commission, EIB, BOAD	2017-2020	Transmission and Distribution grid upgrade and extension	• €118M loan supporting off-grid electricity access in 30 remote locations • The project also intends to upgrade the grids in the cities of Baouake, San Pedro and Abidjan, and create a new national distribution center in Yamoussoukro
Solar mini-grids for productive use in Zanzan Region	UNIDO and EU	2012-2015	Solar mini-grid / productive use	• Solar-diesel hybrid mini-grids operating in the north-east region of Zanzan, pilot project to generate solar electricity in targeted productive use communities • A 2016 evaluation of the project[114] found that it showed promise for a sustained

[114] "Promoting renewable energy-based grids in rural communities for productive uses in Côte d'Ivoire," UNIDO, (2016): https://www.unido.org/sites/default/files/2016-09/GFIVC12005-100186_TE_report-2016_0.pdf

				long-term impact with sufficient Government support • The project's concept is being scaled up in forthcoming projects sponsored by the GEF/EU/EDF
Regional Program for the Development of Renewable Energies and Energy Efficiency (Programme régional de développement des énergies renouvelables et d'efficacité énergétique, PRODERE)	WAEMU, BOAD	2014 - present	Solar kits, solar streetlights, solar-powered water supply systems	• In Côte d'Ivoire, PRODERE is providing for the supply, installation and commissioning of stand-alone solar power plants, low-voltage distribution networks and solar PV streetlights in 12 localities
Power Transmission and Distribution Network reinforcement project	African Development Bank		Transmission and Distribution grid upgrade	• EUR 162M sovereign loan under the "New Deal for Energy in Africa" program to support transmission and distribution network upgrades
Electricity Transmission and Access Project	World Bank	2017-2022	Transmission and Distribution grid upgrade and connection subsidy	• USD 325M IDA loan to upgrade the transmission and distribution grid and improve electricity access in over 200 rural locations • Providing supporting the "Electricity for All" / PEPT grid extension program
Bilateral Partner Initiatives				
Sustainable Use of Natural Resources and Energy Finance (SUNREF) initiative	AFD	2017 - present	Off-grid project financing and TA	• €30 million program provides concessional financing to encourage FIs to fund clean energy projects • Includes TA to validate projects and their eligibility for the program and then present them to partner banks for financing • The facility has been deployed to partner banks in Benin, Côte d'Ivoire, and Senegal • The SUNREF initiative has been largely successful in East Africa, where it has focused on the commercial and industrial (C&I) market segment, where systems are larger, off-takers are often companies with large enough balance sheets to borrow. As a result, this has been one of the stand-alone market segments where there has been some lending to date. The program is now just launching in West Africa and could be a potential partner for ROGEP.
Technical Assistance and Vocational Training Program	GIZ	2018 - present	Solar PV TA and training	• This is a three-year initiative to be launched in 2018 that includes €5 million for vocational education and training for RE for the private sector, including solar PV and specialized training for electricians to become RE specialists.
PRONER / PDER Rural Electrification	KfW	2018 - present	Off-grid / mini-grid project development	• According to the PRONER, 47 of the remaining eligible off-grid/min-grid

				locations that require development have been proposed to KfW.
Power Africa / U.S.-Africa Clean Energy Finance Initiative (ACEF)	USAID	2016 - present	Off-grid solar; Transmission and Distribution grid upgrade and connection subsidy	• Power Africa off-grid interventions are focused on: (i) supporting the government Electricity for All Program (PEPT); (ii) providing transaction advisory assistance for off-grid companies (notably PEG Africa) to expand commercial operations in the country; (iii) the development of a national off-grid policy, (iv) promoting productive use of energy in the agriculture sector, and (v) helping the regulator conduct the country's first ever willingness-to-pay survey, which will help support national tariff reform
	People's Republic of China	2009-2013	Solar kits	• Distribution of 173 solar kits in the localities of Péré, Djamdjankro and Lazarekro in Prikro

1.4.3 Other Initiatives

In addition to the Government and DFI/donor funded initiatives mentioned above, there is very little activity in the off-grid sector from the non-governmental organizations (NGOs) in Côte d'Ivoire. PEG Africa, a private off-grid solar company that recently entered the country, received a grant from the *Scaling Off-Grid Energy* campaign – led by USAID, Power Africa and UK DFID, with support from the Shell Foundation, Microsoft, Acumen and the UN Foundation – to scale up its business in Côte d'Ivoire. The joint initiative aims to extend energy access to 20 million households across Sub-Saharan Africa through off-grid household solar solutions.[115] PEG Africa was also the recipient of the International Ashden Award for Innovative Finance in 2017, an initiative supported by Citi.[116]

[115] "PEG Africa wins Scaling Off-Grid Energy Grand Challenge grant from USAID," PegAfrica, (2016): https://www.pegafrica.com/news/
[116] "PEG Africa: Ghana and Côte d'Ivoire's moment in the sun," Ashden, (June 2017): https://www.ashden.org/winners/peg-africa

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

This section presents the overall market assessment for off-grid solar (OGS) energy systems in Côte d'Ivoire. **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 12** summarizes the overall total cash market potential for OGS systems from each of the analyzed market segments. **Annex 2** provides an overview of the Task 2 methodology.

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

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

Table 12: Indicative Total Cash Potential Market for Off-Grid Solar PV Products in Côte d'Ivoire, 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	827,821	2,483	$37,251,950	$0.00
Plug and play	14,997	150	$1,874,595	$0.00
Small SHS	1,800	90	$449,903	$44,990,278
Medium and Large SHS	0	0	$0.00	$101,228,125
Household Subtotal	**844,618**	**2,723**	**$39,576,448**	**$146,218,403**
Institutional				
Water supply	904	3,286	$8,215,688	-
Healthcare facilities	175	119	$296,625	-
Primary and secondary schools	605	324	$956,310	-
Public lighting	157	79	$235,800	-
Institutional Subtotal	**1,841**	**3,808**	**$9,704,423**	**-**
Productive Use				
SME applications for microenterprises	9,052	2,263	$5,657,500	-
Value-added applications	66,676	12,339	$53,935,725	-
Connectivity / ICT (phone charging)	11,270	4,508	$9,714,878	-
Productive Use Subtotal	**86,998**	**19,110**	**$69,308,103**	**-**
TOTAL	**933,457**	**25,641**	**$118,588,974**	

Source: African Solar Designs analysis

2.1 Demand – Households

This section analyzes the main characteristics of the household (HH) OGS demand in Côte d'Ivoire. 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 related to OGS.

2.1.1 Overview of Household Market Segment

This section gives an introduction to household consumer market segments, their characteristics and size (**Table 13**). 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.

According to the International Energy Agency (IEA), in 2016 there were 1.7 million households (9.2 million people) in Côte d'Ivoire without access to electricity.[117] In that year, an estimated 62% of the population had access to electricity, with the rate of access at 88% in urban areas and 31% in rural areas.

Feedback from household market stakeholders obtained through the focus group discussions (FGDs) indicates a growing off-grid solar market for household products across the country. Households are already using solar products in various forms. Stakeholders made the following recommendations for improvement of the household solar market in Côte d'Ivoire:

- The GoCI needs to launch a real awareness and communication campaign for households and SMEs.
- Solar is the most suitable technology for covering the energy needs of rural households.
- Taxes are too high, which increases the investment costs.
- There is no advice when purchasing solar products
- The 9% VAT reduction for photovoltaic panels is inadequate and should be applicable to other equipment such as batteries and invertors and other solar appliances.
- Policies on certification and assurance of product quality standards need to be adopted by the GoCI and local industry stakeholders to improve confidence in solar technologies among users

This section gives an introduction to household consumer market segments, their characteristics and size (**Table 13**). 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.

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

Table 13: Household Consumer Market Segments[118]

Income Quintile	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HH w/o Access	Avg. GDP per HH per year	Energy Tier	Geographic segments	Description
	2018 Scenario				2023 Scenario				2030 Scenario					
Highest 20%	1%	8,998	$21,071	Tier 3	0.5%	5,120	$28,734	Tier 3	0.1%	1,217	$40,366	Tier 3	High income rural	• Small portion of rural households using a petrol generator set • Has a demonstrated ability to pay for solar off-grid systems
													Mid to high income urban	• Professionals, business owners and salaried people are likely to be connected to the grid. • Small portion without grid access desires replacement to generator power[119]
Fourth 20%	2%	17,996	$9,522	Tier 3	1%	10,241	$12,984	Tier 3	0.2%	2,435	$18,240	Tier 3	Low income peri-urban / urban "under-grid"	• Low income urban population engaged in SME work or casual labor • Lives near grid but cannot afford or does not have access to connection
Third 20%	3%	26,994	$6,436	Tier 3	1.5%	15,361	$8,776	Tier 3	0.3%	3,652	$12,329	Tier 3		
Second 20%	84%	755,837	$4,496	Tier 2	2%	20,481	$6,132	Tier 3	0.4%	4,869	$8,614	Tier 3	Low income rural	• Engaged in farming, or SME • Lives more than 15km from the nearest grid connection.
Lowest 20%	100%	899,806	$2,513	Tier 2	25.9%	264,814	$3,426	Tier 2	13%	158,707	$4,813	Tier 2		
Total Households without Access to Electricity		**1,709,631**			**Total**	**316,016**			**Total**	**170,879**				

Source: IEA and World Bank; African Solar Designs analysis

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

[119] 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**

Côte d'Ivoire has a lower incidence of poverty than some of its neighboring countries, as shown in **Table 14**. For example, roughly 45% of the population in Nigeria and over half (52%) of the population in Sierra Leone live below USD 1.90 a day, compared to 28% in Côte d'Ivoire. Côte d'Ivoire has also experienced an economic resurgence in recent years, with increasing private sector development and investment flowing into the country. Of course, households in rural areas will benefit less from this development than those in urban centers.

Table 14: Poverty Headcount in Côte d'Ivoire, 2015

Poverty headcount ratio	% of population
Lives at or below $1.90 a day*	28.2%
Lives at or below $3.20 a day*	57.4%
Lives at or below $5.50 a day*	82.2%

*2011 PPP

Source: World Bank

As shown in **Table 13**, the largest household market segments for off-grid solar products in the country are low income rural households. In rural areas, household incomes vary from one region to another. Each region of Côte d'Ivoire is characterized by a specific agricultural production (whether they are cash crops or food crops), which is the main activity in off-grid areas. The incomes of off-grid households are related to seasonal harvests for these crops, and energy expenditure is linked to these income trends.

Some agricultural crops such as oil palm and rubber have almost regular production, resulting in nearly stable income for farmers throughout the year, with peaks in periods of high production.

Others such as coffee, cocoa, cashew and cotton have seasonal productions. The type of crops cultivated thus determines the seasonality of household incomes. Populations in the cocoa, cotton, palm oil and cashew producing areas have higher incomes than others, due to the linkage of the prices on the international commodity markets. The crop generating the most surplus for farmers is the cashew nut, indicating that cashew nut farmers may have a higher income and stronger ability to pay for energy services than other households.

There is a lot of labor movement to the off-grid areas during harvest season. For example, cocoa-coffee farmers from the region, students, and small traders will move from their usual places of residence to areas such as the Bouake Region and other parts in the north to participate in the trade of cashew products, which for the past four to six years has generated a lot of attention and contributing to the economy of these areas. Revenues for these workers and farmers fluctuate with the cashew cycle, which sells in the months of April, May, June and July. The cotton platform is very well organized, with cotton companies providing agricultural credits for inputs to farmers. For cocoa, a previous campaign enabled cocoa farmers to better manage the high expenses inherent to cocoa farming, which has smoothened their annual income.

Populations in food producing areas generally practice subsistence agriculture, which generates very little surplus for sale. Some households in off-grid areas produce food crops such as eggplant, tomatoes, peppers, yams, cassava, etc., which provide them with more substantial income. Some food crop producing regions have good incomes because of the high demand for these products. These populations can improve their income by locally processing the products before marketing them. But these transformations are very difficult for the farmers because they are done manually due to lack of electricity.

- **Geographic components of the solar market**

As discussed in the previous section, off-grid households are concentrated in rural areas, while household income (which determines energy expenditure and demand for solar products) varies substantially by geographic region and related agricultural production. The following information provided during the FGDs is helpful in understanding selected geographic segments that represent important consumer markets in the country:

- **Abidjan**: Home to the capital city, the Abidjan region is one of the country's wealthiest areas. Many of the households in the rural areas of Abidjan region are rubber and oil palm growers, with steady annual income. Many villages of the Abidjan district also produce cassava but are unable to add value through processing because of lack of access to electricity.
- **Bouake** (central Côte d'Ivoire): Bouake is the second largest city in Côte d'Ivoire, situated on the southern border of the Vallee du Bandama region. Around Bouake, some farmers produce cashew nuts, but many others remain subsistence farmers.
- **Daloa** (western Côte d'Ivoire): Daloa is a smaller city in western Côte d'Ivoire, in the Sassandra-Marahoue region. Daloa is an important area of export crop production. For example, 18,000 tons of coffee and more than 111,000 tons of cocoa are annually traded in the Region. The region's cocoa production accounts for nearly 10% of national production.
- **Haut-Sassandra** (central Côte d'Ivoire): To the northwest of Daloa, this area is a forested region that remains a reference for agriculture in Côte d'Ivoire. Its population is about 75% rural and its development is based on the practice of agricultural activities. Rice, plantain, cassava, taro, yam, maize and various fruits and vegetables abound in the market. With its fertile land, Haut-Sassandra is the 2nd largest cocoa producing region, about 4000 ha. Coffee still occupies important land areas as well in the region.

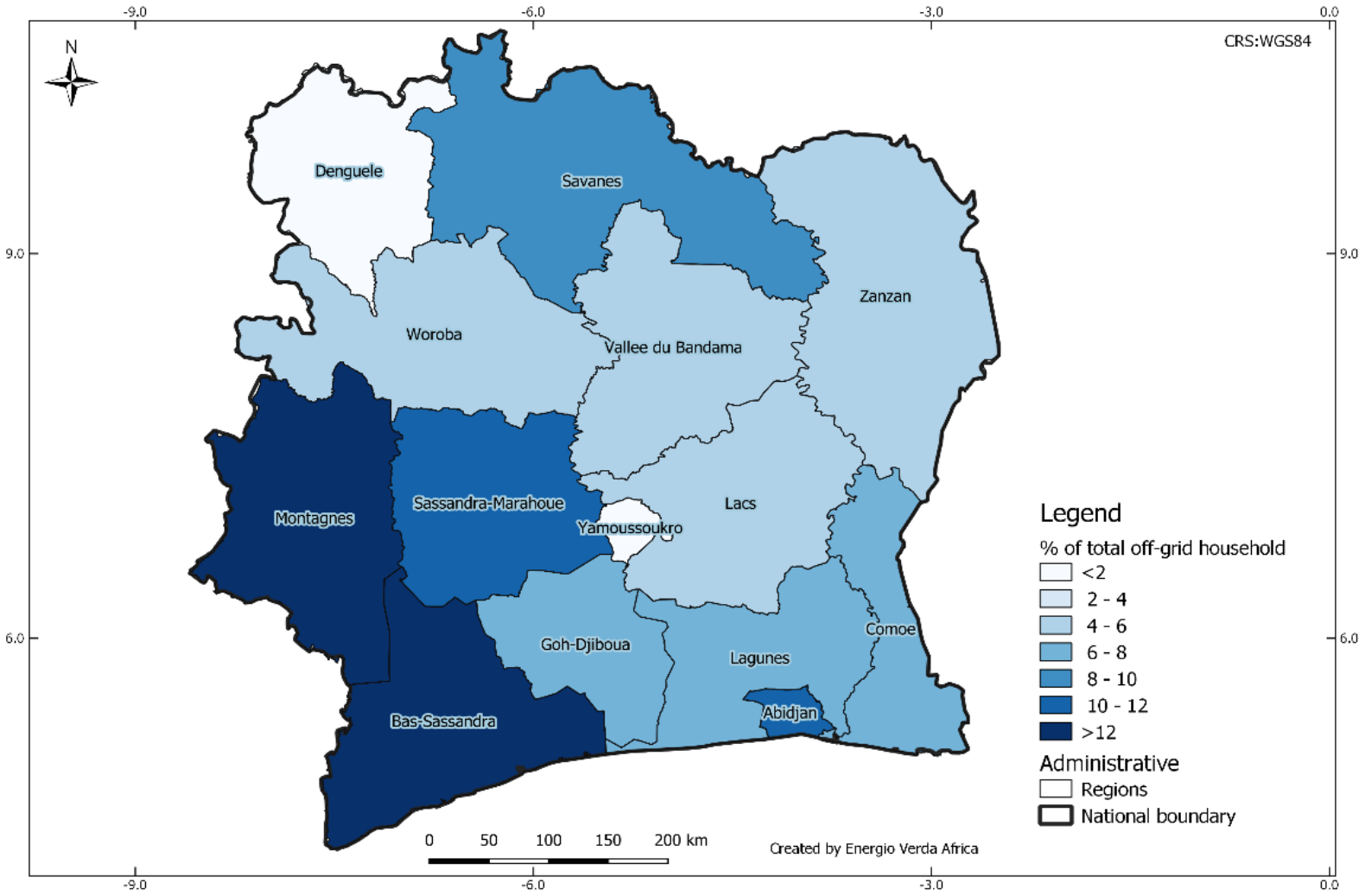
The total number of off-grid households and their geographic distribution will also change significantly over time. To analyze the potential OGS market over time, GIS maps were prepared from demographic information to present potential market areas for OGS. GIS calculations consider drivers of off-grid household market change including grid extension around current urban and peri-urban centers, mini-grid development for more densely populated rural areas, and population growth. Sources of information for the maps presented below (**Figures 19-22)** can be found in **Annex 1**.

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

As shown in the maps and chart summaries below **(Figures 19-22)**, the total size of the OGS market will decrease slightly over time, while also becoming more concentrated in more remote regions in the west of the country. This has implications for solar product market long-term business models, which may need to consider different distribution areas as the total number of households without access to electricity declines. Lessons learned in central districts will be valuable in extending market reach to more remote areas, as will new and more innovative business model approaches.

For example, in the near term (2018-2023), markets in the Sassandra-Marahoue region will be important for solar suppliers because this region has a fair number of households without access along with strong agricultural production zones with higher household income. In the future 2030 scenario, however, supply will need to extend into more remote regions such as Woroba, Zanzan and Bas-Sassandra.

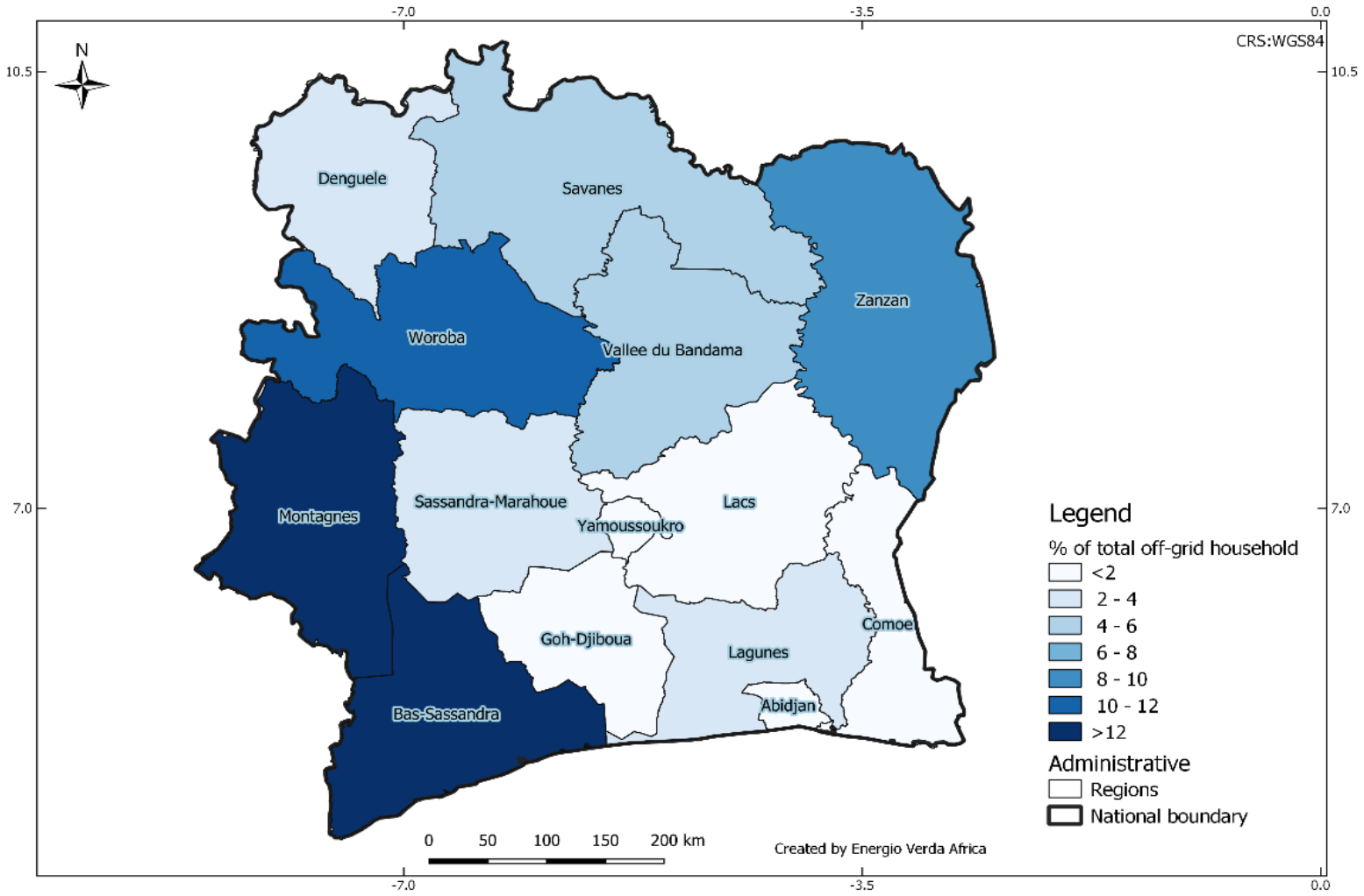
Figure 19: Distribution of Potential Off-Grid Households by Region, 2023[120]



Source: Energio Verda Africa GIS analysis

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

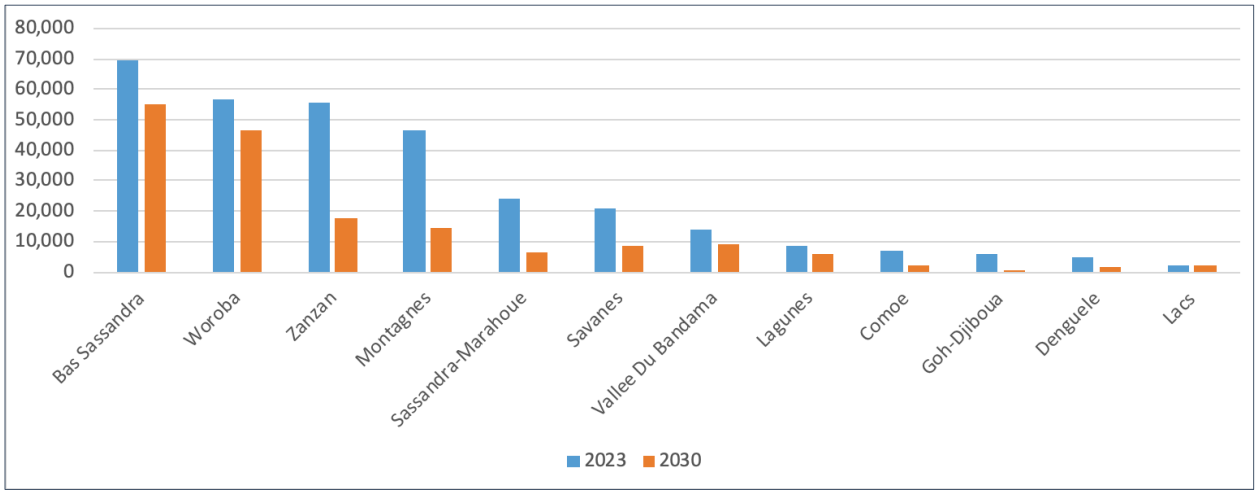
Figure 20: Distribution of Potential Off-Grid Households by Region, 2030[121]



Source: Energio Verda Africa GIS analysis

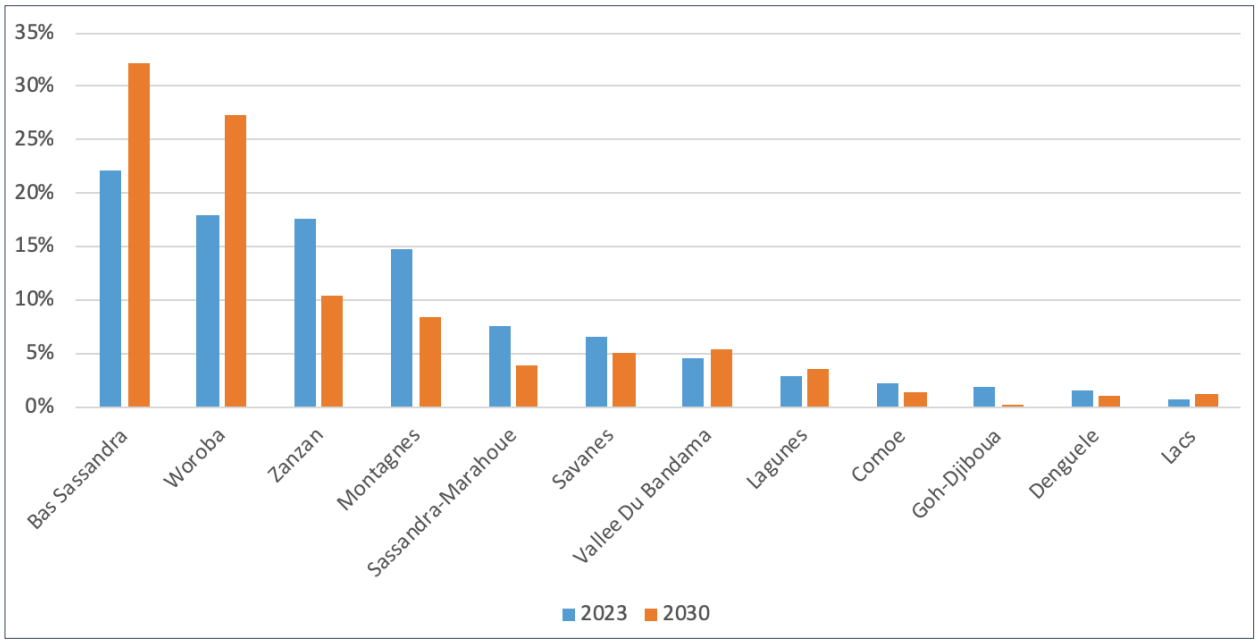
[121] See **Annex 1** for more details, including data sources.

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



Source: Energio Verda Africa GIS analysis

Figure 22: Estimated Percentage of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

2.1.2 Analysis of Household Market Segment Demand

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

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

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

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

According to feedback from focus group discussion (FGD) participants, with respect to domestic energy costs and major off-grid energy needs it can be noted that: rural households commonly use torches powered by 4-8 batteries that have an average life of anywhere between 1 week and 1 month. The torch costs between CFA 2,000 and 10,000 (USD 3-17). Replaced batteries cost between CFA 150 and 200 each (USD 2 per month). In the most remote areas, people choose to save money by taking the batteries out of the torches to keep them before reuse as needed. The most used devices in these areas are: torches, mobile phones and radios. These households spend an additional USD 5 a month for battery charging.

In Daloa, off-grid populations use battery-powered storm lamps, solar and wood fires for lighting. In the same village, there may be several sources of lighting. Oil lamps are no longer commonly used. Electrical devices of most importance to farmers are torches, radios, telephones and televisions.

Table 15 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 16**. 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 23** and **Table 17**.

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 15: Rural Energy Technology and Costs[122]

Technology	Description	Average Life (Years)	# of Units/ Month	Unit Operating Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)
					2018 Scenario		2023 Scenario		2030 Scenario	
Torch lights/Electric Lanterns	Torch lights/electric lanterns powered by D-type, AA-type or AAA-type batteries	0.5	16	$0.16	$2.00	$2.56	$2.12	$2.72	$2.44	$3.12
Cell Phone Charging	Done at a charging station	-	8	$0.21	$0.00	$1.68	$0.00	$1.78	$0.00	$2.05
Smart Phone Charging	Done at a charging station	-	16	$0.21	$0.00	$3.36	$0.00	$3.57	$0.00	$4.10
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	$0.16	$0.00	$1.28	$0.00	$1.36	$0.00	$1.56
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	$1.00	$50	$4.00	$53.00	$4.24	$60.95	$4.88
Small Petrol Generator	Most popular rural generator for basic use is 0.9kW (for phone charging, lighting, TV, fan, music system)	2	30	$1.30	$100.00	$39.00	$106.10	$41.39	$121.90	$47.54

Source: African Solar Designs analysis

[122] Data from FGDs, field surveys and various published sources.

Table 16: Typical Tier-Based Energy Costs

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Typical Monthly Cost (USD) 2018	Typical Monthly Cost (USD) 2023	Typical Monthly Cost (USD) 2030
Tier 0 No electricity	• Characterized by complete lack of electricity services • Many cash-poor consumers are in this situation part of each month when they don't have money to buy dry cells or charge phones	• Rely solely on kerosene, wood and other fuel sources for cooking and lighting	• Subsistence level of energy • Absolute energy poverty	• Subsistence level of energy • Absolute energy poverty	• Subsistence level of energy • Absolute energy poverty
Tier 1 Range: 1 to 20 Wh/day	• Access to one torch powered by dry cell batteries • One cell phone powered by charging service	• One battery-powered light requires dry cell replacement on weekly basis • One cell phone charged 8 times per month	$4.24	$4.50	$5.17
Tier 1.5 Range: 20 to 100 Wh/day	• Access to one torch and one lantern each powered by dry cells • One cell phone powered by charging service • Radio powered by dry cells	• Two battery-powered light points require dry cell replacement on weekly basis • One cell phone charged 8 times per month • Radio dry cells replaced two times per month	$8.00	$8.57	$9.85
Tier 2 Range: 55 to 500 Wh/day	• One torch and two lanterns powered by dry cells • One cell phone and one smart phone powered by charge service • Radio • DC TV	• Three battery light points require dry cell replacement on weekly basis • One cell phone charged 8 times per month and one smart phone charged 16 times per month • TV/Radio powered by lead acid battery recharged once per week	$16.72	$17.74	$20.38
Tier 3 Range: 500 to 2500 Wh/day	• Five lighting points • Multiple cell/smart phones • AC radio and music system • AC TV	• Generator powers a set of appliances	$39.00	$41.39	$47.54

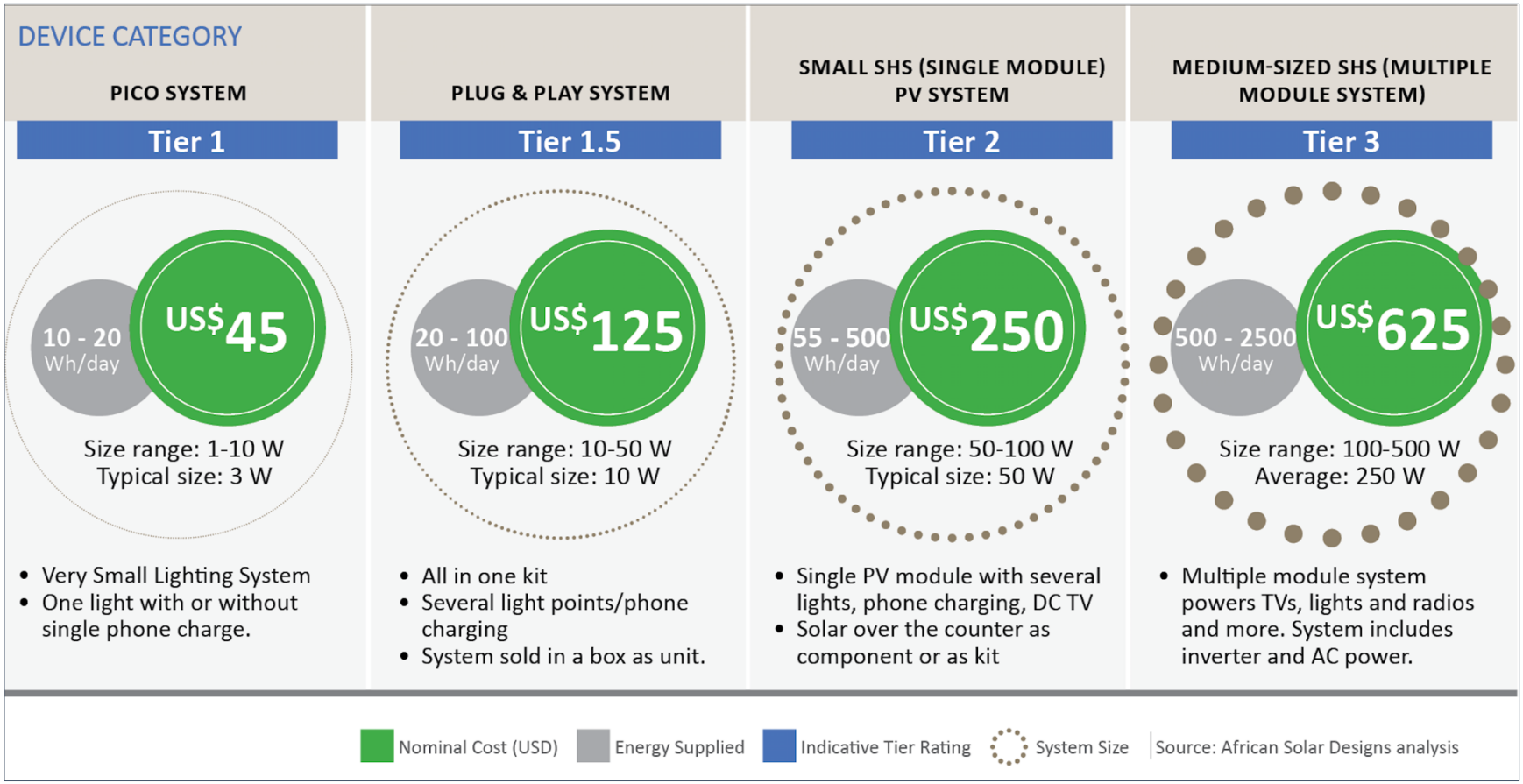
Source: African Solar Designs analysis

Per **Table 16**, it can be seen that, given the purchase price of dry cells and the cost of phone charging, the "ideal" electricity availability is extremely difficult to sustain. This is especially true where there is a high incidence of poverty in rural areas and lack of regular incomes. In reality, households often must reduce their energy consumption when cash is not available. This means that even a Tier 2 level family might drop to Tier 1 for a week each month when cash is not available to pay for phone charging or dry cell purchase.

- **Household Solar PV System Types**

Solar PV systems can provide lower cost and higher levels of service than existing dry cell, phone charging and generator options. In order to model how solar systems can meet existing energy use categories, levels of service and ability to pay, four types of household solar systems are configured to match the tier-based demands of off-grid communities. The system descriptions, energy outputs, prices, tier ratings and target consumer groups are listed in **Figure 23**.

Figure 23: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

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

According to estimates shared during the FGDs, less than 10% of the off-grid population is using solar systems. The most active sales areas are: Soubre and San-Pedro, where almost all players are active, followed by the Gbèkè region (Bouake). Many companies are also active in regions such as the Bas Sassandra (San Pedro), the Marahoue (Bouafle), the Montagnes (Man), the Gbèkè (Bouake), the Loh-Djiboua (Divo), the Sud-Comoe (Aboisso), the Belier (Yamoussoukro), la Nawa (Soubre).

Several off-grid villages and localities in the northern part of the country also have access to solar products, which entered the country illegally through the northern and western borders from neighboring countries where prices are more affordable. A reduction or exemption of taxes on solar products can have a positive impact on prices.

The accessibility of off-grid solar power is generally tedious for these off-grid populations. There is little organization in the villages, which has left villagers skeptical, as underqualified electricians have sold them poor equipment. Some households in Bouake region also have self-procured solar installations sourced from Bouake city. Farmers growing coffee, rice, rubber tree and cocoa are reported to be buying solar products through their seasonal incomes. Some cocoa farmers have large plantations with modern solar equipment.

For the import of off-grid solar products, product selection and purchase is followed by negotiation to transport the product to the port of Abidjan, at which point the forwarder manages the customs clearance.

Two off-grid solar projects were noted during the FGDs:

- Off-grid solar (micro-grid) was used to electrify seven villages in the Zanzan region in the north-east of the country. That project was designed by "Delegation Fondation Akwaba," an NGO based in Bouake, and implemented thanks to funding from EU and UNIDO in 2014.
- PRODERE Project (with funding from UEMOA): Supply and installation of mini-hybrid power plants photovoltaic- dual diesel and biofuels, and distribution network low voltage and solar street lights PV in Ouangolodougou (Sinakaha and Djelisso) in the north, Abidjan (Yopougon), Tiassalé (Broukro, Ehoumankoffikro, Diallokro and Adomkro) in the center.

With the exception of these projects, there are no specific regions where the GoCI is implementing solar for off-grid electrification. However, the Government is planning to introduce a concession policy to drive developers towards less covered areas. The Government is also planning the extension of the grid supplied by the construction of new hydroelectric dams, the construction of 700 MW coal-fired power stations and the extension of the Combined Cycle gas plants.

- **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 17** is sourced from analysis of 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 and second lowest income quintiles.

Table 17: Energy Expenditure of Different Income Groups

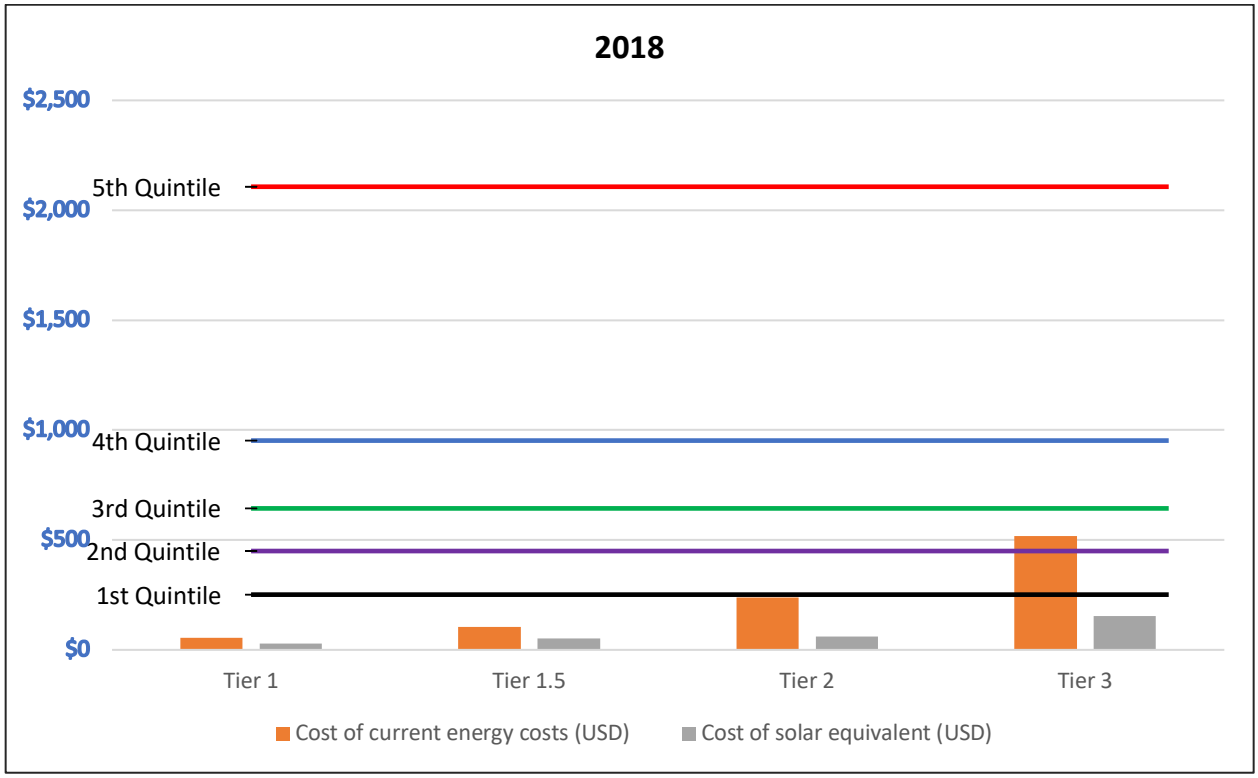
Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	$38.78	$209.39	10%	$20.94
2nd Quintile of Population	$69.39	$374.70	10%	$37.47
3rd Quintile of Population	$99.32	$536.33	10%	$53.63
4th Quintile of Population	$146.94	$793.48	10%	$79.35
Highest Quintile of Population	$325.17	$1,755.94	10%	$175.59
2023 Scenario				
Lowest Quintile of Population	$52.88	$285.53	10%	$28.55
2nd Quintile of Population	$94.62	$510.96	10%	$51.10
3rd Quintile of Population	$135.44	$731.37	10%	$73.14
4th Quintile of Population	$200.38	$1,082.03	10%	$108.20
Highest Quintile of Population	$443.42	$2,394.48	10%	$239.45
2030 Scenario				
Lowest Quintile of Population	$74.28	$401.12	10%	$40.11
2nd Quintile of Population	$132.93	$717.80	10%	$71.78
3rd Quintile of Population	$190.27	$1,027.44	10%	$102.74
4th Quintile of Population	$281.49	$1,520.04	10%	$152.00
Highest Quintile of Population	$622.93	$3,363.80	10%	$336.38

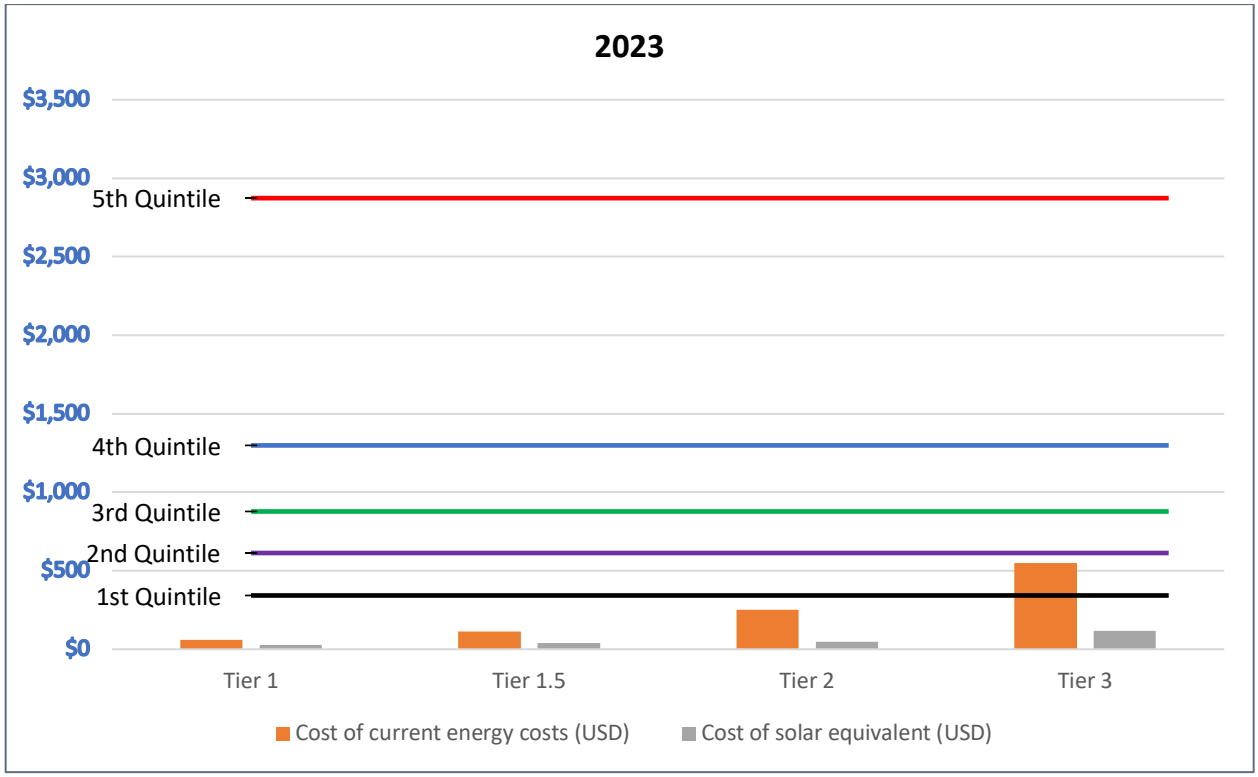
Source: African Solar Designs analysis

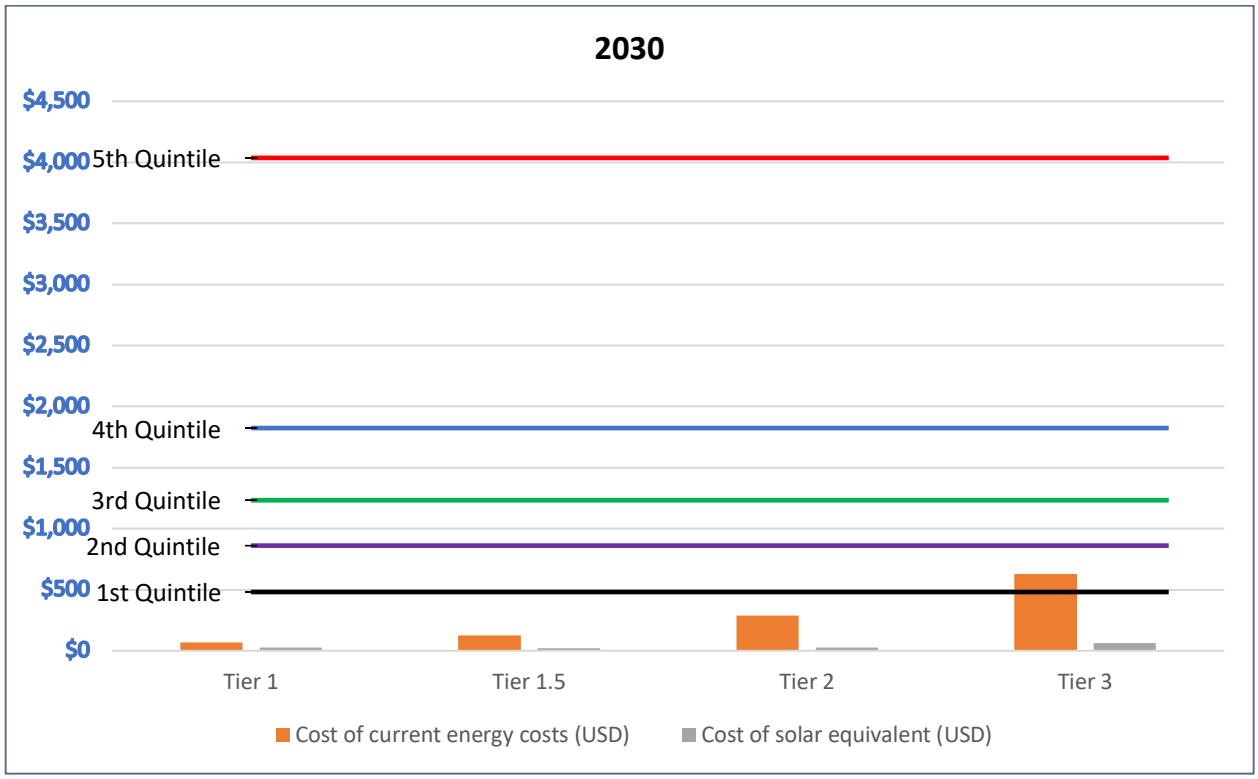
Figure 24 summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. Both the annual costs of current energy technologies and equivalent solar solutions consider the capital costs of the units, and the operating costs considered over the average unit life times.

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

Figure 24: Annual Household Energy Budget by Quintile, Annual Energy Costs and Cost of Solar Equivalents







Source: African Solar Designs analysis

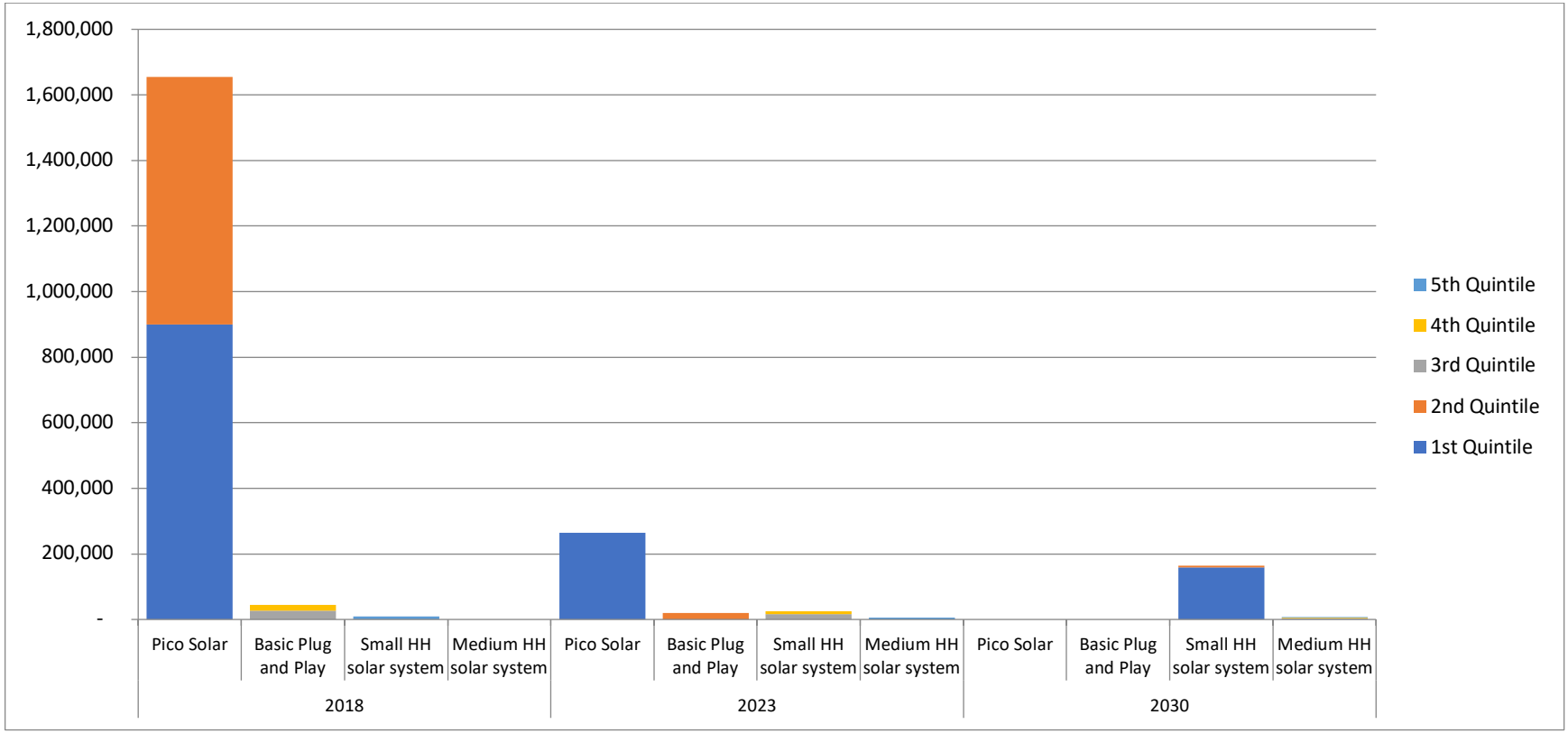
2.1.3 The Market for Household Devices without Consumer Finance

This section analyzes the cash market for various income levels and the corresponding energy services powered by OGS systems they can afford. Modeling 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 17**. 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, all the households without electricity access in all the income quintiles can afford an OGS system unfinanced. In the 2018 and 2023 scenarios, the lowest quintile households can afford pico solar products while households in higher quintiles can afford basic plug and play systems and small SHS. Affordability increases significantly over time as solar prices drop and household incomes increase. However, the need for financing solutions for the lower income quintiles is clear. The vast majority of the market without electricity access is represented by the two lowest income quintiles.

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

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



Source: African Solar Designs analysis

Table 18 presents the estimated annualized cash market potential for off-grid solar product sales in the country's household sector.

Table 18: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	827,821	2,483	$37,251,950
Basic Plug and Play	14,997	150	$1,874,595
Small HH solar system	1,800	90	$449,903
Medium HH solar system	0	0	$0.00
Total	**844,618**	**2,723**	**$39,576,448**
2023 Scenario			
Pico Solar	132,407	397	$5,885,816
Basic Plug and Play	6,827	68	$643,605
Small HH solar system	5,120	256	$965,408
Medium HH solar system	1,024	256	$482,704
Total	**145,378**	**977**	**$7,977,533**
2030 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	0	0	$0.00
Small HH solar system	32,715	1,636	$3,193,643
Medium HH solar system	1,461	365	$356,490
Total	**34,176**	**2,001**	**$3,550,133**

Source: African Solar Designs analysis

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

- The most common type of systems which the market can afford on a cash basis are pico and small plug and play systems. Based on available income figures Tier 2 and Tier 3 solutions are less viable for the vast majority of the population in the near term. However, this picture changes significantly with the introduction of finance, and as incomes increase over time.
- 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.
- There is reason to be optimistic about solar product market growth. In fact, evidence presented in section 2.4 shows that there is significantly more market activity in the solar market than predicted by this income-driven analysis. Uptake of cash purchases of electric lamps, mobile phones and other consumer goods signify changes in consumer expenditures – especially among the rural population – that are not captured in income figures and economic analysis. This could be driven by a number of complex financial dynamics not represented well by aggregated household survey data. For example, some rural households benefit from remittances sent by family members earning a higher income in urban areas or in foreign countries. People working in urban areas may also purchase OGS products there and send them back to rural family households. Other fluctuations in seasonal rural income and familial support networks could also be driving rural uptake. A significant portion of Tier 1 customers may be likely to move to Tier 1.5. There are also indications that purchasers of generator sets will begin to move to Tier 3 solar systems as consumer awareness and willingness to pay change.

2.1.4 The Financed Market for Off-Grid Solutions

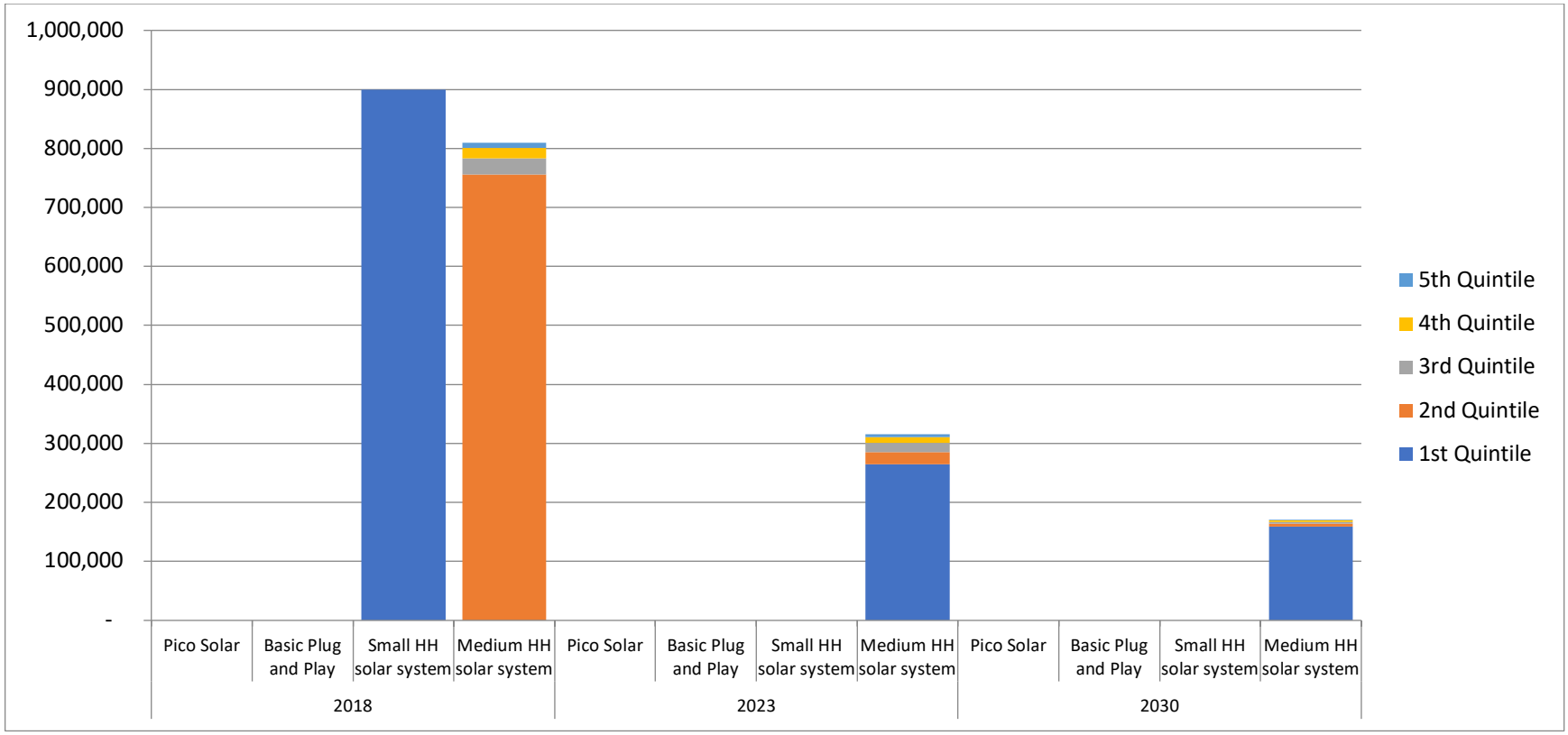
- **Financial Model**

In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with a 24% p.a. interest rate[123] 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.

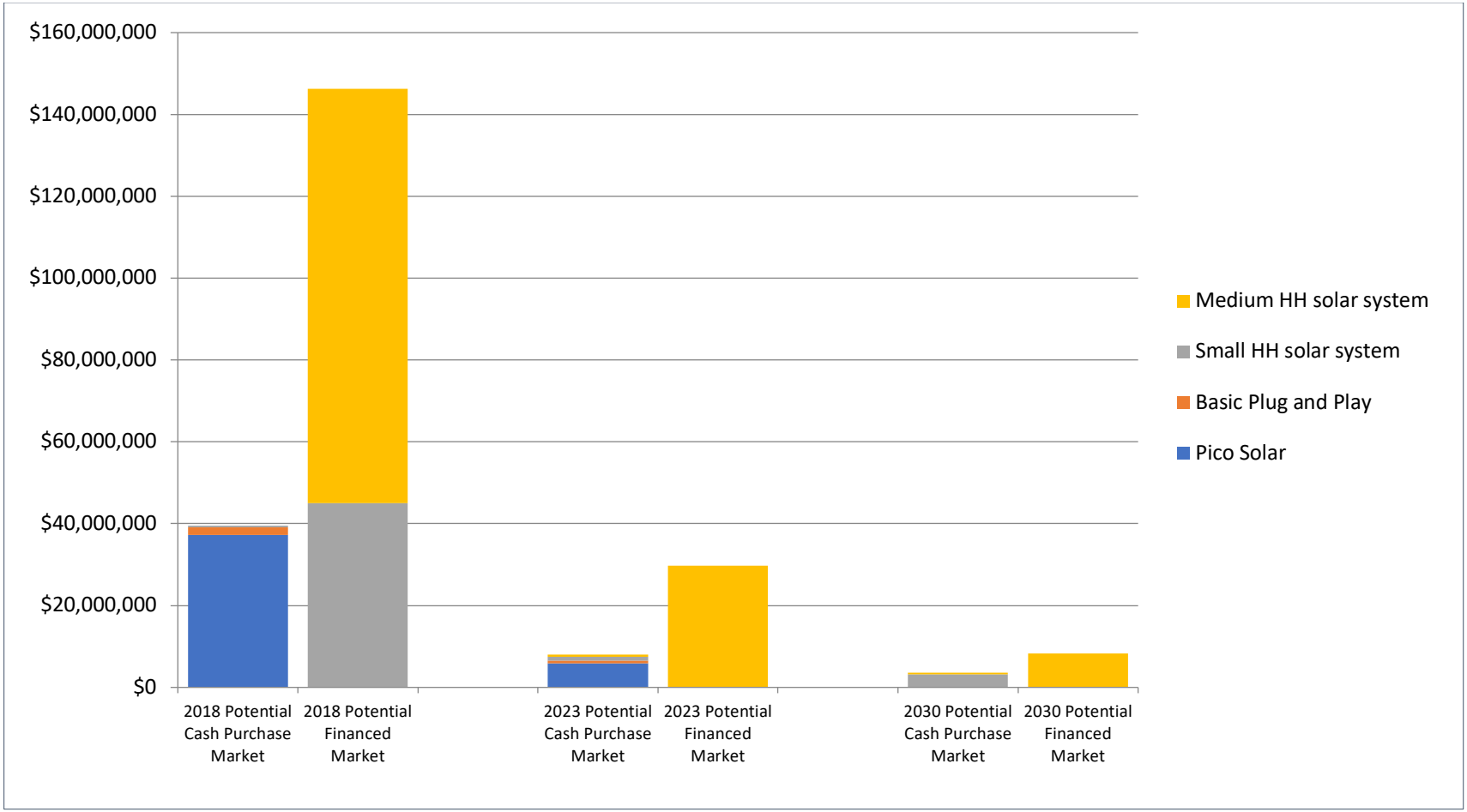
[123] Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf

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



Source: African Solar Designs analysis

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



Source: African Solar Designs analysis

In 2018, without financing, all 1,709,631 households without electricity access in the country could afford an OGS system. However, with financing, they were enabled to acquire the larger systems. Consequently, the annualized potential market size increases from USD 39,576,448 to USD 146,218,403 (**Figure 27**).

The least-cost electrification 2023 scenario calculates that 316,016 households could be electrified by stand-alone systems. Under this scenario also, all the households without access have the ability to acquire at least one OGS system, however, financing enables them to acquire the larger systems. The annualized potential market size increases from USD 7,977,533 to USD 29,791,923 (**Figure 27**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems would drop further to 170,879. Under this scenario as well, all the households without access have the ability to acquire at least one OGS system, however, financing enables them to acquire the larger systems. The annualized potential market size therefore increases from USD 3,550,133 to USD 8,340,598 (**Figure 27**).

Table 19 presents the estimated annualized financed market potential for off-grid solar product sales in the country's household sector.

Table 19: 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	179,961	8,998	$44,990,278
Medium HH solar system	161,965	40,491	$101,228,125
Total	**341,926**	**49,489**	**$146,218,403**
2023 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	63,203	15,801	$29,791,923
Total	**63,203**	**15,801**	**$29,791,923**
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	34,176	8,544	$8,340,598
Total	**34,176**	**8,544**	**$8,340,598**

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.[124]
  - 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.

[124] Focus group participants indicated that awareness varies regionally with the northern part of the country having better overall knowledge of / experience with solar products.

- 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 Côte d'Ivoire. 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 20 shows the estimated annualized cash market potential for institutional users in Côte d'Ivoire. This estimation is calculated using available GIS data, secondary research, and primary source field data. The analysis is based on available information from planned expansion of the sectors and typical usage patterns and costs of existing systems in the country.

Table 20: Indicative Total Cash Market Potential for Institutional Sector[125]

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	609	914	$2,285,438
	Medium power pumping system	95	382	$954,000
	High power pumping system	199	1,991	$4,976,250
	Subtotal	904	3,286	$8,215,688
Healthcare	Health post (HC1)	140	35	$87,750
	Basic healthcare facility (HC2)	22	33	$82,875
	Enhanced healthcare facility (HC3)	12	50	$126,000
	Subtotal	175	119	$296,625
Education	Primary schools	590	295	$884,550
	Secondary schools	15	29	$71,760
	Subtotal	605	324	$956,310
Public lighting	Public lighting (excluding street lighting)	157	79	$235,800
TOTAL		**1,841**	**3,808**	**$9,704,423**

Source: African Solar Designs analysis

[125] 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 21: Key Assumptions for Water Supply Sector Analysis

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

Focus groups meetings revealed that some solar water pumping projects have been realized in Tanda (East), San Pedro (Southwest), Bouaké (Centre), Azaguié (South) and Bingerville (South), with funding from individuals and communities, for storage capacities ranging between 13 and 30 cubic meters.

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 Ghana[126] identified off-grid water points such as boreholes and wells that could be electrified by stand-alone systems. Based on the analysis, the estimated annualized cash market potential for the water supply sector is presented in **Table 22**.

Table 22: Estimated Cash Market Potential for Water Supply[127]

Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	609	914	$2,285,438
Medium power	95	382	$954,000
High power	199	1,991	$4,976,250
Total	**904**	**3,286**	**$8,215,688**

Source: African Solar Designs analysis

[126] Ghana was grouped in the same category as Côte d'Ivoire; See **Annex 2** for more details.
[127] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

- **Healthcare**

Table 23: Key Assumptions for Healthcare Sector Analysis

Sector	System Sizes	Key Assumptions
Healthcare	• HC1: Dispensary health post (300 W) • HC2: Basic health facility (1,500 W) • HC3: Enhanced health facility (4,200 W)	1,384 off-grid healthcare facilities were identified that could be electrified by stand-alone systems

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

Available GIS data identified off-grid health facilities categorized according to their size (HC1, HC2, and HC3) that could be electrified by stand-alone systems.[128] 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 electrical load of the facility (**Table 24**). The assumptions of system size below are based on the services offered at each facility.

Table 24: Healthcare Facility Categorization and Electricity Demand[129]

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

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

Based on these assumptions, the estimated annualized cash market potential for health facilities is presented in **Table 25**. The distribution of potential off-grid health facilities is shown in **Figure 10** in **Section 1.2.2.4**.

Table 25: Estimated Cash Market Potential for Healthcare Facilities[130]

Type of Facility	Units	kW Equivalent	Cash value (USD)
Health post (HC1)	140	35	$87,750
Basic healthcare facility (HC2)	22	33	$82,875
Enhanced healthcare facility (HC3)	12	50	$126,000
Total	**175**	**119**	**$296,625**

Source: African Solar Designs analysis

- **Education**

Table 26: Key Assumptions for Education Sector Analysis[131]

Sector	System Sizes	Key Assumptions
Education	• Elementary schools (500 W) • Secondary schools (1,920 W)	11,794 off-grid primary schools and 299 off-grid secondary schools were identified that could be electrified by stand-alone systems

The education sector analysis considered the electricity needs of off-grid primary and secondary schools.[132] 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. Available GIS data 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 27**).

Table 27: School Categorization and Electricity Demand[133]

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

[130] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[131] 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**).
[132] 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.
[133] "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ__2016__Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

Based on these assumptions, the estimated annualized cash market potential for primary and secondary schools is presented in **Table 28**. The distribution of potential off-grid primary and secondary schools is shown in **Figure 10** in **Section 1.2.2.4**.

Table 28: Estimated Cash Market Potential for Primary and Secondary Schools[134]

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	590	295	$884,550
Secondary school	15	29	$71,760
Total	**605**	**324**	**$956,310**

Source: African Solar Designs analysis

Unlike health facilities, schools and other education centers in off-grid areas, although they are public institutions, are administered by local management committees called COGES. With funds provided by subsidies received from the Government, contributions collected and income from investments made, COGES carry out electrification activities of the institutions they are responsible for. Focus group participants indicated that many primary schools in off-grid areas of the country have already been electrified with solar power thanks to funding from village workers associations, NGOs and business foundations. Many of these systems are still functional and continue to benefit local communities.

- **Public Lighting**

Table 29: Key Assumptions for Public Lighting Sector Analysis[135]

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

Analysis of the public lighting sector considered the public lighting needs for off-grid villages and market centers. It did not assess public street lighting, which would generally be included in road infrastructure projects. Based on these assumptions, the estimated annualized cash market potential for the public lighting sector is presented in **Table 30**.

Table 30: Estimated Cash Market Potential for Public Lighting[136]

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	157	79	$235,800

Source: African Solar Designs analysis

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

Focus group participants made the following important observations vis-à-vis the public lighting sector:

- Apart from the 336 street lights installed as part of the Zanzan micro-grids, solar energy has been used for public lighting mainly in Abidjan and its grid-connected suburbs
- Solar installations are usually undertaken by the village association that is in charge of construction of a school and its equipment
- Most solar installations are financed by village officials and/or elected officials, who pay for these facilities through contributions from local communities or individually
- Sometimes solar installations are financed by cooperatives operating in the village. For the reimbursement of equipment, a levy is often applied to producers in villages that have agricultural productivity through cooperative societies.
- There are NGOs and foundations that also provide institutional solar installations in rural areas
- Some local authorities such as regional councils and town halls intervene for the purchase of solar systems with a short schedule and after-sales service
- It is generally preferred to rely on local cooperatives for financing solar in off-grid villages
- In Daloa, the COGES work in partnership with microfinance institutions to pay for off-grid electrification initiatives
- The majority of solar retailers in Daloa are unreliable traders, who are not technically proficient

2.2.3 Ability to Pay and Access to Finance

Financing for institutional off-grid systems in Côte d'Ivoire 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.[137]

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.

[137] 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 Côte d'Ivoire. Focus group participants noted that productive use applications in the agricultural, food processing and informal sectors already exist in the country, including solar powered lighting, mobile phone charging, refrigeration and chilling, water pumping, irrigation and agricultural processing. The PUE market sizing analyzed demand for SME applications for village microenterprises, value-added applications for solar powered irrigation, milling and refrigeration, and connectivity applications for mobile phone charging enterprises.

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

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

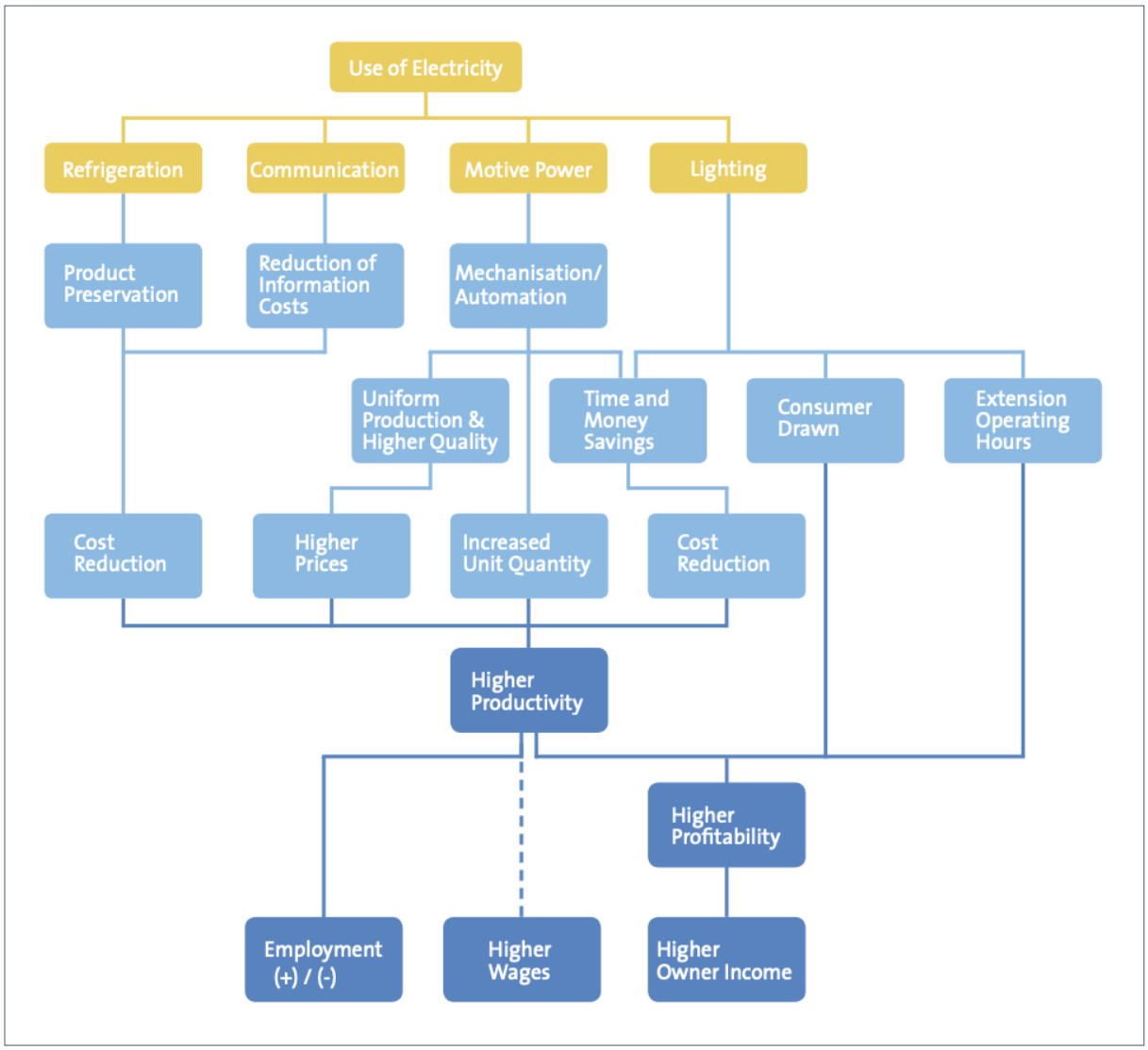
Off-grid solar power supports a wide range of connectivity applications, including mobile phone charging, wi-fi servers, banks, mobile money kiosks, and telecommunications towers. Mobile phone and internet connectivity are also necessary precursors for mobile money and PAYG solutions in the off-grid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

A number of donor-supported projects have tried to promote productive use appliances such as freezing of fish in Zanzan and a solar cassava grinding intervention carried out by the International Rescue Committee. Since services make up 41.58% of Côte d'Ivoire's GDP[138] lack of reliable power has been shown to have substantial adverse effects on the profitability of firms. Furthermore, business owners in areas with widespread grid connections have also been forced to deploy off-grid solutions, usually fossil fuel powered generators, due to uncertainty and low availability of grid connected power.[139] There are also a number of productive use sub-sectors where solar power can immediately add value and build income. The impact of electricity use on and SMEs depends on a variety of external and internal factors especially access to markets, the location of the firm, supply of inputs and financial capability. Therefore, the extent to which firms may be able to afford to invest in off-grid solar solutions is determined largely by increases in productivity, profitability, and employment/wages from the investment in the off-grid appliance (**Figure 28**).

[138] "Share of economic sectors in the gross domestic product (GDP) from 2007-2017, Côte d'Ivoire," Statistica, (2018): https://www.statista.com/statistics/452068/share-of-economic-sectors-in-the-gdp-in-ivory-coast/

[139] Surveyed Firms in Côte d'Ivoire had an average of 3.4 power outages a month, refer to World Bank, Enterprise Surveys: http://www.enterprisesurveys.org/

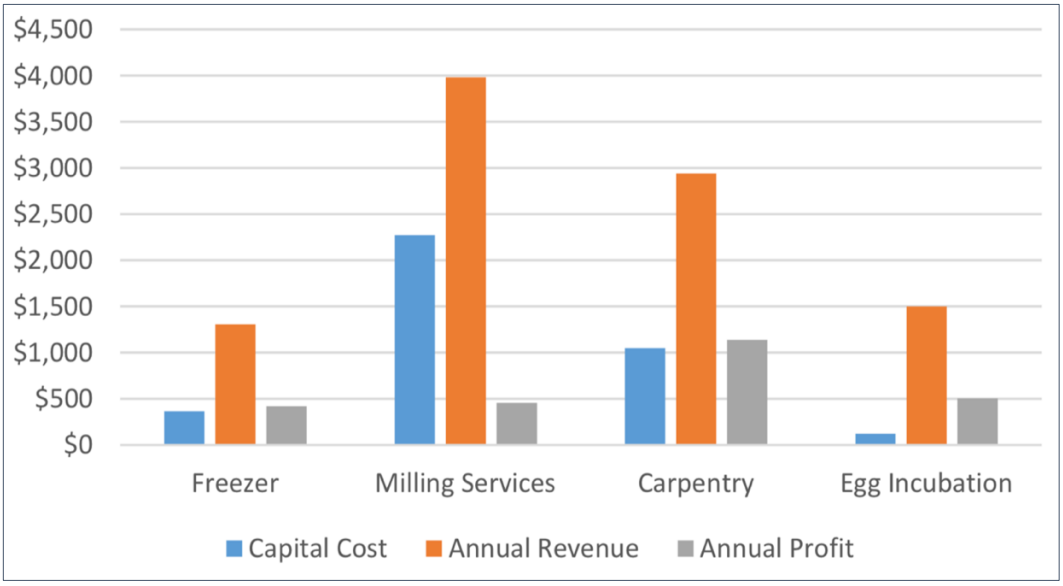
Figure 28: Pathways from Electricity to Income Generation[140]



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

[140] "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 29: Analysis of Cost, Revenue and Profit for Various Off-Grid Productive Use Applications[141]



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 in order to deliver meaningful insights on country level market sizing, productive solar applications have been divided into three main groups (**Table 31**).

Table 31: 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

[141] "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**

Côte d'Ivoire is one of Africa's fastest growing economies and has sustained a GDP near 9% over the last few years.[142] Most PUE sector activities will take place in rural areas in the northern and western regions of Côte d'Ivoire, as well as areas still recovering from the political instability of 2002 to 2010 such as the Daloa region. These are areas where grid access is limited, and rural agricultural livelihoods are the predominant means of income generation.

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

Table 32: Estimated Total Cash Market Potential for Productive Use Sector[143]

Productive Use Sector		Units	kW Equivalent	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	9,052	2,263	$5,657,500
Value-added Applications	Irrigation	65,972	7,917	$42,881,944
	Milling	547	3,557	$8,892,281
	Refrigeration	157	865	$2,161,500
	Subtotal	66,676	12,339	$53,935,725
Connectivity Applications	Phone Charging	11,270	4,508	$9,714,878
TOTAL		**86,998**	**19,110**	**$69,308,103**

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

- **SME Applications for Village Businesses**

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

With the exception of replacing diesel gensets, the estimation of the available market for off-grid solar appliances for SMEs is not as closely correlated with economic indicators. Nonetheless, some widely marketed solar powered appliances are more centrally related to the revenue generation of SMEs. Investments in such appliances in off-grid and low-income settings are more likely to be sustainable. This study analyzed barbering and tailoring appliances (i.e. hair clippers and sewing machines designed or marketed for off-grid solar powered settings) with respect to microenterprises that face difficulty in accessing outside capital, as the two appliances would provide an economic opportunity for such

[142] "Côte d'Ivoire: Sustaining Its Economic Transformation," IMF, World Economic Outlook (2018): https://www.imf.org/en/News/Articles/2018/06/29/NA-062918-Côte-d-Ivoire-Sustaining-Its-Economic-Transformation

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

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.[144]

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 5.6 million (**Table 33**).

Table 33: Estimated Cash Market Potential for SMEs – Barbers and Tailors[145]

No. of SMEs with Constrained Access to Finance[146]	Units	kW Equivalent	Cash Value (USD)
45,260	9,052	2,263	$5,657,500

Source: World Bank; African Solar Designs Analysis

- **Value-Added Applications**

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

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

Solar Powered Irrigation:

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

Solar pumping systems vary in their wattage depending on the area of land irrigated, the depth of water abstracted and the quality of the soil and crops among other factors.[147] GIS analysis demonstrated that

[144] 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

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

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

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

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 Côte d'Ivoire are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 30**).

It is important to note that many Ivorian farmers may be discouraged from making long-term irrigation investments on their due to unclear land tenure rights because of competing claims under customary land laws and the period of political unrest that has stymied efforts to bring greater formalization of land rights as provided under the Rural Land Law.[148]

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 34 presents the estimated annualized off-grid solar cash market potential for smallholder value-added solar irrigation applications in Côte d'Ivoire, which has an estimated cash value of USD 42.8 million (see **Annex 2** for more details).

Table 34: Estimated Cash Market Potential for Value-Added Applicaitons – Irrigation[149]

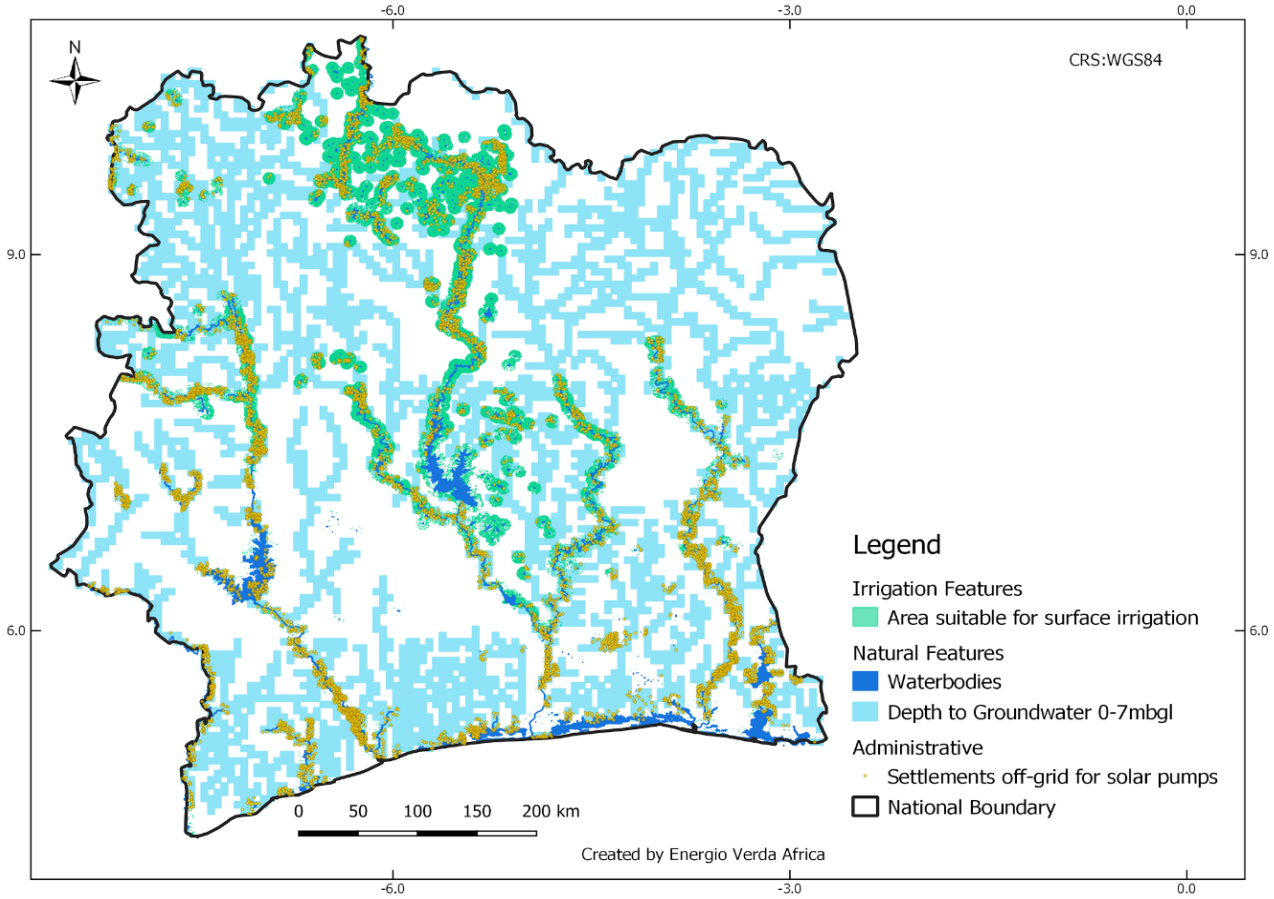
Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation	Units	kW Equivalent	Cash Value (USD)
395,833	65,972	7,917	$42,881,944

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

[148] "LandLinks, Côte d'Ivoire Profile," USAID: https://www.land-links.org/country-profile/Côte-divoire/

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

Figure 30: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps[150]



Source: British Geological Survey, ESA Climate Change Initiative and Columbia University Center for International Earth Science Network (CIEN); Energio Verda Africa GIS analysis

[150] NOTE: mbgl = meters below ground level
Sources: Mapping provided by the British Geological Survey © NERC 2012; 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 Facebook Connectivity Lab and Center for International Earth Science Information Network (CIESIN) Columbia University, 2016; High Resolution Settlement Layer (HRSL) © 2016 DigitalGlobe.

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 35 presents the estimated annualized off-grid solar market potential for smallholder value-added solar grain milling applications in Côte d'Ivoire, which has an estimated cash value of USD 8.8 million (see **Annex 2** for more details).

Table 35: Estimated Cash Market Potential for Value-Added Applications – Milling[151]

Estimated No. of Solar Mills	Units	kW Equivalent	Cash Value (USD)
10,944	547	3,557	$8,892,281

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 36** presents the estimated annualized off-grid solar market potential for smallholder value-added solar refrigeration applications in Côte d'Ivoire, which has an estimated cash value of USD 2.1 million (see **Annex 2** for more details).

Table 36: Estimated Cash Market Potential for Value Added Applications – Refrigeration[152]

Off-grid Market Centers	Units	kW Equivalent	Cash Value (USD)
3,144	157	865	$2,161,500

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

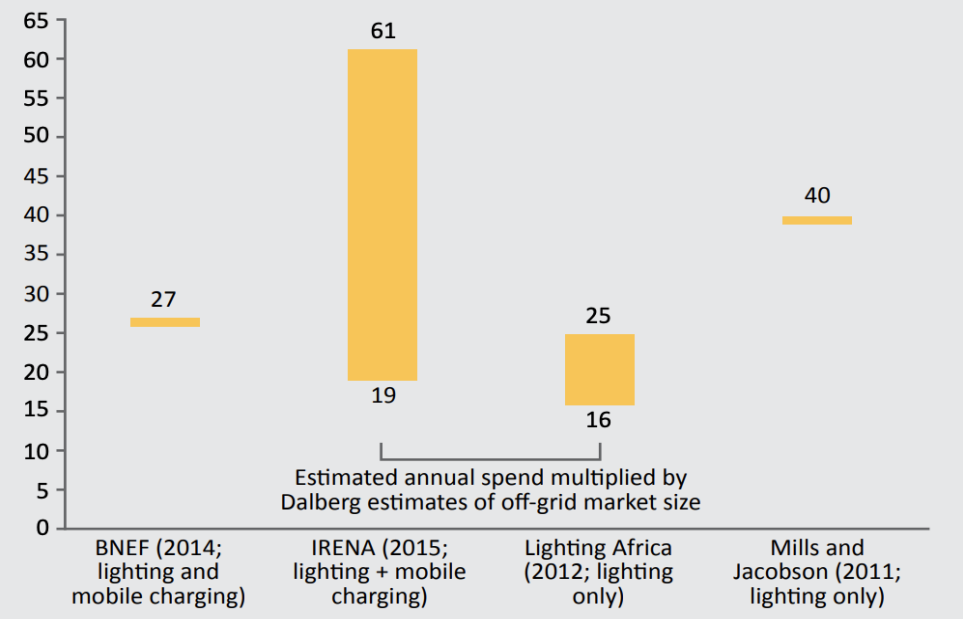
Ultimately, the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry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

- **Connectivity/ICT Applications**

Mobile phone charging stations/kiosks make up a critical segment of off-grid solar demand, as the market for solar phone charging is expected to grow significantly in the near-term. Household rates of mobile phone ownership often greatly exceed rates of electricity access (**Figure 18**), while households spend a significant share of income on lighting and phone charging (**Figure 31**). Increasingly, off-grid solar devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

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

Figure 31: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging[153]



NOTE: Figures in Billion USD

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

Figure 32 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.

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 37** presents the estimated annualized cash market potential for off-grid solar mobile phone charging enterprises in Côte d'Ivoire, which has an estimated cash value of USD 9.7 million (see **Annex 2** for more details).

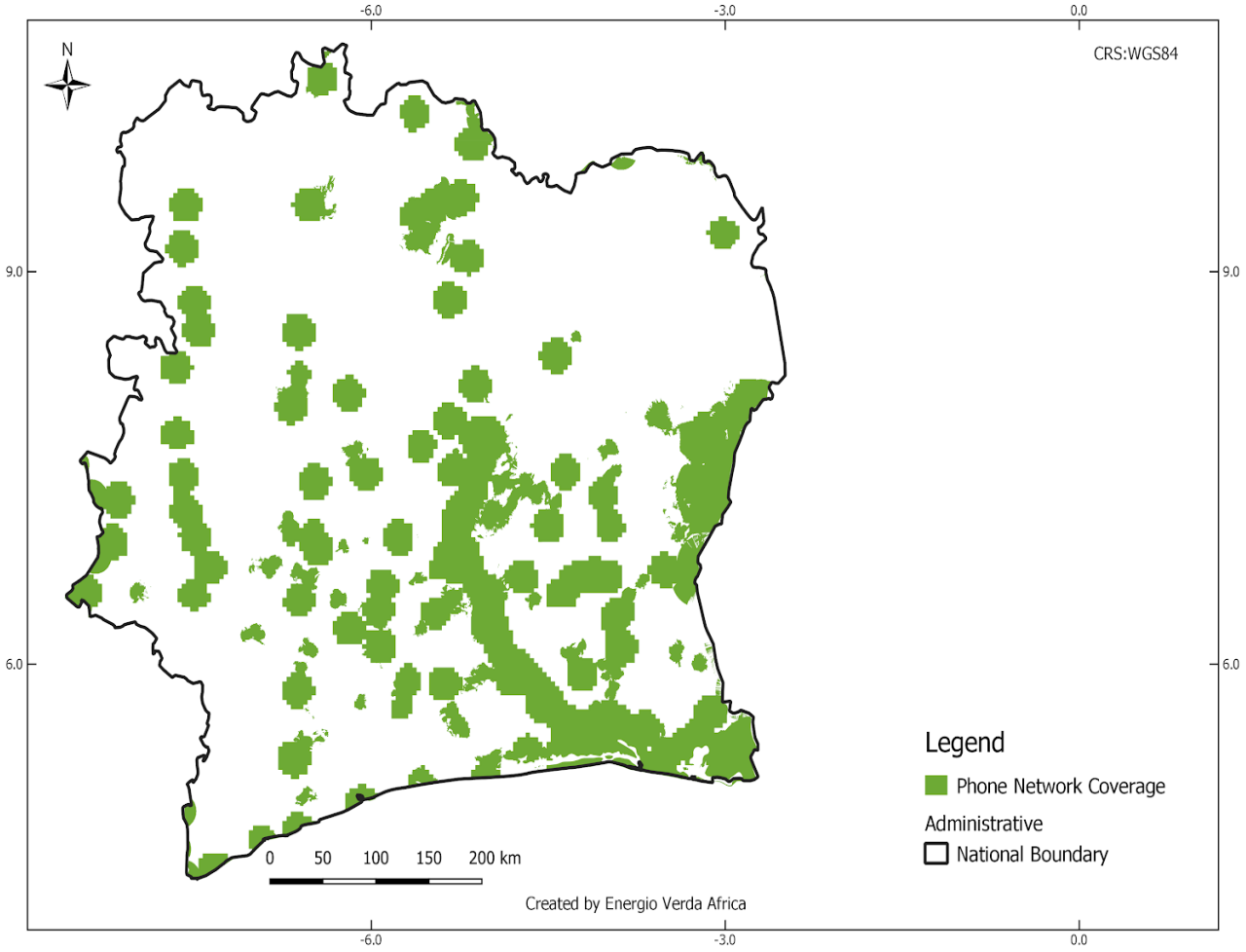
Table 37: Estimated Cash Market Potential for Mobile Phone Charging Enterprises[154]

Mobile Subscribers[155]	Rural Population (%)[156]	Units	kW Equivalent	Cash Value (USD)
12,500,000	45.10%	11,270	4,508	$9,714,878

Source: GSMA; World Bank; African Solar Designs analysis

[153] "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
[154] Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.
[155] "The Mobile Economy: Sub-Saharan Africa," GSMA, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[156] World Bank: Rural Population (% of total population) https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS

Figure 32: Mobile Phone Network Geographic Coverage[157]



Source: GSMA

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

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 Côte d'Ivoire. However, more research needs to be done in each segment to better understand affordability of OGS appliances and equipment based on ability and willingness to pay as well as other factors such as access to finance and ultimately whether the expenditure for the equipment is justifiable given increased revenue/productivity in the long-term.

The value-added market for water pumping for irrigation indicates that increased revenues from the use of solar appliances would justify the expenditure for the equipment – although as mentioned, agricultural productivity also depends on other environmental and market factors that are specific to each country. Solar powered irrigation systems may require a financed solution to be profitable investments for farmers, as their cost may exceed benefits depending on how the systems are designed and what components are used.

With regard to microenterprises, further study would be needed to determine the impact of off-grid solar on this sector, especially as it relates to income and affordability of the sectors analyzed (phone charging, barbers and tailoring). Providing solar-kits through subsidized micro-credit schemes can lead to productive uses and boost household income.

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

- Many companies cannot afford the up-front cost of the solar solutions. A potential solution to this problem would be to implement a third-party ownership system and increased access to financing. There is recognition that improving credit access will involve stronger legal rights for borrowers and creditors and deeper credit information on borrowers in rural areas.
- The Strategic Action Plan for the Development of the Electricity Sector (Plan Stratégique de Développement 2011-2030 de la République de Côte d'Ivoire Ministère des Mines, du Pétrole et de l'Energie) will increase the share of Solar PV in the country's energy mix while also supporting decentralized solar PV projects within the rural areas by including private sector participation in financing of energy access. The Rural Electrification Fund has also been deployed to address the challenge of upfront connection charges rural communities. Also, AFD's West African Sustainable Use of Natural Resources and Energy Financing (SUNREF) facility provides support for local and regional financial institutions to provide funding to businesses to finance the renewable energy investments.
- The provisioning of financing for OGS appliances should leverage the support of trade associations and cooperatives in order to lower financing risks and broaden engagement with potential users

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Côte d'Ivoire, 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 38**.

Table 38: Solar Company Tier Classification

Classification		Description
Tier 1	Startup companies	• Less than 3 full time employees • Less than 300 SHS or Less than 1,500 lanterns sold • Less than USD 100,000 annual revenues • Does not have access to outside finance except personal loans and may have a business account
Tier 2	Early stage companies	• 3 to 25 full time employees • 300 to 30,000 solar home systems or 1,500 to 50,000 lanterns sold
Tier 3	Growth/Mature	• More than 25 full time employees • More than 30,000 solar home systems or 50,000 lanterns sold • More than USD 3 million annual revenues • Has a credit line at a bank and financial statements • Raising equity or other outside financing

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

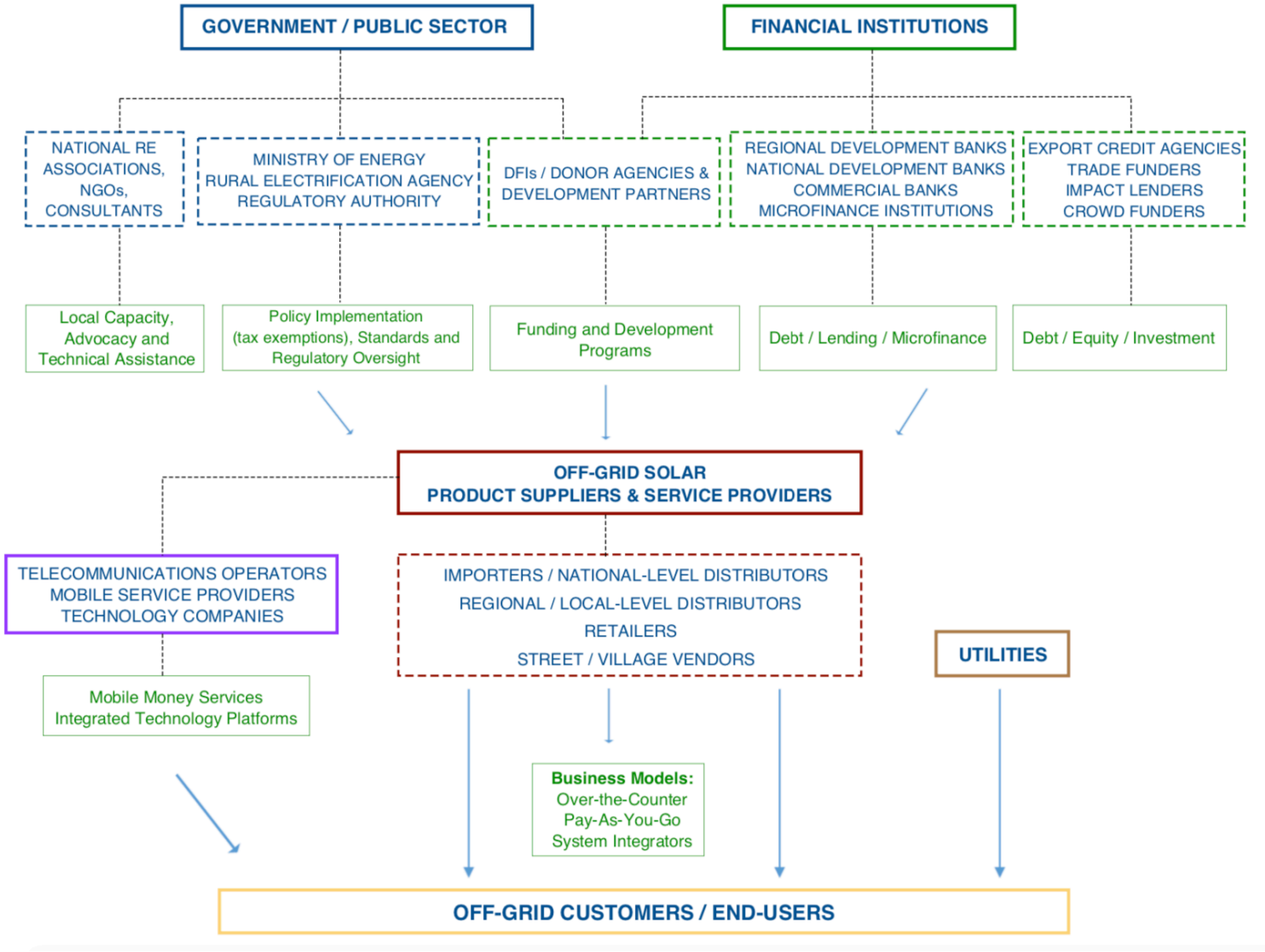
2.4.1 Overview of Commercial Market for Solar PV Equipment

The off-grid solar supply chain in Côte d'Ivoire is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 33**). Côte d'Ivoire's solar market is in a period of rapid growth as it is among the largest markets in the region. In addition, the country's overall market environment and opportunity for solar companies is improving (**Figure 15**).

A variety of solar products and systems are offered by companies in the market (by both the formal and informal sector) and, as examined in further detail below, there are a number of business models currently being utilized. Rural households make up the main market for off-grid lighting products in the country, as the demand for lighting products and household electrical appliances is growing. Nevertheless, urban households, both electrified and non-electrified, are also a key consumer market, as they may have greater ability to afford OGS products and systems. Moreover, despite the high level of grid connectivity in urban areas, power supply is often not sufficient, continuous, or reliable (**Figure 5**), further supporting expanded use of solar PV equipment by this consumer segment.

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

Figure 33: 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.[158] 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.

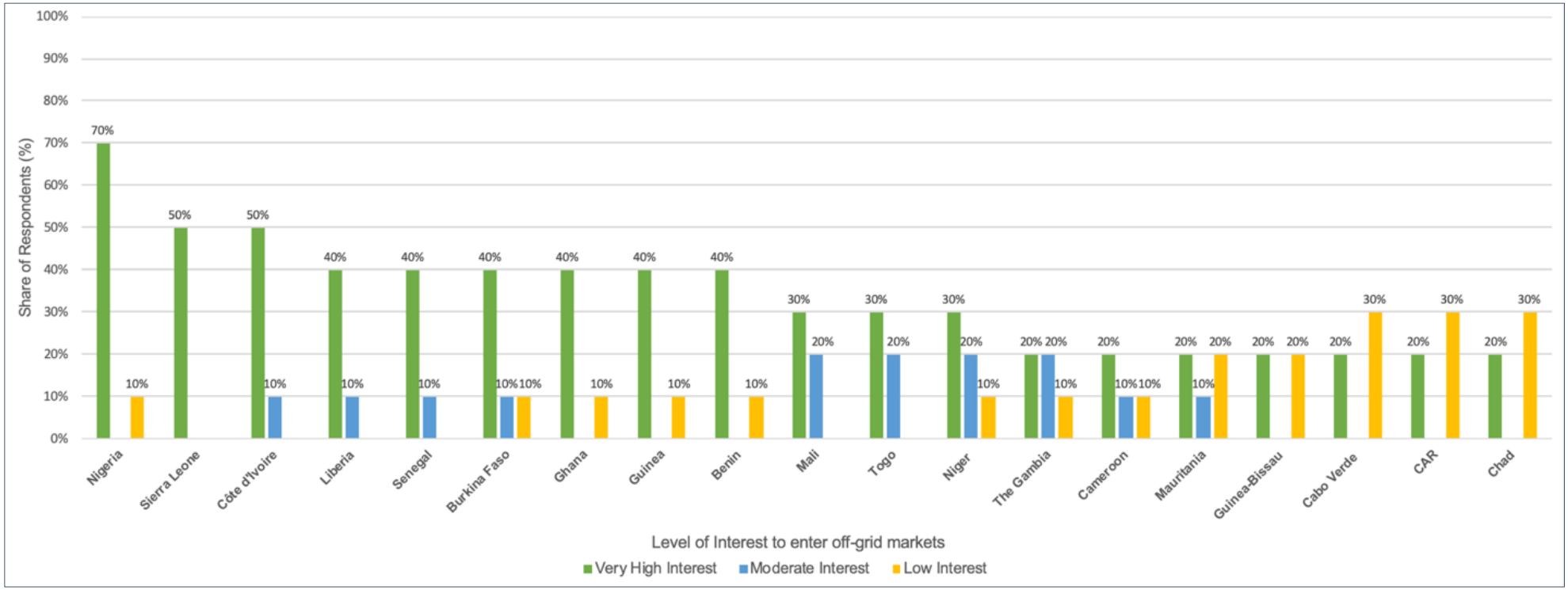
Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money 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.[159]

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.[160]

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 34**. 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.

[158] "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
[159] Ibid.
[160] "Insights from Interviews with Off-Grid Energy Companies," ECREEE, (June 2018).

Figure 34: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[161]



Source: GreenMax Capital Advisors analysis; Stakeholder interviews

[161] 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 Côte d'Ivoire

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

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

Focus groups and stakeholder interviews identified nearly 50 companies operating in Côte d'Ivoire'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). These suppliers include importers, distributors and retailers, many of which are members of the country's renewable energy and energy efficiency association – AIENR. 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, Côte d'Ivoire had one of the highest concentrations of Tier 3 companies in West Africa and the Sahel, with 10 companies identified that meet these characteristics, behind only Mali (16) and Senegal (11) in the region (see **Table 38** for a description of the tier classification).[162]

PEG Africa, ZOLA and Baobab+ are the largest international companies operating in the market. PEG entered the market in 2016 and also has operations in neighboring Ghana.[163] ZOLA is a Joint Venture between Off-Grid-Electric (OGE) and EDF, which recently received an AfDB partial credit guarantee – CFAF 15.75 billion in local currency loan arranged by Société Générale and Credit Agricole Corporate and Investment Bank – to expand its operations in the country and wider region.[164] Other major international players include Lumos, who entered the market in 2017,[165] and Fenix International, who initially partnered with MTN, which later entered in partnership with Lumos to set up MTN Lumos.[166] Separately, the French company, Orange, began a SHS distribution program in 2018 and has sold around 1,000 units by the end of that year.

Some of the country's larger Tier 3 companies (e.g. ZOLA, PEG Africa and Baobab+ etc.) acquired longstanding industry experience in other African countries prior to entering the Ivorian market. While there is no manufacturer of solar products based in Côte d'Ivoire, the largest companies in the market have formed key partnerships with global manufacturers (mainly in East Asia). Many solar companies are also forming strategic partnerships with telecommunications operators and IT companies to improve upon customer-relationship management by offering more payment options (i.e. PAYG services).

Most companies specialize in the sale of stand-alone systems (pico lanterns, single modular systems, plug and play systems) mainly to households and businesses. Many firms are manufacturer representatives, buying directly from a manufacturer outside the country, representing international brands and acting as local distributors for these brands. Both Baobab+ and PEG Africa sell BBOXX solar lanterns and plug and play products in Côte d'Ivoire. All of the major companies operating in the country offer PAYG consumer financing as well as installation, operation and maintenance services for the products they sell to customers.

[162] "Insights from Interviews with Tier 3 Off-Grid Energy Companies," ECREEE, (June 2018).
[163] "PEG Africa raised US$ 13.5 million for off-grid solar in West Africa," PEG Africa, (2017): https://www.pegafrica.com/news/
[164] "AfDB backs local currency financing structure for off-grid projects," ESI Africa, (18 June 2018): https://www.esi-africa.com/afdb-backing-local-currency-financing-structure-for-off-grid/?utm_source=Spintelligent+Publishing+mailer&utm_medium=email&utm_campaign=ESI+Daily+Enews+18+June+2018&utm_term=https%3A%2F%2Fwww.esi-africa.com%2Fafdb-backing-local-currency-financing-structure-for-off-grid%2F
[165] "Lumos enters Côte d'Ivoire," Ecofin, (2017): https://www.ecofinagency.com/electricity/1311-37729-lumos-enters-ivorian-market
[166] "Engie and Fenix complete acquisition to bring affordable power to the last mile across Africa," Fenix International, (2018): https://www.fenixintl.com/blog/engie-fenix-complete-acquisition-bring-affordable-power-last-mile-across-africa/

Surveys of local industry stakeholders found that financing remains a barrier to growth, particularly for smaller Tier 1 and Tier 2 companies. Focus group participants also noted that there is insufficient involvement from the Government in the sector, a prevalence of low-quality products flooding the market, weak knowledge and technical capacity and generally low consumer awareness among other challenges facing solar companies in Côte d'Ivoire.

- **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 39** and **Table 40**. 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 Côte d'Ivoire.

Table 39: Total Sales Volume and Cash Revenue for Stand-alone Systems in Côte d'Ivoire, 2016-17[167]

Sales Volume / Revenue	2016	2017	Total
Total Volume of Products Sold (Units)			
Total Volume of Products Sold	29,538	24,893	**54,431**
Pico Solar	25,107	23,399	**48,506**
SHS	4,431	1,494	**5,925**
Total Cash Sales Revenue (USD)			
Total Cash Sales Revenue	$128,856	$162,044	$290,900
Pico Solar	$123,702	$139,358	$263,060
SHS	$5,154	$22,686	$27,840

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

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

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

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

Table 40: Cash and PAYG Sales Volume and Revenue for Pico Solar Products, H1 2018[168]

Sales Volume / Revenue	Cash	Share (%)	PAYG	Share (%)	Total
Total Sales Volume Côte d'Ivoire	**340**	**1.9%**	**17,106**	**98.1%**	**17,446**
Total Sales Volume West Africa	194,251	65%	104,520	35%	299,041
% of Total Sales Volume in West Africa	0.2%	-	16.4%	-	5.8%
Total Sales Revenue Côte d'Ivoire	no data		**$8,158,133**		**$8,158,133**
Total Sales Revenue West Africa	$14,972,591	50%	$15,008,999	50%	$29,981,589
% of Total Sales Revenue in West Africa	no data	-	54.4%	-	27.2%

NOTE: H1 = First half of year

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

- **In 2016-2017, 54,431 pico solar and SHS units were sold for a total cash sales revenue of USD 290,900**. While the volumes sold have decreased from 29,538 units to 24,893 units between 2016 and 2017, cash sales revenue increased from USD 128,856 to USD 162,044 over the same period.

- **Côte d'Ivoire, together with Sierra Leone, was noted to be a growing market in the West African region, with about 15,000 units sold in H2 2017**. Based on 2017 GOGLA Sales figures,[169] a total of 25,000 units were sold in 2017, 10,000 in H1 2017 and 15,000 in H2 2017 (+38%). This increase also reflects the high volatility of the solar market in Côte d'Ivoire, which like many West African countries is far from having reached a mature commercial market stage. While total cash sales revenue amounted to USD 162,044 in H1 2017 for about 10,000 units sold, no data was available for H2 2017 (and thus for the total of 2017).

- **Côte d'Ivoire represented a very small share of the total cash sales in the West African market in 2017**. The number of units sold in the country represented less than 4% of the number of total units sold in the region in 2017. The total cash sales revenue in H1 2017 accounted for less of total cash sales revenue in the region.

- **However, Côte d'Ivoire's market mostly utilizes PAYG sales over cash sales and accounts for more than half of PAYG sales revenue in West Africa**.[170] PAYG is the dominant customer transaction model, which partly explains why cash sales are relatively low compared to other countries in the region. In H1 2018, 98% of sales reported by GOGLA affiliated companies were PAYG sales, and only 2% were cash sales. Côte d'Ivoire's market represented 54% of total PAYG sales revenue in the region, compared to 16% of total PAYG sales volumes.

- **Pico Solar PV represent the vast majority of products sold**. Based on regional data for 2016 and 2017, pico solar products represent about 89% of total volume sales of GOGLA companies' total reported sales volumes and 90% of sales revenue. Even though country data are not available, it is possible to assume that this percentage of solar Pico products is lower in Côte d'Ivoire, as the market is relatively more developed and the breakdown between PAYG and cash sales in terms of revenue and volume suggests a higher share of SHS sold (see iii). Côte d'Ivoire would thus sell a higher share of SHS systems than the regional average.

[168] "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
[169] GOGLA only reports sales of their members/affiliated companies, hence the data do not represent the entire market
[170] In the GOGLA H1 2018 Report, the methodology has slightly changed compared to 2017 – in addition of cash sales, affiliated companies also reported PAYG sales

➢ Main Solar Products and Components

Table 41 lists the brands of common solar products and components in Côte d'Ivoire. The list does not include non-certified brands that are also common in the country's grey market.[171]

Table 41: Off-Grid Solar Products and Components in Côte d'Ivoire

Systems	Companies
Distributors of pico solar & plug and play system	Zola Energy, PEG Africa, Fenix International, Baobab+, Aphelion Energy, AD Solar, Lumos, Total CI
Single module distributors	Aphelion Energy, Zola Energy, AD Solar, Yandalux, S-TEL, Lumos, Schneider Electric, Haier
Multi module system distributors	Aphelion Energy, AD Solar, Yandalux, S-TEL, NOA Trading
Very large system supplier	Aphelion Energy, AD Solar, Yandalux, S-TEL, NOA Trading
Products/Components	**Brands**
Pico/plug & play system	Sun King Pro, BBOXX plug and play, ZOLA, ReadyPay, Phaesun, M-KOPA, Mobisol, d.Light, Engie
Solar module	Solar World, France Solar, Jinko, Amerisolar, Helios, Phaesun, ENGIE
Inverter	Steca, Opti Solar, Frokus, Victron
Lead Acid Battery	Steca, Victron, Ritar Power, Narada

Source: Stakeholder interviews

➢ Market Prices

Table 42 presents average prices for off-grid systems and components in Côte d'Ivoire's solar market. Although sales volumes are growing rapidly, prices of Lighting Global products for consumers are still significantly higher than in more mature markets.

Table 42: Estimated Prices of Solar Systems and Components in Côte d'Ivoire

Off-Grid System / Component	Estimated price range (USD / per unit)
Pico solar	$9-$95
Plug and play	$50-420
Small SHS	$14-$200
Inverter	$87- $8,700
Lead Acid Battery	$35-$870

Source: Stakeholder interviews

➢ Importation Clearance Processes

For the importation of solar products (and all types of imports), three government agencies are involved in Côte d'Ivoire: Customs, the Abidjan Port Authorities and the Directorate-General for Taxation (DGI). Solar modules are applied a 9% VAT tax, while all other products (including components such as batteries and inverters) are applied an 18% tax. It takes more than three months or 100 days to import solar equipment to Côte d'Ivoire. It takes about 10 days to go through the order and logistics procedures, 45 days after the

[171] 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.

initial order for the products to arrive at the port of Abidjan and an additional 45 days for customs clearance procedures to complete. There are two existing national bodies that would be in a position to make this process more efficient – the Buildings And Public Work Laboratory (Laboratoire du Bâtiment et des Travaux Publics, LBTP), and CODINORM, the standardization agency in charge of standards quality.

2.4.4 Overview of Business Models

- **Company Approach to Market**

Historically, solar companies in Côte d'Ivoire have developed as vertically integrated companies, based on in-house design of solar systems, outsourcing of manufacturing, in-house software design and the use of equity and grants for growth and development. Most of the companies surveyed have been in business between one and three years, with the balance having been in business at least five years. Sogelux has been operating in the market the longest (since 2003).

While some companies continue selling a wide range of products, many have started to specialize in order to focus on specific consumer segments. For most formal solar companies, their most important clients are large institutional groups such as NGOs and public health facilities or large high-income clients. Many firms utilize PAYG financing to target low-income households and base of the pyramid customers. Companies that only use cash/over-the-counter sales are typically retailers, selling low-quality products without a warrantee.

- **Business Models**

There are four primary business models utilized in the market (**Table 43**), although in reality solar companies utilize a number of business models to reach a variety of clients:

- **Over-the-counter cash sales** include both informal and formal components and is estimated to account for approximately 60% of market share in terms of cash value. Many traders simply offer solar products over-the-counter. Formal sector solar companies also stock modules, batteries and balance of system and offer them over-the-counter to do-it-yourselfers and agents.
- **System integrators** handle large systems and projects. They design, procure and install systems which range from high-end residential sites, to institutional power to mini-grids. Local integrators represent international solar, inverter and battery brands with whom they partner with on projects.
- **Plug and play and pico suppliers** cooperate with many of the major OGS brands to distribute products in the country.
- **The PAYG sector** is still in its early stages but is growing rapidly. Suppliers are building up client bases which number in the tens of thousands and are quickly evolving to develop credit mechanisms that fit with local income patterns. The margins are made from subscriptions of thousands of consumers who buy systems through created accounts. The task of installation and after sales services is undertaken by agents. Common products sold include plug and play systems that are fully designed. Nearly all major suppliers in Côte d'Ivoire utilize this business model.

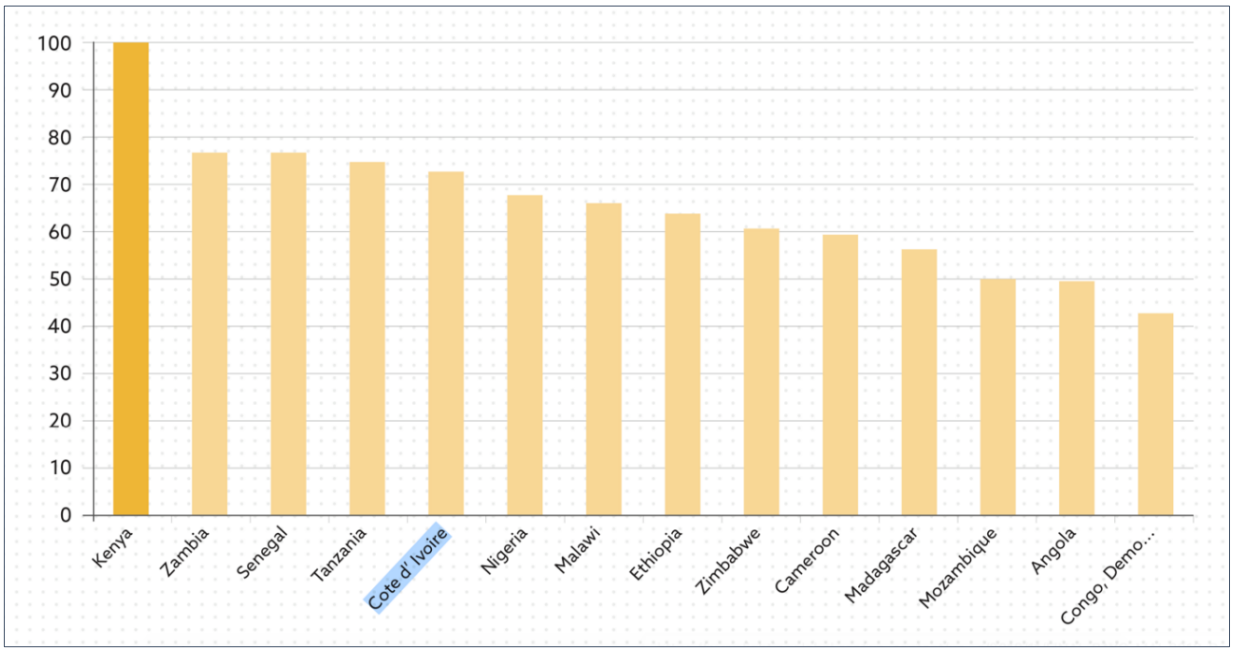
Table 43: Overview of Off-Grid Solar Business Models

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

Source: African Solar Designs analysis

A 2018 analysis undertaken by Lighting Global ranked Côte d'Ivoire highly with regard to the market's attractiveness for the deployment of the PAYG business model, demonstrating that the country possesses sufficient demand (market size, willingness to pay, ability to pay) supply (access to finance, operational infrastructure, low market penetration, human capital) and an enabling environment (e.g. policy / legal framework, commercial environment) to support consumer financing for off-grid solar (**Figure 35**).

Figure 35: PAYG Market Attractiveness Ranking for Select Africa African Countries[172]



Source: Lighting Global

- **Company Financing**

With so many companies utilizing the PAYG model to sell off-grid products and systems on credit (sometimes with lengthy repayment periods), it can become difficult for companies to finance their operations and grow their business. In addition to financing customer payment options, suppliers also require significant working capital to purchase equipment, conduct marketing campaigns, and cover field costs. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited. Most of the firms surveyed in Côte d'Ivoire are self-financed with cash flow covered by shareholders and founders and from on-going business transaction. A few of players are supported by FI/MFI loans, donor funding/grants and CSR but these resources are limited for most.

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 Côte d'Ivoire are unable to raise funds to expand their business. Local financiers have yet to develop an appetite for the solar sector. Local banks are extremely conservative with regard to solar enterprises. Commercial financiers – including banks and MFIs – are not set up to service solar distributor financing requirements. Local SME financing is not available to support businesses in their growth phase. If it was available, companies would make use of cash-flow/credit line financing against the signed contracts with major commercial clients, large NGOs or donors.

When importing, companies are exposed to considerable FOREX risks because they must cover costs of equipment in foreign currency. When projects are delayed, during seasonal low-income periods or when products are delayed in port, dealers must bear FOREX losses. The lack of consumer financing arrangements impedes the growth of the solar market because distributors must take all finance risks and cannot plan with commercial or MFI financing to grow their business.

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

- **Evolving Business Models**

Côte d'Ivoire 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 44**).

Table 44: Evolving Off-Grid Solar Business Models

Partnership	Description
Solar Distributors	• Improve efficiency within the supply/distribution chain, positioning them to be able to manage distribution, seek potential for long-term credit lines and capital infusions • Develop better contract terms between large local suppliers in Côte d'Ivoire with foreign manufacturers • Test new sales and distribution strategies that increase sales at minimum cost • Prove solar market potential, ultimately attracting a strong group of competing players that scale up solar product access
Commercial financiers	• Commercial financiers are key to unlocking working capital and consumer finance and enabling the market by providing both the funds and means of transferring these funds • Develop financial products for both distributors (financing for working capital needs) and off-grid solar consumers (consumer financing for purchase of systems)
Telecommunications companies and technology providers	• Bring together telecommunications operators, mobile service providers and technology companies and solar supplier/distributor companies to develop Pay-As-You-Go technology platforms • Encourage telecommunications partners to distribute off-grid solar systems through their existing network of agents
Business/Retail Sector	• Comprises networks of retail stores that cover the entire country and provide all types of domestic and agriculture goods for the rural community • Encourage linkages between specialized solar companies and these networks so as to facilitate the increase of the distribution network at a lowest cost possible • Provide promotional tools for local retailers to promote solar products to households/SMEs • Facilitate microfinancing for the domestic market through these networks
Advocacy Bodies	• Capitalize on GoCI and donor efforts to (i) facilitate interagency dialogue and oversee policy proposals on new business models and (ii) enhance legislative changes to support the sector

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

2.4.5 The Role of Non-Standard Players in the Market

Stakeholder interviews and FGDs found that the over-the-counter informal market makes up between 60-80% of the 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 GoCI 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

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

Informal traders selling counterfeit products are a significant barrier to OGS market growth in Côte d'Ivoire. Poor-quality and/or counterfeit products negatively impact the entire market by creating a misperception about product quality, which in turn undermines consumer confidence in solar equipment. Moreover, grey-market traders significantly undercut the prices of registered businesses who are still subject to taxes and import duties. Low prices of over-the-counter products make compliant products uncompetitive as many customers opt to buy non-compliant goods that are cheaper. Feedback from focus group meetings suggested that there is a role either for the regulator, ANARE, and/or the renewable energy and energy efficiency association, AIENR, to assist in enforcement of standards through mediation efforts between regulatory bodies, market players and consumers.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

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

The synergy with formal training institutions has yet to be fully explored and most of the players in the industry are not adequately equipped with the skills needed to design and assess policies, understand and deploy technologies, grasp electricity user needs and ability to pay, and operate and maintain systems. FGDs acknowledged a number of initiatives undertaken to support local capacity in the country but also indicated that they were inadequate. GIZ has recently initiated development of local capacity in solar PV for the country through a three-year renewable energy education and training program. 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:

- Perceived high taxes on solar products is a major challenge facing the industry in Côte d'Ivoire. Solar market players expect a higher level of involvement from the Government.
- While the industry's largest players have access to various sources of financing, local financing is largely not available (or affordable) to support the sector's development; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations.
- 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 a few professionals in the industry working for large established solar companies; the majority of vendors lack the expertise or knowledge necessary to adequately service the market.
- Address the issue of import duty and or VAT on imported solar lighting products and components
- There is a clear lack of expertise amongst customs officials in being able to identify with certainty which products should be considered part of this category and thus merit the exemptions
- Improve regulations and develop framework to ensure product quality and address issues of low-quality products that compete with certified products sold by formal companies

Table 45 presents various areas of support and associated capacity building for the OGS supply chain in Côte d'Ivoire. Attention should be given to the following:

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

Table 45: Capacity Buildings and Technical Assistance for the OGS Supply Chain in Côte d'Ivoire[173]

Area of Support	Description	Rationale
Tax exemptions on solar technology	• Effective and consistent implementation of solar products exemption from VAT and import duties	• Costs of solar products are inflated by high import duties (9% VAT on solar panels and 18% for other products and components); costs are passed on to customers, making solar less affordable.
Consumer education programs	• Supplier and consumer education and benefit awareness campaigns, targeting both segments, distributors and retailers	• Overcome investment fatigue / negative perceptions • Influence purchase decisions and ease access to distribution channels
Inventory financing facility	• Concessionary credit line so financial institutions can access liquidity for solar market lending; • Create frameworks that avail loans to solar companies (small household systems, larger PV installations, and mini-grids) • Pilot with aim of scaling out	• Long inventory financing periods present a key challenge to growth for solar lantern and solar home system distributors • High upfront financing requirements present a key challenge to distributors of larger PV systems (including pumps)
Credit guarantee scheme for inventory financing	• Private sector lending portfolio is de-risked through guarantees and effect loss sharing agreements to cover irrecoverable inventory loans	• De-risking encourages private sector lending to solar sector • Initial security until the proof case of economic viability of lending to solar businesses has been established
Market entry and expansion grants	• Combination of upfront grants and results-based financing to invest in infrastructure and working capital; mostly for scaling up	• Significant upfront investment to build distribution network and source inventories to serve household market
Technical Assistance	• Help solar companies set up technology platforms for PAYG • Support incubation and acceleration of early-stage businesses; • Capacity building for solar technicians to enable nationwide installation and maintenance of solar equipment	• Make the business environment more conducive and profitable • Strengthen the overall ecosystem surrounding the solar market • Ensure knowledge transfer from abroad for faster, more cost-efficient progress

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

[173] 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 Côte d'Ivoire, 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 46 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 46: Key Barriers to Off-Grid Solar Market Growth in Côte d'Ivoire

Market Barrier	Description
Demand[174]	
Consumers are unable to afford solar systems	• Low-income consumers, particularly in rural areas, lack of access to finance • Purchasing solar products of all varieties among end-consumers remains relatively low. The absence of end-consumer markets for solar PV systems deters many potential new entrants.
Lack of initial funding by HHs, businesses and institutions for the initial capital investment	• Relatively high costs of OGS systems • Consumers rather choose cheaper one-off solutions – like generators and fuel – rather than more expensive up-front solutions that will be cheaper long-term (especially with incremental payments, e.g. PAYG)
A lack of understanding of and trust in solar solutions among consumers impedes development of the market	• There is still considerable lack of general awareness about solar solutions • There is an inability to distinguish between solar products or product quality • Consumers lack information about the most suitable design options, funding options, PAYG benefits and options, points of sales and support, etc. • Products are still not widely available in rural areas, so consumers are unfamiliar with them • Any poor history / track record with OGS will deter consumers from taking expensive risks
Informal sector competition and market spoilage	• The non-standard / unlicensed market still accounts for a majority of OGS product sales • Consumers need to understand the quality and value issues of quality solar products vis-a-vis inferior over-the-counter lighting products and generators. Educated consumers drive markets.
Lack of experience in maintaining the systems and sourcing qualified technicians	• A sustainable approach to O&M is critical for long-term success
Supply	
Technical capacity	• Technical skills lack through the supply chain within the sector, affecting both the upstream, midstream and downstream, thus adversely affecting the ability of the sector to pick up and grow. Majority of the firms decry lack of adequate number of technicians to support the downstream side of the market
Transportation costs	• High transportation costs of inventory deter new entrants; devices and equipment are shipped either from China or from Europe, creating long delivery lead times of up to three months and long inventory holding times once products have arrived in country • Typical supplier payment terms are 30% upon placement of the production order and the remaining 70% upon shipment before any cargo has even left its port of origin. • Transport by container would reduce the costs dramatically; however, this requires purchases in bulk, which local solar distributors aren't able to make without financing
Poor sales and performance history of the sector	• A lack of investment into the sector prevents growth; this is due to perceived high risks resulting primarily from lack of track record of sales • Solar distributors have limited alternative financing options. Solar suppliers are unwilling to provide trade financing while commercial financiers in Côte d'Ivoire, including banks and MFIs, are currently not positioned to service the financing requirements of solar distributors.

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

Company finance	• Entrants into the sector require significant working capital, which is not readily available • Equity investments are needed into the local distribution/sales companies. It is quite easy to obtain debt financing and other loans once the solar companies have sufficiently grown and reached the "level of interest" of the larger funds; however, until the number of customers and sales volumes are reached, they need some equity investors to share higher risks with the original founders of the companies
Informal sector competition and market spoilage	• Several informal entrepreneurs have taken advantage of high import duties by illegally importing low-quality solar products ranging from solar lanterns to larger home installations • Black-market traders are able to significantly undercut the prices of registered businesses who are still subject to high taxes and import duties • These products are largely low-grade, failure-prone knock-offs with short product lifespans (sometimes of little more than a few weeks) • Damaged perceptions of solar systems durability and reliability hinders market uptake
Lack of data	• No clear figures on the actual needs, actual usage or experience of consumers • The data for the private market players on the available opportunities is very limited and not concise due to fragmented data
High 'transaction costs' for solar installations	• Cash-flow and bureaucratic hurdles for the local suppliers • Sales and O&M services in remote areas can be costly, especially for small businesses

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

2.5.2 Drivers of Off-Grid Solar Market Growth

Table 47 is a summary of the key drivers of OGS market growth in the country.

Table 47: Key Drivers of Off-Grid Solar Market Growth in Côte d'Ivoire

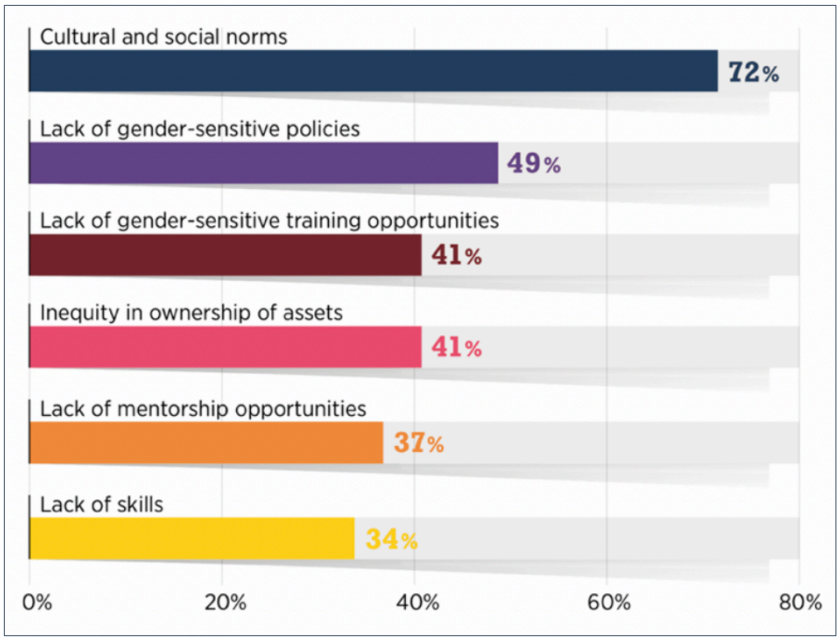
Market Driver	Description
Strong off-grid electricity demand	• Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	• The Government is viewed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

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

2.5.3 Inclusive Participation[175]

Given that the off-grid market is only beginning to emerge in Côte d'Ivoire, 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 36**). 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.[176]

Figure 36: 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.[177] 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.[178]

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,

[175] See **Annex 4** for more details
[176] "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
[177] "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
[178] "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.[179] 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.[180]

The gender analysis undertaken in Côte d'Ivoire 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)[181]
- 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 Côte d'Ivoire's off-grid sector. In 2018, ECREEE partnered with AfDB to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of inclusion of women in the energy value chain – only 2% of energy sector entrepreneurs in West Africa today are women. The initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Côte d'Ivoire.[182]

Another initiative is the *"Women and Solar Entrepreneurship*" Program, which is being implemented by EDF in partnership with the Togolese institution, Energy Generation. Under the program, EDF will design training modules that will help equip women with skills needed to set up and repair off-grid solar systems as well as teach them more about entrepreneurship in the clean power sector. Energy Generation will leverage its local knowledge of the West African market to support implementation of the training program at various training centers across the region, with initial beneficiaries from Côte d'Ivoire, Togo and Ghana.[183]

[179] "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

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

[181] 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.**

[182] "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/

[183] "EDF Teams Up with Energy Generation in West Africa," Alternative Energy Africa, (6 August 2018): https://www.ae-africa.com/read_article.php?NID=9362

III. ANALYSIS OF THE ROLE OF FINANCIAL INSTITUTIONS

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

3.1 Introduction to Financial Products for the Off-Grid Sector

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

3.1.1 Financial Products for End-Users

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

- **Households**

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

- **Public Institutions**

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

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

- **Productive Use**

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

- **Commercial and Industrial**

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

3.1.2 Financial Products for Suppliers/Service Providers

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

- **Working Capital**

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

- **Inventory and Trade Finance**

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

- **Asset-Based or Receivables Financing**

Once stand-alone solar system providers achieve a portfolio of operating PAYG or LTO installations, the system assets and revenues from customer payments can be used to leverage debt financing to fund business activities and expansion. Typically, a Special Purpose Vehicle (SPV) is established to house the asset portfolio, which is sold by the solar provider to lenders. This form of financing has been widely deployed in East Africa and is also increasingly available in West Africa through a variety of regionally focused specialized debt funds that are focused on portfolio financings in the range of USD 1-10 million.[184]

- **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.[185]

[184] 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.

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

3.2 Financial Market Overview

3.2.1 Market Structure

As a member of the West African Economic and Monetary Union (WAEMU, or Union Économique et Monétaire Ouest Africaine, UEMOA), Côte d'Ivoire shares a currency with seven other countries in the economic community, the West African CFA Franc, which is pegged to the euro. FIs in Côte d'Ivoire 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, Côte d'Ivoire 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%.[186]

Côte d'Ivoire plays an important role in WAEMU, as the country's financial market is one of the largest in the region, led by its banking sector, which represents about 30% of the consolidated assets of the WAEMU banking system (**Table 49**). The sector's balance sheet reached a total of CFA 11 billion (USD 19 million) in 2017, up 14.1% from 2016.[187] The banking sector, which consists of 28 commercial banks, two leasing companies, and over 50 microfinance institutions, has experienced significant growth in recent years, driven mainly by its West African subsidiaries – Fidelis Bank (Burkina Faso), the Bank of the Union (La Banque de l'Union, Mali) and the Regional Bank of Markets (La Banque Régionale des Marchés, Senegal).

An average of about one new bank joins the sector annually, which has gradually increased competition. This trend is reflected in bank lending percentages; at around 1% and averaging 0.8% between 2013 and 2016. This differs starkly from other WAEMU countries, whose average lending percentage is above 2%.[188] Despite strengthening competition, the sector remains highly concentrated and oligopolistic, with one-third of banks and financial institutions representing 80% of the credit market; moreover, the top eight banks represent two-thirds of the country's bank branches (**Table 48**).[189]

Table 48: Market Shares of Largest Banks in Côte d'Ivoire, 2015

Share of total assets (% of total)		Share of total deposits (% of total)	
1. SGBCI	13.9%	1. SGBCI	15.2%
2. BACI	13.6%	2. EcoBank	12.2%
3. Ecobank	13.1%	3. BACI	12.1%
4. NSIA	9.1%	4. NSIA	9.8%
5. Attijariwafa Bank	9.1%	5. SIB	9.2%
6. Bank of Africa	7.4%	6. BICICI	8.7%
7. BICICI	7.2%	7. BNI	8.3%
8. BNI	7.1%	8. Bank of Africa	5.1%

Source: Government of France, Ministry of Economy and Finance

[186] "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

[187] "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

[188] "Le Secteur Bancaire Ivoirien," Director General of the Treasury, Ministry of Economy and Finance, Government of France, (2016): https://www.tresor.economie.gouv.fr/Ressources/16643_secteur-bancaire-de-luemoa

[189] Ibid.

As of 2017, Ivorian FIs accounted for the largest share (31.2%) of the WAEMU market (**Table 49**).[190]

Table 49: 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

- **Banking Sector Financial Soundness Indicators**

Since 2011, the GoCI has committed to dispose of assets in the banking sector. This reform notably led to the liquidation of the Bank for Financing Agriculture (Banque pour le Financement de l'Agriculture, BFA), the privatization of Habitat Bank of Côte d'Ivoire (Banque de L'Habitat de Côte d'Ivoire, BHCI) and Versus Bank, as well as the restructuring of ailing banks, particularly National Investment Bank (Banque Nationale d'Investissement, BNI) and the Caisse National Savings Bank (Caisse Nationale des Caisses d'Epargne, CNCE). In 2018, the Caisse Deposits and Consignment Côte d'Ivoire (Caisse des Dépôts et Consignation Côte d'Ivoire, CDC-CI) was created based on the French model of deposits and consignments, designed to mobilize long-term financing for the economy.[191] While these changes have led to a highly concentrated banking system, the sector remains financially sound (**Table 50**).[192]

In comparison to the commercial banking sector, MFIs have a considerably smaller footprint in Côte d'Ivoire. Whereas banks represent 80% of total financial assets, the insurance sector represents 17% and microfinance only 2%. In 2017, 51 MFIs were present in the country, servicing about 1.3 million customers and accounting for about one-third of total bank accounts in financial institutions. The MFI sector is also highly concentrated, as the largest MFI, National Union of Savings and Credit Cooperatives of Côte d'Ivoire (Union Nationale des Coopératives d' Epargne et de Credit de Côte d' Ivoire, UNACOOPEC-CI) accounted for almost 75% of MFI customers in 2014.[193] There are two types of microfinance institutions that operate in the country – savings and credit cooperatives/units and NGOs/public limited companies.[194]

[190] "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
[191] "Communiqué du Conseil des Ministres du mercredi 10 janvier 2018," Government of Côte d'Ivoire, (2018): http://www.gouv.ci/doc/1515612450Communique-du-Conseil-des-Ministres-du-10-janvier-2018.pdf
[192] "Côte d' Ivoire: Country Report No. 18/182," International Monetary Fund, (June 2018): https://www.imf.org/en/Publications/CR/Issues/2018/06/25/Côte-d-Ivoire-Staff-Report-for-the-2018-Article-IV-Consultation-and-Third-Reviews-Under-the-46008
[193] "La course vers l'émergence," World Bank, (2016): http://documents.worldbank.org/curated/en/324141467904787703/pdf/WP-v2-PUBLIC-RAPPORT-SITUATION-ECONOMIQUE-DE-LA-CIV-juillet-2016-ligth.pdf
[194] "Financial Inclusion Insights 2018," The Consultative Group to Assist the Poor (CGAP), (October 2018): https://www.cgap.org/research/slide-deck/financial-inclusion-insights-2018

Table 50: Banking Sector Financial Soundness Indicators (%)

Indicator	2013	2014	2015	2016	2017
Capital Adequacy					
Risk-weighted capital to assets ratio	10%	10.1%	8.2%	8%	9.8%
Asset Quality					
Total loans/total assets	55.4%	53.7%	55.7%	56.2%	55.9%
Concentration of loans to the five largest borrowers	63.2%	76.3%	109.5%	126.8%	98.9%
Nonperforming loans (NPLs) (gross)/ total loans	12.3%	11.3%	10.6%	9%	9.9%
Provisions/NPLs	73.6%	77.1%	68.6%	71.1%	65.3%
NPLs net of provisioning/total loans	3.6%	2.9%	3.8%	2.8%	3.9%
NPLs net of provisions/capital	49%	28.2%	47%	36.5%	38.5%
Earnings and Profitability					
Return on assets (net income/total assets)	1%	1.5%	1.4%	1.6%	-
Return on equity (net income/equity)	14.7%	24.4%	24.5%	29.2%	-
Personnel costs/net revenue	29.6%	27.3%	26.3%	25.5%	-
Liquidity					
Liquidity of assets/total assets	37.1%	49.8%	52%	50.8%	50.6%
Liquidity of deposits/total deposits	50%	67.5%	71%	73.8%	74.1%
Loans/deposits	82%	72.8%	76.1%	81.7%	87.4%

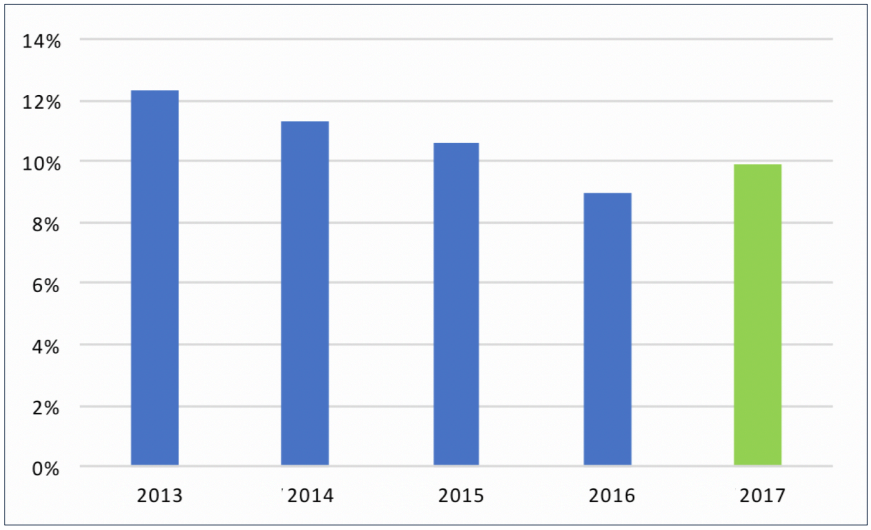
Source: International Monetary Fund

Income and Performance-Based Indicators: The profitability of Ivorian banks has considerably improved since the end of the political crisis. The concentration ratio of loans to top five borrowers relative to capital improved from about 127% at the end of 2016 and to about 99% at the end of 2017. The return on equity for banks increased 29.2% in 2016, up from 14.7% in 2013 (**Table 50**). Return on assets, which has slightly increased from 1% in 2013 to 1.6% in 2016, remains below the WAEMU average.[195]

Asset-Based Indicators: The share of non-performing loans (NPLs) to total loans has steadily decreased since 2013 and has remained under 10% since 2016. Despite a slight increase in 2017, about two-thirds of the NPLs are covered by provisions (**Figure 37**).[196]

[195] BCEAO, 2018 and IMF, 2018.
[196] IMF, 2018.

Figure 37: Banking Sector Non-Performing Loans to Total Loans (%)



Source: International Monetary Fund

Capital-Based Indicators: The capital adequacy ratio (CAR), measured by risk-weighted capital to assets, decreased from 10% in 2013 to 8% in 2016, and then again increased to 9.8% by the end of 2017 (**Table 3**). This increase can largely be attributed to BCEAO's new minimum capital requirement effective from mid-2017. The recent introduction of new prudential rules, aligned with Basel II/III principles, is expected to further improve the CAR as well as other financial soundness indicators.

Liquidity: Liquidity indicators have also improved since 2013. The liquidity of assets/total assets ratio increased to 50.6% by the end of 2017 compared to 37.1% in 2013. The liquidity of deposits reached 74.1% by the end of 2017, a significant increase from 50% in 2013. The loans to deposits ratio also increased to 87.4% by the end of 2017, up from 82% in 2013.

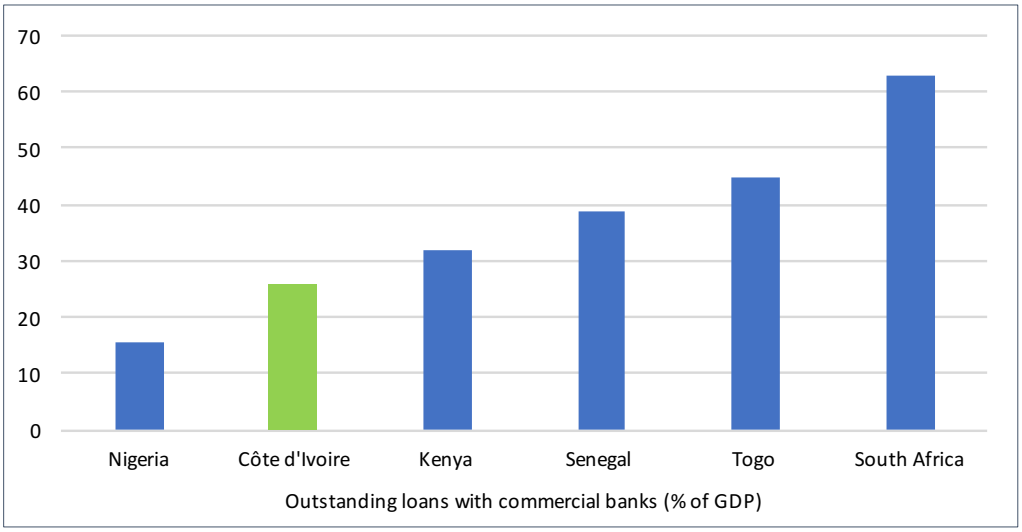
- **Distribution of Credit by Sector**

Credit is mainly provided to companies (78%) and individuals (16%). Despite the large share of credit provided to companies, two-thirds of Ivorian companies (mostly SMEs) consider access to credit a major constraint to growth. Rather than lending to SMEs, banks have increasingly dedicated a larger share of their liquidity to purchasing securities; in 2015, 38% of bank liquidity was used for this purpose compared to 20% in 2010. This trend can largely be attributed to the sector's risk aversion, the low cost of refinancing, and increased profitability of public securities.

Loans are extremely concentrated, with five of the largest borrowers accounting for about one-third of total loans in the country. This is primarily the result of weaker regulations than international standards (in the WAEMU zone, the exposure limit for a single client is 75% of the capital base vis-a-vis the international standard of 25%). Moreover, banks are not incentivized to diversify their customer base given how difficult it is to assess risks with customers in the informal sector. As a result, most of the sector's outstanding credit is in the form of short-term loans.

Despite significant growth of credit in recent years, the credit-to-GDP ratio represented only 25.7% of GDP in 2016.[197] Outstanding loans with Ivorian commercial banks (as a % of GDP) remains low compared to other countries in the region (**Figure 38**).

Figure 38: Credit to GDP Ratio (%), 2016



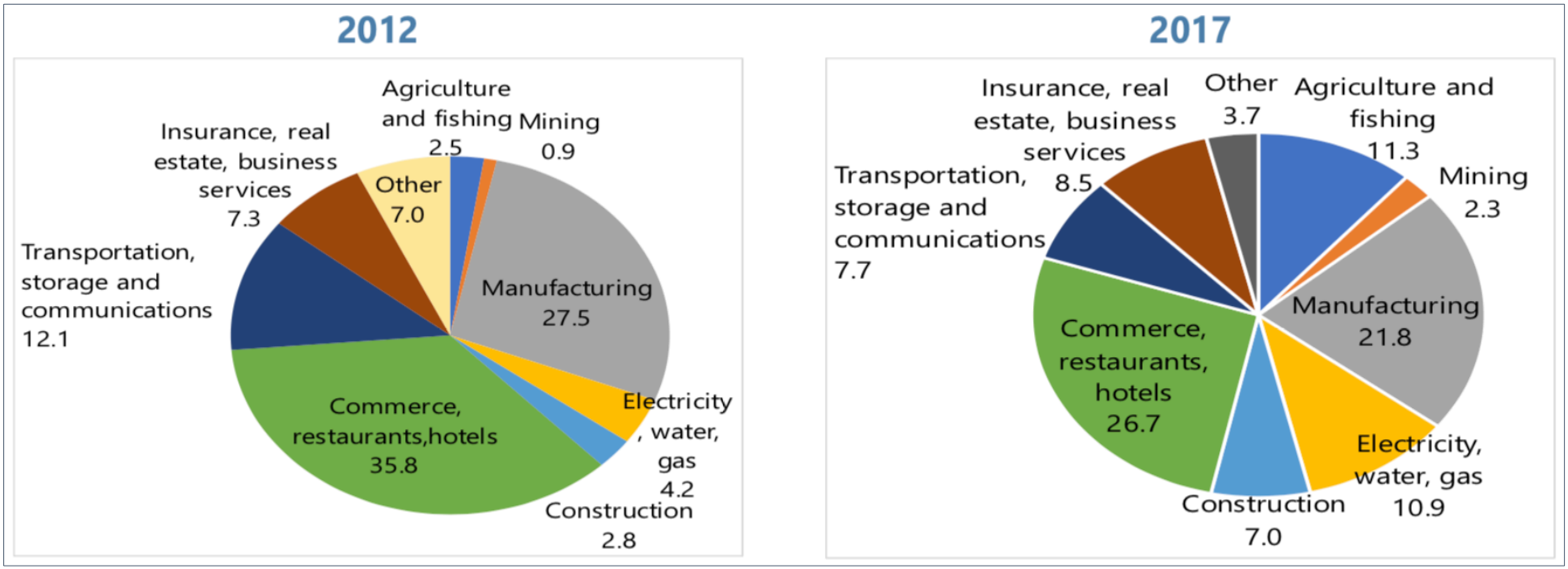
Source: International Monetary Fund

The distribution of credit by sector has diversified considerably between 2012 and 2017 (**Figure 39**).[198]

[197] "Country Financial Access Survey (FAS)," IMF Data, (2017): http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460043522778

[198] IMF, 2018.

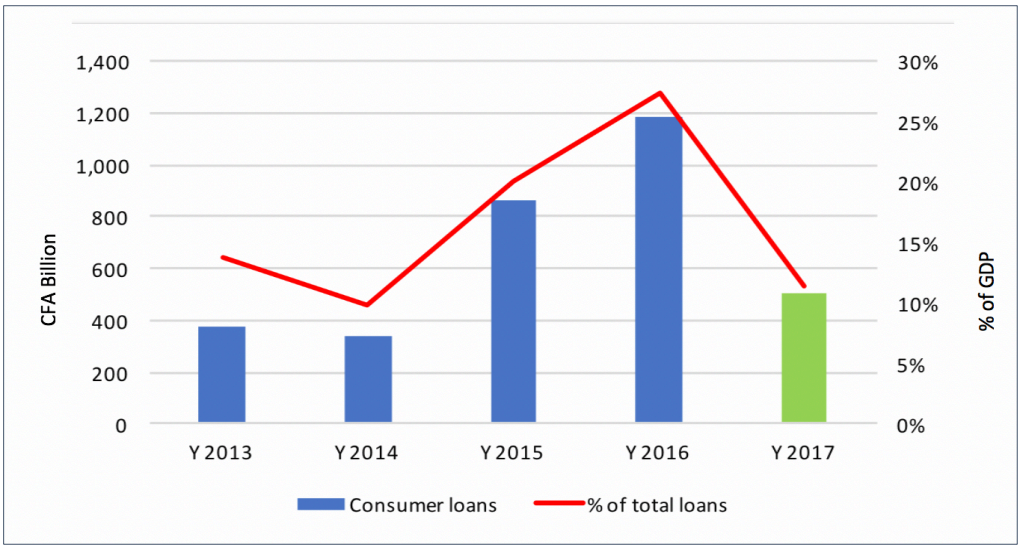
Figure 39: Distribution of Credit by Sector (%)



Source: International Monetary Fund

In 2017, 71.3% of total credits were used for cash loans, 11.4% for consumer loans, and 9% for equipment loans.[199] Cash loans and equipment credits have increased between 2016 and 2017, while consumer loans have decreased considerably, a trend that is in line with the WAEMU zone, where consumer loans decreased by -34.9% over the same period (**Figure 40**).

Figure 40: Consumer Loans by Volume (CFA billion) and Share of GDP (%)



Source: BCEAO

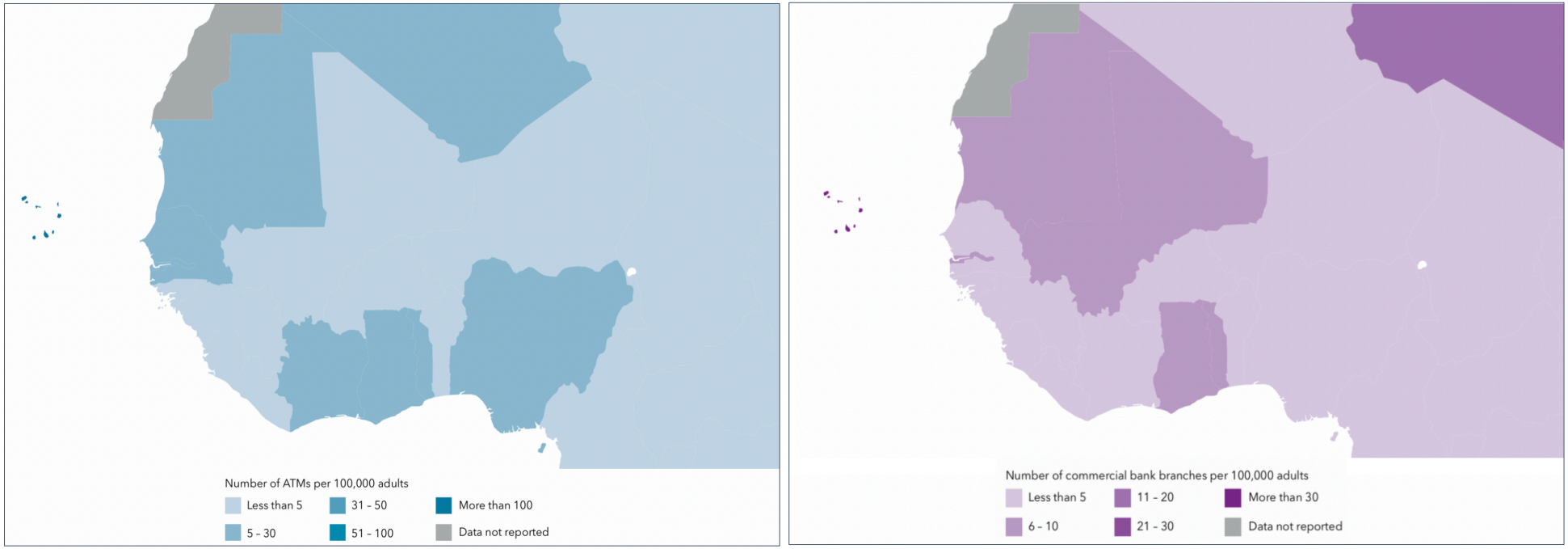
3.2.2 Financial Inclusion

- **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 41**).[200] 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%.[201] Many countries across the region, including Côte d'Ivoire, have also seen a sharp increase in mobile money account ownership (**Figure 42**) and transaction volume (**Figure 43**).

[199] BCEAO, 2018.
[200] "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
[201] Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., "The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution," World Bank, (2017): http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf

Figure 41: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017[202]

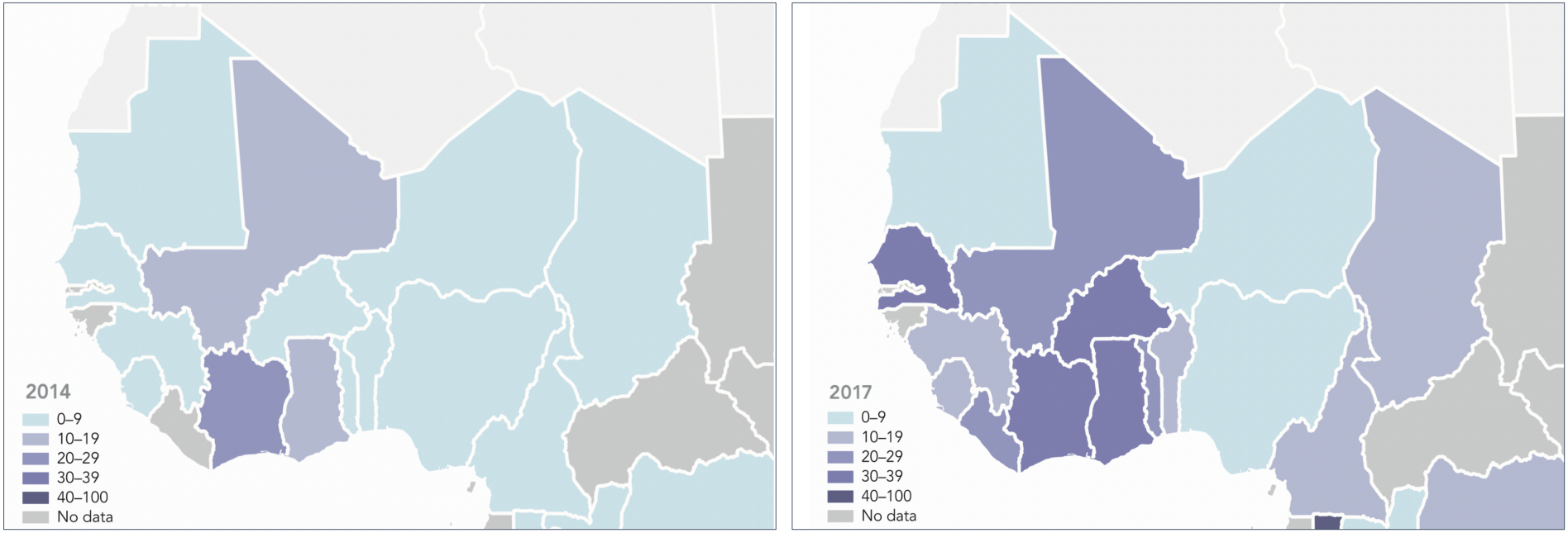


Source: International Monetary Fund

Figure 41 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.

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

Figure 42: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[203]



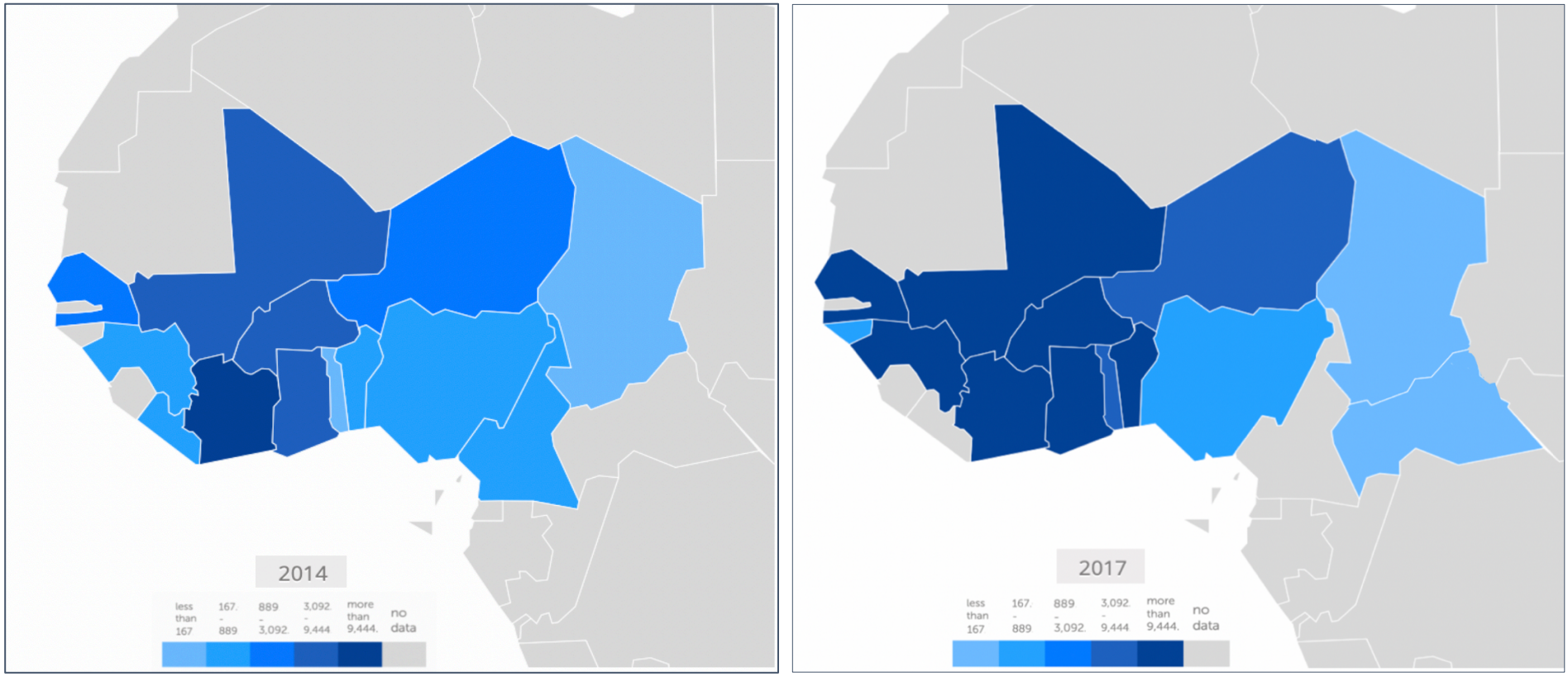
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 42 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.

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

Figure 43: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[204]



NOTE: Maps exclude Cabo Verde (no data)

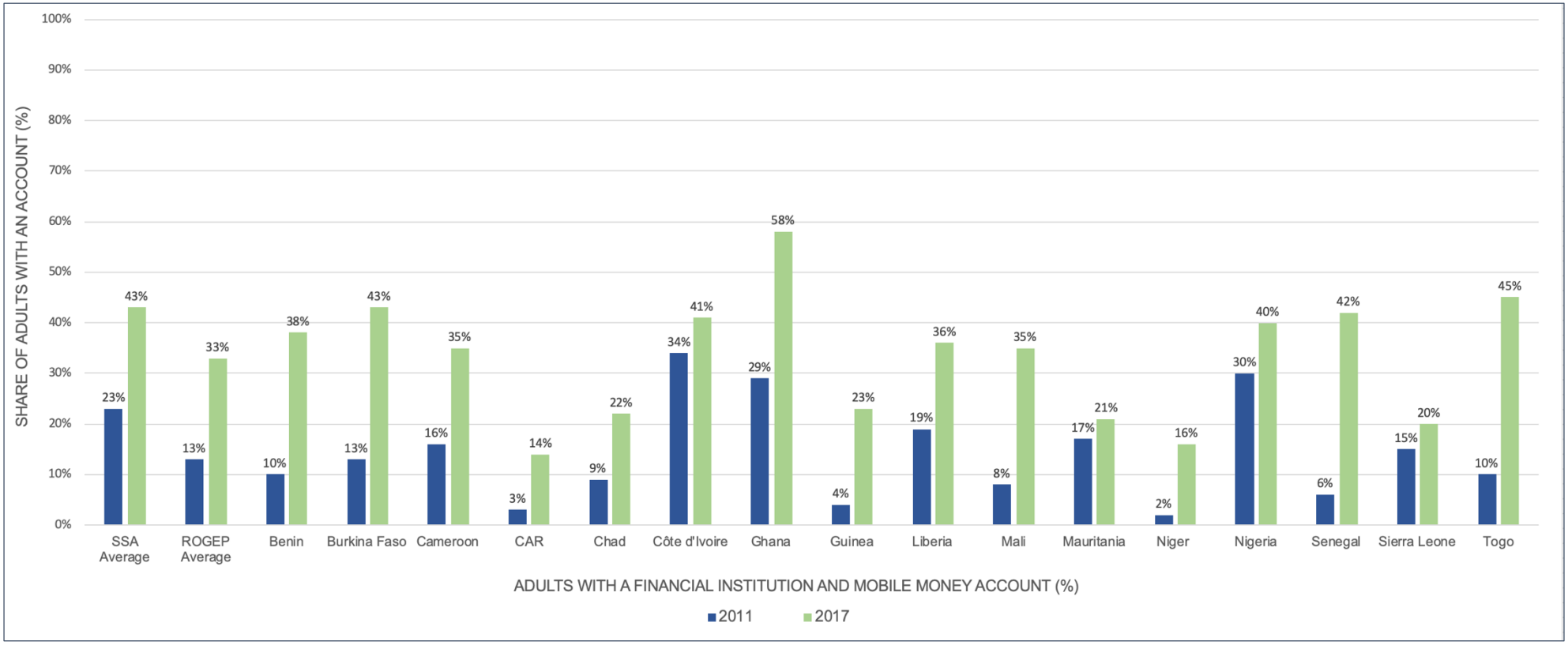
Source: International Monetary Fund

Figure 43 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.

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

In 2017, 41% of Côte d'Ivoire's adult population had an account at a financial institution or with a mobile money service provider, up from 34% in 2014. In 2017, the country had among the highest rates of financial inclusion in West Africa and the Sahel, 8% above the regional average and slightly below the average for Sub-Saharan Africa (**Figure 44**).

Figure 44: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017[205]



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

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

In 2012, the GoCI launched a campaign and strategy to promote financial inclusion through microfinance The objective was to restructure, professionalize and improve the quality of assets of the MFI sector, which had been negatively affected by 2002 and 2010 political and economic crises. As a result of this reform, the number of MFIs has reduced from 75 in 2014 to 51 in 2017, while the number of customers has increased from 850,000 to 1.3 million over the same period. Total savings and total credits have been multiplied by four over the same period, to reach CFA 306.6 billion (USD 539.1 million) and CFA 270.4 billion (USD 476.4 million). The main beneficiaries of microfinance loans are households, retailers, and informal craftsmen/artisans.[206]

The Ivorian mobile money market is the largest in the WAEMU zone.[207] At the end of 2016, the total value of transactions reached EUR 7.5 billion (CFA 4.9 trillion), increasing by 120% since the end of 2014, with Côte d'Ivoire accounting for nearly 40% of total transactions in the region (**Figure 45**). The Ivorian market also has the highest number of subscriptions (12.8 million), which represents 35% of the WAEMU total. Mobile banking started in 2009 in Côte d'Ivoire and is mostly driven by partnerships between major banks and telecommunications companies, including (i) Orange Money (Orange and the International Bank for Trade and Industry, Banque Internationale pour le Commerce et L'Industrie, BICICI), (ii) MTN Money (MTN and Société Générale of Côte d'Ivoire), and (iii) Moov Flooz (Moov and New Inter-African Insurance Company, Nouvelle Société Interafricaine d'Assurance, or NSIA).

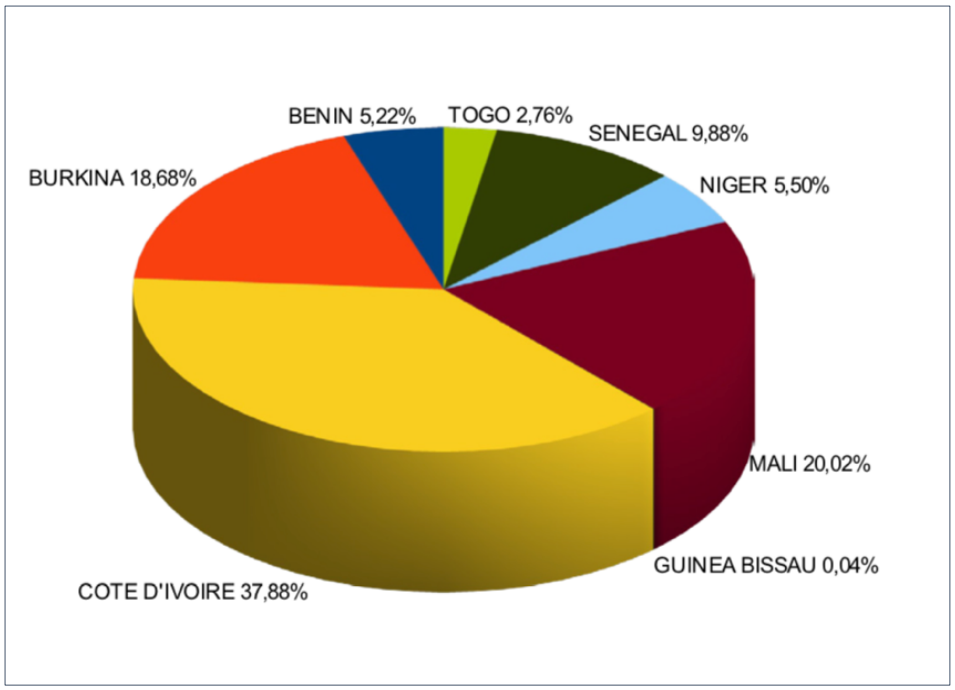
The GoCI intends to build upon the financial inclusion policies that are being pursued at a regional level. In 2016-2017, the BCEAO, in partnership with the UN Capital Development Fund and the IMF, organized a series of high-level meetings of key West African policymakers to develop a regional policy 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.[208]

[206] "Microfinance: 1, 3 million d'épargnants grâce aux réformes," Government of Côte d'Ivoire, (2018): http://www.gouv.ci/_actualite-article.php?recordID=9152&d=4#p

[207] "Le dévelopement rapide du mobile banking dans l'WAEMU," Director General of the Treasury, Ministry of the Economy and Finances, Government of France, (2017): https://www.tresor.economie.gouv.fr/Ressources/16643_secteur-bancaire-de-luemoa

[208] "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

Figure 45: WAEMU Mobile Money Market – Share of Transaction Volume by Country, 2016[209]



Source: BCEAO

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

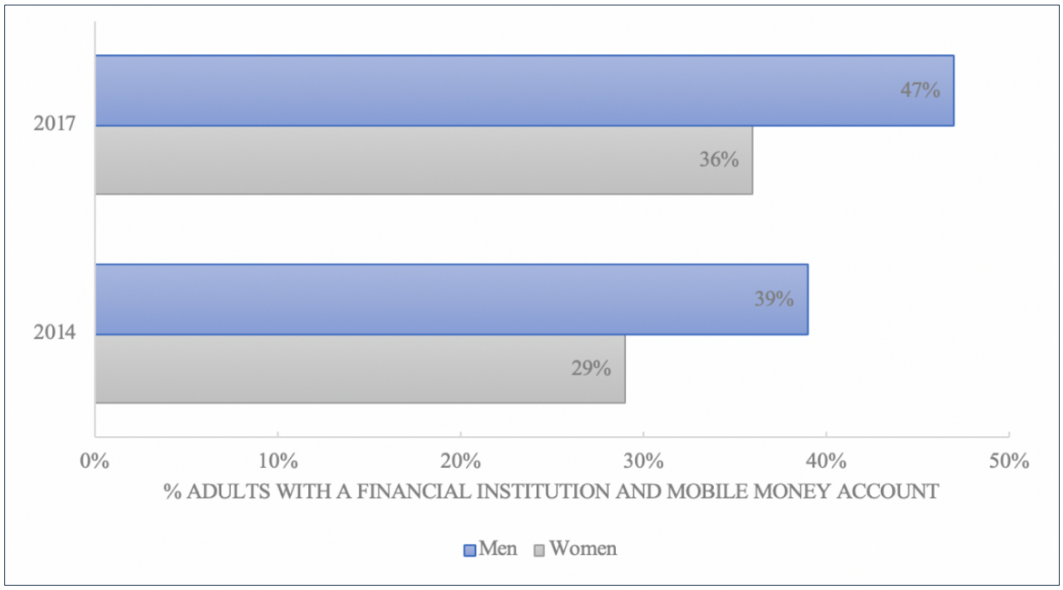
According to data from the World Bank's 2017 Global Findex survey – which examines, among many things, the extent of financial inclusion in Sub-Saharan Africa (SSA) – women in the region are about 10% less likely to have an account at a financial institution or with a mobile money service provider than men.[210] A similar gender gap also exists in Côte d'Ivoire (**Figure 46**), where 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.

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.[211] 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. Indeed, financial inclusion has improved considerably in Côte d'Ivoire over just a three-year period, driven by the proliferation of mobile money services; more adults in the country have an account with a mobile money service provider than at a financial institution. In 2017, the share of adults with a mobile money account exceeded 30%, ranking the country behind only Ghana in the West Africa and Sahel region and 12% higher than the average country in Sub-Saharan Africa. Furthermore, there are preliminary signs that mobile

[209] "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
[210] Demirguc-Kunt et al., 2017.
[211] El-Zoghbi, M., "Measuring Women's Financial Inclusion: The 2017 Findex Story," Consultative Group to Assist the Poor (CGAP), (30 April 2018): https://www.cgap.org/blog/measuring-womens-financial-inclusion-2017-findex-story

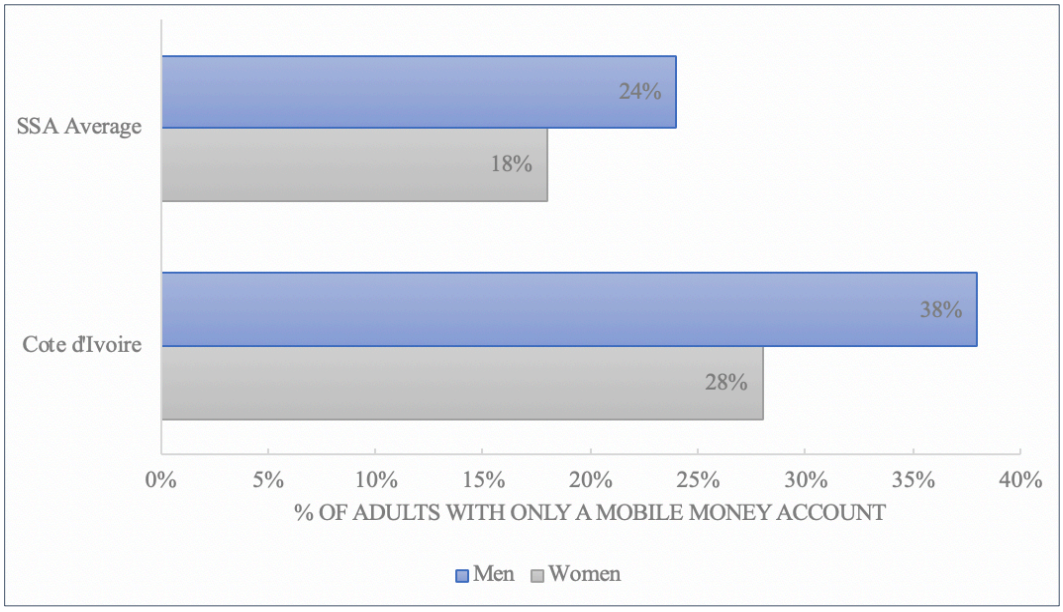
money might also be helping to close the gender gap in financial inclusion.[212] In Côte d'Ivoire, women significantly outperform the regional average in terms of access to mobile money accounts (**Figure 47**).[213]

Figure 46: Financial Inclusion Gender Gap in Côte d'Ivoire



Source: World Bank Global Findex Database

Figure 47: Gender Gap in Mobile Money, 2017



Source: World Bank Global Findex Database

[212] "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
[213] Demirguc-Kunt et al., 2017.

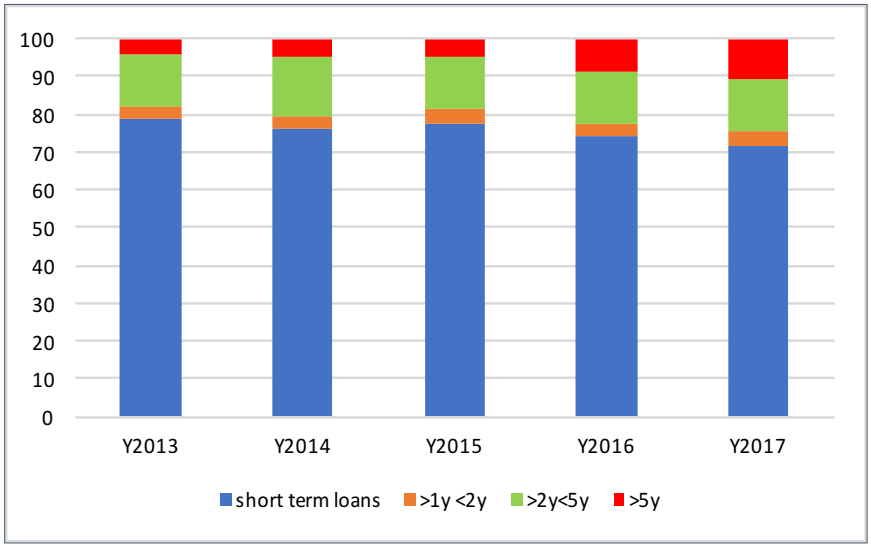
Widespread mobile phone ownership (**Figure 18**), rapidly growing mobile internet usage (**Figure 17**) and extensive network coverage (**Figure 32**), have led to the proliferation of mobile money services and platforms in the country. These dynamics are collectively increasing usage of mobile banking services, expanding overall access to financial services and driving financial inclusion in Côte d'Ivoire. 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

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

Short-term maturities largely dominate the credit market, with only 10.5% having a maturity greater than five years (**Figure 48**).[214] While short-term credits are considered less exposed to payment default by the banks, another reason for this unbalanced structure is linked to the short-term structure of deposits, which limits the capacity of banks to offer long-term loans.

Figure 48: Maturity Structure of Bank Loans (%)



Source: BCEAO

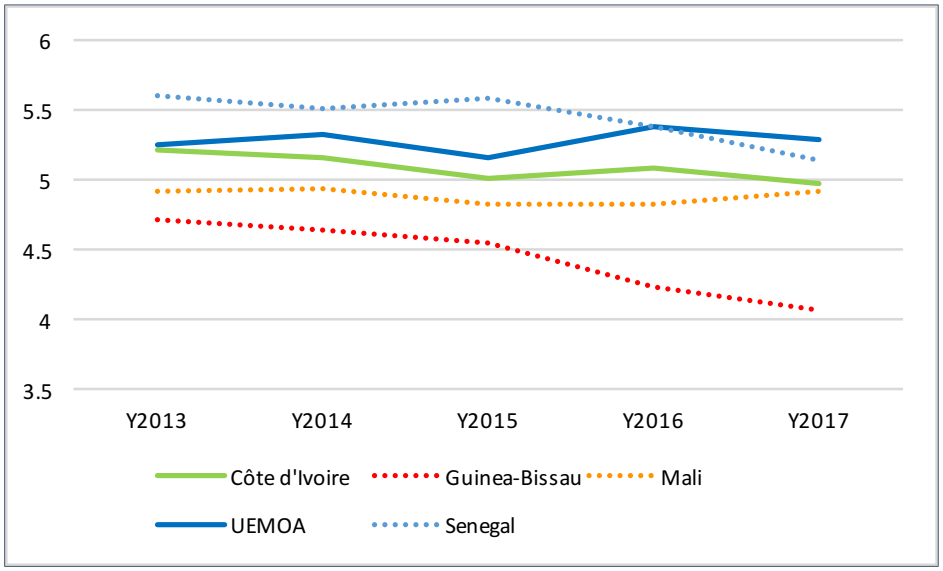
- **Interest Rates**

As a member state of WAEMU, Côte d'Ivoire'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.[215] 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.[216]

[214] BCEAO, 2018.
[215] IMF, 2018.
[216] BCEAO, 2018.

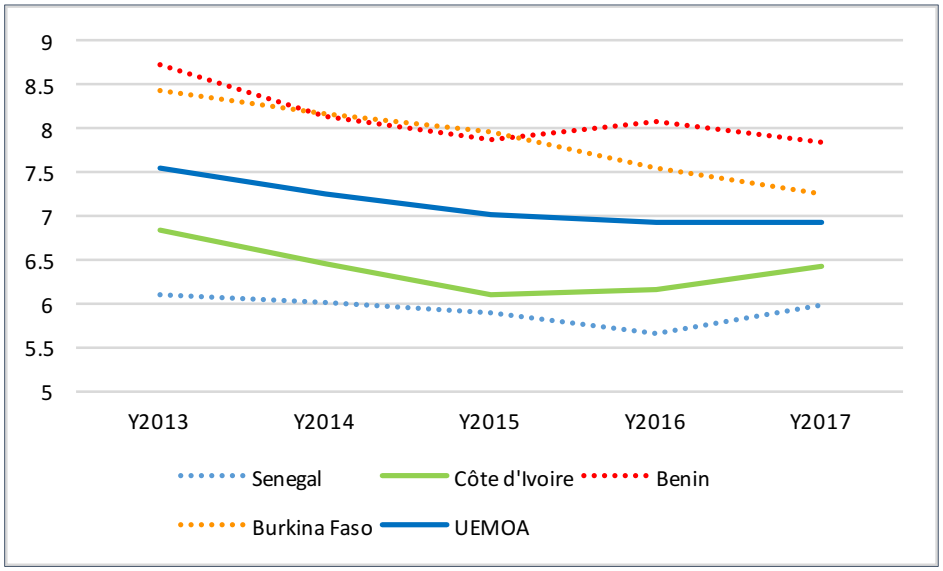
Like in the rest of the WAEMU zone, Côte d'Ivoire's banking sector's net liquidity position was at a deficit of about 3% of GDP at the end of 2016. It remained negative in 2017 after the BCEAO tightened monetary policy. As a result, banks' demand for government debt securities declined, which raised the domestic debt interest rates and led the GoCI to issue Eurobonds in June 2017. The tight monetary policy helped moderate the country's inflation rate and keep it below the WAEMU average of 3%. **Figure 49** and **Figure 50** illustrate the average interest rates on deposits and loans, respectively, in Côte d'Ivoire and the WAEMU zone from 2013-2017.

Figure 49: Interest Rates on Deposits (%)



Source: BCEAO

Figure 50: Interest Rates on Loans (%)



Source: BCEAO

➢ Foreign Exchange Market

As a member state of WAEMU, Côte d'Ivoire'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.[217] In general, the CFA franc monetary zone consistently outperforms other Sub-Saharan countries in terms of inflation rate and overall macroeconomic stability (**Table 51**).

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.[218] This provides stability and credibility to the currency. The common currency also expedites trade by removing foreign exchange between member states. This includes the eight members of WAEMU as well as the six countries in the Economic and Monetary Community of Central Africa (Communauté Economique et Monétaire de l'Afrique Centrale, CEMAC). On a regional level, there are plans to implement a single currency across all of West Africa by 2020, although there are many hurdles to overcome before this degree of macroeconomic convergence can be achieved.[219]

Table 51: Official Exchange Rate (CFA-USD)[220]

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

The IMF considers that tighter global financial conditions could have a negative impact on the exchange rate and capital flow volatility and potentially jeopardize the Government of Côte d'Ivoire's access to international debt markets. However, the recent Eurobond issuance (in 2017 and 2018) was denominated in euros and hence does not present exchange rate risks. On the contrary, the issuance of the Eurobond has allowed the Government of Côte d'Ivoire to diversify the currency composition of Côte d'Ivoire's debt portfolio. In addition, according to the IMF, the Government of Côte d'Ivoire will be considering the possibility to hedge coupon payments associated to its USD-denominated sovereign debt.

➢ 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.

[217] 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/
[218] 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
[219] 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
[220] International Financial Statistics (IMF): http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B

Ivoirian banks are risk adverse and often refuse to grant a loan because of the lack of collateral. In fact, four out of 10 loans are refused because of insufficient collateral.[221] Even when a client has a bank account, getting a loan can prove to be difficult because the bank can sometimes ask for a deposit equivalent to 100% of the requested loan amount. Banks also have limits on the usage of collateral. For instance, in real estate, only 30% of land has ownership titles and the mortgage market is still nascent in the country. Recovering collateral securities is also a long and costly judicial process and for these reasons combined commercial credit is more difficult to obtain for most businesses.

- **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.[222] Côte d'Ivoire adopted these regulations in 2016.

3.2.4 Lending to the Off-Grid Solar Sector

Several Ivorian banks, including United Bank for Africa (UBA), International Bank for Trade and Industry, NSIA Banque, Ecobank and Orabank among others are already engaged in providing loans for the purchase of solar lanterns and to a lesser extent SHS to SMEs with support from DFIs. Some of the solar companies that have received financial support from local FIs to support the OGS sector are described below.

PEG Africa received local currency funding from OikoCredit, an international financial institution whose regional headquarters are in Abidjan. By the end of 2017 PEG had already sold more than 5,000 solar kits.

Zola Energy Côte d'Ivoire (ZECI), a subsidiary of French company EDF and Californian Off-Grid Electric (OGE), obtained a loan in local currency of CFA 15.7 billion (USD 27 million), arranged by Société Générale Côte d'Ivoire, a subsidiary of Société Générale de Banque (France) and Credit Agricole Corporate and Investment Bank, with support from AfDB. This project will finance prepaid solar home systems with the aim of connecting 100,000 households in rural areas by 2020.

BAOBAB Microfinance Institution: formerly Microcred, a subsidiary of Planet Finance, the company marketed solar products as ancillary products to its loans before setting up its subsidiary, Baobob+, dedicated specifically to the distribution of solar kits.

[221] World Bank, 2016.

[222] "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

Project Developers: such as S-TEL, AD Solar and Yandalux received financial support consisting of short-term loans to meet cash requirements.

3.2.4.1 Programs Supporting Financial Institutions in Off-Grid Solar Lending

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

The CEADIR activity in West Africa took place from 2016 to 2018. The program's objective was to strengthen the capacity of FIs for clean energy lending in eight West African countries (**Côte d'Ivoire**, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone) addressing their common challenges by developing the capacity of bank staff to provide loans for various clean energy technologies and business models and adapting their support to the specific context of each country. CEADIR engaged local banks by delivering a national workshop on stand-alone solar and mini-grids, which was complemented with one-on-one technical assistance to help banks develop clean energy lending strategies.[223]

- **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).[224]

3.2.4.2 Key Barriers to Off-Grid Solar Lending

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

With the exception of the abovementioned institutions, most local FIs in Côte d'Ivoire 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 CEADIR and 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.

- **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 for businesses in the

[223] USAID CEADIR: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
[224] SUNREF: https://www.sunref.org/en/sunref-elue-meilleure-solution-financiere-pour-lenergie-durable-en-afrique-de-louest/

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**

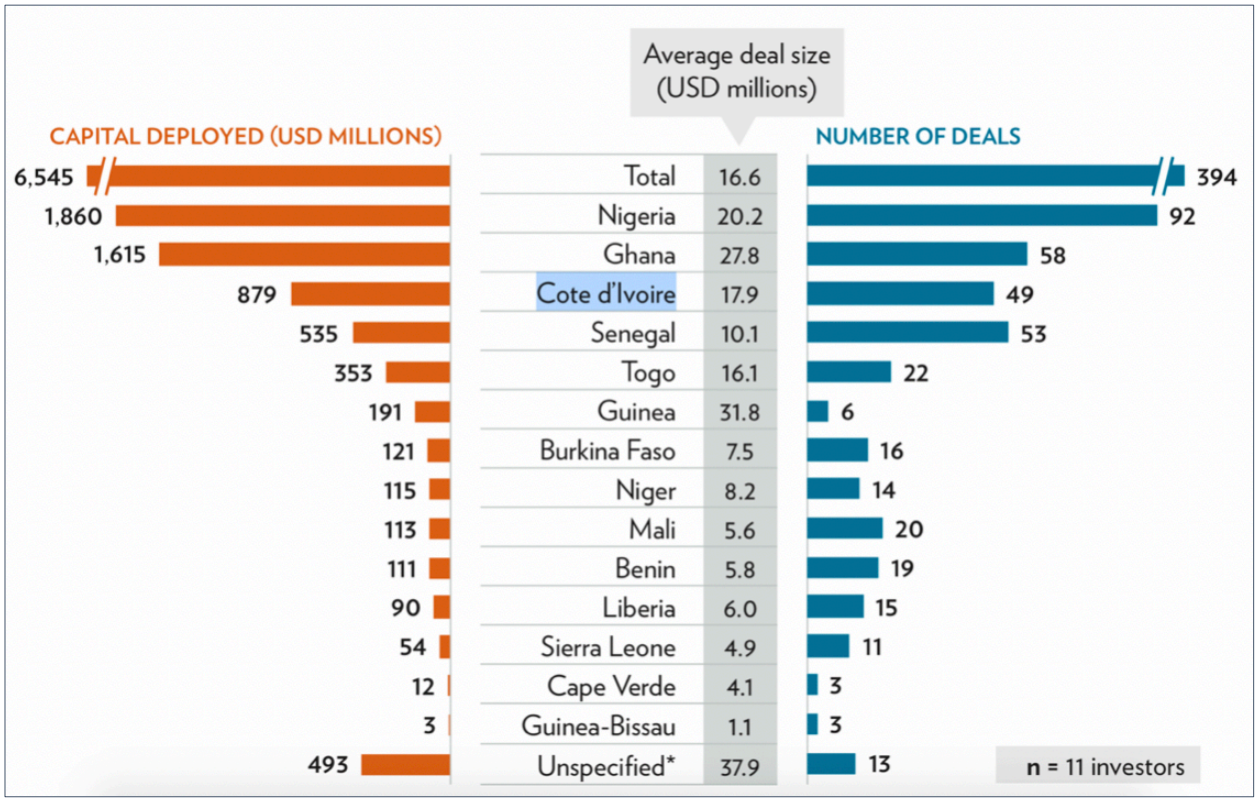
As described in **Section 3.2.3**, consumers in Côte d'Ivoire face strict collateral requirements. Many consumers also lack basic financial literacy and knowledge about the terms and conditions of financial products and therefore struggle to obtain loans. The lack of credit history/track record and the 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 Institutions[225]

3.1.1 Development Finance Institutions

Between 2005 and 2015, Côte d'Ivoire received a total of USD 879 million in DFI funds with an average deal size of USD 17.9 million; the amount comprised about 13% of the total DFI investment across West Africa over this period (**Figure 51**).[226]

Figure 51: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Apart from the above-mentioned AFD SUNREF program, DFI programs that are relevant to the OGS sector in Côte d'Ivoire are described below.

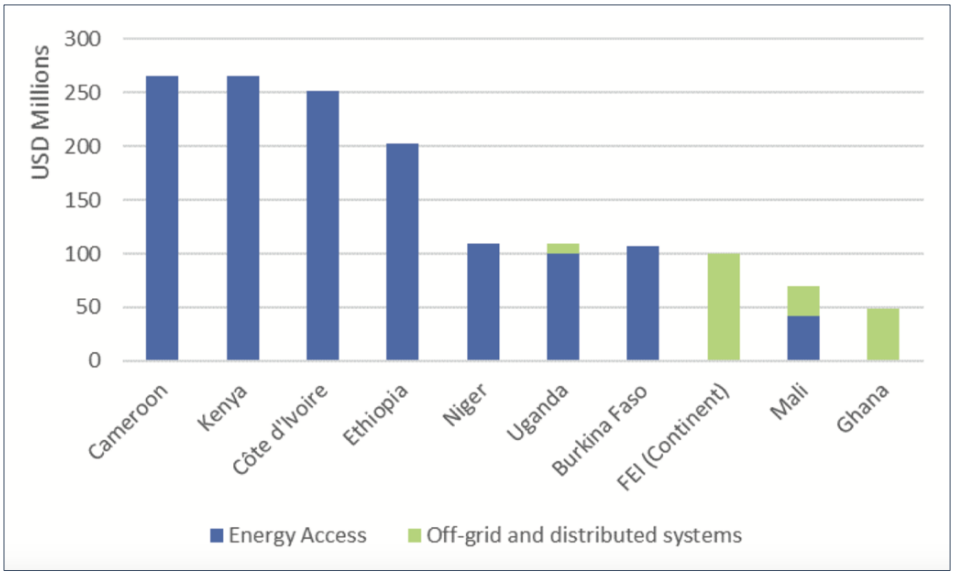
- **African Development Bank Sustainable Energy Fund for Africa / Facility for Energy Inclusion**

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.[227]

[225] Excluding commercial banks, which are reviewed in detail in **Section 3.2**.
[226] "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
[227] "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. Côte d'Ivoire received approximately USD 250 million in energy access financing from AfDB between 2014 and 2017 (**Figure 52**).

Figure 52: Distribution of AfDB Energy Access Financing in Sub-Saharan Africa, 2014-2017[228]



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.[229] The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[230]

- **International Finance Corporation**

In June 2018, the IFC announced it had invested USD 60 million in a regional risk-sharing facility to support Bank of Africa Group's lending to SMEs in eight African countries, including Côte d'Ivoire. 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.[231]

[228] 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

[229] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com

[230] "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/

[231] "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

- **DEG**

Through its subsidiary, the German Investment and Development Corporation (Deutsche Investitions und Entwicklungsgesellschaft, or DEG), decided in 2014 to invest approximately CFA 20 billion (USD 33.5 million) in Côte d'Ivoire. DEG is committed to the renewable energy sector in Côte d'Ivoire and has particularly expressed interest in supporting rural electrification and SME financing.[232] DEG regards financing as long-term loans, guarantees, mezzanine financing and equity investments.

- **European Investment Bank**

The European Investment Bank (EIB) is very active in Côte d'Ivoire through institutional and private loans. In 2016, the bank made a commitment to support the development of the Energos project in particular and has a focus on institutional and strategic framework support for renewable energies and energy efficiency. This project, worth a total of EUR 188 million (USD 123 billion), co-financed by EDF and the European Investment Bank, encourages, among other things, the involvement of the private sector in electrification via renewable energies. Since 2010, the EIB has loaned EUR 1.45 billion (CFA 951 billion) to 39 projects across 16 West African countries. The aim of these projects is to support growth and job creation in key sectors of the economy, including energy. The EIB concluded in March 2016 that the institution is committed to devote 35% of its activities to climate action.[233]

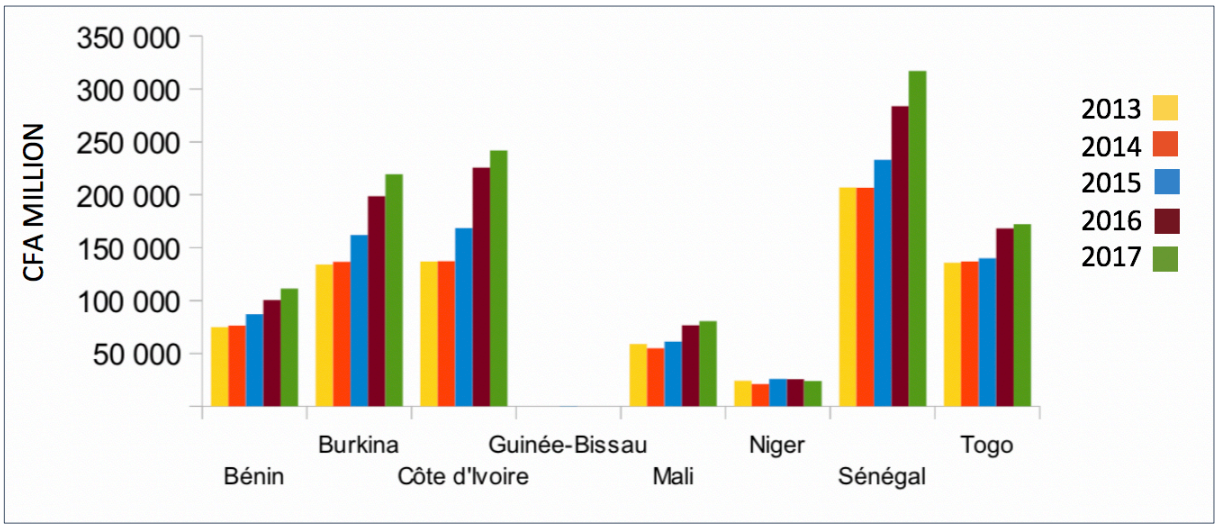
3.1.2 Microfinance Institutions

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.[234]

Figure 53 and **Figure 54** illustrate trends in MFI deposits and loans, respectively, in WAEMU between 2013 and 2017. Côte d'Ivoire has witnessed a particularly strong increase in MFI deposits, up 23.3% in 2017 from 2016.

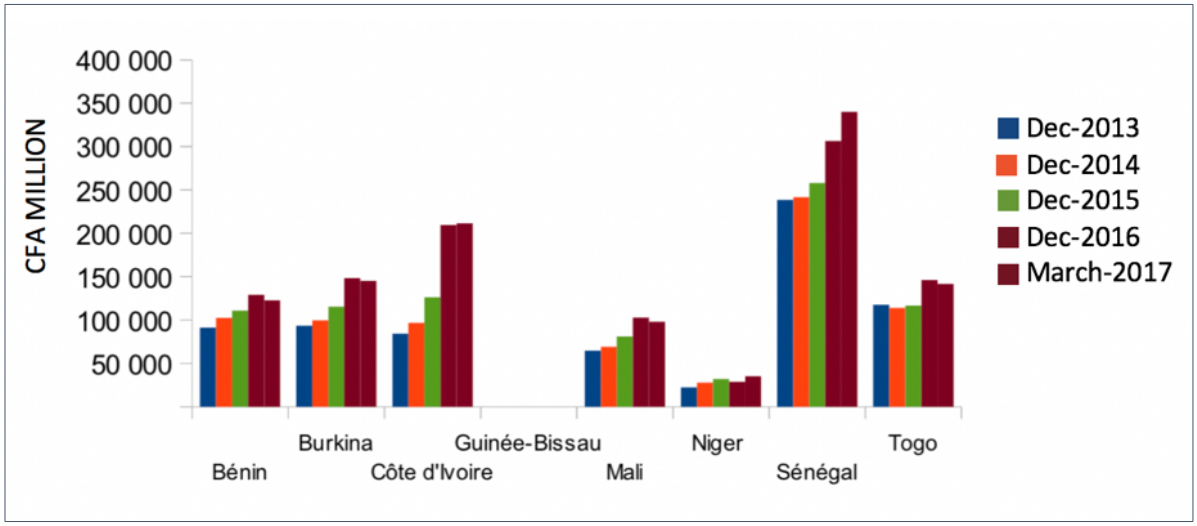
[232] "Deg (KfW) envisage un investissement de 20 milliards FCFA," NewsAbidjan.Net, (February 2014): http://news.abidjan.net/h/486069.html
[233] "Note d'Information sur les actions en Infrastructures," European Union, (May 2017): https://eeas.europa.eu/sites/eeas/files/actions_de_lunion_europeenne_en_Côte_divoire_dans_le_domaine_des_infrastructures.pdf
[234] "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 53: Microfinance Deposits in WAEMU



Source: BCEAO

Figure 54: Microfinance Loans in WAEMU



Source: BCEAO

The microfinance sector has experienced renewed growth in recent years. The upturn is due primarily to a series of reforms undertaken since 2012. In addition, the arrival of new players such as the international firms Microcred and Advance Côte d'Ivoire, or Atlantic Microfinance from the Moroccan group Central Popular Bank, has significantly helped increase MFI service offerings. **Table 52** details some of the sector's performance indicators.[235]

[235] The Professional Association of Decentralized Financial Systems of Côte d'Ivoire (APSFD), Côte d'Ivoire (2017): http://www.apsfd.ci

Table 52: Microfinance Sector Performance Indicators

Indicators	Dec-2016	Dec-2017	March-2018
Number of approved institutions	54	51	50
Number of institutions that reported their indicators	31	37	43
Number of service points	346	375	375
Number of members or clients	1,168	1,261	1,644
Outstanding deposits (CFA billion)	210	278	262
Volume of credits set up during the quarter (CFA billions)	83	99	79
Outstanding loans (CFA billion)	189	270	266
Ratio of outstanding loans to outstanding deposits (%)	90.4%	97.2%	101.5%
Proportion of SFDs meeting the regulatory standard associated with the portfolio (>90 days), out of the sample of the 20 largest	30%	15%	15%

Source: The Professional Association of Decentralized Financial Systems – Côte d'Ivoire

3.1.3 Informal Financial Institutions

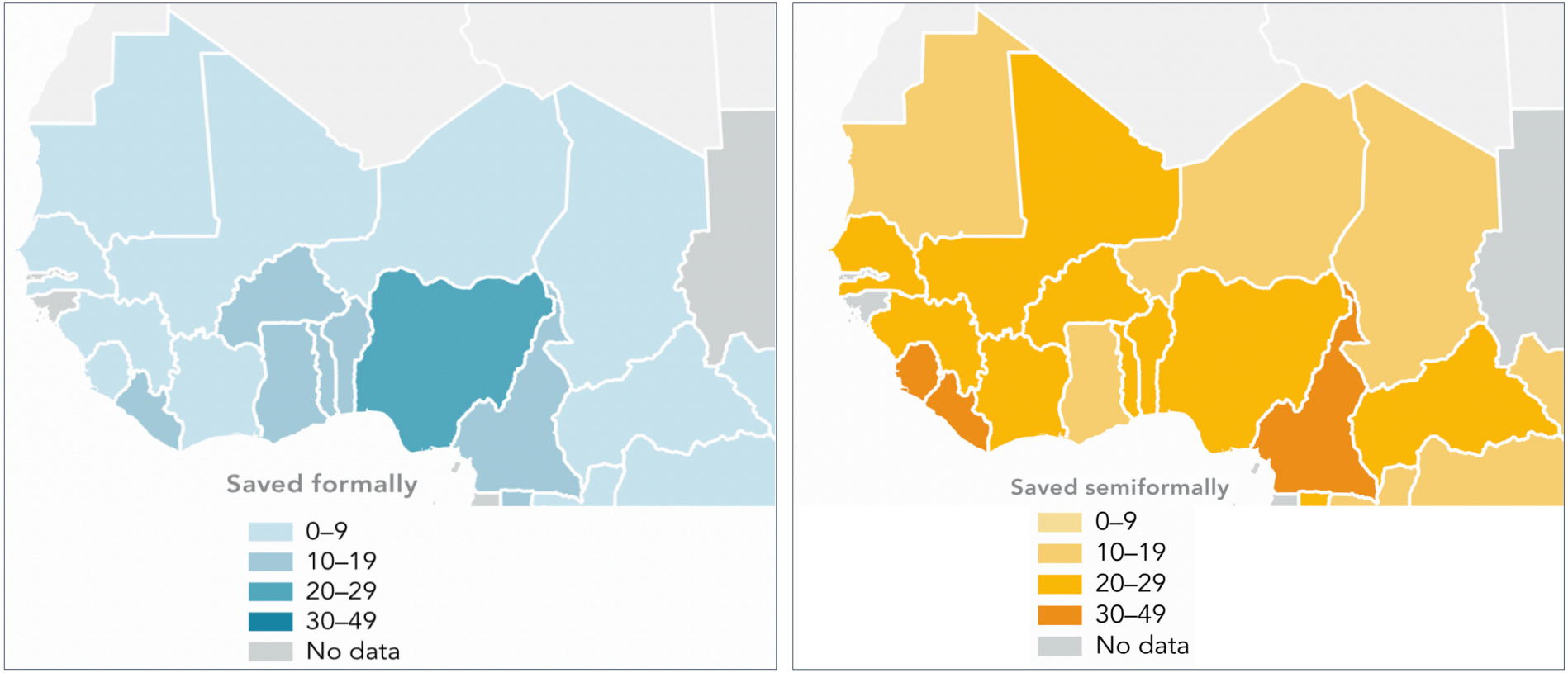
A 2017 World Bank study found that 38% of adults in Africa had borrowed money from an informal FI as opposed to 5% who borrowed from a formal FI. Although informal borrowing occurs at different rates across Africa, roughly 100 million adults in Sub-Saharan Africa use informal sources of finance.[236] 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.[237]

Much like in other African states, there is a large informal financial sector in Côte d'Ivoire (**Figure 55**). Data from this sector remains limited, largely due to the informal nature of these institutions, which does not facilitate access to information on their practices, cost standards and transaction levels. The World Bank's Findex survey suggests that between 2011 and 2014, borrowing from FIs increased while borrowing from informal lenders decreased slightly over the same period (**Figure 56**).

[236] "Demirguc-Kunt, A., Klapper, L., and Singer, D., "Financial Inclusion and Inclusive Growth: A Review of Recent Empirical Evidence," World Bank Policy Research Working Paper 8040, (April 2017): http://documents.worldbank.org/curated/en/403611493134249446/pdf/WPS8040.pdf

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

Figure 55: Share of Adults Saving in the Past Year (%), 2017[238]



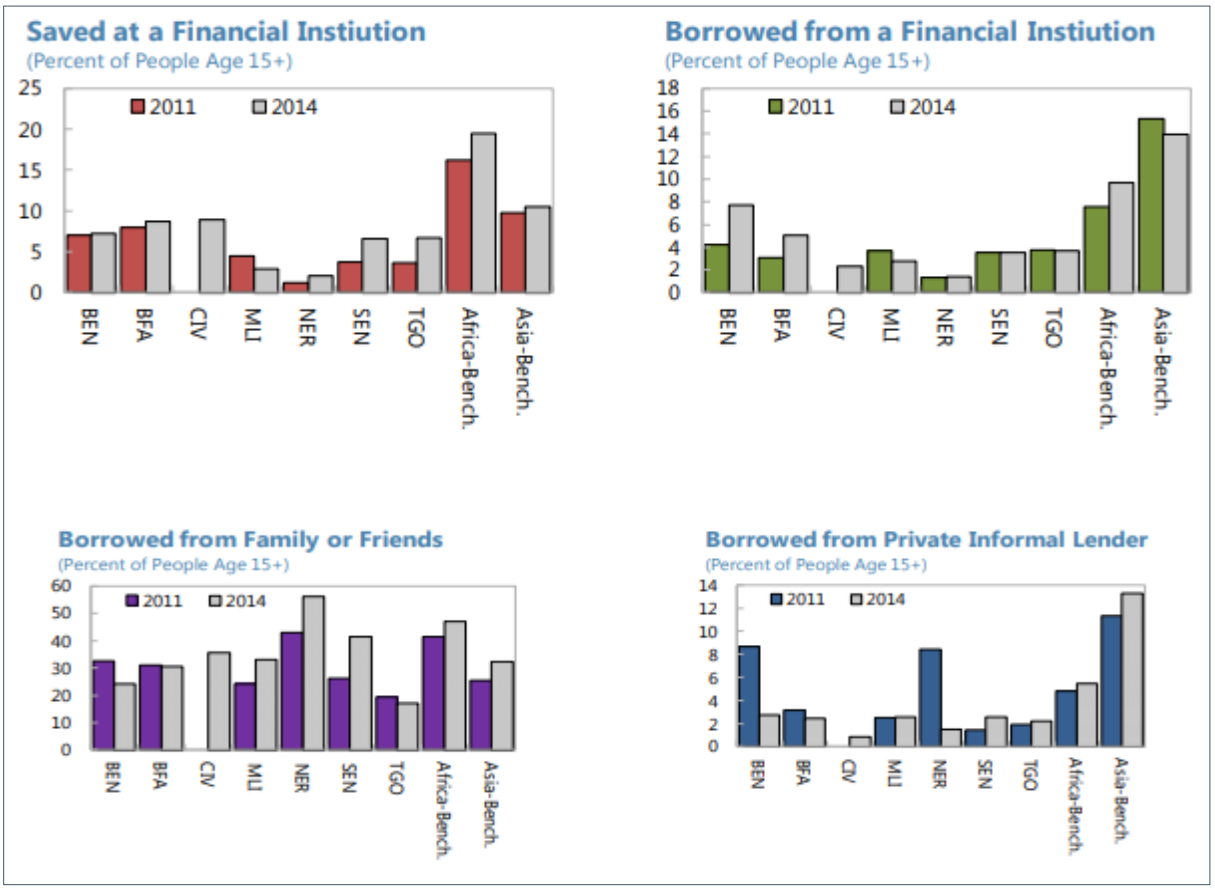
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

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

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

Figure 56: Informal Financial Sector Indicators in WAEMU, 2011-2014[239]



Source: International Monetary Fund

3.1.4 Impact Investors

Côte d'Ivoire is attracting an increasing amount of active investment funds and impact investors. The country has obtained more than EUR 670 million (CFA 439 billion) in investment pledges through its "Invest in Côte d'Ivoire 2014" forum. The main impact investors active in Côte d'Ivoire include: Comoe Capital; IP-Dev; Cauris Management; Amethis, Acumen, Oikocredit, Africinvest and FRAGG Investment Management.

- **Comoe Capital**

Comoe Capital is the first impact investment company dedicated to financing and supporting SMEs with high potential in Côte d'Ivoire. Comoe Capital is sponsored by Investors and Partners (Investisseurs & Partenaires, I&P). To carry out its mission, Comoe Capital raised a capital of CFA 4.9 billion (USD 8.4 million) from numerous Ivorian and international investors. Comoe Capital also manages the first fund dedicated to SMEs in the education sector in Côte d'Ivoire, financed by the Jacobs Foundation. It also benefits from the support of AFD, which has financed part of the costs of implementing the fund and provides technical assistance grants to accompany SMEs. Comoe Capital makes a complementary contribution to the entrepreneurship support mechanisms in place in Côte d'Ivoire, collaborates with all

[239] "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

stakeholders in the SME and start-up environment, and maintains a view to consolidate the entrepreneurial ecosystem; while supporting the development of a dynamic network of sustainable Ivorian companies. Comoe Capital targets SMEs and start-ups with high growth potential from all sectors of activity and regions of Côte d'Ivoire, whose financing needs range from CFA 20 million to 300 million (USD 34,000 to 519,000); and provides active and personalized support according to the needs of each company.[240] Comoe Capital aims to finance over fifty companies in the country over the next ten years.[241]

- **Investors and Partners**

Through the Investors and Partners – Development Program (IP-DEV), divided as IP-DEV1 and IP-DEV2 programs, I&P sponsors African investment teams based in five African cities, including Abidjan. The IP-DEV1 program was a pioneering impact fund in Africa, with an exceptional record of exits in private equity and a strong socio-economic impact. IP-DEV1 was a pilot experience, essential to develop the I&P model and to demonstrate the relevance of its investment strategy, based on the existence of talented African entrepreneurs seeking financial and strategic support to launch and develop their businesses. With capital of EUR 11 million, IP-DEV1 has helped to revive several SMEs, including Cofipeche, Viseo, and AEI microfinance. IP-DEV2 has been designed as a sponsor of African impact funds. These funds provide financing and TA to small businesses. IP-DEV2's strategy consists in incubating and financing 10 funds in 10 African countries over 10 years, thus helping to create or support more than 500 companies and 15,000 jobs. These funds will target companies with high growth potential and financing needs between EUR 30,000 and EUR 300,000 (CFA 19 million and CFA 196 million). In Côte d'Ivoire, IP-DEV2 is contributing EUR 7 million (CFA 4.5 billion) to Comoe Capital's financing.[242]

- **Cauris Management**

Cauris Management was created in 1996 and is located in Côte d'Ivoire and Togo. Since its creation, Cauris Management, through its three generations of funds (Investment Cauris, Growth Cauris, Limited Growth Cauris), has made more than 47 investments and 38 exits in seven countries in the West African sub-region. The Cauris Croissance Fund, launched in 2006, financially represented CFA 10 billion (USD 17 million), twice the amount of the Cauris Investissement Fund launched in 1996. Cauris Management invests in equity and quasi-equity capital and focuses primarily on SMEs. The Cauris Croissance Limited fund invests in many sectors such as agri-food, hotels and energy. In addition to Cipharm, this fund has contributed to the development of many companies in Côte d'Ivoire, including CDCI, Azala, IBIS Hotel, VIP NET and others. The West African investor capital had invested CFA 1 billion (USD 1.7 million) in Bridge Bank Group Côte d'Ivoire in two stages: CFA 600 million (USD 1 million) in 2008 and CFA 400 million (USD 692,000) in 2010, thus acquiring 11.76% of the capital of Teyliom Group's subsidiary. According to Jeune Afrique, the private equity firm has reaped about three times its initial investment, with an internal rate of return of just over 20% in the sale of its shares.[243]

- **Amethis**

Amethis is an investment fund manager dedicated to African, with an investment capacity of over EUR 600 million (USD 346 billion). Created in 2012 in partnership with the Edmond de Rothschild Group, Amethis is based in Paris and invests in growth capital in fast-growing companies in a variety of sectors across

[240] "Lancement de Comoé Capital, premier fonds d'impact dédié aux PME et start-up en Côte d'Ivoire," Investisseurs & Partenaires, (2018): http://www.ietp.com/fr/content/lancement-como%C3%A9-capital
[241] "Côte d'Ivoire : lancement du premier fonds d'impact dédié aux PME et aux startups," La Côte d'Ivoire Agricole, (2018): http://laCôtedivoireagricole.ci/Côte-divoire-lancement-premier-fonds-dimpact-dedie-aux-pme-aux-startups/
[242] "I&P Développement," Investisseurs & Partenaires, (2018): http://www.ietp.com/fr/content/fonds-dimpact
[243] "Nouvelle sortie de Cauris Management en Côte d'Ivoire," Jeune Afrique (October 7, 2016): https://www.jeuneafrique.com/363635/economie/nouvelle-sortie-de-cauris-management-Côte-divoire/

Africa. Amethis began operating in Abidjan in 2015 by investing EUR 6 million (CFA 3.9 billion) in the hydrocarbon distributor Pétro Ivoire. Amethis then sold its shares in Pétro Ivoire through a leveraged management buyout in 2018. This operation, which had not been carried out in the WAEMU region before, enabled the founding family to regain control of the company.[244] According to the Ecofin Agency, Amethis has acquired a stake of USD 30 million in the capital of the Afriwara group, the main shareholder of Société Nouvelle de Confiserie de Vridi, a major agro-industrial company based in the country.[245]

- **Acumen**

Acumen is a non-profit impact investment fund incorporated in 2001 with seed capital from the Rockefeller Foundation, Cisco Systems Foundation and three individual philanthropists. Acumen raises charitable donations to make equity investments in early-stage companies that provide a product or service to the poor. In 2017, Acumen invested in PEG Africa, a Ghana-based company providing SHS to off-grid households in West Africa on a PAYG basis. Acumen participated in PEG's USD 13.5 million Series B raise alongside Blue Haven Initiative, EAV, Investisseurs & Partenaires, ENGIE Rassembleurs d'Energies and PCG Investments. The funding round included a syndicated loan with participation from six lenders, including SunFunder, ResponsAbility, Oikocredit, Global Partnerships and Palladium Impact Investments. To date, PEG has sold more than 16,000 SHS in Ghana and Côte d'Ivoire with plans to expand across West Africa.[246]

- **Oikocredit**

Oikocredit is a social impact investor and worldwide cooperative established in 1975. Oikocredit promotes sustainable development by providing loans, equity investments and capacity building particularly in low income countries in Africa, Asia and Latin America. Guided by the principle of empowering people to sustainably improve their livelihoods, Oikocredit finances organizations active in inclusive finance, agriculture and renewable energy. The cooperative is privately financed by individuals and institutions who want to use their money for positive change.[247] As of 2017, Oikocredit and its financial partners had reached 36 million (84% female, 49% rural) clients and provided 15,600 households with improved energy access.

- **AfricInvest**

AfricInvest is part of the Integra Group, an investment and financial services company based in Tunisia that specializes in African SMEs and is supported by IFC, Proparco, Finnfund, AfDB, and Bank of Africa. The group is now one of the leading private equity investment fund managers in Sub-Saharan Africa with more than USD 1.4 billion (CFA 800 billion) in assets under management.[248] AfricInvest began operating in Côte d'Ivoire in 2009 and has made numerous investments in several companies such as Alios Finances, MTN, CDCI, and Petro Ivoire, and plans provide a total of CFA 98 billion (USD 169 million) in financing.[249] In 2014, AfricInvest acquired approximately 30% of Bridge Group West Africa as part of its

[244] "Amethis cède sa participation dans Pétro Ivoire," Edmond de Rothschild, (December 10, 2018): https://www.edmond-de-rothschild.com/site/france/fr/actualites/groupe/13916-Amethis-cede-sa-participation-dans-petro-ivoire

[245] "Côte d'Ivoire: Amethis Finance s'offre une participation indirecte dans le capital du groupe agro-industriel Afriwara," Agence Ecofin, (15 January 2018): https://www.agenceecofin.com/investissement/1501-53466-Côte-divoire-Amethis-finance-soffre-une-participation-indirecte-dans-le-capital-du-groupe-agro-industriel-afriwara

[246] "Providing affordable solar home systems to households in West Africa with 'Pay-As-You-Go' financing, PEG: https://acumen.org/investment/peg/ and "PEG Africa completes US$13.5 million fundraise," Investisseurs & Partenaires, (June 2017): http://www.ietp.com/en/content/peg-africa-completes-us135-million-fundraise

[247] Oikocredit: https://www.oikocredit.coop/about-us/about-us2

[248] "Capital Investments," Integra-Partners (2019): http://www.integra-partners.com/site/fr/team.php?id_article=3

[249] "AfricInvest décaisse une enveloppe de 98 milliards pour les PME-PMI," NewsAbidjan.net, (18 June 2013): http://news.abidjan.net/h/462494.html

development towards a broader and more complete range of products such as bancassurance or asset management, while strengthening its offer for Ivorian and Senegalese SMEs, the core of its business.[250]

- **FRAGG Investment Management**

FRAGG Investment Management is an impact investor and SME-focused fund that mobilizes investment and raises capital for high-growth companies in West Africa. FRAGG finances and invests in growing and inclusive SMEs that create social and environmental impact but are not able to attract capital for their business at affordable conditions. The fund provides businesses with long-term risk capital that allows them to operate at their full potential; these come by way of long-term debt facility and equity investments.[251] Outside of Côte d'Ivoire, the fund is also engaged in Benin, Togo, Ghana and Nigeria.

3.1.5 Crowd Funders

Crowdfunding is growing exponentially on a global scale. According to the World Bank, this mode of financing could reach 2.5 billion USD in Africa by 2025 (CFA 1.4 trillion). Crowdfunding is primarily for project developers and is used as an alternative to formal and informal financing systems. It also reduces intermediation in granting credit and makes the system of lending more flexible. Crowdfunding focused on off-grid micro projects is of interest to OGS industry players. Some of the active crowdfunding platforms in the country include Orange Collecte, Happy Benky, Babi Talent Show, Oukaley.com and Seekewa.

- **Orange Collecte**

Orange Collecte was developed by HelloAsso (a French crowdfunding platform) and Orange Côte d'Ivoire in September 2015. It is an extremely simplified platform for participatory financing by donations, and from "Orange Money" contributions only. This new crowdfunding platform can bring together a community of between 20 and 100,000 people. The group's stated objective is not to generate revenue with this new service, but rather to set up a collaborative approach for the four million mobile money users in the country. Operators intend to enhance the value of their mobile money service by offering an ever-increasing variety of services. Orange Côte d'Ivoire is capitalizing on its local domination and the development of its mobile money product to enable its customers to pool savings and finance joint projects. Orange Money Ivorian customers can create a collection directly from their mobile phone. The amounts are then transferred to the Orange Money account of the customer receiving the collection.[252] Being integrated into a telecommunications operator allows Orange Collecte not to overtax contributions made in mobile money, unlike an independent platform that often pays the operator to offer this contribution channel to its user.[253]

- **Happy Benky**

Happy Benky is a participatory financing platform created by a group of Côte d'Ivoire entrepreneurs. Happy Benky gives Internet users the opportunity to finance small companies and startup projects as well as social projects, by reducing the burdens associated with traditional investment methods. For investors, it is not an investment in the true sense of the word but 'support' in exchange for which they receive tangible rewards from the team (or person) in charge of the project, such as a thank you letter, a personalized t-shirt, or one

[250] "AfricInvest s'offre environ 30% de Bridge Group West Africa," Jeune Afrique, (21 March 2014): https://www.jeuneafrique.com/11496/economie/africinvest-s-offre-environ-30-de-bridge-group-west-africa/
[251] FRAGG Investment Management: http://www.fragginvest.com/about-us/
[252] "Les plateformes de financement participatif existantes en Afrique subsaharienne," Medium, (May 28, 2016): https://medium.com/@iroko_project/les-plateformes-de-financement-participatif-existantes-en-afrique-subsaharienne-ca9e36b720af
[253] "Côte d'Ivoire : Orange se lance dans le financement participative," Jeune Afrique, (11 September 2015): https://www.jeuneafrique.com/263736/economie/Côte-ivoire-orange-se-lance-dans-le-financement-participatif/

of the first products in a new production line. The key element of the platform's success is not so much the amount raised by the campaigns but rather the number of creative and innovative projects that will survive beyond the platform. The platform is remunerated by taking a 10% commission on the total amount of funds raised for startup and small company's projects. For social projects Happy Benky does not take any commission.[254]

- **Babi Talent Show**

Babi Talent Show is a participative payment platform hosted on the Internet and operated by Côte Ouest, a public limited company with a share capital of CFA 10 million (USD 17,000), whose headquarters are in Abidjan. Côte Ouest provides the general public with an innovative service that allows them to make donations to Babi Talent Show, or "Talent." Collection is definitive when, at the end of the collection period, at least 50% of the financing objective is reached. Côte Ouest does not at any time act as an investor in the Projects, nor as a guarantor of the authenticity and viability of the Projects. Côte Ouest is the intermediary between the beneficiaries, knowns as "The Talents," and the donors. Although a pre-selection is made prior to the publication of the Projects, Côte Ouest cannot guarantee the completion of the projects, which is the responsibility of The Talents. The platform offers them the opportunity to develop all or part of their financing with the intrinsic risk that this implies. [255]

- **Oukaley.com**

Oukaley.com is a participatory financing platform, created in 2015 by the Ivorian law company KAB SAS. It is an initiative of young Ivorians who are trying to provide a solution to unemployment by promoting self-employment and youth entrepreneurship in the primary (agriculture, livestock, fish farming, etc.), secondary, tertiary (transport, tourism, etc.) and quaternary (entertainment, information technology, etc.) sectors. Oukaley.com is also a promoter of an innovative and complementary solution to bank financing by offering a decentralized platform for financing. The platform has a particular focus on entrepreneurs, craftsmen, and inventors and, in general, Oukaley seeks to support all those who do not have the means to present a sufficient guarantee in order to obtain a credit line needed actualize their project ideas. The platform is designed to connect individuals with an idea and concept to interested financiers who also can contributed to early-stage concept ideas in exchange for potential future financing.[256]

- **Seekewa**

Seekewa collaborated with Particeep to launch a crowdfunding platform that connects lenders and farmers to finance agricultural projects across Côte d'Ivoire. Seekewa is a zero-rate crowdlending platform exclusively dedicated to agricultural activities in Africa. It was initiated by two Ivorian entrepreneurs and by AgTech Nadra Ventures (ANV) a French investment fund. ANV, a fund specializing in Agritech and Fintech, focus on equity investments in start-ups across Sub-Saharan Africa. The platform has already established fruitful partnerships with the Chérifien Phosphates Office (Office Chérifien des Phosphates, OCP), the world's leading producer of phosphate fertilizers, and Ascoma, a major insurance group with a strong presence in Francophone Africa. The partnerships mainly concern the financing of agricultural projects presented on the Seekewa's platform. Seekewa's mission is to create communities of contributors through internet users from all over the world (including corporate sponsors, local authorities, etc.) and grant loans ranging from EUR 100 to 4,000 (CFA 65,595 to 2.6 million) farmers in Africa. Seekewa's ambition in the next 3 years is to establish itself in a dozen major African agricultural countries and become the main source of digital financing on the continent.

[254] "Happybenky: une plateforme ivoirienne de financement participative," Startup.info (2019): https://startup.info/fr/happybenky/
[255] "Présentation de la plateforme,"Babi Talent Show, (2019): http://babitalentshow.com/apropos#
[256] "A Propos de Oukaley," Oukaley (2019): https://www.oukaley.com/fr/menu_item_pages/609

3.4 Summary of Findings

- **Opportunity for ROGEP Credit Lines:** Ivoirian 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 Côte d'Ivoire, 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 Côte d'Ivoire 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.

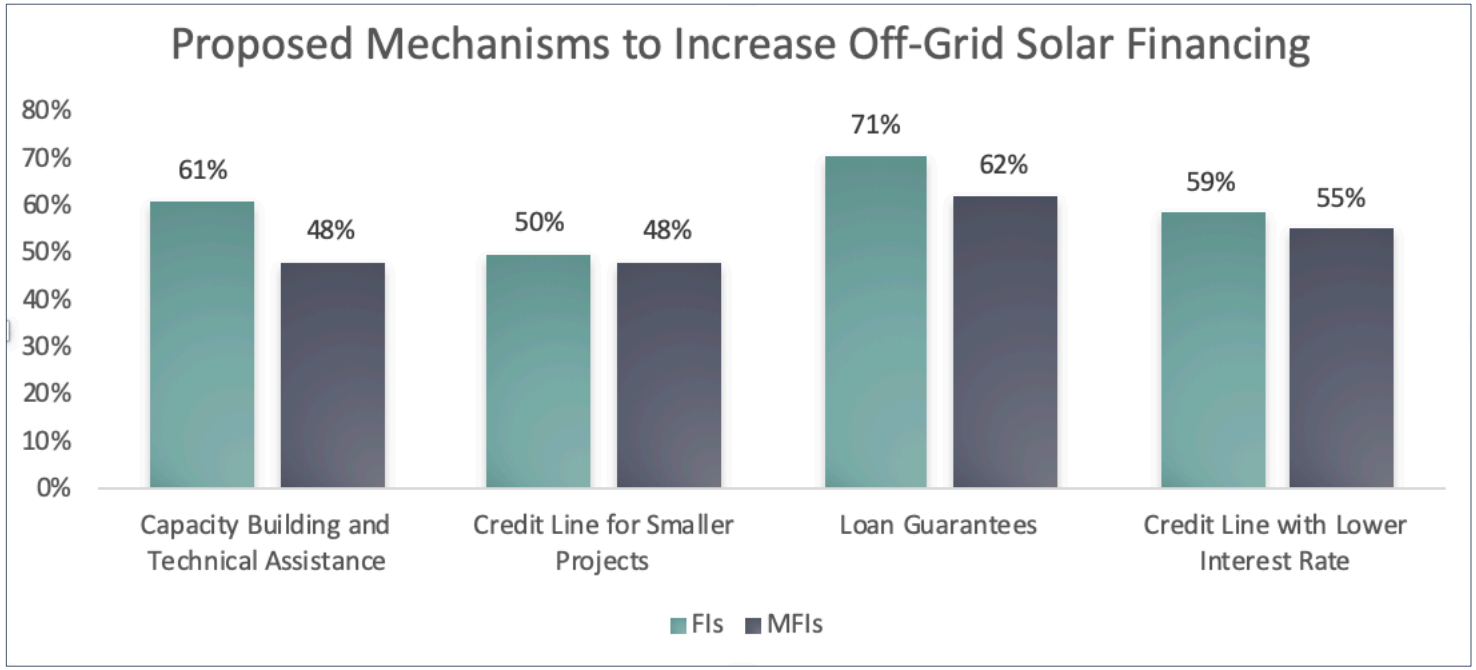
- **Risk Perception of New Lenders**: In order to attract additional lenders into the off-grid solar market segment, there is need for strong, reasonably priced credit enhancement mechanisms. In order to cover "market entry" risks for lenders unwilling to enter this market, guarantee instruments that 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 such as CEADIR and 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.

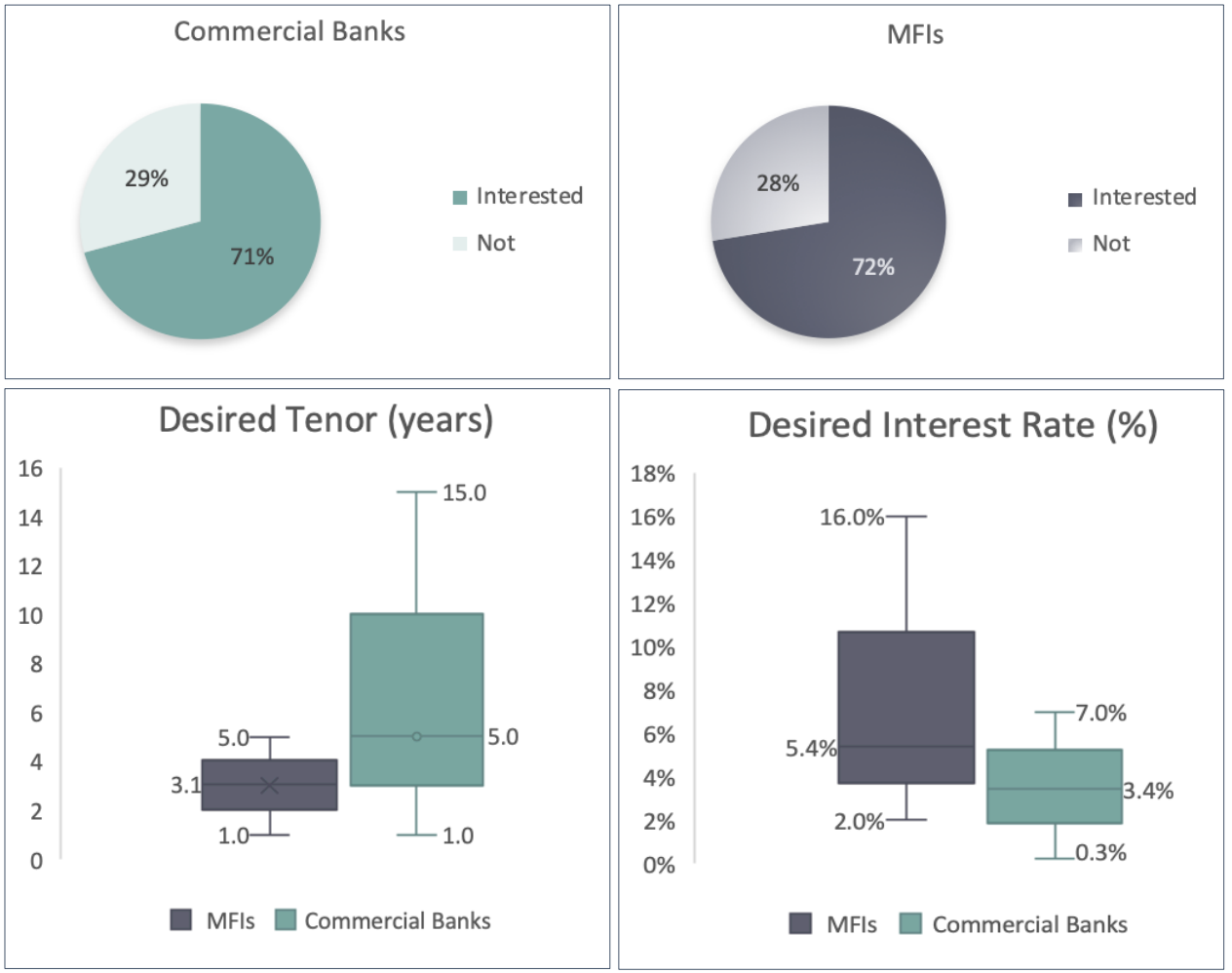
- **Digital Financial Services**: The advent of digital financial services and mobile money is one of the most important developments in off-grid solar market development to date, as it has allowed new and

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.

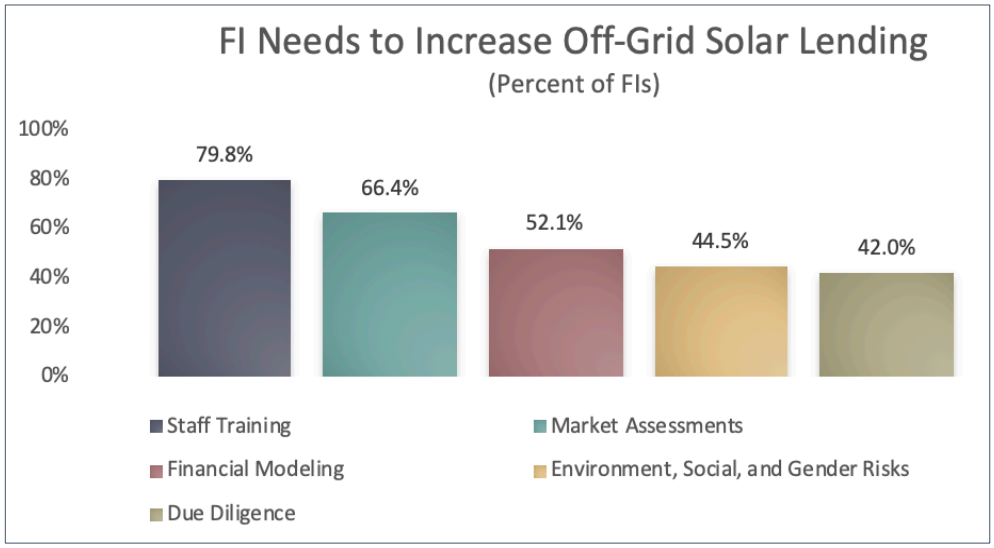
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from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



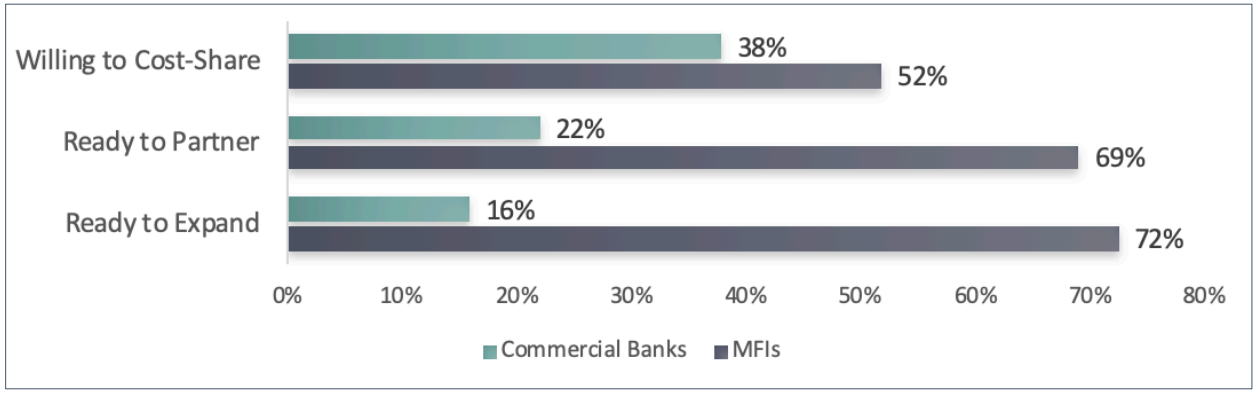
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy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

ANNEX 1: TASK 1 METHODOLOGY

STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

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

GIS DATA ANALYSIS APPROACH / METHODOLOGY

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

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

1.1. Categorization/definition of settlements: Scenario 2023

1.1.1. *Electrification by grid extension* – settlements which are located within 5 km of the current electrical grid network[257] (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)[258]
- Are located within areas that have a population density of more than 350 people per km^2 (as defined by Eurostat for rural areas),[259] plus an additional 50 people per km^2 for greater feasibility of mini-grids[260] and are within 1 km[261] of a social facility and existing mini-grids of 2018.

1.1.3. *Electrification by stand-alone systems* – settlements that do not fall in 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 high voltage line extensions[262]

1.2.2. *Electrification by mini-grid* – settlements that:
- Were defined as mini-grid settlements in 2023

[257] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[258] 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
[259] http://ec.europa.eu/eurostat/web/rural-development/methodology
[260] Identified in discussions with different international mini-grid developer.
[261] Preferred maximum distance for mini-grids from discussions with different international developer.
[262] NOTE: Low- voltage and future medium-voltage distribution lines were not considered in this analysis (data was unavailable)

- 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.[263]

1.2.3. *Electrification by stand-alone systems* – settlements that do not fall in 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 (below 350 people per km^2)

1.4. Determination of population per settlement

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

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

"New data sources and recent methodological advances made by the WorldPop program now provide high resolution, open and contemporary data on human population distributions, allowing accurate measurement of local population distributions, compositions, characteristics, growth and dynamics, across national and regional scales. Statistical assessments suggest that the resultant maps are consistently more accurate than existing population map products, as well as the simple gridding of census data." [264]

Due to the unavailability of settlement data (settlements with known coordinates), points representing an approximate location of settlements had to be developed utilizing the high-resolution layer of population density. The population density is represented in polygons; the center points of each polygon are regarded as one settlement for this analysis.

A Voronoi polygon analysis[265] was used to create boundaries for each identified settlement. These boundaries were then used in combination with the population density layer to estimate the total settlement population of the given year. The current annual national population growth rate of 2.5%[266] was applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses.

[263] 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.
[264] https://www.worldpop.org
[265] To learn more about Voronoi polygons, see wikidot: http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons
[266] World Bank: https://data.worldbank.org/indicator/SP.POP.GROW?locations=CI

2. Summary of Key Datasets

The table below summarizes the key datasets used for 2023 and 2030 scenarios 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); georeferenced from the Grid Map	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	CI-ENERGIES and Energie Electrique de Côte d'Ivoire (EECI), Jan 2016
Electricity grid network (planned)	Future network planned to be built (HV lines); georeferenced from the Grid Map	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	CI-ENERGIES and Energie Electrique de Côte d'Ivoire (EECI), Jan 2016
Power Generation	Anare Power Plants; Indicator of electrified settlements; georeferenced from map in Annex 2, page 97	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	Anare Rapport d'activités, 2015
Mini-grids	Existing mini-grids in 2018	Not considered	≤ 1km distance	≥ 1km distance	Not considered	≤ 1km distance from all identified mini-grids in Scenario 2023	≥ 1km distance from all identified mini-grids in Scenario 2023	ECOWREX, 2018
Night-lights	Night-time light emissions used to identify electrified areas	Not considered	≤ 15km distance	≥ 15km distance	Not considered	Not considered	Not considered	NASA Earth Observatory, 2016
Population density	Population distribution in people per km^2.	≥ 350 people per km^2 [267]	≥ 350 people per km^2	≤ 350 people per km^2	Not considered	Not considered	Not considered	Hrsl layer Ciesin/ facebook lab, 2015[268]
Settlements	Centroids of the polygons in the population density layer, which	Used	Used	Used	Used	Used	Used	Hrsl layer Ciesin/ facebook lab, 2015

[267] 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

[268] Facebook Connectivity Lab and Center for International Earth Science Information Network - CIESIN - Columbia University. 2016. High Resolution Settlement Layer (HRSL). Source imagery for HRSL © 2016 DigitalGlobe.

	are identifying visible buildings in the satellite imagery							
Social facility: education centers	Non-exhaustive set of education centers (schools, colleges, universities and kindergarten) as identified in OpenStreetMap (OSM); Indicator of active local economy	Not considered	≤ 1km distance[269]	≥ 1km distance	Not considered	Not considered	Not considered	OSM, 2018
Social facility: health centers	Small set of hospitals and clinics as identified in OSM and uploaded on HDX; Indicator of active local economy	Not considered	≤ 1km distance[270]	≥ 1km distance	Not considered	Not considered	Not considered	Humanitarian Data Exchange (HDX), 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[271]

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

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

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

1. HOUSEHOLD DEMAND

1.1 Household market segments

1.1.1 Total population without access to electricity was calculated using World Bank total population figures,[272] multiplied by electricity access rates from the International Energy Agency (IEA),[273] 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.

[272] World Bank Open Data, 2017: https://data.worldbank.org/

[273] IEA Energy Access Outlook, 2017: https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

1.2 Household energy expenditure and potential savings

1.2.1 Current household expenditure on energy-related items (believed to be candidates for replacement with solar products) was estimated using information from the FGDs.

1.2.2 From the existing household expenditures, "typical" monthly costs were estimated that households would incur in order to receive a standard level of electricity service according to the Multi-Tier Energy Access Framework.

1.2.3 The unit monthly costs were used for each of the energy-related items identified above.

1.2.4 The cumulative monthly expenditure was then determined for each tier.

1.2.5 Monthly expenditure by tier was compared with monthly cost associated with OGS products by tier to estimate potential household cost savings. Monthly cost for OGS products was based on representative data from the West African region.

1.2.6 In the process of this analysis, the following assumptions were made:

1.2.6.1 Solar system sizes and costs:

- Cost per watt on solar systems vary greatly and have changed rapidly in the past five years. Smaller pico and plug and play systems have a much higher per cost per watt. The USD/Watt prices are based on sample cost ranges from Lighting Global equipment available on the open market.
- Average system size by watts: values are chosen as representative values for solar systems from each of the Tier values. They are intended to represent system sizes that typical members of each group would purchase.
- Average system life values represent typical 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 Ivory Coast, the number of off-grid households by income quintile was derived. For this, a percentage of off-grid households by quintile was assumed, as follows:

Quintile	% Off-Grid
Highest 20%	1%
Fourth 20%	2%
Third 20%	3%
Second 20%	84%
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."[274] Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.[275] For the purpose of this research, we have assumed that households can allocate 10% of their income on average to energy.

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

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

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

- **Tier 0**: Assumed to be an absolute energy poor household, relying solely on kerosene and charcoal both for cooking and lighting.

[274] 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).
[275] 10% is an acceptable figure for lighting and cell phone charging costs for low income groups. See: https://www.brookings.edu/blog/africa-in-focus/2017/03/17/figures-of-the-week-benefits-of-off-grid-electricity-solutions/

- **Tier 1**: The household was assumed to have access to 1 torch light/lantern powered by dry cells, charging services for a phone charged on average 8 times a month.
- **Tier 1.5**: The household was assumed to have access to 1 torch light and 1 lantern each powered by dry cells, one regular cell phone charged on average 8 times a month, and a radio powered by dry cells (assume access to 2 low quality cells) replaced 4 times a month.
- **Tier 2**: The household was assumed to have access to 1 torch light and 2 lanterns each powered by dry cells, one regular cell phone charged on average 8 times a month, and one smart phone charged on average 16 times a month, a DC TV powered by lead acid battery recharged once per week.
- **Tier 3**: The household was assumed to have access to a generator powering a number of appliances but available only for 2-3 hours a day.
- **Annualized energy costs** for each of the systems = ([Capital system cost/average system life in years]+[Monthly operating cost*12])

1.3.6 The potential market size for each solar tier was then calculated by multiplying the number of off-grid households per quintile that will be willing to pay for each solar tier by the cost of each system (system cost is based on representative data from Ivory Coast, 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.[276]

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

1. The GIS analysis[277] estimated that by 2023, 65.6% of the population will be grid connected, 28.3% will be connected by mini-grids while 6.2% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 92.3% of the population will be grid connected, 4.9% will be connected by mini-grids while only 2.8% of the population will be connected by off-grid stand-alone solutions. Based on these dynamics in the demographic patterns, coupled with the existing government plans, the following assumptions regarding the off-grid population based on the quintiles were made:
   - In the 2023 scenario, it was assumed that as the grid gets extended and mini-grids are deployed (based on GIS data), the households in the quintiles with the highest income will be given priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest quintile was assumed to have only 1% off-grid households, while the second highest quintile was assumed to have 2% off-grid households with the third quintile having 45.7% off-grid households. The percentages of off-grid households in the bottom two quintiles

[276] 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
[277] See Annex 1 for GIS methodology

remain unchanged. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2023 estimate.

- Similarly, in the 2030 scenario, it was assumed that the higher income quintiles will be prioritized for electrification, based on economic considerations, above the lower quintiles. Hence, the highest four quintiles were assumed to have only 1%, 2%, 3%, and 4% off-grid households respectively, while the lowest quintile was assumed to have 12% 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%	45.7%	3%
Second 20%	99%	4%
Lowest 20%	100%	12%

2. Inflation rates for Ivory Coast: According to the IMF World Economic Outlook data, inflation in Ivory Coast is estimated to be at 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 1.02.

3. Based on a 2.5% population growth rate from the World Bank[278] and the population density dataset used in the study, the estimated total population will be 27,649,375 in 2023 and 32,866,419 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 93.8% in 2023 and 97.2% in 2030.

5. To estimate GDP, it was assumed that the current annual GDP growth rate of 7.6% will be maintained through 2023 and 2030:

Parameter	2023	2030
Population	27,649,375 (GIS estimate)	32,866,419 (GIS estimate)
GDP (constant 2010 USD)	$61,558,278,816	$102,795,089,184

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,[279] 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

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

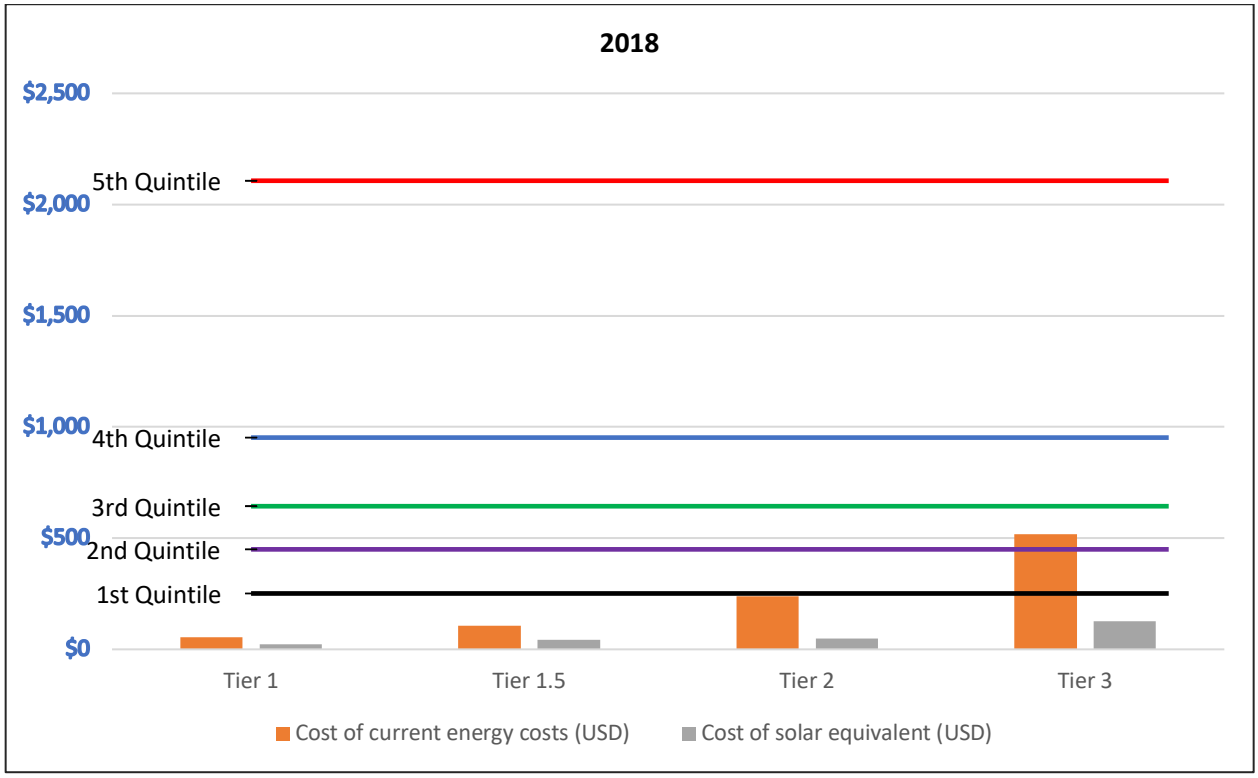
[279] "Off-Grid Solar Market Trends Report 2018," Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

figures, the average annual decrease in prices from 2020 was estimated at 10.76%. It was assumed that the annual price decrease will be maintained at this level through 2030 (annual cost reduction factor of 0.89).

8. It was assumed the maximum interest rates in Ivory Coast 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:

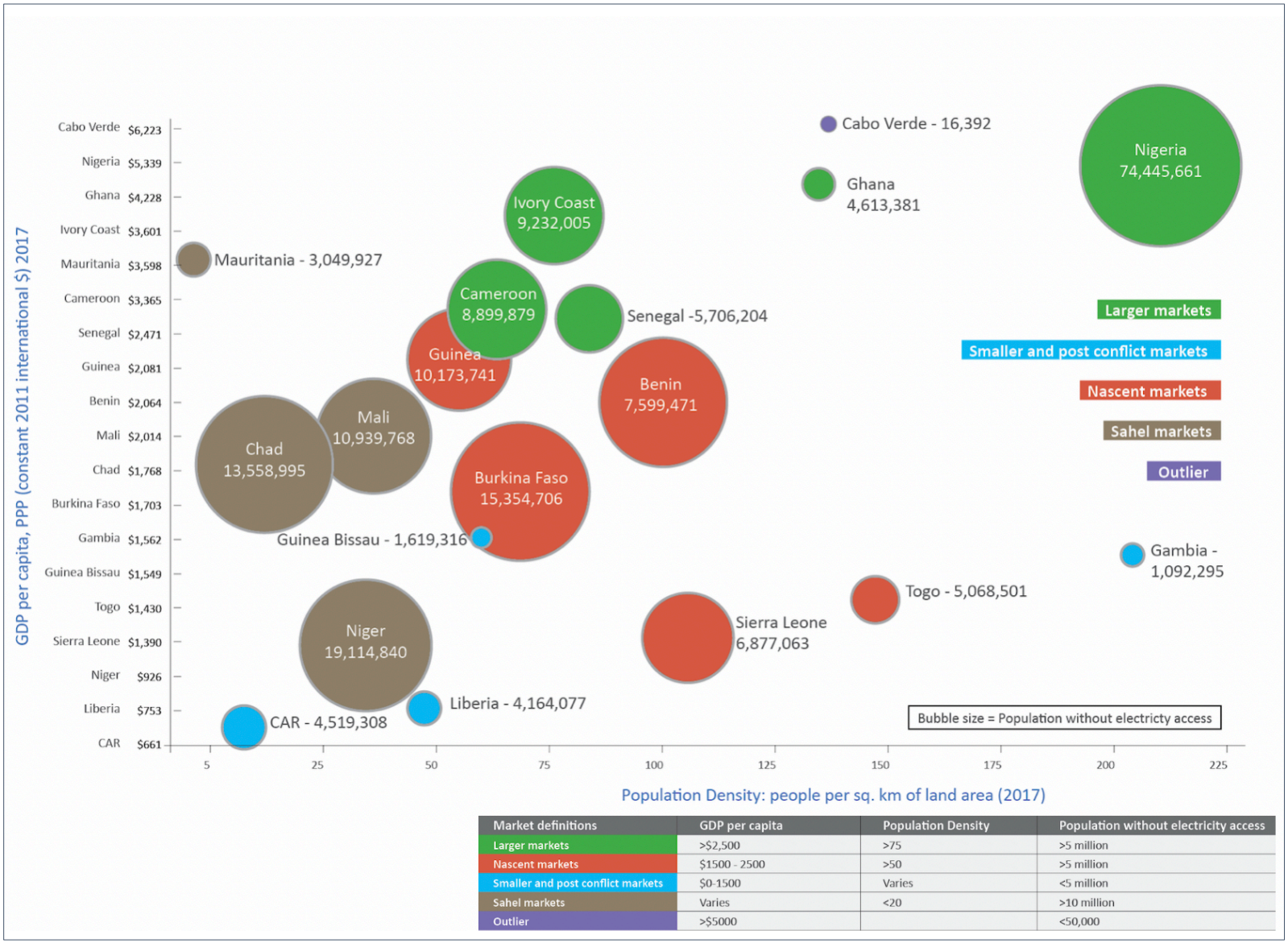
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	**Category 2:** Low-income / high population density	**Category 3:** High-income/ low population density	**Category 4:** High-income / high population density
Niger	Benin	Cameroon	Nigeria
Burkina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

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

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

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

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



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

Source: African Solar Designs analysis

2.2 Energy Needs by Institutional Market Segment

Institutional Sector	Description	Rating (W)	Time of use (hrs)	Total Wh/day	Total Load	Recommended system (W)
Water Pumping						
Low power		1,500	6	9,000		1,500
Medium power		4,000	6	24,000		4,000
High power		10,000	6	60,000		10,000
Healthcare						
HC1 Health post	Lighting	30	8	240		
	Communication	20	8	160		
	ICT	100	8	800	1,200	250
HC2 Basic healthcare facility	Lighting	200	8	1,600		
	Maternity	200	4	800		
	Vaccine refrigeration	100	8	800		
	Communication	100	4	400		
	Medical exams	200	2	400		
	ICT	200	8	1,600		
	Staff housing	50	8	400	6,000	1,500
HC3 Enhanced healthcare facility	Lighting	400	8	3,200		
	Communication	200	8	1,600		
	Medical exams	600	2	1,200		
	ICT	300	8	2,400		
	Maternity	600	4	2,400		
	Laboratory	1,000	2	2,000		
	Sterilization	1,200	1	1,200		
	Vaccine refrigeration	150	8	1,200		
	Staff housing	200	8	1,600	16,800	4,200
Education						
Primary school	Communication	20	8	160		
	Lighting	80	8	640		
	ICT	100	8	800		
	Staff house	50	8	400	2,000	500
Secondary school	Communication	20	8	160		
	Lighting	240	8	1,920		
	ICT	400	8	3,200		
	Laboratory use	100	8	800		
	Staff house	200	8	1,600	7,680	1,920
Public Lighting						
Street lighting	Lights	200	8	1,600	1,600	500

Source: The estimates in the table above are based on data obtained from local experts, interviews with solar industry stakeholders and corroborated by secondary desk research.

CALCULATIONS: Rating of systems is based on data for sizes of the appliances from a 2016 GIZ solar PV catalogue.[280] The solar PV sizing factor is based on the peak sun hours available across most of Africa.

[280] "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[281]	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

[281] 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						
HC 1	X	Cost per tier 3 system ($625)	X	Divided by system lifetime of 5 years	=	Estimated Annualized Off-Grid Solar Market Potential for Healthcare Sector
HC 2		Size of solar system in Watts (1500W)		Cost per watt ($2.50) divided by system lifetime of 20 years		
HC 3		Size of solar system in Watts (4200W)		Cost per watt ($2.50) divided by system lifetime of 20 years		

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

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

2.4 Data Collection Approach by Institutional Market Segment

CÔTE D'IVOIRE			
Water Supply	**Healthcare**	**Education**	**Public Lighting**
Per capita assumption	GIS data	GIS data	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Côte d'Ivoire 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:[282]

- **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.

[282] 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[283]	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)[284]	X 25%	=	Smallholder Irrigation Potential (hectare)[285]	Divided by 0.3[286]	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	$650 (cost of solar pumping kit)[287]	Divided by 6 year (life of system)	=	Estimated Annualized Off-Grid Solar Market Potential for irrigation

Methodology for identifying areas suitable for irrigation activities on farms:

The areas for potential irrigation activities were calculated using the visible cropland[288] adjacent to permanent surface water sources. As identified by experts in a study in Zambia[289] and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure 30** is a map of the cropland within a 5 km distance from permanent surface water.

[283] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap
[284] AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
[285] 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
[286] 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/
[287] 120W solar pumping kit: https://futurepump.com/futures-bright-farmers-kenya/
[288] "Prototype Land Cover Map over Africa at 20m Released," Esa, (February 2018): https://www.esa-landcover-cci.org/?q=node/187
[289] "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)[290]	X	70%[291]	X	50%[292]	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor[293]	=	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[294]	X	5,500 W[295]	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[296]	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

[290] Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
[291] Assumption that 70% of crops are milled
[292] Assumption that 50% of milled crops are processed at smallholder farmer level
[293] 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/
[294] https://www.citypopulation.de
[295] 5.5kW solar powered refrigeration system – *See*: https://www.deutschland.de/en/solar-powered-coldhubs-nigeria
[296] "The Mobile Economy, Sub-Saharan Africa," GSMA Intelligence, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download

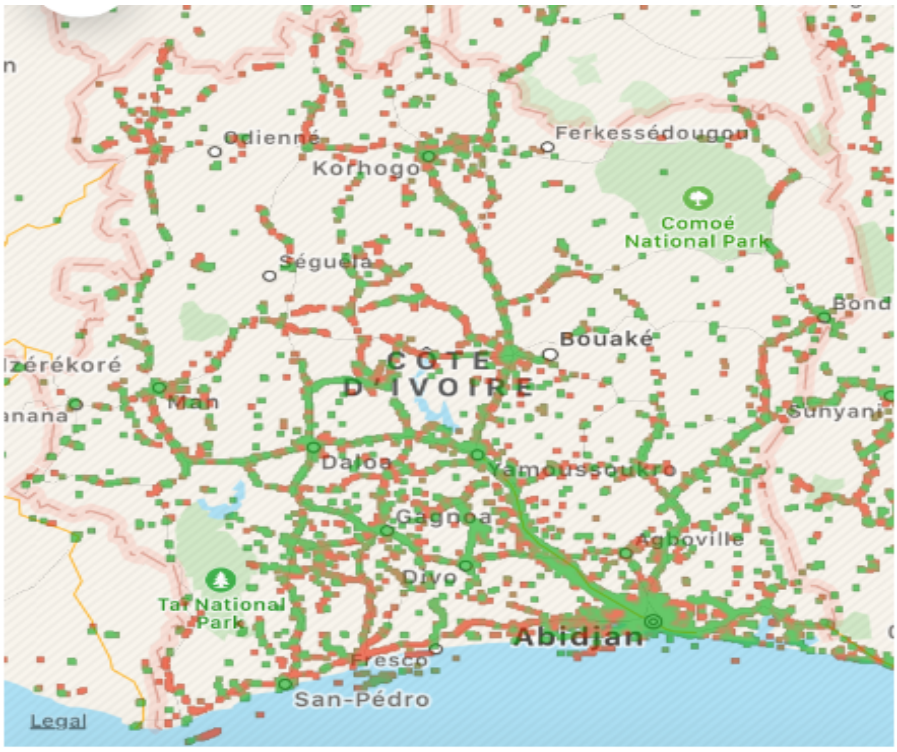
* Indicative Costs for Phone Charging Appliances[297]

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 32**). 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

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

3. SUPPLY CHAIN ANALYSIS

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

- Supplier focus group discussions held in Abidjan, Bouake, and Daloa in June 2018
- Survey of 11 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- GOGLA semi-annual sales reports[298]
- 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 Côte d'Ivoire is included below:

1	AD Solar	26	Ivoire Techniques Nouvelles
2	Aphelion Energy	27	Lumos Global
3	Baobab+	28	Lynays
4	Kabirou	29	NOA Trading
5	Meliani	30	NEGEB
6	PEG	31	PEG Africa
7	S.A	32	Phaesun
8	Saidou	33	Schneider Electric
9	Sogelux	34	Securicom
10	S-Tel	35	SEEE
11	Yandalux	36	SI2E ENR
12	Dulo Solar	37	SIDEES
13	EBATP SARL	38	SIPES-CI
14	Ecosolar	39	Solci Energy
15	ED SERVICE	40	Solener
16	EGCP	41	S.P.T (Solar Power Technics)
17	EGEBAT	42	S-TEL
18	Elec Services Experts Conseils	43	Sunlight Energy
19	ENGIE	44	SUN-CI (Lagazel)
20	Epsolia	45	TD Continental
21	Fenix Int'l	46	Total Awango
22	GECI	47	Yandalux
23	GENEZ	48	Zola Energy
24	Green Ker		

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

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

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT

Data collection under Task 3 included a combination of desk research, collaboration with local experts, and extensive stakeholder engagement with key officials and representatives from local and regional commercial banks, microfinance institutions and other development banks and agencies in Côte d'Ivoire. 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.[299]

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.[300] The results of the survey are summarized in **Section 3.4**.

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

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

comfortable launching with initially?

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

ANNEX 4: GENDER ASSESSMENT

1. Context and Purpose of the Gender Analysis

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

Women in energy-poor households are at substantially higher risk of illness attributable to indoor air pollution and solid fuel (biomass) use.[301] 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.[302]

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.[303] 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.[304] 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.[305]

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

[301] "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

[302] 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

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

[304] Ibid.

[305] "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/

[306] "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 Abidjan, Bouaké and Daloa in June 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Côte d'Ivoire to assess the main barriers/constraints for inclusive participation in the country. The survey was structured to assess each market segment analyzed under Task 2 and examined a number of key gender issues, including *inter alia* access to credit, access to education and information, entrepreneurial and income-generating activities for women (including productive use of energy), representation of women in leadership positions in business and government.

➢ Gender Questionnaire

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

HOUSEHOLD

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

COMMUNITY/INSTITUTIONAL

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

PRODUCTIVE USE

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

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

SUPPLIER

Please describe the level of engagement that women have in in the off-grid energy services sector. Are women highly employed in this area (e.g. is there data collected on the number of women-owned businesses/SMEs)?

Are there any related programs and initiatives (donor, government, private sector, NGO etc.) that provide training for women to manage or be employed by energy-related enterprises?

ADDITIONAL:
What are the main barriers women face to access information?
What are the main barriers/constraints for women entrepreneurs to have access to credit?
Do women have equal access to capacity building and training services (e.g. vocational training/technical education) or do they experience discrimination in access to these services?
What policy, regulatory and institutional framework(s) exist, if any, to address gender mainstreaming[307] (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 Côte d'Ivoire

Structural inequalities and gender discrimination against women and girls persist in Côte d'Ivoire, 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 such as access to primary education as well as healthcare, gender disparities still exist across the economy, particularly in access to resources, higher education, land ownership, inheritance systems, political power and decision-making. These findings are supported by UNDP Human Development Index (HDI) rankings.[308]

2.2 Gender and poverty

Despite gradual improvement in poverty rates, nearly half of the labor force in Côte d'Ivoire is considered working poor at PPP USD 3.10/day.[309] Female access to education and enrollment rates in the country remains low compared to men (**Figure 10**). This has troubling implications given the well-known relationship between education and poverty.

2.3 Gender, Human Capital and Economic Empowerment

2.3.1 Education, Skills Development and Training

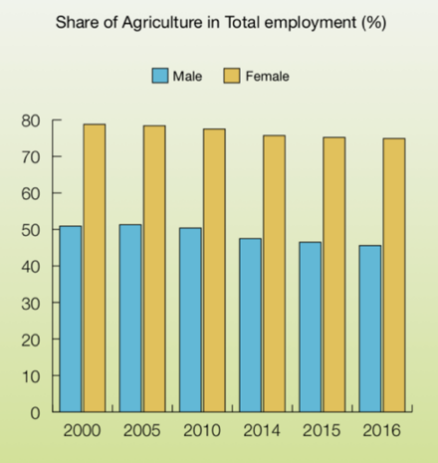
Côte d'Ivoire remains among the lowest ranked countries in the world in a wide range of UN Human Development Indicators.[310] As the country emerged from a period of prolonged conflict in 2011, the education system has been expanding rapidly. The GoCI implemented a Transitional Education Plan (TEP) in 2012, re-extended its implementation through 2016 prior to developing a new ten-year strategy through 2025, which was formally adopted by the Government in May 2017 and endorsed by development partners. However, while access to education has improved under the TEP, gender gaps still exist in higher levels of

[307] **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.
[308] "UN Human Development Indicators: Côte d'Ivoire," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/CIV
[309] Ibid.
[310] "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

education. According to the UNDP, as of 2018, 17.8% of women aged 25 and older had at least some secondary education compared to 34.1% of men.[311]

The national literacy rate in Côte d'Ivoire also remains low, at 43.9%.[312] The general level of schooling in the country is poor, as more than one-third of the country's youth have no formal education at all. In Côte d'Ivoire, 39% of children of official primary school ages are out of school – including approximately 34% of boys of primary school age compared to 43% of girls of the same age. Nearly 64% of female youth of secondary school age are out of school compared to 46% of male youth of the same age. For youth of secondary school age, the biggest disparity can be seen between the poorest and the richest youth.[313]

According to the UN, as of 2017, 35.6% of women in Côte d'Ivoire had an account at a financial institution or with a mobile money service provider.[314] 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, which consistently employs a disproportionate share of the country's female labor force.[315]



Source: African Development Bank

2.3.2 Fertility Rates and Reproductive Health

As of 2017, the fertility rate in Côte d'Ivoire remained high, at 5 children per woman. Côte d'Ivoire's maternal mortality rate is also very high; for every 100,000 live births, 645 women die from pregnancy-related complications. The infant mortality rate also remains extremely high at 66 per 1,000 births. As of 2018, 30.5% of women had an unmet need for family planning.[316]

[311] "UN Human Development Indicators: Côte d'Ivoire," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/CIV
[312] "Human Development Indices and Indicators: 2018 Statistical Update," UN Development Programme, (2018): http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf
[313] Côte d'Ivoire National Education Profile: https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Côte%20d%20Ivoire.pdf
[314] "Human Development Indices and Indicators: 2018 Statistical Update," UN Development Programme, (2018): http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf
[315] "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
[316] "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

2.3.3 Participation and Decision-Making

Socio-cultural perspectives in Côte d'Ivoire 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 reflected in the rates of representation of women in the labor market as well as in leadership positions in business and government.

In recent years, the Government of Côte d'Ivoire has taken measures to promote the participation of women in politics and public life, introducing a 30% quota system in its legal systems and political platforms. Côte D'Ivoire adopted a Political Party Quota for Electoral Candidates, requiring that 30% of candidates be women. Despite this quota, women are still poorly represented in public office in Côte d'Ivoire. As of 2018, women hold only 9.2% of the country's seats in parliament.[317]

2.4 Gender Policy, Institutional and Legal Framework in Côte d'Ivoire

2.4.1 Gender Mainstreaming initiatives by the Government

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

Côte d'Ivoire's policy framework for promoting gender equality and women's empowerment is guided mainly by (i) the Solemn Declaration of Côte d'Ivoire on Equality of Chances, Equity and Gender (Déclaration solennelle de la Côte d'Ivoire sur l'égalité des chances, l'équité et le genre), which manifested the intention to introduce a 30% quota for female candidates in elections; and (ii) the National Policy for Equalities for Chances, Equity and Gender (Politique Nationale de l'Egalité des Chances, l'Equité et le Genre) in 2009 to promote the consideration of gender in the public and private sectors. These policies were reinforced by policies and action plans to promote gender equality and a strategy for the fight against gender-based violence implemented under the National Development Plan (Plan national de développement) for 2012-2015, which aims to transform Côte d'Ivoire into an emerging nation by 2020. In order to achieve this objective, the plan has five strategies, one of which is "gender and equity."

The 2016 Côte d'Ivoire New Constitution and the country's fundamental legal instruments formally recognize equality between the sexes. The GoCI 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. At the international level, Côte d'Ivoire has ratified the Convention on the Elimination of All Forms of Discrimination Against Women and is also signatory to the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa, the Solemn Declaration on Gender Equality in Africa and the Beijing Platform for Action, among others. The Government has also adopted various additional policies, laws and regulations in order to reduce the gender inequalities, including establishment of the National Council for Women, the National Committee to Combat Practices Harmful to Women and Girls and lastly the Observatory for Equity and Gender in 2014.

Gender groups have been established in several government ministries although they are not all operational. Several other ministries are supporting gender mainstreaming in the country, namely the Ministry of

[317] "UN Human Development Indicators: Côte d'Ivoire," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/CIV

Employment, Social Action and Professional Training (Ministère de l'Emploi, l'Action Sociale et Formation professionnelle) and the Ministry of Justice, Human Rights and Public Liberties (Ministère de la Justice, des Droits de l'Homme et des Libertés Publiques).

In the energy sector, a Gender Focal Unit or Point was established at the Ministerial Level. The World Bank's AFREA Gender Program and Energy is also active in several ROGEP countries and plans to expand its operations into Côte d'Ivoire.[318] The ECOWAS Policy for Gender Mainstreaming in Energy Access is another initiative adopted by the GoCI that is committed to promoting favorable policies and frameworks and mobilizing resources to more fully engage women in all areas of energy access.[319] The regional policy aims to achieve this by securing the local support of a gender focal point in government to integrate gender into energy policies and by conducting gender audits of the sector.

2.4.2 Gaps in the Gender Policy/Legal Framework

Despite the Government's policy initiatives and legislative reforms, gender inequality remains an ongoing challenge across Côte d'Ivoire's political, economic and socio-cultural landscape, as women still face many barriers to inclusive participation. These include low rates of education and corresponding high rates of illiteracy. Women are also often curtailed in their access to information and decision-making. Moreover, Côte d'Ivoire's legal system consists of a mix of French law and local customs leading to contradictions and inconsistencies among the two.

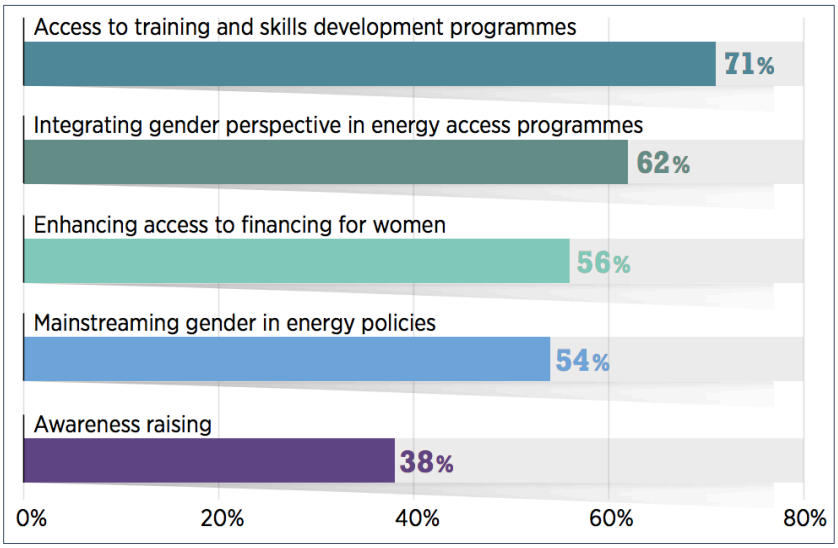
2.5 Summary of Recommendations

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.[320]

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.[321]

[318] http://www.euei pdf.org/sites/default/files/field_publication_file/annex_5_aeep_mapping_of_energy_initiatives_overview_of_initiatives_0.pdf
[319] "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," ECREEE and National Renewable Energy Laboratory, (2015): https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf
[320] "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
[321] 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 Côte d'Ivoire's energy sector:[322]

- Take measures to close the gender gap in access to education, particularly in higher levels of education
- Implement a quota system to increase the number of women employed in government's energy ministry and ensure that women are part of decision-making processes in the energy sector
- Implement policy and budgetary measures to support programs that aim to raise awareness and promote opportunities for women as energy customers, suppliers, financiers, and educators
- Commission studies to collect, synthesize and publish gender-specific/sex-disaggregated data on women's energy access and usage to inform (i) public policy development to improve rates of access for women; and (ii) private sector on potential customer needs (e.g. clean cooking technologies, productive use of energy applications etc.)
- Undertake a "gender audit" of the energy sector and develop a gender action plan to inform long-term policy objectives targeting gaps in the existing framework and promoting inclusive participation (e.g. by adding gender categories to policies and projects and accounting for gender impacts in strategic planning).
- Establish a Gender Focal Point or Unit within key national and local institutions in order to administer targeted gender policies and programs
- Raise awareness / provide training and technical support to private sector businesses / SMEs on (i) the benefits of gender inclusion and in viewing business decisions through a gender lens; (ii) the value of gender-disaggregated data; and (iii) how to develop and implement gender strategies to encourage inclusive participation.[323]

[322] **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

[323] "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

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