REGIONAL OFF-GRID ELECTRIFICATION PROJECT

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

NIGER REPORT

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ABBREVIATIONS & ACRONYMS

AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ANERSOL	Agence Nationale de l'Énergie Solaire (National Agency for Solar Energy)
ANPER	L'Agence Nigérienne de Promotion de l'Electrification en milieu Rural (Nigerien Rural Electrification Promotion Agency)
ARSE	Agence de Regulation du Secteur de l'Energie (Energy Sector Regulatory Authority)
ASD	Africa Solar Designs
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
BIC	Bureaux d'Information sur le Crédit (Credit Information Bureaus)
BOA	Bank of Africa
BRVM	Bourse Régionale des Valeurs Mobilières (Regional Stock Exchange)
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAR	Capital Adequacy Ratio
CEMAC	Communauté Economique et Monétaire de l'Afrique Centrale (Economic and Monetary Community of Central Africa)
CFA	Communauté Financière Africaine (African Financial Community)
CILSS	Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (Inter-State Standing Committee for Drought Control in the Sahel)
CNES	Centre National d'Energie Solaire (National Solar Energy Center)
COD	Cash-on-Delivery
CODDAE	Collectif des Organisations pour la Défense du Droit à L'Energie (Collective Organization for the Defense of the Right to Energy)
DFI	Development Finance Institution
DfID	Department for International Development
DFS	Digital Financial Services
ECA	Export Credit Agency
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
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUR	Euro
EVA	Energio Verda Africa
EPC	Engineering, Procurementand Construction
FAO	Food and Agriculture Organization of the United Nations
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion
FI	Financial Institution
FSA	Fond de Solidarité Africain (African Solidarity Fund)
FX	Foreign Exchange
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information Systems
GIIN	Global Impact Investing Network
GNI	Gross National Income
GoN	Government of Niger

GOGLA	Global Off-Grid Lighting Association
GSMA	Groupe Spéciale Mobile Association (Global System for Mobile Communications)
HC	Health Center
HDI	Human Development Index
HDX	Humanitarian Data Exchange
HFO	Heavy Fuel Oil
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
INS	Institut National de Statistique (National Statistics Institute)
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LTO	Lease-to-Own
MCC	Millennium Challenge Corporation
MOE	Ministry of Energy
MFI	Microfinance Institution
MTF	Multi-Tier Energy Access Framework
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NES	National Electrification Strategy
NESAP	Niger Solar Electricity Access Project
NGO	Non-Governmental Organization
NIGELEC	Société Nigérienne d'Electricité (National Electric Power Company)
NPL	Non-Performing Loan
NREL	National Renewable Energy Laboratory
O&M	Operation and Maintenance
OGS	Off-Grid Solar
OHADA	L'Organisation pour l'Harmonisation en Afrique du Droit des Affaires (Organization for the Harmonization of Business Law in Africa)
ONERSOL	Office National de l'Énergie Solaire (National Office of Solar Energy)
PANER	Plan d'Action National pour les Énergies Renouvelables (National Renewable Energy Action Plan)
PARMEC	Programme d'Appui à la Réglementation des Mutuelles d'Epargne et de Credit (Regulatory Program for Mutual Support)
PASE	National Strategy for Access to Modern Energy Services
PAYG	Pay-As-You-Go
PPA	Power Purchase Agreement
PPP	Public Private Partnership
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
SDR	Stratégie de Développement Rural (Strategy for Rural Development)
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SHS	Solar Home System
SINERGI	Societe d'Investissement de Gestion et d'Initiatives au Niger (Investment Management and Initiatives Company of Niger)
SME	Small and Medium Enterprise
SNED	Stratégie Nationale pour les Energies Domestiques (National Strategy for Domestic Energies)
SNER	Stratégie Nationale pour les EnergiesRenouvelables(National Renewable Energy Strategy)
SOMINA	The Societe des Mines d'Azelik SA
SORAZ	La Société de Raffinage de Zinder
SPV	Special Purpose Vehicle
SSA	Sub-Saharan Africa
SUNREF	Sustainable Use of Natural Resources and Energy Finance
TA	Technical Assistance
UEMOA/WAEMU	Union Économique et Monétaire Ouest Africaine / West African Economic and Monetary Union
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak

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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]

[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

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.).

Multi-tier Matrix for Measuring Access to Household Electricity Supply

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

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

WEST AFRICA AND THE SAHEL

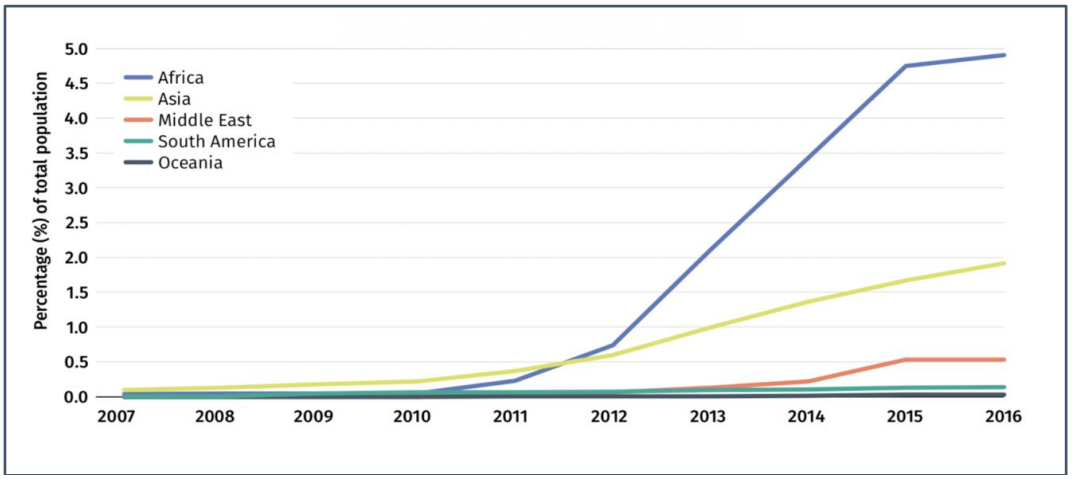
The term "West Africa and the Sahel" as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina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

EXECUTIVE SUMMARY

I. INTRODUCTION

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

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



Tier 1 access and above

Source: International Renewable Energy Agency

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

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

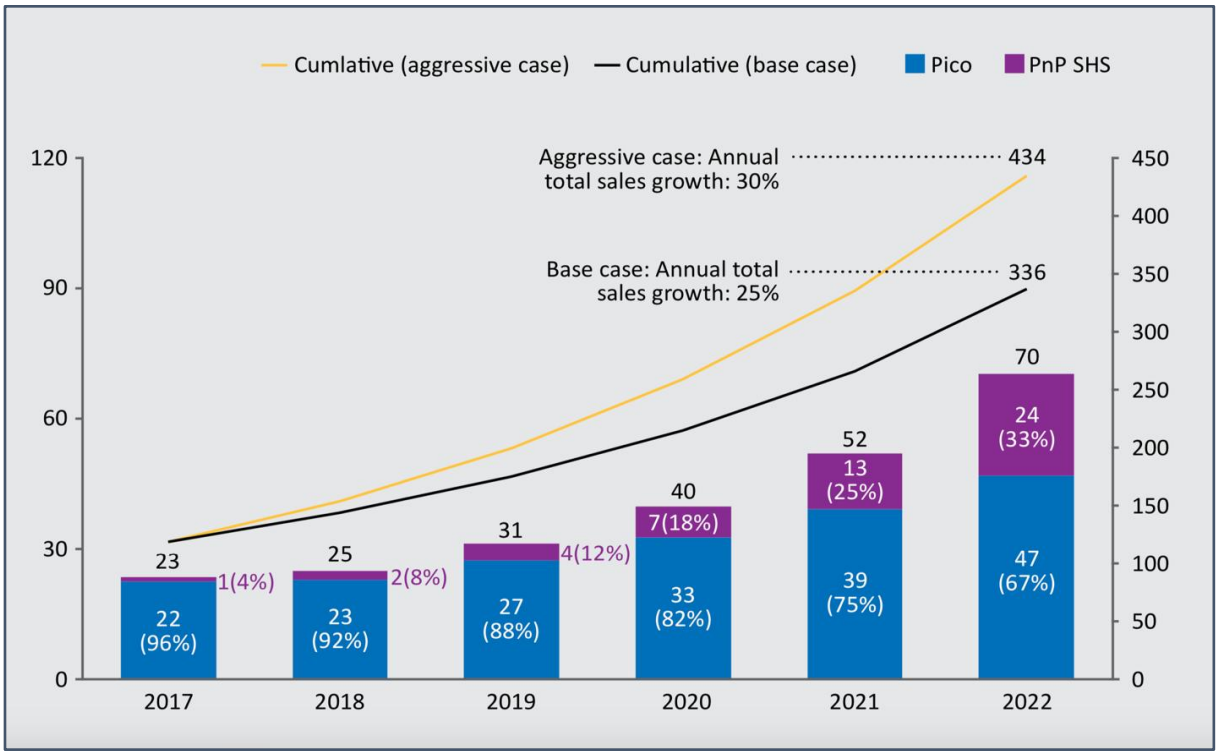
Until recently, diesel generators largely served as the expensive alternative both for rural electrification and for urban and peri-urban "bad grid" areas, where electricity was unreliable or only available for part of the day. However, the advent of decentralized renewable energy technologies, particularly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

[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

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

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 toincrease electricity access of households, businesses and public institutions using modern stand-alone solar systems through a harmonizedregional 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 toestimate 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.

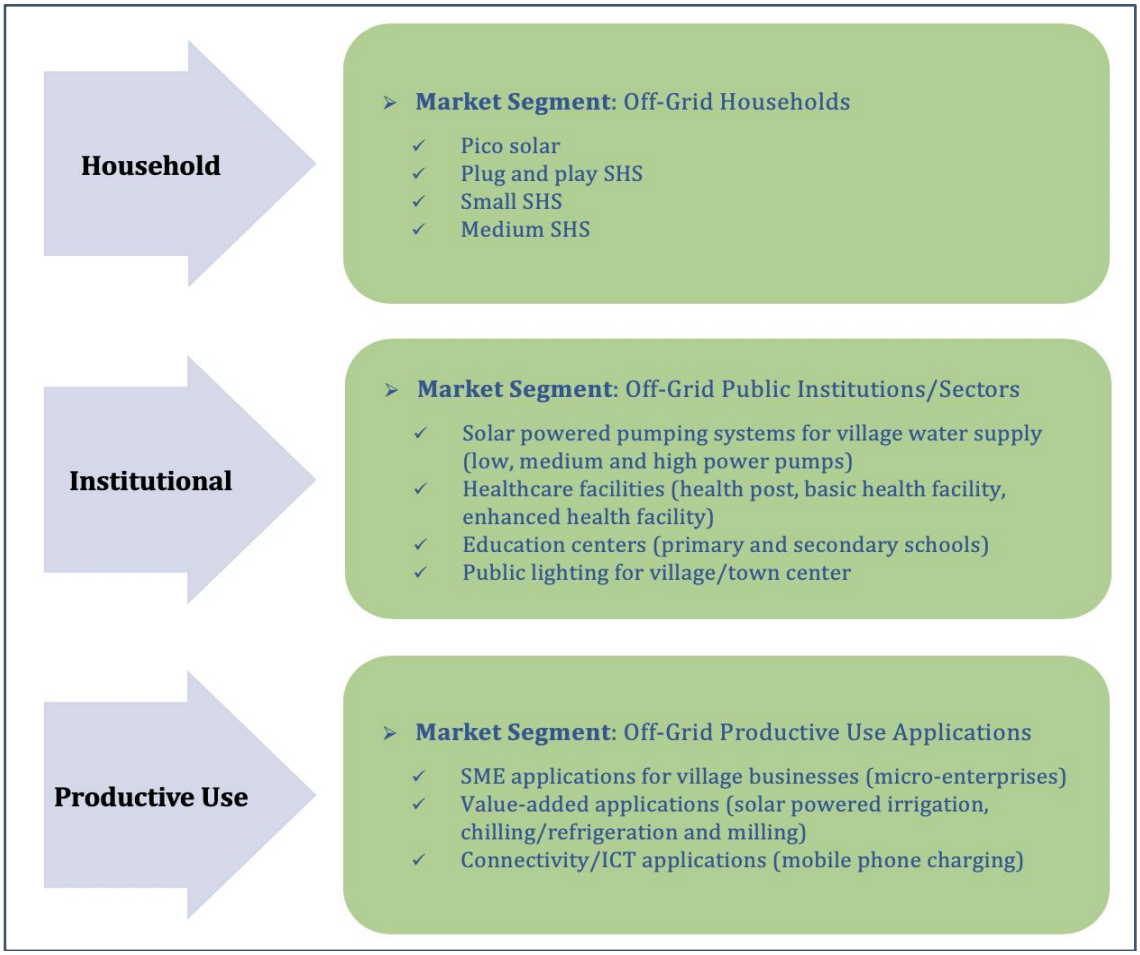
The institutional sector analysis combines available GIS data with secondary research to estimate potential demand based on assumptions about the electricity needs, usage patterns and associated costs of solar electrification of four public/institutional markets – water supply for off-grid communities,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

Niger is a landlocked West African state that consistently ranks among the least-developed countries in the world. Poverty is widespread, particularly in rural areas, where a significant share of the population relies on subsistence farming. Economic growth is driven mainly by increased activity in the country's nascent oil sector.[24] Exports from the mining sector have also increased in recent years, as Niger has some of the world's largest deposits of uranium. Despite these promising indicators, the Government of Niger (GoN) faces considerable development challenges going forward in its efforts to reduce poverty, diversify the economy and provide basic social services to a young and rapidly growing population.

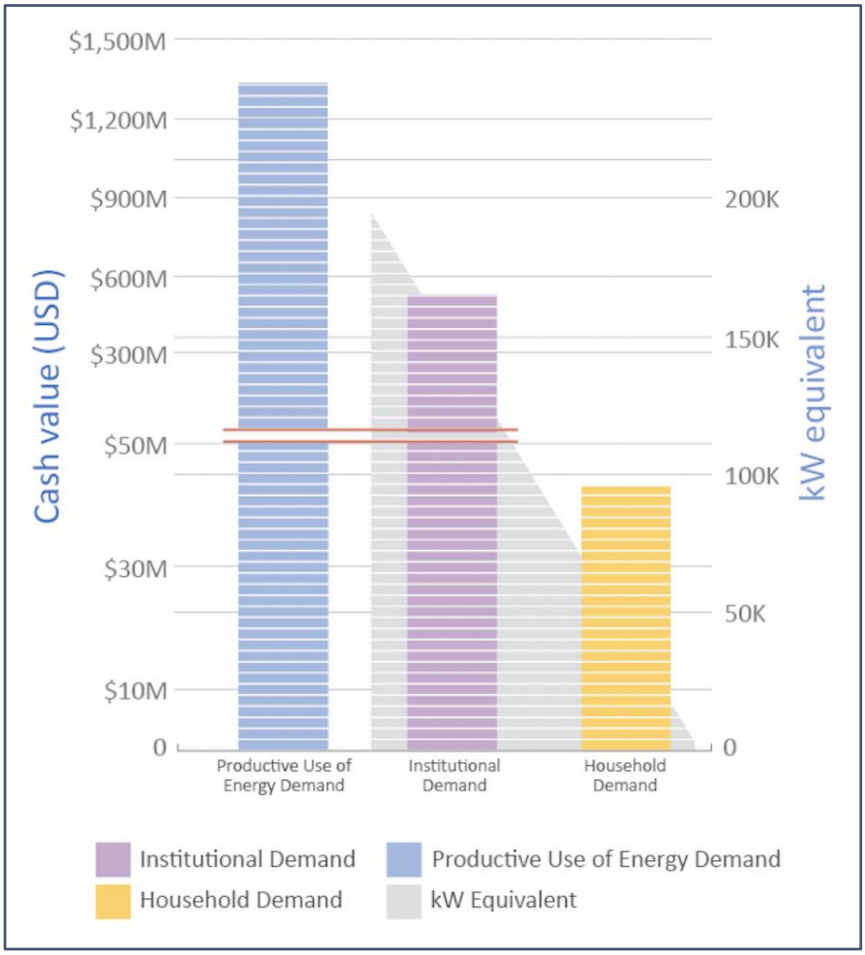
Access to electricity remains an ongoing challenge. In 2016, approximately 90% of Niger's population– an estimated 18 million people – lacked access to electricity, with a significant disparity between rates of access in urban (54%) and rural (1%) areas.[25]Even where grid connections exist, power supply is often unreliable, with fewer than one-third of firms and households reporting reliable access to electricity when surveyed.[26]Off-grid electrification is a policy priority for the Government, which is committed to achieving universal access by 2035.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 26-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017.In the 2017 RISE evaluation, Niger ranked seventh among countries in West Africa and the Sahel.[27]

Several off-grid programs are in various stages of implementation by the GoN, with funding and support from development partners.With support from ECREEE, the Government has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan (Plan d'Action National pour les Énergies Renouvelables, PANER). In addition, the Government is pursuing the National Electrification Strategy (NES) as its main policy and is also developing an electrification Master Plan. In early 2018, the Government announced the launch of a USD 50 million credit line from the World Bank through the Niger Solar Electricity Access Project (NESAP), USD 7 million of which is dedicated to stimulating off-grid sector development with a focus on the stand-alone solar market segment.[28] The Government has also adopted the Electricity Access Expansion Project (NELACEP), which focuses on grid connections.

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 Niger (**Figure ES-4**). The assessment reveals that there is a significant OGS market opportunity, with the total cash market potential in 2018 estimated to be USD 1.91 billion. The productive use sector ($1.33B) makes up the majority of this estimated market potential, followed by the institutional ($528.9M) and household ($43M) sectors.

[24] "Niger Economic Outlook," African Economic Outlook, African Development Bank, (2018): https://www.afdb.org/en/countries/west-africa/niger/niger-economic-outlook/
[25] IEA Energy Access Outlook, 2017.
[26] Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019): https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y
[27] "Policy Matters: Regulatory Indicators for Sustainable Energy," World Bank ESMAP, (2018): http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf
[28] "US 7 Million Line of Credit for Solar Off-Grid Electricity to Launch in Niger," Lighting Africa, (2018): https://www.lightingafrica.org/us-7-million-line-credit-solar-off-grid-electricity-launch-niger/

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

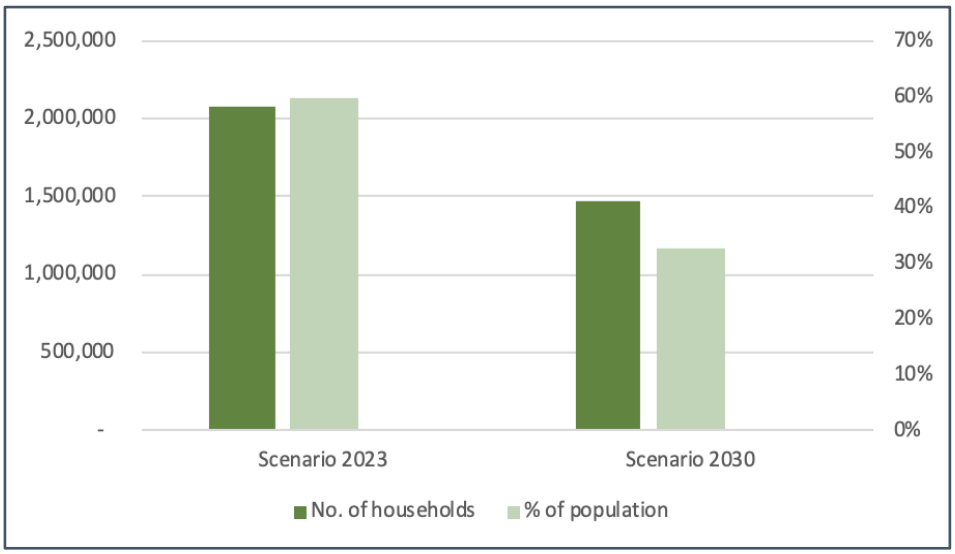


Source: African Solar Designs analysis

The least-cost electrification analysis found that by 2023, 3,865 settlements across Niger (1,136,695 households) will be connected to the main grid, representing 32.7% of the population. By 2030, this figure will increase to 11,519 settlements (2,631,061 households), equivalent to 58.3% 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 23,345 settlements (2,078,163 households), representing 59.8% of the population in 2023, as suitable for stand-alone systems, decreasing to 14,276 settlements (1,477,974 households) and 32.7% of the population in 2030 (**Figure ES-5**). While the total size of the off-grid solar market will slightly decrease over the analyzed timeframes, the geographic distribution of off-grid households across the countrywill remain relatively unchanged through 2030.

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

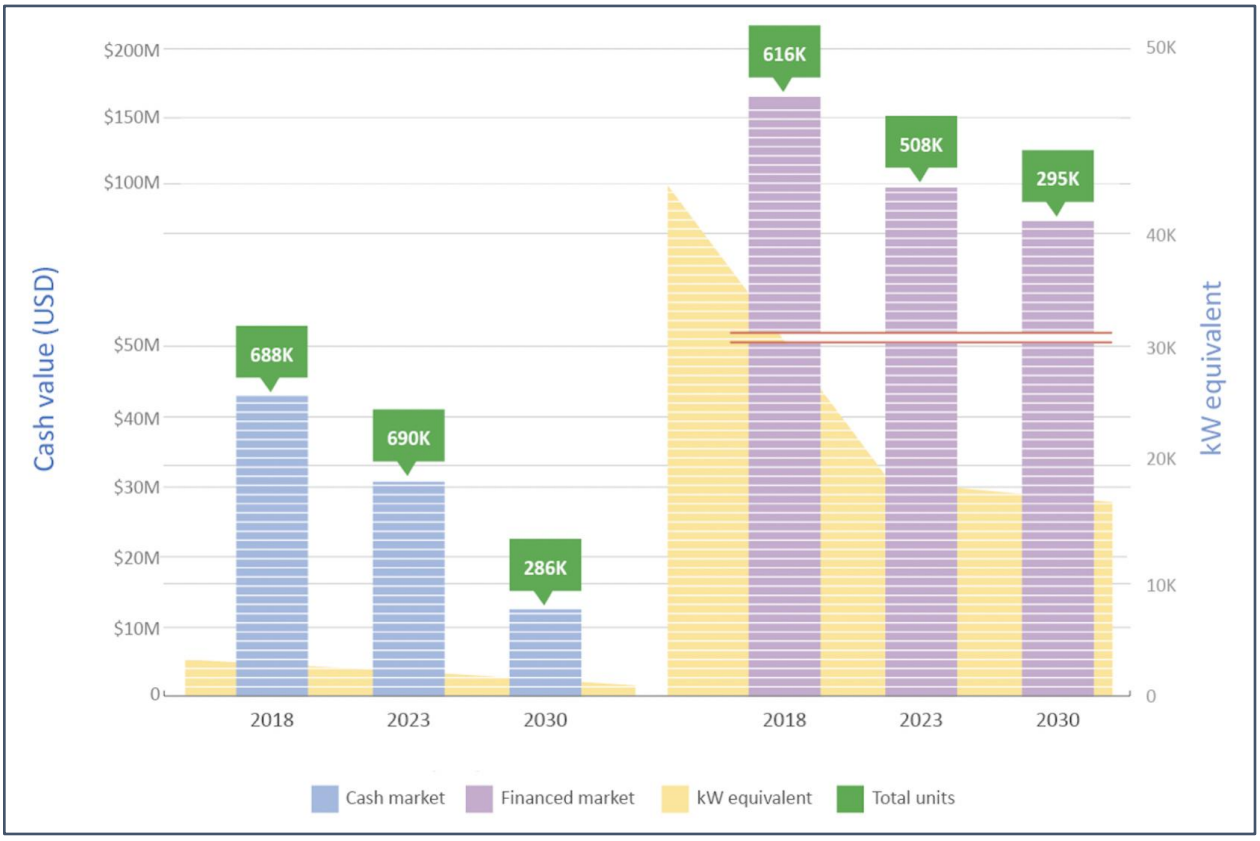


Source: Energio Verda Africa GIS analysis

The analysis of demand from private households estimates a total cash market potential in 2018 of USD 43 million, with the estimated market value more than tripling in size to USD 163.5 million with the addition of consumer financing (**Figure ES-6**). Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems.

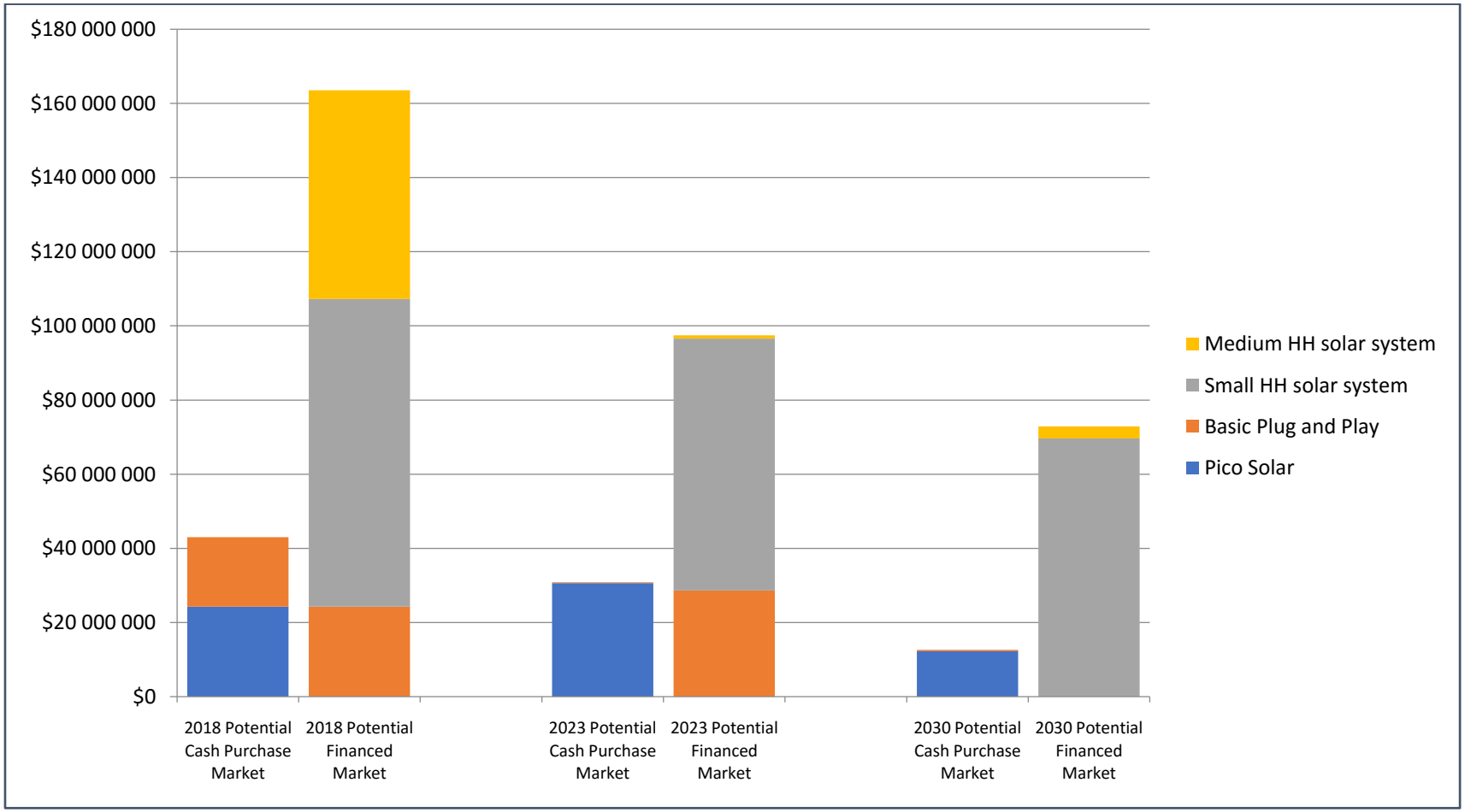
According to the assessment, the most common types of systems the market can afford on a cash basis are pico solar; however, this changes significantly with the introduction of financing (**Figure ES-7**). While affordability improves over time, households in the lowest income quintiles cannot afford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

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



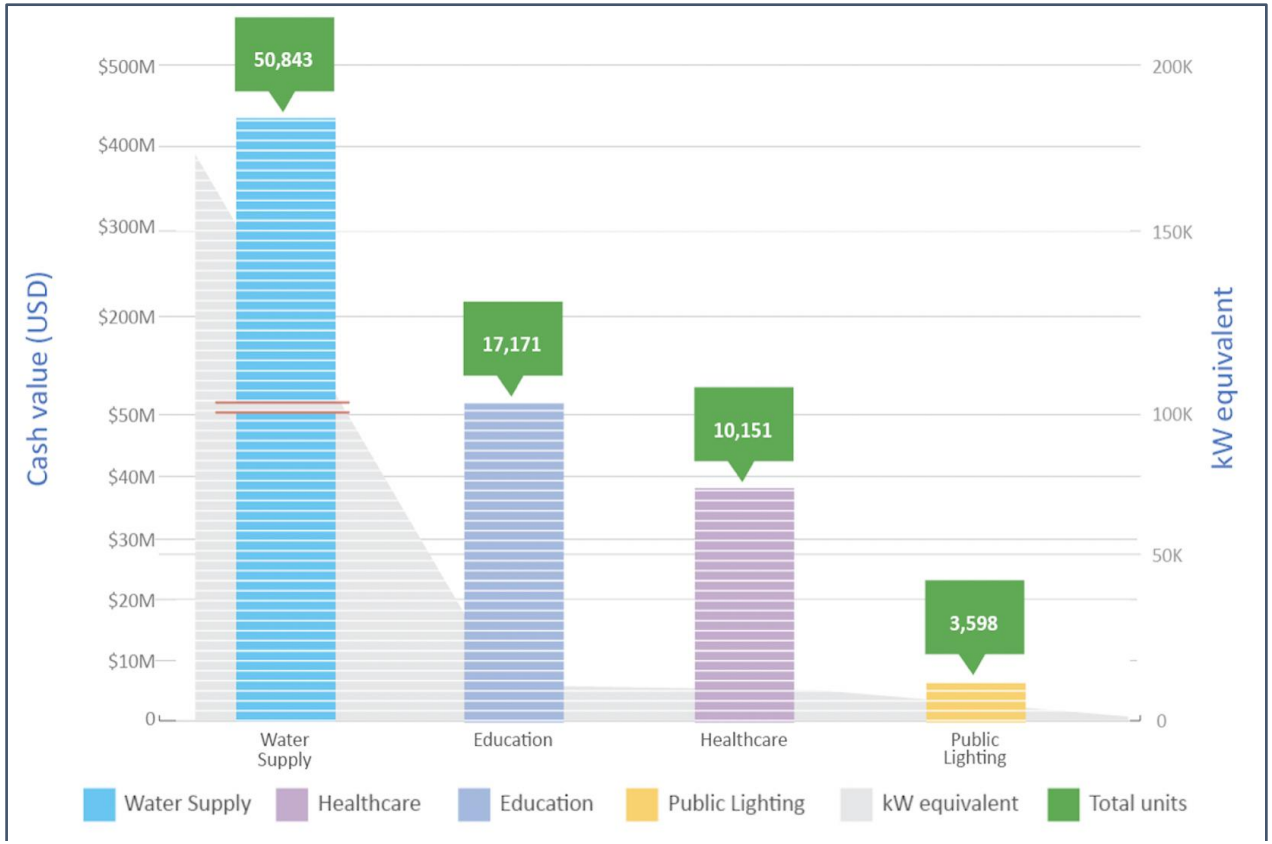
Source: African Solar Designs analysis

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



Source: African Solar Designs analysis

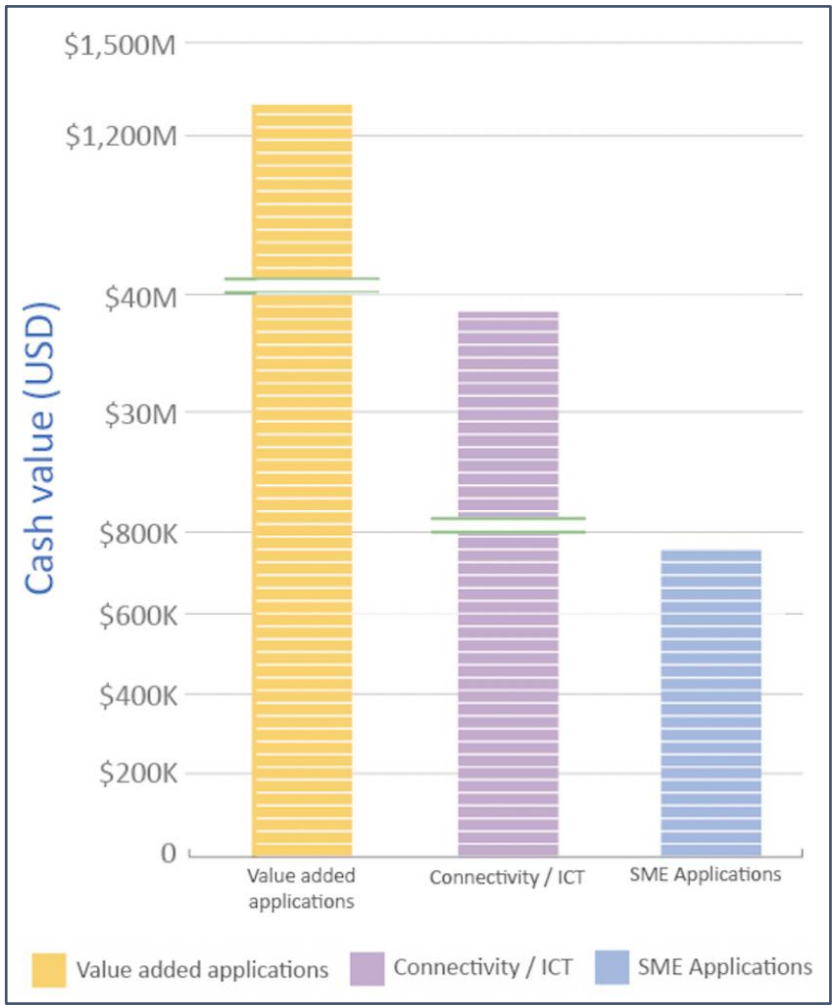
Figure ES-8: Estimated Off-Grid Solar Cash Market Potential for Institutional Sector



Source: African Solar Designs analysis

The estimated total cash market potential for Niger's public/institutional sector in 2018 is USD 528.9 million (**Figure ES-8**). The institutional market segment with the largest potential isvillage water supply ($432.5M), followed by the education ($51.9M), healthcare ($38.1M) and public lighting ($6.5M) sectors. The water supply sector analysis identified 50,843 off-grid water points (such as boreholes and wells) that could benefit from solar technology for water pumping. The education sector analysis identified 17,171 off-grid schools(15,571 primary and 1,600 secondary) that could be electrified by stand-alone systems. The healthcare sector analysis identified 10,151 off-grid health facilities categorized by their size (from basic clinics to enhanced health facilities) 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).

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



Source: African Solar Designs analysis

The analysis of demand from productive use estimates a total cash market potential in 2018 of USD 1.33 billion (**Figure ES-9**). The PUE market segment with the largest potential is value-added applications ($1.3B), followed by applications for connectivity ($38.5M) and SMEs ($772K).

The value-added applications that were analyzed include solar milling, solar powered chilling/refrigeration, and solar pumping for agricultural irrigation. The assessment utilized a series of inputs, including data from the UN's Food and Agriculture Organization on national agricultural production, as well as the most available/applicable solar technologies to support income generation by small shareholder farmers. Access to energy for agriculture is critical for the country's economic development, particularly given the sector's importance to GDP and the range of agricultural practices that would benefit from OGS solutions.

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

The calculation of the estimated off-grid solar market for SMEsfocuses 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 benecessary 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.

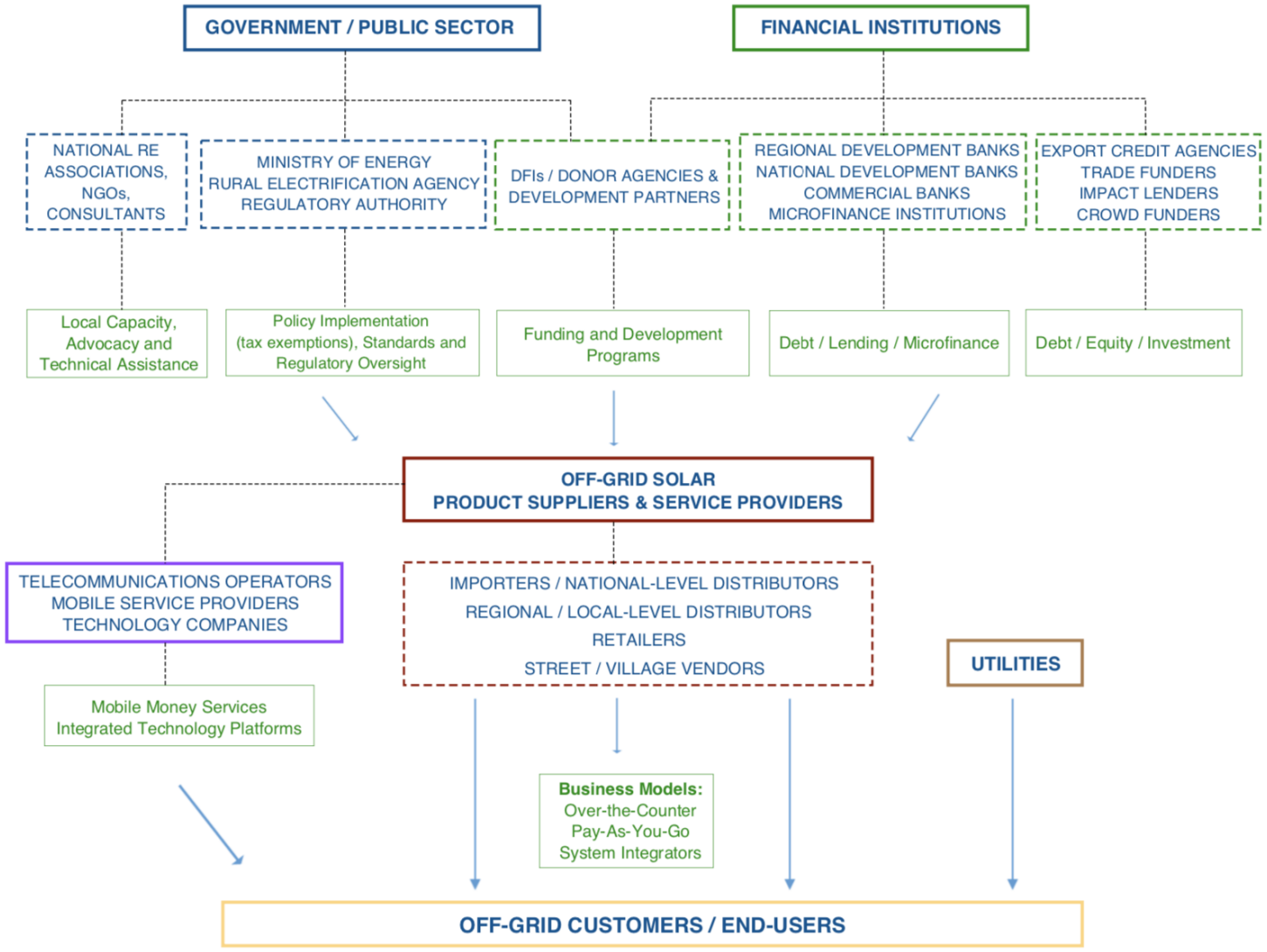
For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realties, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely 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 Niger, which includes a wide range of stakeholders, including importers, distributors, wholesalers, retailers and end-users(**Figure ES-10**).The off-grid solar sector is most developed in the regions of Agadez, Tahoua and Maradi. The solar supply chain is made up of both formal and informal companies that offer a variety of solar products and systems and deploy several business models.Rural households make up the main market for OGS products in the country, as the demand for lighting products and household electrical appliances is growing. Nevertheless, urban households, both electrified and non-electrified, are also a key consumer market, as they may have greater ability to afford solar products and systems.

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

Niger'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 Niger:

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

With 12 commercial banks active in Niger, the number of institutions relative to the population is extremely low. Moreover, commercial banks operate mainly in urban areas, leaving many rural and low-income people and businesses with limited access to financial services. While microfinance institutions have helped fill this void, informal sources of financing also serve a significant portion of the population.

Although access to banking and financial services through formal institutions remains limited, Niger 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, 16% of the country's adult population had an account at a financial institution or with a mobile money service provider, up from 2% in 2011, but still one of the lowest rates of financial inclusion in the region. Despite the country's overall improvement, there is a significant gender gap in rates of access to financial services, as women in Niger are 9% less likely than men to have an account at a financial institution or with a mobile money service provider.[29]

Expanding digital financial services, especially mobile money, can create new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the

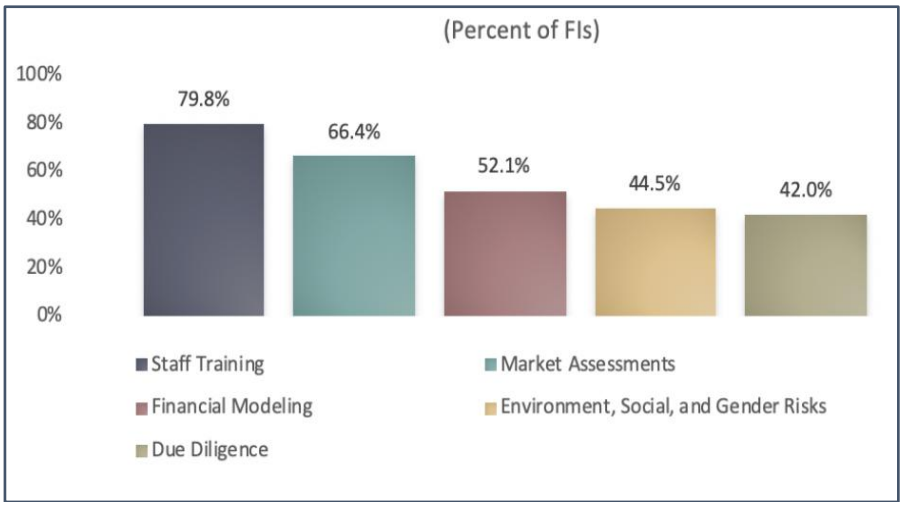
[29]Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., "The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution," World Bank, (2017): http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf

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.

While there are several donor and DFI-funded programs and initiatives that provide financing to support development of Niger'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 sectoras a result of donor-funded initiatives such as AFD's Sustainable Use of Natural Resources and Energy Finance (SUNREF)West Africa program, the recently completed USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR) program, and the abovementioned Niger Solar Access Project (NESAP).

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

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



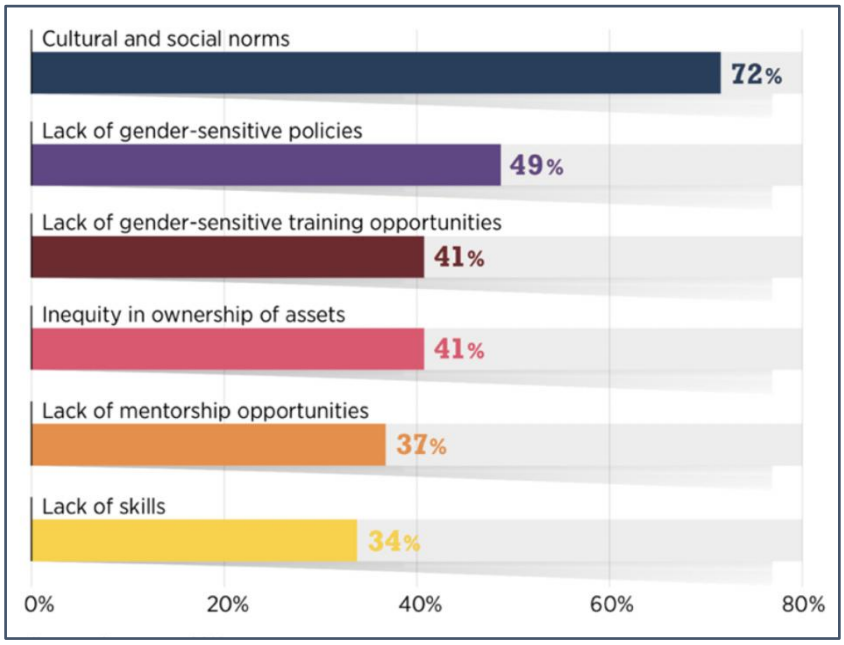
Source: Financial Institution survey; Stakeholder interviews; GreenMax Capital Advisors analysis

Gender inclusiveness is also a key component of this market assessment, and the key findings of the gender analysis are presented throughout this report. Given that the off-grid market is only beginning to emerge in Niger, women are not yet highly engaged in the sector. The overall lack of inclusive

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

participation in the off-grid space is attributable to a wide range of factors. A 2018 survey conducted by IRENA found that nearly three-quarters of respondents cited cultural and social norms as the most common barrier to women's participation in expanding energy access, which reflects the need for gender mainstreaming (**Figure ES-12**). More than half of the women surveyed in Africa identified a lack of skills and training as the most critical barrier, compared to just one-third of respondents globally.[31]

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

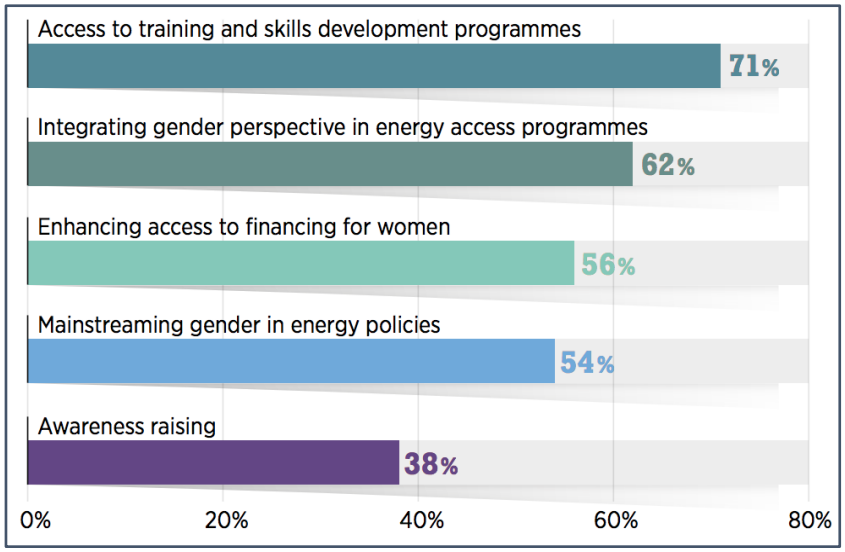


Source: International Renewable Energy Agency

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

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

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



Source: International Renewable Energy Agency

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

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

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 Niger.[33]

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

I. STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

This section begins with a brief introduction of key macroeconomic and social indicators in Niger (**Section 1.1**). This is followed by an overview of the country's existing energy sector (**Section 1.2**), with a focus on the status of energy access, including an assessment of both the on-grid and off-grid markets, a least-cost electrification analysis and a review of gender policies. **Section 1.3** examines national energy policy and regulation vis-à-vis the off-grid solar market, including detailed analysis of the existing framework for stand-alone systems[34]in Niger 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

Niger is a landlocked West African state that consistently ranks among the least-developed countries in the world. Poverty is widespread, particularly in rural areas, where a significant share of the population relies on subsistence farming. Economic growth was estimated at 5.2% in 2017 and is expected to continue along this trajectory in the near-term, driven mainly by increased activity in the country's nascent oil sector.[35] Exports from the mining sector have also increased in recent years, as Niger has some of the world's largest deposits of uranium. Despite these promising indicators, the Government of Niger (GoN, or "the Government") faces considerable development challenges going forward in its efforts to reduce poverty, diversify the economy and provide basic social services to a young and rapidly growing population.

Table 1: Macroeconomic and Social Indicators

Population	21.5 million[36]
Urban Population	19.3% of total
GDP	USD 8.1 billion
GDP growth rate	5.2%
GNI per capita*	USD 360
Unemployment rate	2.8%
Poverty rate	48.9% (2014)
Urban	18.6%
Rural	55.2%
Currency	West African CFA franc (CFA)
Official language	French
Natural resources	Agricultural (livestock); hydrocarbons (oil, coal); ores (uranium, gold, phosphates, tin)

* World Bank Atlas method (current USD)[37]

All figures from 2017 unless otherwise indicated
Source: AfDB, World Bankand IMF[38]

[34] NOTE: The term "off-grid" as it is widely used throughout this report (e.g. "off-grid sector") refers to both mini-grids and stand-alone systems. When "off-grid solar" or its acronym "OGS" are used, this refers *only* to stand-alone systems and does not include mini-grids
[35] "Niger Economic Outlook," African Economic Outlook, African Development Bank, (2018): https://www.afdb.org/en/countries/west-africa/niger/niger-economic-outlook/
[36] 50.3% male/49.7% female
[37] "World Bank Open Data: Niger," World Bank (2017): https://data.worldbank.org/country/niger
[38] "Niger Country and Program Report," IMF, (2017): https://www.imf.org/en/Publications/CR/Issues/2017/12/16/Niger-Second-Reviews-under-an-Arrangement-under-the-Extended-Credit-Facility-and-the-45469

1.2 Energy Market

1.2.1 Energy Sector Overview

The Ministry of Energy (MoE) is responsible for development and implementation of energy policy. The Nigerien Electricity Company (Société Nigérienne d'Electricité, NIGELEC) is Niger's utility that is majority-owned by the Government and has a monopoly over the transmission and distribution of power. The NigerienRural Electrification Promotion Agency (L'Agence Nationale de Promotion de l'Energie en milieu Rural, ANPER) was established to manage the country's rural electrification programs and initiatives. Niger has an independent regulatory authority, the Energy Sector Regulatory Agency (Agence de Régulation du Secteur de l'Énergie, ARSE), which advises the MoE on policies, laws and regulations.

Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Ministry of Energy (MoE)	Ministry responsible for development andimplementation of national energypolicy.
Nigerien Electricity Company (Société Nigérienne d'Électricité, NIGELEC)	Public utility under the MoE responsible for generation, transmission and distribution of electricity in Niger;NIGELEC has a monopoly over the transmission and distribution of power, but not over generation, as there are several IPPs. NIGELEC is majority owned by the Government of Niger and its management is overseen by the Ministry of Energy. It also facilitates electricity imports from Nigeria and electricity exports to Benin
Nigerien Rural Electrification Promotion Agency (L'Agence Nationale de Promotion de l' electrification en milieu Rural, ANPER)	Agency under the MoE responsible for implementation and monitoring of rural electrification development programs in Niger. ANPER is responsible for preparing annual and multi-year programs in the field of rural electrification.
Energy Sector Regulatory Authority (Agence de Regulation du Secteur de l'Energie, ARSE)	Regulatory authority responsible for developing laws and regulations governing the electricity sub-sectors by transparent and non-discriminatory means. ARSE also advises on any draft laws, regulations, strategy or policy in the energy sector
National Agency for Solar Energy (Agence Nationale de l'Energie Solaire, ANERSOL), formerly CNES	Office under the MoE responsible for quality control and compliance, project management, capacity building, training, research and development activities in renewable energy, specifically in the solar sector

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

1.2.2 Electricity Access: *Grid and Off-Grid*

Energy access in Niger represents a significant challenge, as the country has one of the lowest electrification rates in the world. In 2016, over 90% of the population – approximately 18 million people – did not have access to electricity, with a significant disparity in rates of access between urban (54%) and rural (1%) areas.[39]The Government has set a target of achieving universal access by 2035.

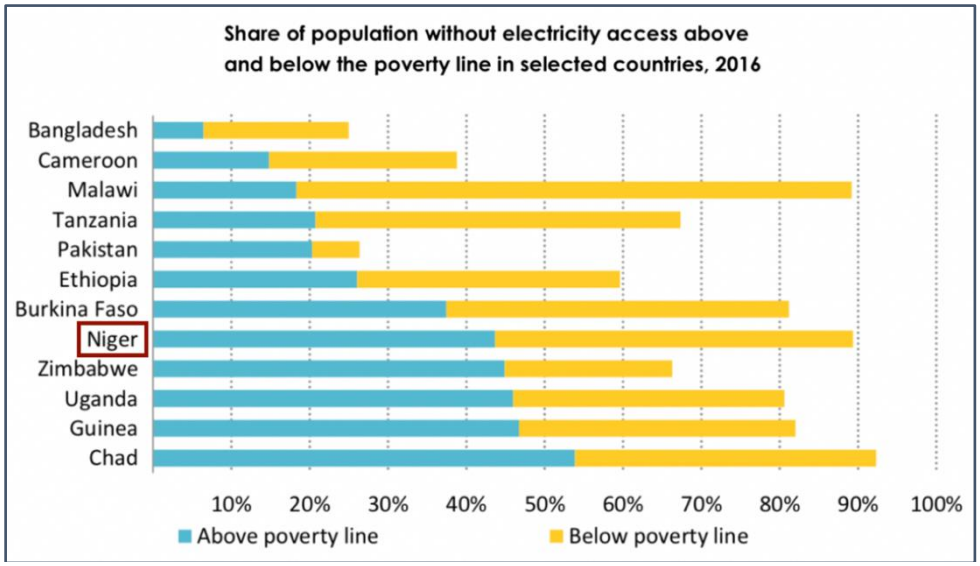
1.2.2.1 Off-Grid Market Overview

Niger's ability to achieve its electrification target is hindered by challenges in the energy sector. Despite widespread poverty, a significant portion of the population lives above the poverty line without electricity access, signaling that the lack of access is due in part to systemic issues related to grid infrastructure and the high cost of connection (**Figure 1**).Indeed, Niger's electricity networkexperiences frequent load shedding and outages. Efforts to extend the grid are further impeded by low population densities and purchasing power – an estimated 27% of the Nigerien population lives in localities with a population of

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

less than 500 people, and another 42% live in localities with a population ranging from 501 to 2,000, spread across the country's vast 1,265,000 sq. km.[40]

Figure 1: Rates of Electricity Access and Poverty



Note: World Bank defines the poverty line at below $1.90 a day ($2011 at purchasing power parity)

Source: International Energy Agency

In an effort to increase rural electrification and address energy access issues, the GoN is pursuingthe National Electrification Strategy (NES) as its main policy and is developing an electrification Master Plan. There are numerous donor agencies and development partners providing financing and technical assistance to the Government to support rural electrification projects and initiatives (see **Section 1.4**).In early 2018, the Government announced the launch of a USD 50 million line of credit through the Niger Solar Electricity Access Project (NESAP), USD 7 million of which is dedicated to stimulating off-grid development with a focus on the stand-alone solar market segment.[41]The Government has also adopted the Electricity Access Expansion Project (NELACEP), which focuses on gridconnections.

The 2017 Solar Access Report estimates the market for solar technology in Niger to be USD 204 million. Households represent a large portion of this market potential since 90% of the country's households are not connected to the grid.[42] The prevalence of rural poverty in Niger will only increase the urgency for financial support to initiate future off-grid projects. The agricultural sector, which represents 40% of Niger's GDP and 67% of annual freshwater pumping, also presents an opportunity for off-grid development, as do public institutions, including health facilities, schools and public institutions, who would benefit specifically from institutional lighting systems.[43]

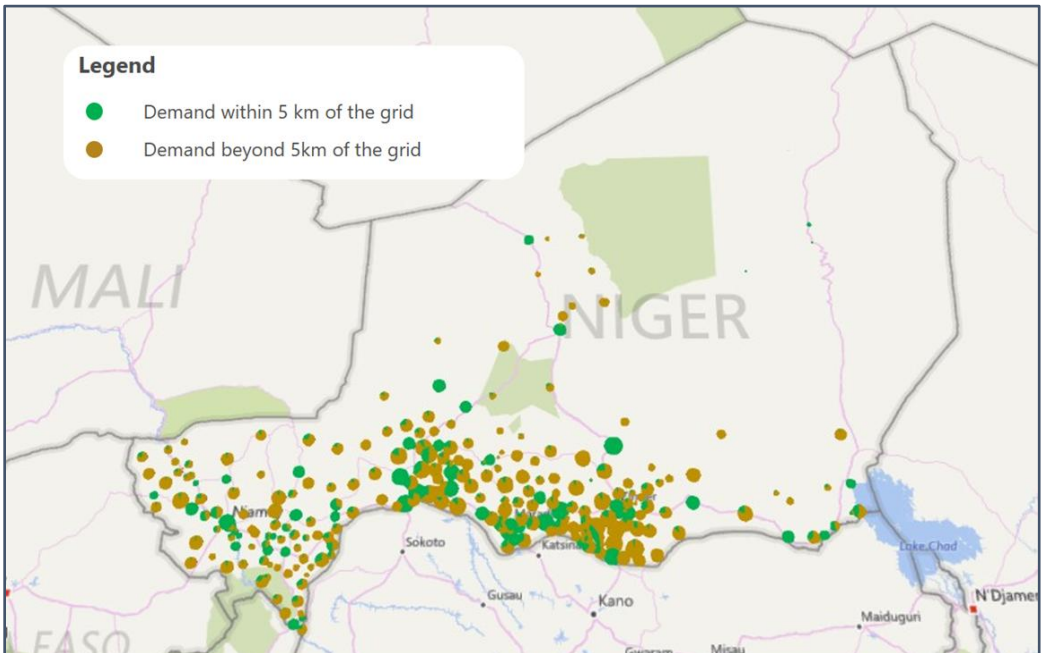
The estimated market for individual irrigation systems amounts to around USD 33 million each year and represents an annual sales volume of around 50,000 units. An average solar pumping station has an approximate capacity of 22 kW, but size varies with different crop types and water sources and can range

[40] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[41] "US 7 Million Line of Credit for Solar Off-Grid Electricity to Launch in Niger," Lighting Africa, (2018): https://www.lightingafrica.org/us-7-million-line-credit-solar-off-grid-electricity-launch-niger/
[42] Ibid.
[43] "World Bank Open Data: Niger," World Bank (2016): https://data.worldbank.org/country/niger

from 6 kW to nearly 120 kW. There are additional opportunities to expand the solar pump market to serve smallholder farms with integrated solar water pumping kits, which would expand the estimated market value to around USD 12.5 million.[44]Opportunities for off-grid solutions like Solar Home Systems (SHS) will provide relief to public institutions like schools which have much smaller electricity demand profiles compared to other off-grid users. Primary schools, 88% of which are not connected to Niger's grid, represent 80% of the country's solar market potential.[45]

In the off-grid space, private developers have piloted multiple projects to meet electricity demand (**Figure 2)**. Rural electrification agency ANPER has an estimated 152 mini-grid projects and 127 villages will be supplied with SHS, amounting to 15,000 households.[46] Two of these projects have already been completed, and five villages have also been supplied with solar kits to provide schools, health centers, mosques, and households with lighting and revenue generating activities.

Figure 2: Off-Grid Energy Demand by Grid Proximity



Source: World Bank

Although there is notable growth within the off-grid market, there are still few off-grid stakeholders present in the country to encourage growth of the sector. A total of 20 Engineering, Procurement, and Construction (EPC) firms, eight of which established a solar company association, have demonstrated interest in Niger's off-grid market in response to tenders from NGOs, development partners and the Government. These tenders request a broad range of services and community electrification projects including street lighting, solar irrigation and solar home systems. APE Solaire (Association des Profesionnels du Solaire), established in 2013, represents solar companies considered "system integrators" or engineering-procurement-commissioning companies registered in Niger (see **Section 2.4**).

[44] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[45] Ibid.
[46] "Niger National Renewable Energy Action Plan," SEforALL PANER, (2015): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Niger_Plan_d_Actions_National_des_Energies_Renouvelables.pdf

1.2.2.2 Demand and Supply/Generation Mix

In 2017, fossil fuels made up 95% of Niger's electricity generation mix. Diesel thermal plants comprised about three-quarters of fossil fuel capacity, with two coal-fired 18 MW generators at the SONICHAR Anou Araren plant making up the balance. The country's public utility, NIGELEC,operates four large diesel plants, while private uranium mining and refining companies SOMINA and SORAZ act as self-supplying IPPs to meet on-site load demand.

Table 3: Electricity Sector Indicators, 2017[47]

Installed Capacity	146 MW
Thermal diesel	103 MW
Coal	36 MW
Solar PV	7 MW*
National electrification rate (2016)	11%
Urban electrification rate	54%
Rural electrification rate	1%
Population without access	19.1 million
Households without access	2.7 million
Electrification target	Universal access by 2035

** Commissioned in 2018*

Source: IEA, USAID Power Africa and World Bank

The remaining share of installed capacity comes from solar PV. Niger's first solar PV plant (7 MW) was commissioned in 2018 in central Niger with support from the Indian government. This is part of a longer-term plan by the Government to deploy 100 MW of solar by 2021, which includes a streamlined 20 MW project, four plants in Dosso (10 MW), Maradi (20 MW), Niamey-Gorou Banda (30 MW) and Malbaza (13 MW), and a 22 MW solar-diesel hybrid project.[48]

Niger has one of the highest population growth rates in the world (3.9% annually).[49]In order to cope with the population's fast-growing electricity demand and reduce its reliance on imports from Nigeria, the GoN and NIGELEC are investing in major power infrastructure expansions to increase installed capacity **(Table 4)**.Over the last decade, imports of cheap electricity from Nigeria have enabled strong growth in electricity consumption. Nigerian imports contributed to 86.5% of total supply in 2010 but declined to 76.4 % in 2015 as demand growth exceeded transmission capacity. From 2001-2015, consumption grew 16% per year, substantially outstripping annual GDP growth of 4%. Large infrastructure projects currently planned to meet this demand growth include 100 MW of diesel,[50] 130 MW of large hydro, 200-600 MW of coal, and a new interconnection line with the WAPP to increase Nigerian imports by 400 MW.[51]

Table 4: Current and Planned Installed Capacity[52]

Installed Capacity (MW)	2017	2020 (planned)	2030 (planned)
Thermal	139	275	675
Hydro	-	130	139
Solar	7	50	150
Total Installed Capacity (MW)	**146**	**455**	**964**
Total thermal	139	275	675
Total renewable energy	7	180	289

NOTE: 2017 data does not include an estimated 126 MW of imported electricity from Nigeria

[47] See **Section 2.1** for more details on households/population without access to electricity.
[48] Bellini, E., "Niger commissions first solar park," PV magazine, (November 26, 2018): https://www.pv-magazine.com/2018/11/26/niger-commissions-first-solar-park/
[49] "Niger Country Overview," The World Bank: https://www.worldbank.org/en/country/niger/overview
[50] The first 80 MW of this are due to be commissioned in 2018, with the balance (20 MW) due to come online in 2020.
[51] "Niger: Power Africa Fact Sheet," USAID, (2018): https://www.usaid.gov/powerafrica/niger
[52] "Plan d'Actions National des Energies Renouvelables (PANER)," SEforALL/ECREEE, (2015): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Niger_Plan_d_Actions_National_des_Energies_Renouvelables.pdf; and "Niger Solar Electricity Access Project," World Bank, (2017): http://documents.worldbank.org/curated/en/184321492035663284/pdf/ITM00194-P160170-04-12-2017-1492035661106.pdf

Source: MoE, NIGELECand World Bank

NIGELEC sells both imported and locally generated power to on-grid consumers at a tariff of USD 0.16/kWh.[53] In 2012, the Government introduced a social tariff to increase rates of grid access and support low-income and low-consumption subscribers, mainly households, by providing price subsidies based on consumption. Consumers below 3 kWh per day are charged USD 0.11/kWh for the first 50 kWh of electricity consumed. Fixed concessionary rates also apply to industrial consumers (USD 0.11/kWh) and agricultural facilities (USD 0.07/kWh).[54]

1.2.2.3 Transmission and Distribution Network

Niger's power system(**Figure 3**) is made up of (i) four grids that are interconnected with Nigeria, which sells electricity at very low cost; (ii) one grid supplied by a coal plant operated by private company SONICHAR; and (iii) a number of diesel-based isolated grids. Decentralized mini-grids operated by the national utility supply 82 centers with electricity service levels ranging from continuous power to a few hours of power per day, using small diesel generators.Although the grid currently only reaches under 11% of the population and only covers a small portion of Niger's total area, a significant share of the off-grid population lives within relatively close proximity to the network, as the majority of the population is concentrated in the southern part of the country (**Figure 2**).[55]

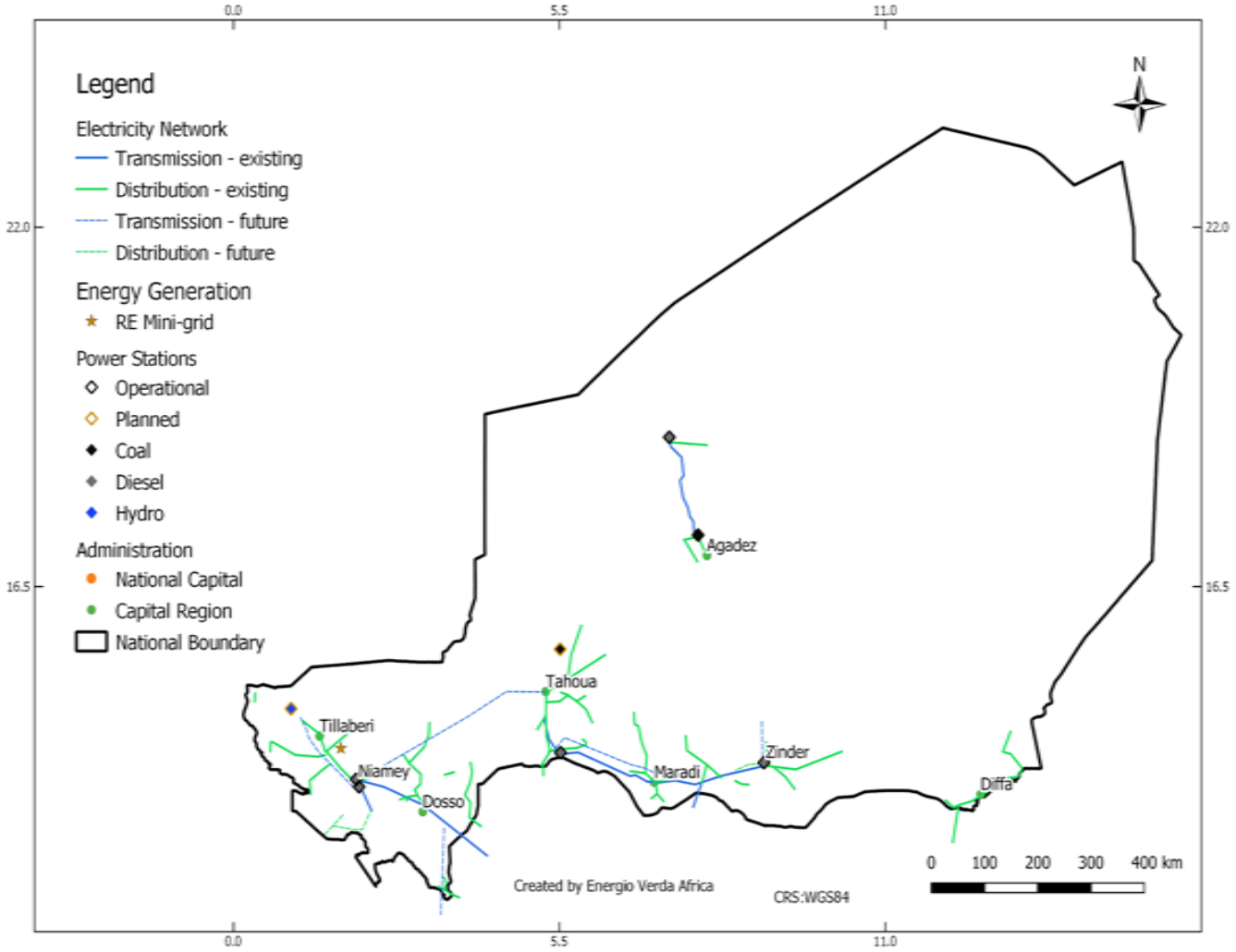
NIGELECdistributes electricity to approximately 350,000 client connections, most of which experience frequent load shedding, as electricity service remains largely unreliable (**Figure 4**). The electrical transmission network in Niger is divided into six zones:

- The River Zone fed by the 132kV interconnection line from BirninKebbi (Nigeria) to Niamey (Niger) with a contractual power of 120 MW;
- The Niger Centre East (NCE) Zone whichbrings together the regions of Zinder, Maradi and Tahoua, powered by the 132kV interconnection line from Katsina (Nigeria) to Gazaoua (Niger) with a power contract of 60 MW with Nigeria;
- The Northern Zone, which includes the towns of Agadez, Arlit and Tchirozerine, fed from the Sonichar coal plant and a central thermal diesel in Agadez with an installed capacity of 37 MW;
- The Diffa Zone connected to the 33 kV Nigerian network from Damasak with a capacity of 5 MW and installed thermal diesel production of 2.3 MW;
- The Gaya/Malanville Zone, which is fed by a 33kV interconnections from Kamba in Nigeria and has contracted power of 7 MW with Nigeria;[56]and
- The Isolated Zone, which is formed by all other centers in Niger powered in total by 100 diesel power stations and operated by NIGELEC.

Due to each zone's distance from one another, there is little movement of energy from a surplus area to a deficit area. The distribution network is also underdeveloped, dilapidated and saturated in major cities. The household access rate in urban areas is about 50%. The situation is different in rural areas, where access to electricity is less than 1% – a key driver of poverty in these areas.The World Bank (NELACEP, NELACEP), AFD and AfDB among others have provided financing and TA to support grid extension and access in urban and rural areas of the country.

[53] "Regulatory Indicators for Sustainable Energy: Niger," (2018): http://rise.worldbank.org/country/niger
[54] "World Bank help to Increase Access to Electricity in Niger," World Bank, (16 December 2015): http://www.worldbank.org/en/news/press-release/2015/12/16/world-bank-help-to-increase-access-to-electricity-in-niger
[55] "The Energy Sector of Niger: Perspectives and Opportunities," Energy Charter, (2015): https://energycharter.org/fileadmin/DocumentsMedia/Occasional/Niger_Energy_Sector.pdf
[56] "Sustainability Electricity Supply Scenarios for West Africa," IAEA, (2016): https://www-pub.iaea.org/MTCD/Publications/PDF/TE1793web.pdf

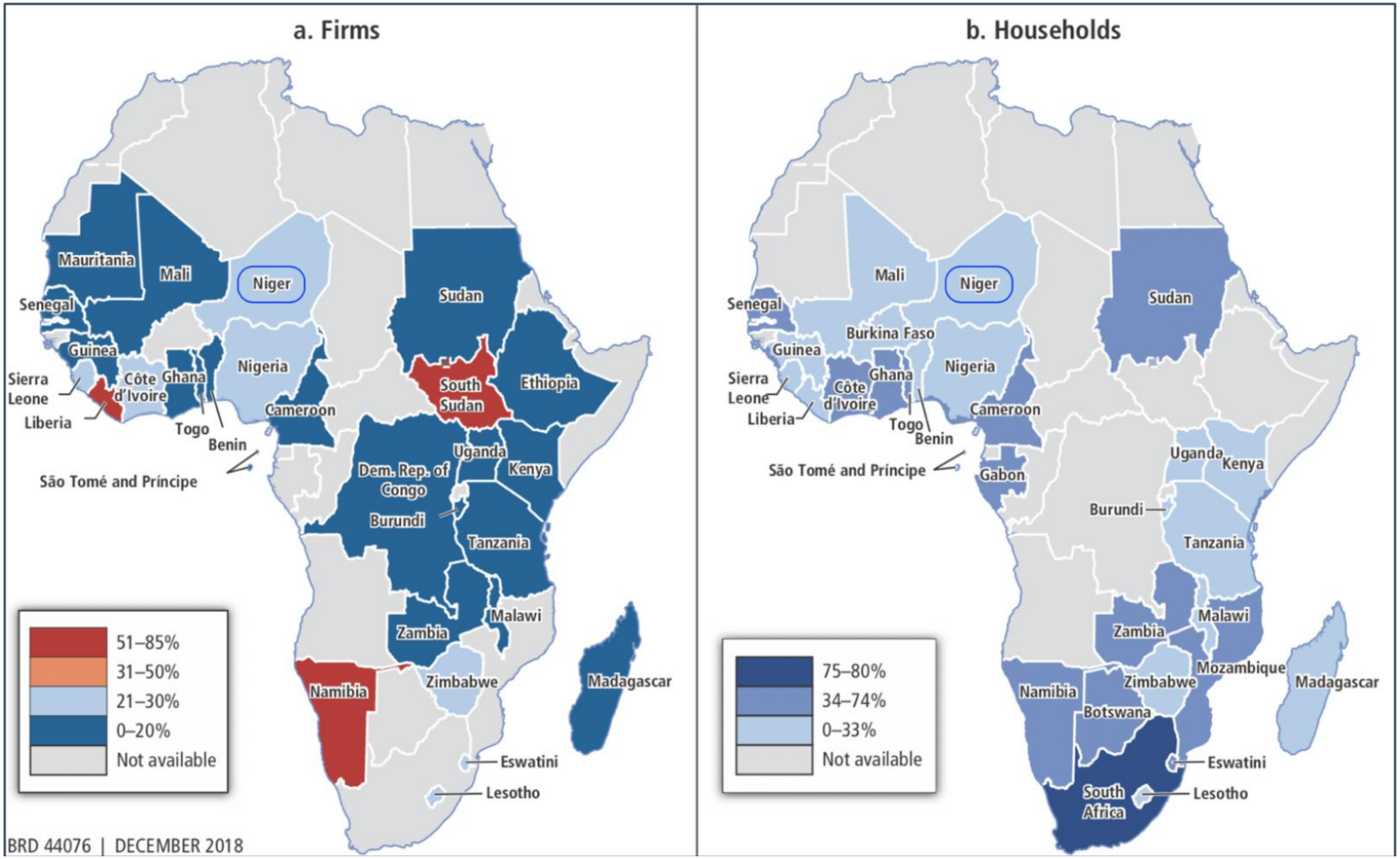
Figure 3: Electricity Transmission and Distribution Network[57]



Source: Energio Verda Africa GIS analysis

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

Figure 4: Access to Reliable Electricity by Firms and Households in Africa[58]



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

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

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

1.2.2.4 Least-Cost Electrification Analysis

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

For the scenario 2023 analysis, it is assumed that widespread densification of the existing electrical grid will enable settlements within 5 km of existing grid lines and Power Stations to connect to the grid (in line with "Programme special d'électrification du Président de la République").[60] Beyond this area, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km^2) and have active local economies, evidenced by the presence of social facilities and by their proximity to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km^2) or far from the national grid – are defined as candidates for off-grid stand-alone systems.

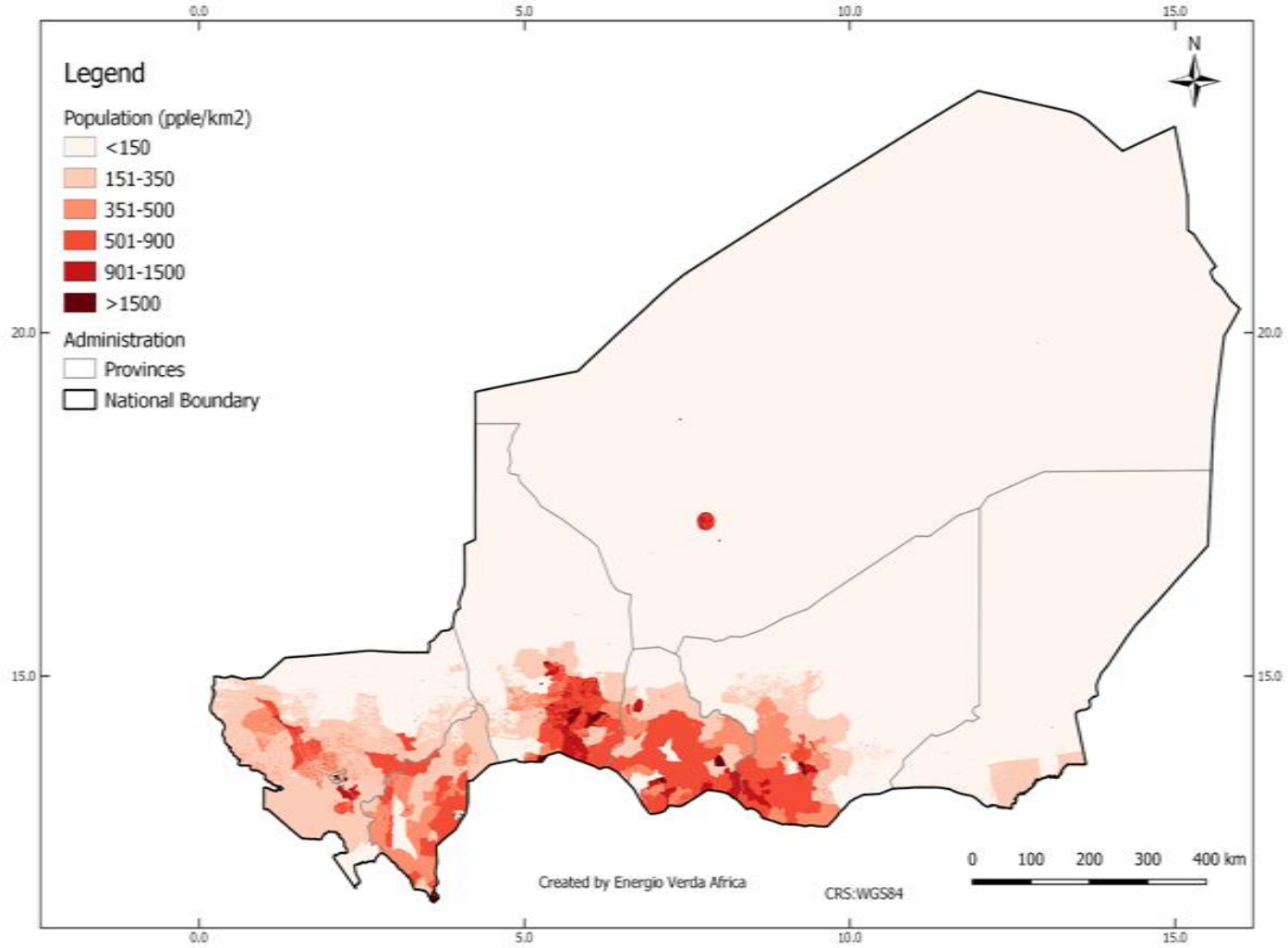
For the scenario 2030 analysis, it is assumed that the grid and the reach of grid densification efforts will extend far beyond the existing network. Hence, settlements that are within 15 km of current lines (according to NIGELEC in a personal interview) and 5 km of future planned line extensions are assumed to be connected. For mini-grids, future economic development – which will allow new settlements to grow sufficiently to become candidates for mini-grids – is assumed to occur in settlements within 1 km of mini-grid settlements (average distance of mini-grid coverage of different developers) identified in the scenario2023 analysis, as well as within 15 km of economic growth centers – airports, mines and urban areas. All other settlements are defined as candidates for off-grid stand-alone systems.

Given the lack of low voltage distribution line data, it is necessary to approximate areas where un-electrified settlements in close proximity to the grid exist. The analysis therefore focuses on settlements that are within 5 km of the high and medium voltage network, but that are located beyond 15 km of areas with night-time light emissions (indicative of electrification). Settlements in areas of low population density that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within scenario2023.[61]

Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 3.8%[62]was applied to the geospatial analysis to project population figures for the scenario 2023 and 2030 analyses.[63]**Figure 5**shows population density across the country, which served as the basis for this analysis.

[59] NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to GoN electrification targets for 2030
[60] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[61] 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
[62] The World Bank: https://data.worldbank.org/indicator/SP.POP.GROW?locations=NE
[63] See **Annex 1** for the results of this analysis as well as more details on the approach and methods used

Figure 5: Population Density, 2015[64]



Source: Energio Verda Africa GIS analysis

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

- **Results**

Table 5summarizes 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 (7.1 persons/household).[65]

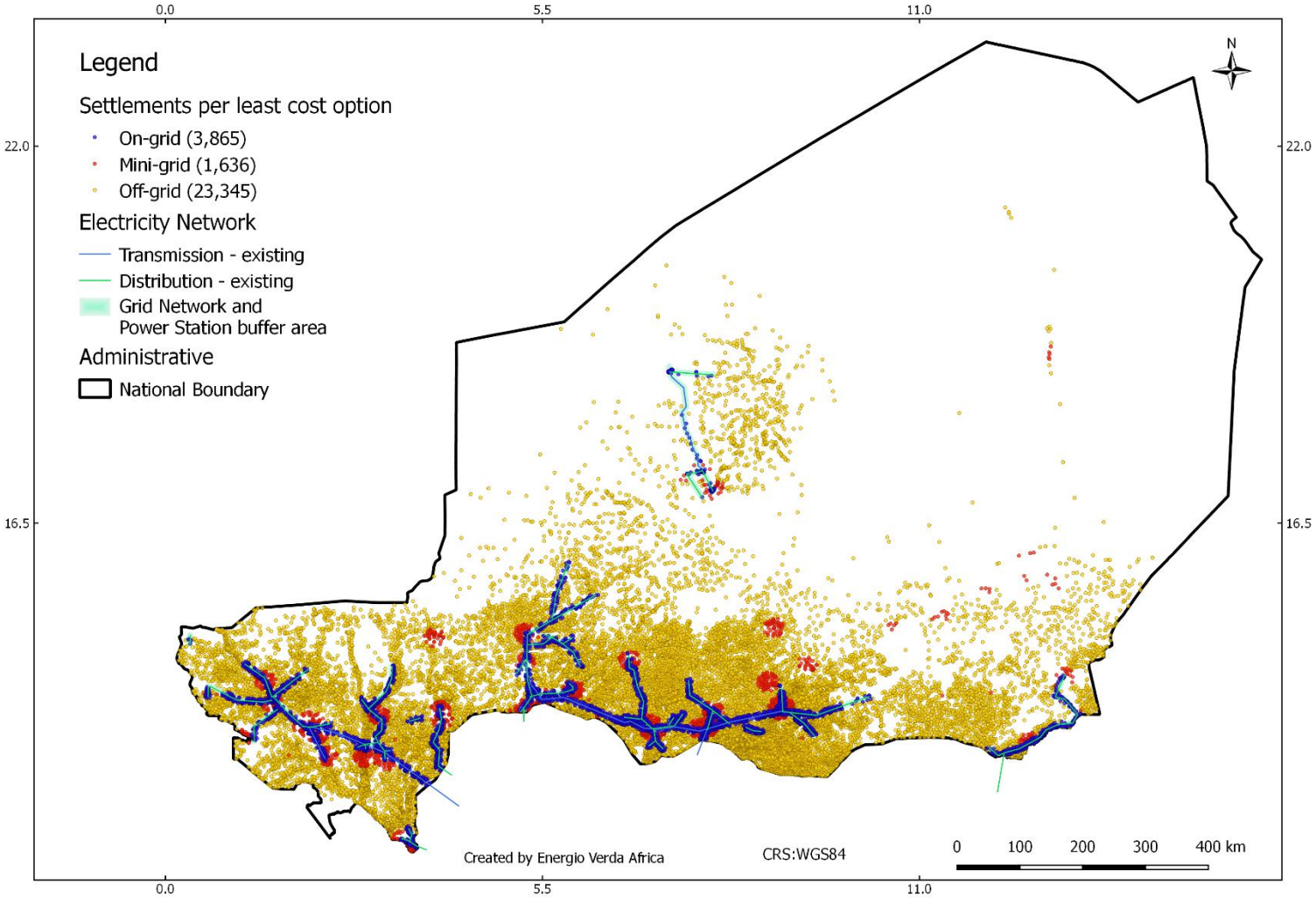
Table 5: Results of Least-Cost Electrification Analysis

Scenario	Indicator	Least-Cost Electrification Option			Grid Vicinity		
		Grid extension	Mini-grid	Off-grid stand-alone systems	Under-grid un-served	Total under-grid	Total outside grid vicinity
Scenario 2023	Number of settlements	3,865	1,636	23,345	848	4,713	24,137
	% of settlements	13.4%	5.7%	80.9%	18.0%	16.3%	83.7%
	Total population	8,070,533	1,856,772	14,754,955	451,793	8,522,326	16,161,776
	% of population	32.7%	7.5%	59.8%	5.3%	34.5%	65.5%
	Number of households	1,136,695	261,517	2,078,163	63,633	1,200,328	2,276,306
Scenario 2030	Number of settlements	11,519	3,054	14,276	Not calculated	11,519	17,331
	% of settlements	39.9%	10.6%	49.5%	Not calculated	39.9%	60.1%
	Total population	18,680,530	2,873,298	10,493,616	Not calculated	18,680,530	13,367,313
	% of population	58.3%	9.0%	32.7%	Not calculated	58.3%	41.7%
	Number of households	2,631,061	404,690	1,477,974	Not calculated	2,631,061	1,882,720

Source: Energio Verda Africa GIS analysis

[65] "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

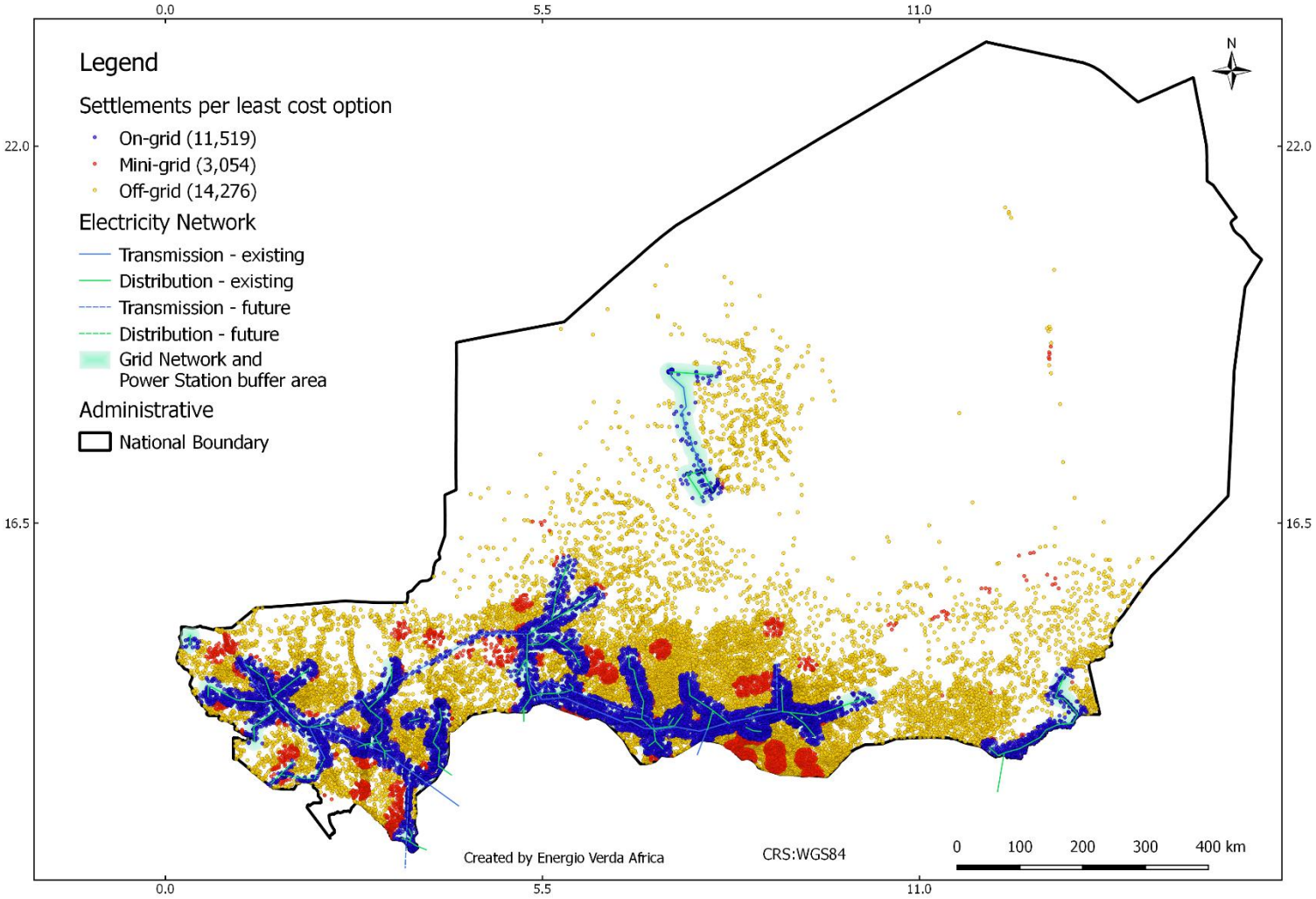
Figure 6: Distribution of Settlements by Least-Cost Electrification Option, 2023[66]



Source: Energio Verda Africa GIS analysis

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

Figure 7: Distribution of Settlements by Least-Cost Electrification Option, 2030[67]



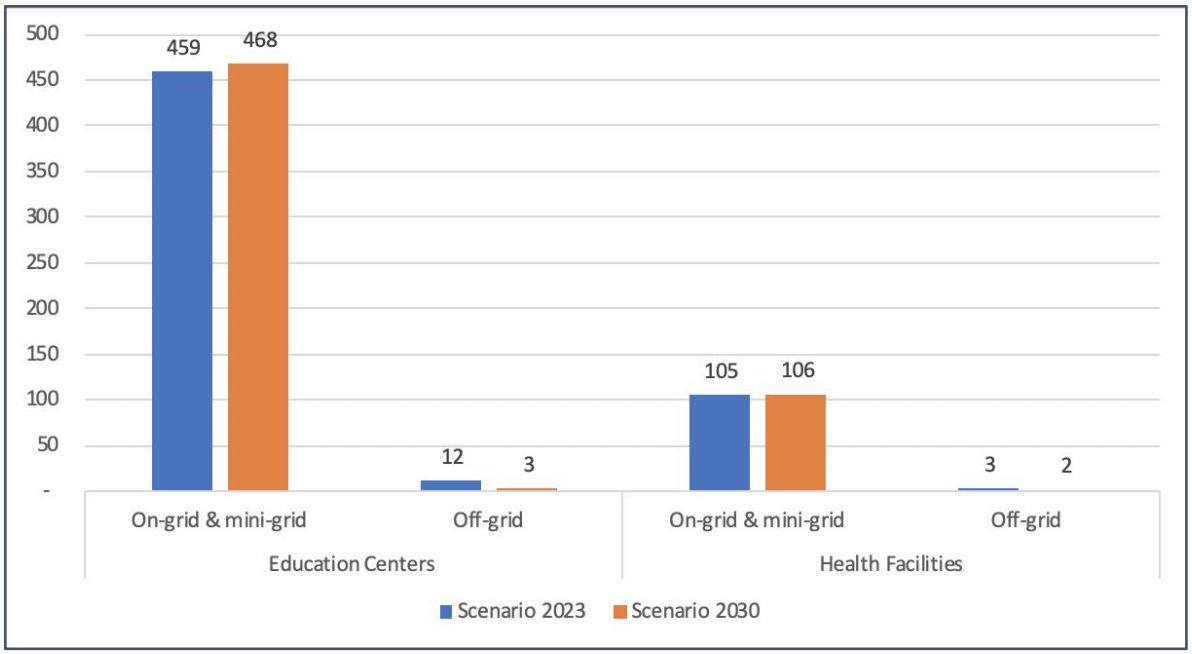
Source: Energio Verda Africa GIS analysis

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

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

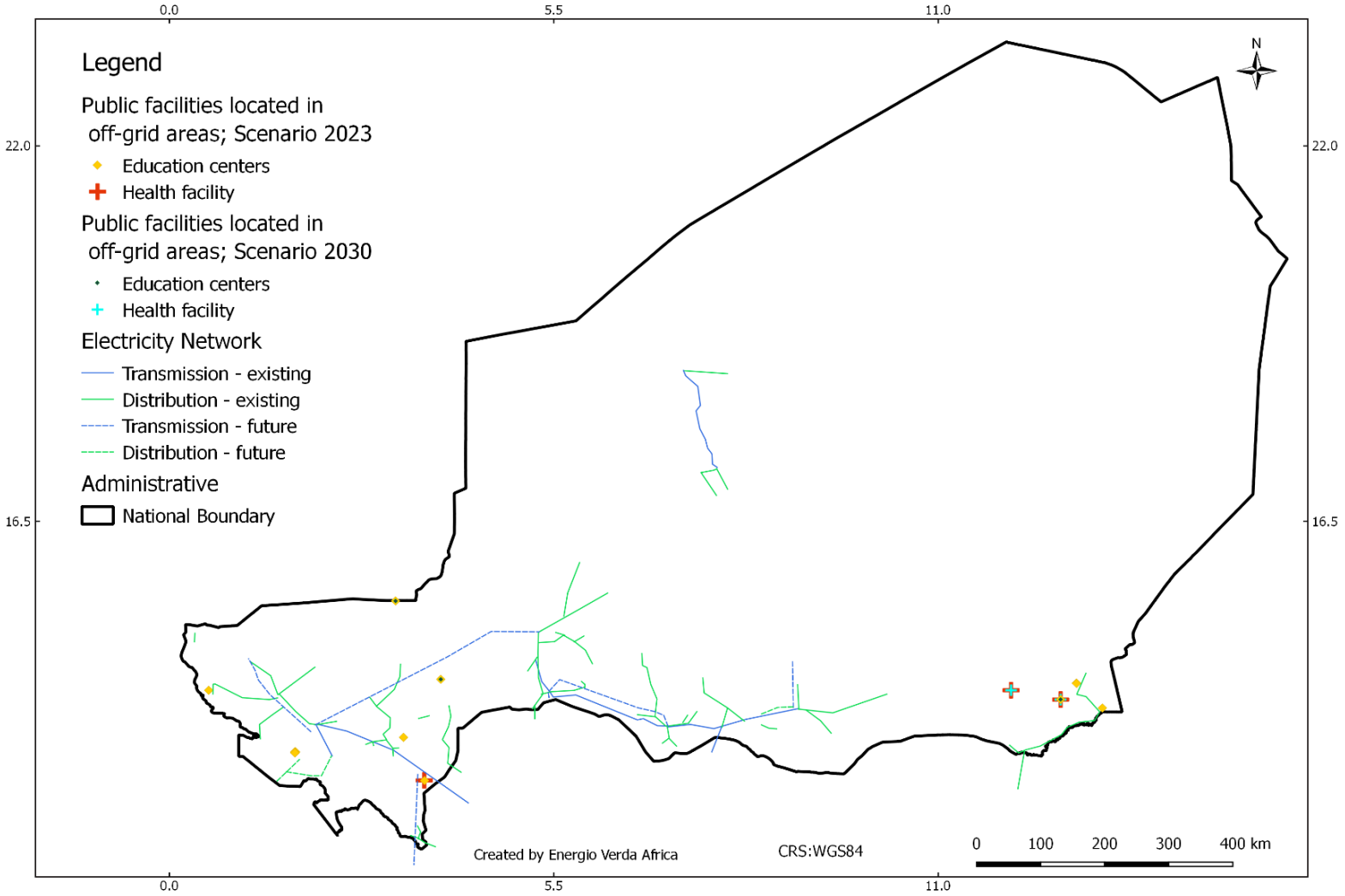
Figure 8 summarizes the number of education centers and health facilities that may be electrified (on-grid and mini-grid) or suitable for off-grid solutions in scenarios 2023 and 2030. **Figure 9**illustrates the distribution of potential off-grid facilities across the country under the two scenarios.

Figure 8: Identified Social Facilities for On-Grid, Mini-Grid and Stand-alone Solutions, 2023 and 2030



Source: Energio Verda Africa GIS analysis

Figure 9: Distribution of Potential Off-Grid Social Facilities, 2023 and 2030[68]



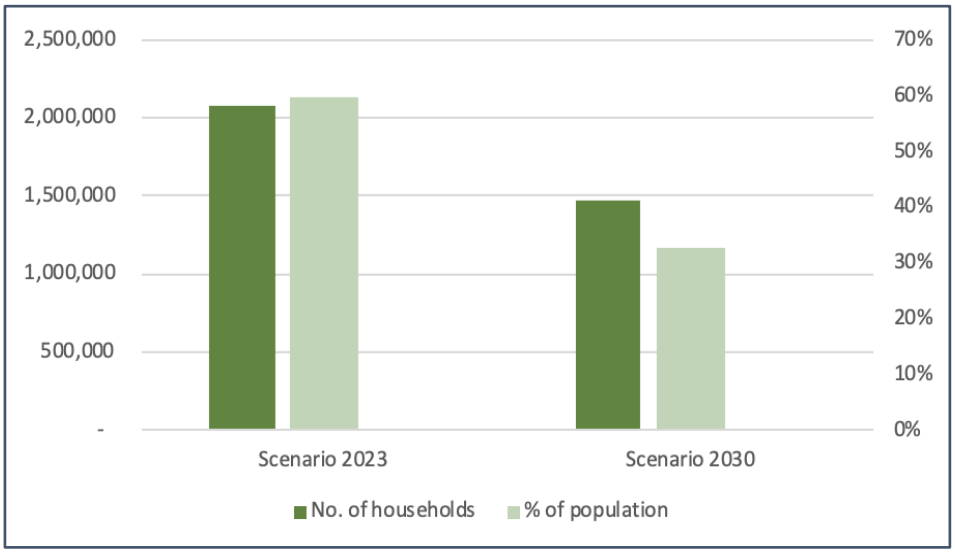
Source: Energio Verda Africa GIS analysis

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

According to the geospatial analysis (**Table 5**), by 2023, 3,865 settlements across Niger (1,136,695 households) will be connected to the main grid, representing 32.7% of the population. By 2030, this figure will increase to 11,519 settlements (2,631,061 households), equivalent to 58.3% 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 848 settlements located under the grid will meet these criteria (or 18.0% of the settlements located within 5 km of the grid).

Outside of the main grid areas, settlements with higher economic growth potential and higher population density can optimally be electrified by mini-grids. By 2023, this represents an estimated 1,636 settlements (261,517 households), or 7.5% of the population, increasing to 3,054 settlements (404,690 households), or 9.0% 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 23,345 settlements (2,078,163 households) and 59.8% of the population in 2023, decreasing to 14,276 settlements (1,477,974 households) and 32.7% of the population in 2030 (**Figure 10**).

Figure 10: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

The analysis indicates that the off-grid stand-alone market has the potential to grow significantly. According to figures published by the Global Off-Grid Lighting Association (GOGLA),[69] an estimated 3,640 off-grid stand-alone solar PV products (pico solar and SHS) have been sold in Niger as of the end

[69] "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

of 2017 (see **Section 2.4.3**). The least-cost analysis estimates that over 2 million households in 2023 are suitable for off-grid stand-alone solutions.

In its SEforALL National Renewable Energy Action Plan (PANER), the GoNenvisions a relatively significant share of the population will gain electricity access through off-grid systems (**Table 6**). The findings of the least-cost analysis suggest that the Government may need to consider increasing the utilization of off-grid solutions (a combination of mini-grids and stand-alone systems) in its electrification planning in order to achieve its energy access targets, particularly in the near-term until planned grid extensions are realized.

Table 6: Estimated Share of Population Served by Off-Grid Systems[70]

Share of population with access to off-grid systems powered by renewable energy (%) *	2020 (target)	2030 (target)
	15%	30%

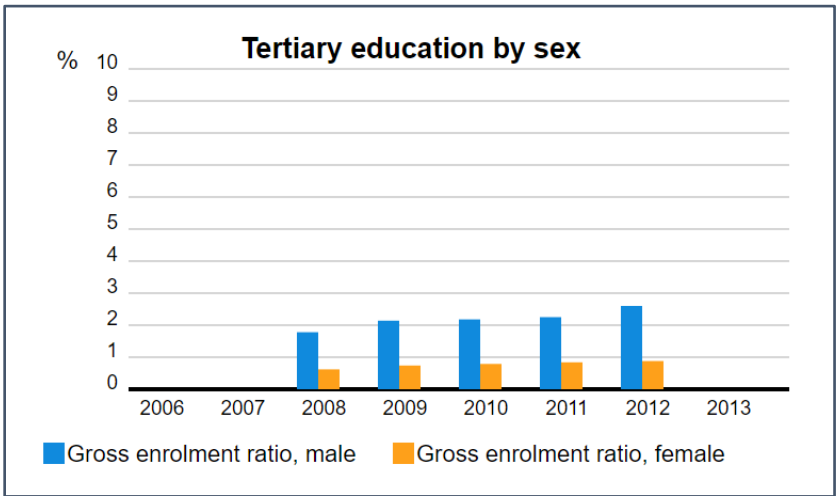
* Estimate includes both mini-grids and stand-alone systems

Source: SEforALL National Renewable Energy Action Plan (PANER)

1.2.2.5 Inclusive Participation[71]

Inclusive participation in Niger 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. Niger performs poorly in the UNDP Gender Inequality Index, which measures several indicators to assess levels of gender inequality in the areas of health, access to education, economic status and empowerment.[72]Female participation in education, particularly higher education, remains disproportionately low (**Figure 11**).[73] While gender discrimination is widespread, these issues tend to be more pronounced in rural areas of the country.

Figure 11: Rates of Enrollment in Tertiary Education



Source: UNESCO Institute for Statistics

[70] "Plan d'Actions National des Énergies Renouvelables (PANER): Niger," SEforALL / ECREEE, (2015): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Niger_Plan_d_Actions_National_des_Energies_Renouvelables.pdf

[71] See **Annex 4** for more details

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

[73] "Niger Participation in Education," UNESCO Institute for Statistics, (2018): http://uis.unesco.org/en/country/bf?theme=education-and-literacy

Niger 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. Niger has signed both the Convention on the Elimination of All forms of Discrimination against Women (CEDAW) and the Optional Protocol on violence against women (2004).[74]The GoN has signed but has not ratified the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa.[75]The Ministry of the Advancement of Women and Child Protection (le Ministère de la Promotion de la Femme et de la Protection de l'Enfant) developed and implemented a National Gender Policy in 2008 that promoted rights and economic opportunities for women.

In the energy sector, efforts have been made to implement measures under the regional framework, ECOWAS Policy for Gender Mainstreaming in Energy Access, and 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. The ECOWAS Federation on Business Women and Entrepreneurs (ECOWAS/FEBWE) is an initiative open to national federations/associations of business women and entrepreneurs from within the Community as well. Other initiatives such as the WAPP Master Plan includes provisions to address gender disparities in Niger's energy sector along with the Inter-State Standing Committee for Drought Control in the Sahel (Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel, CILSS), which includes four high level objectives pertaining to gender equality.[76]

1.2.3 Key Challenges

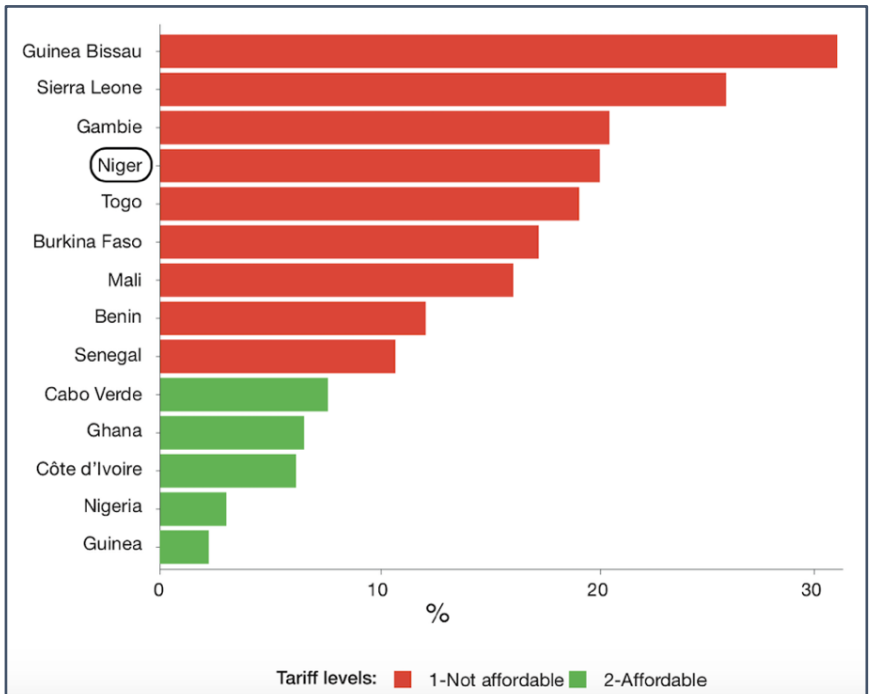
Some of the key energy sector challenges facing Niger include (but are not limited to) the following:

- **Investment in Grid Extension and Maintenance**: Rapid 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. Moreover, the five zones of the electricity network are isolated from each other, which inhibits the network's efficiency and reliability as electricity cannot not be moved between the country's regions.

- **Electricity Tariffs**: The GoN subsidizes tariffs to ensure their affordability and the commercial viability of NIGELEC. Average electricity tariffs (USD 0.16/kWh)[77]are below the ECOWAS region's average tariff of USD 0.20/kWh.[78]The Government subsidizes electricity tariffs for low-income consumers, providing electricity to poorer households below the cost of supply with funds from a range of residential and commercial consumers who pay higher electricity rates. Despite this cross-subsidization scheme, average households in the country still spend a disproportionate amount of their income on electricity (**Figure 12**).

[74] United Nations Treaty Collection: https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=IV-8&chapter=4&lang=en#EndDec
[75] African Commission on Human and Peoples' Rights: http://www.achpr.org/states/niger/reports/2014-2016/
[76] "SE for All, Situation Analysis of Energy and Gender Issues in ECOWAS Member States, " SEforAll, (2015): https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf
[77] "Regulatory Indicators for Sustainable Energy: Niger," World Bank, (2018): http://rise.worldbank.org/country/niger
[78] "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

Figure 12: Share of Income Spent on Household Electricity in ECOWAS Countries, 2018



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

Source: ECOWAS Regional Electricity Regulatory Authority

- **Imbalanced Energy Mix**:Although Niger has its own refinery, the country still reliesto an extent on imported fossil fuels for power generation, which leaves the country susceptible to price volatility and favors a more carbon intensive energy source despite the strong potential for cleaner renewable alternatives. Despite the country's commitment to increase the share of RE in the energy mix (**Table 4**), policy and investment still continue to favor fossil fuels, and there is comparatively little investment in renewable energy, which cannot compete in the country's existing regulatory environment.[79]

- **Off-Grid Market Development**:Private sector companies dedicated to distributing and installing independent solar systems have not yet reached scale. Most off-grid initiatives have focused on stand-alone solar PV systems that meet the lowest tiers of electricity service, providing only several hours of electricity per day but have not included adequate measures to build the technical and commercial capacity of markets (availability of technicians and spare parts and product quality guarantee) nor a sustainable revenue stream to ensure maintenance and/or renewal of the systems. Other major challenges facing the off-grid market sector in Niger include low end-user purchasing power, limited access to finance for business and consumers, the lack of formal distribution channels to reach off-grid population (in peri-urban and rural areas), and market deterioration due to inflows of low-grade imitation products.[80]

[79] It is worth noting that there are potential issues that may arise related to the absorption capacity of RE given the current status of the grid / electricity systems in Niger.
[80]"Niger Solar Electricity Access Project," World Bank, (2017): http://documents.worldbank.org/curated/en/184321492035663284/pdf/ITM00194-P160170-04-12-2017-1492035661106.pdf

- **Local Financial Institutions**:[81] 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.[82]

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

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

[82] One notable exception to this is the commercial and industrial (C&I) market segment, where systems are larger, and off-takers are often companies with large enough balance sheets to borrow. This has been one of the stand-alone market segments where there has been some lending to date in Africa (e.g. AFD's Sunref program).

1.3 National Policy and Regulation

1.3.1 National Electricity/Electrification Policy

The 2004 Energy Policy Statement is Niger's broad enabling framework for renewable energy, private sector participation, and PPP facilitation. The framework has been periodically augmented over the course of several years by the National Renewable Energy Strategy (Stratégie Nationale pour les Energies Renouvelables, SNER), the National Strategy for Access to Modern Energy Services, the National Strategy for Domestic Energies and the Strategy for Rural Development, all of which aim to promote renewable energy in Niger.[83]

The SNER, adopted in 2004, seeks to increase RE use in the national energy mix from less than 0.1% in 2003, to 10% by 2020 by increasing RE supply, targeting rural electrification and promoting RE technology education, training, research and development.[84]

As a member state of ECOWAS, the GoN is also committed to the ECOWAS Regional Renewable Energy Policy[85] for the period 2015-2030, which seeks to: (i) set national RE targets, (ii) create a harmonized regulatory framework as well as common tax and duties policies and standards, (iii) develop technology knowledge and capacity building, and (iv) promote a regional RE market. For the electricity sector, the objective is to increase the share of RE in total generation and ensure that RE is used to serve the population without access through mini-grid and stand-alone systems by 2030.

1.3.2 Integrated National Electrification Plan

Niger's electricity sector policy and regulation are still in their very early stages; as a result, there is currently no integrated national electrification plan in place. However, the GoN is developing a National Electrification Strategy (NES)with the support of the World Bank/IDA under the Niger Electricity Access Expansion Project.[86] The objective is to prepare a regulatory framework, as well as technical, financial and institutional outlines in order to increase energy access in urban, semi-urban and rural areas. Although the NES was completed in 2017, it has yet to be adopted by the Government. The corresponding electrification plan and investment plan are also under development.[87]

To date, NIGELEC and ANPER have used three methods to develop rural electrification: (i) grid extension in the southern region of the country where the majority of the population is concentrated; (ii) mini-grids for isolated villages (power generator, hybrid or solar mini-grids); and (iii) distribution of solar kits for remote areas with a widely dispersed / inaccessible population.[88]

[83] "Niger Energy Profile," UNEP, (2015):https://wedocs.unep.org/bitstream/handle/20.500.11822/20521/Energy_profile_Niger.pdf?amp%3BisAllowed=&sequence=1

[84] "Niger National Renewable Energy Action Plan, (PANER)," SE4ALL ECREEE, (2015):http://se4all.ecreee.org/sites/default/files/plan_daction_se4all_niger_2015.pdf

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

[86] "Niger Electricity Access Expansion Project, Appraisal Document," World Bank, (2015): http://projects.worldbank.org/P153743/?lang=en&tab=overview

[87] "Niger Electricity Access Expansion Project, Disclosable Version of the Implementation Status & Result Report (ISR)," World Bank, (2018): Electricityhttp://documents.worldbank.org/curated/en/358781530280796731/pdf/Disclosable-Version-of-the-ISR-Electricity-Access-Expansion-Project-P153743-Sequence-No-05.pdf

[88] "Atelier régional d'électrification hors réseau (ROGEP)," ANPER, The Ministry of Energy of Niger, ECREEE, (2018)

1.3.3 Energy and Electricity Law

The 2003-2004 Electricity Code and its related Implementation Decree set the legal basis for electrical legislation in Niger. The Code governs all electricity sector activities including generation, distribution, transport, import, export, and rural electrification under NIGERLEC. The 2016 Electricity Act[89] liberalizes the energy sector to allow private sector participation and renewable energy alternatives to conventional sources. It also establishes the following organizations:

- ARSE, the Energy Sector Regulatory Agency (2015);
- ANPER, the Nigerien Agency for the Promotion of Rural Electrification, with numerous provisions to guide implementation (2015);
- ANERSOL, a National Agency for Solar Energy, responsible for supporting deployment of solar technologies[90]

The Implementing Decree of the 2016 Electricity Act includes provisions to address the management of a Renewable Energy and Energy Efficiency Fund.[91] The Fund's purpose is to finance RE and EE projects and programs (co-financed by the GoN and DFIs/donors). Laws relevant to energy access in rural areas include the Ordinance Law (2010) on Local Governing Authorities Code, Public Procurement Public Service Delegation and IPP Contract Regimes (2011).[92]NESAP is also financing the development of a regulatory and legal framework for the private sector led rural electrification plan.

While a comprehensive enabling legislative framework for off-grid market development in Niger has not been developed, the Tax Exemption Order of 2017 waives taxes and VAT on all renewable energy products and provides a financial incentive for solar market development.[93]AfDB's African Legal Support Facility consultants[94] are working to develop legal and regulatory provisions for mini-grids. Future additions to these provisions may include rural electrification strategies and incentives for private sector participation such as tariffs, licensing, quality standards, and a bidding strategy that would attract private sector investments to develop the off-grid sector.

[89]"Niger Solar Electricity Access Project," World Bank, (2017): http://documents.worldbank.org/curated/en/184321492035663284/pdf/ITM00194-P160170-04-12-2017-1492035661106.pdf

[90] "Allocution de Son Excellence Monsieur Issoufou Mahamadou, Président du Niger Cher de l'Etat, à l'occasion du sommet de l'Alliance Solaire Internationale," The Presidency of the Republic of Niger, (2018): https://www.presidence.ne/discours-du-prsident/2018/3/11/allocution-de-son-excellence-monsieur-issoufou-mahamadou-prsident-de-la-rpublique-du-niger-chef-de-letat-loccasion-du-sommet-de-lalliance-solaire-internationale-new-delhi

[91]"Atelier de lancement du projet d'électrification régionale hors réseau," ROGEP, Legal Department of the Niger Ministry of Energy, ECREEE, (2018)

[92]"Niger National Renewable Energy Action Plan, (PANER)," SE4ALL ECREEE, (2015):http://se4all.ecreee.org/sites/default/files/plan_daction_se4all_niger_2015.pdf

[93] "Niger Tax Exemption Decree," World Bank Lighting Africa, (2017): https://www.lightingafrica.org/publication/niger-tax-exemption-decree/

[94] "Niger: Power Africa Fact Sheet," USAID, (2018): https://www.usaid.gov/powerafrica/niger

1.3.4 Framework for Stand-alone Systems

Figure 13 is an overview of the key national policies, programs, laws, and regulations pertaining to Niger'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's26-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017. In the 2017 RISE evaluation, Niger ranked seventh among countries in West Africa and the Sahel (**Figure 14**).

Figure 13: Policy and Regulatory Framework for Stand-alone Systems

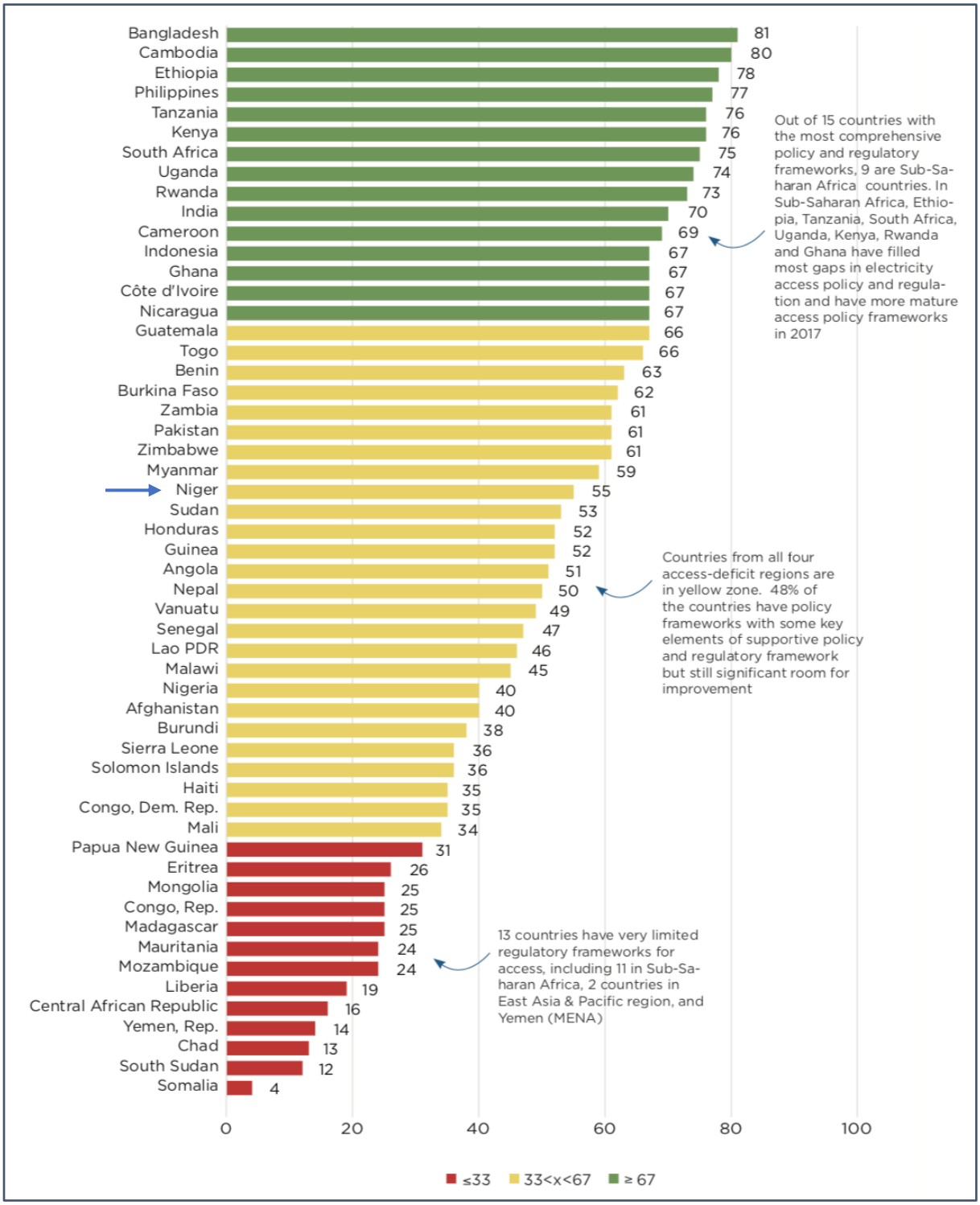
	NIGER		
	World Bank RISE 2017 Energy Access Score: 55 World Bank RISE 2015 Energy Access Score: 29	2017 ranking among West Africa and the Sahel (ROGEP) countries: 7th	
Policy/Regulatory Support and Financial Incentives	**Specific National Policies, Laws and Programs**[95]		
	National electrification policy with off-grid provisions	√	SNER
	Integrated national electrification plan		National Electrification Strategy (NES)
	Energy/electricity law with off-grid provisions	√	2016 Electricity Act
	National programs promoting off-grid market development	√	NESAP, NELACEP
	Specific target for rural electrification	√	Universal access by 2035
	Financial Incentives		
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	√	30% import tax exemption for solar
	Standards and quality		
	Government-adopted international quality standards for stand-alone systems	x	
	Government-certified program for solar equipment installers	x	
	Consumer awareness/education programs	x	
	Concession Contracts and Schemes	x	
	Business Model Regulation	x	

√= existing/implemented provisions in the current regulatory framework
X = no existing provisions
[] = planned/under development

Source: World Bank RISE, Stakeholder interviews and GreenMax Capital Advisors analysis

[95] Under this analysis, national electrification policies, laws and regulations were only considered if they include detailed provisions and corresponding action plans to support development of the off-grid sector (through the utilization of mini-grid and stand-alone systems)

Figure 14: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017[96]



Source: World Bank Regulatory Indicators for Sustainable Energy

[96] "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

A number of national programs aimed at ensuring energy access have been initiated: (i) NESAP, supported by the World Bank/IDA, with a main objective to increase energy access through off-grid solar solutions in rural and peri-urban areas of the Republic of Niger; and (ii) NELACEP, also supported by the World Bank/IDA to improve energy access (distribution/grid-densification), including a key component on the development of the National Electrification Strategy.

1.3.4.2 Financial incentives

In 2017, the GoN implemented a Tax Exemption Order (No. 0029 ME/MF)[97] waiving import taxes and VAT on all renewable energy products. More specifically, it eliminates taxes on domestic solar energy production kits and wind solar equipment.[98] Previously, pico solar systems were subject to a 52% tax (custom duties and VAT),[99] which had a negative impact on the volume of sales. Based on a World Bank estimate, these taxes reduced the size of the market by 27% (to USD 57 million). Even though consumer finance incentives/options were available, the taxes put significant pressure on poor households that could not afford a simple solar lantern. These taxes also negatively impacted sales volume potential forsolar home systems.

1.3.4.3 Standards and Quality

Niger lacks a framework for quality standards for solar systems. Informal solar entrepreneurs have taken advantage of high import duties by illegally importing low-quality solar products such as solar lanterns and solar home installations.This has allowed black-market traders to significantly undercut the prices of registered businesses who are still subject to high taxes and import duties. Moreover, it has created a market for low-grade, failure-prone products with a short lifespan. This has exacerbated consumer reluctance to purchase solar technology by tainting the industry's reputation and standard of quality.

1.3.4.4 Concession Contracts and Schemes

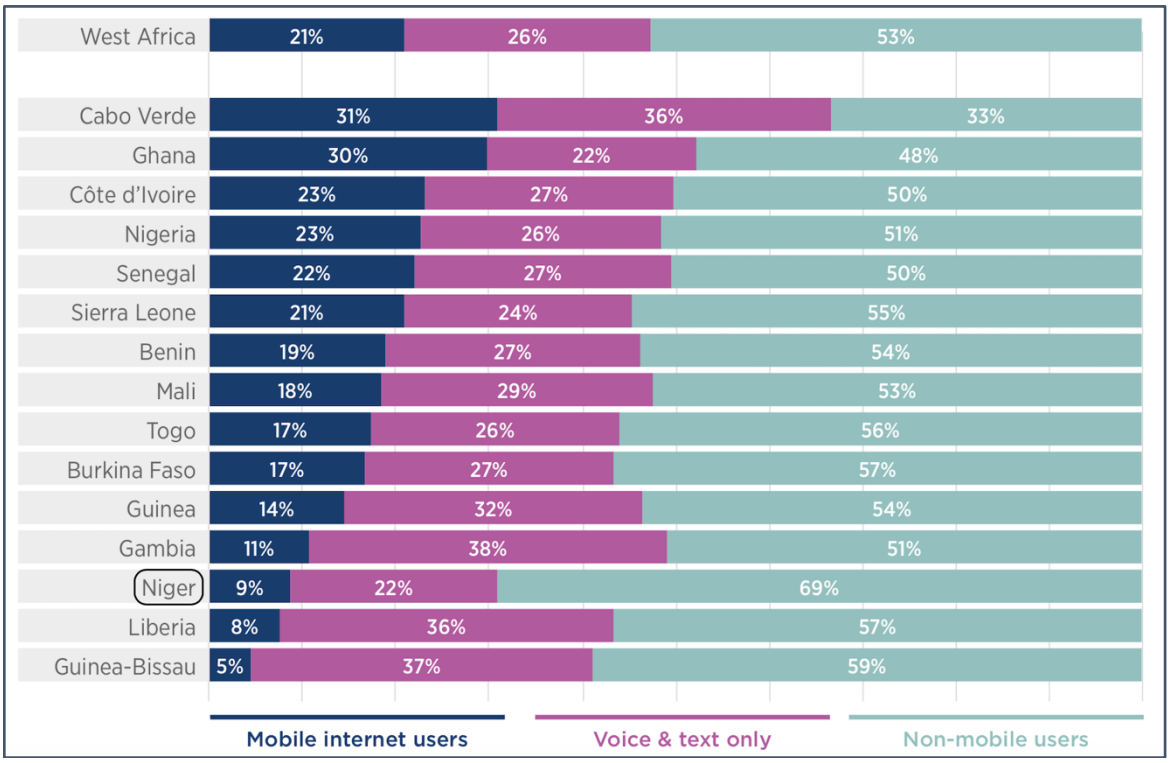
Niger lacks a supportive regulatory framework to engage with private sector off-grid market actors as there is no national framework for concession contracts and related schemes.Under the NES, the GoN is also working to revise the legal framework to support increased private sector participation in the financing and operation of mini-grids.

1.3.4.5 Specific Business Model Regulation

No specific business model regulations exist for the off-grid sector in Niger, although the Government can take measures to support PAYG business models that have already been deployed by private solar companies engaged in the market. As was demonstrated in East Africa in recent years, the proliferation of mobile money platforms can rapidly facilitate energy access. Recent data suggests that there is an opportunity for the GoN to bring together key stakeholders in the off-grid sector (solar providers, telecommunications companies etc.) to take advantage of the country's rapidly growing mobile internet usage (**Figure 15**) and high rates of mobile phone ownership in rural areas (**Figure 16**).

[97]"Niger Tax Exemption Decree," World Bank, (2017): https://www.lightingafrica.org/publication/niger-tax-exemption-decree/
[98]"Arrêté conjoint ME-MF portant liste des équipements et matériels à énergies renouvelables à exonérer des droits et taxes perçus en douanes," Government of Niger, (2017): https://www.lightingafrica.org/wp-content/uploads/2018/02/Arreté-Conjoint-ME-MF-Exoneration.pdf
[99] "Niger Tax Exemption Decree," World Bank Lighting Africa, (2017): https://www.lightingafrica.org/publication/niger-tax-exemption-decree/

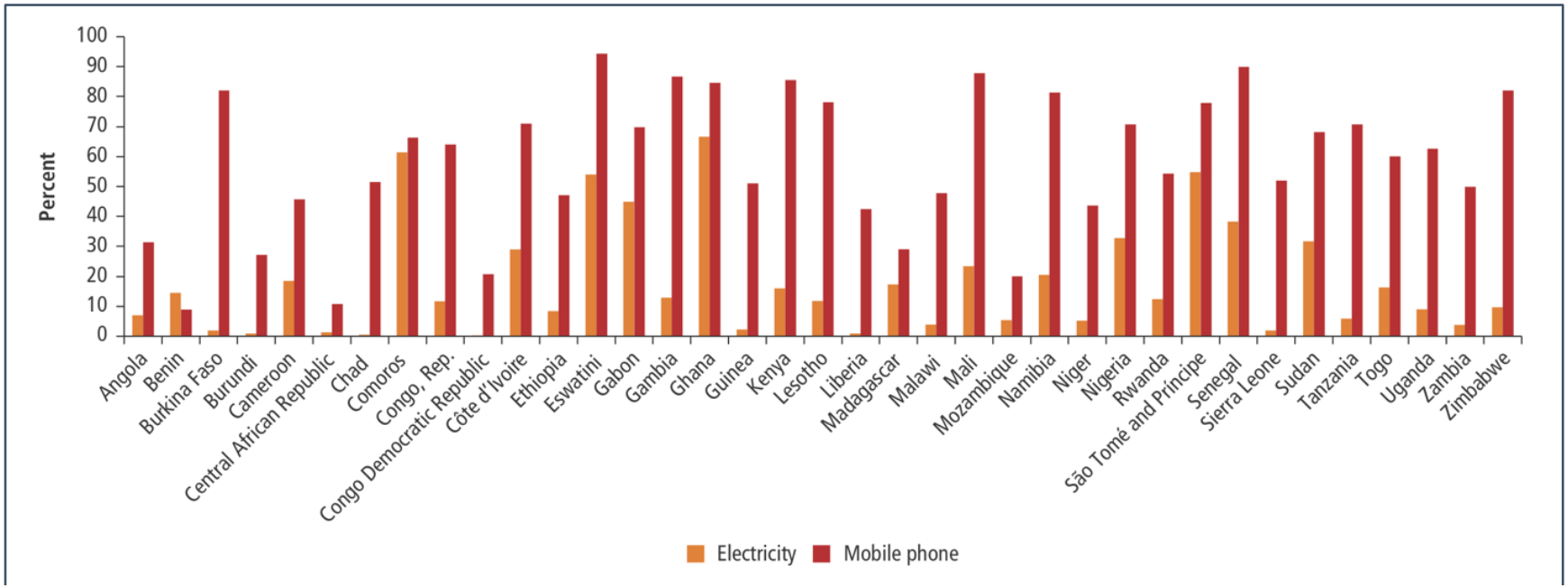
Figure 15: West Africa Mobile Internet Penetration Rates, 2017[100]



Source: GSMA Intelligence

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

Figure 16: Electricity Access and Mobile Phone Ownership, Sub-Saharan Africa, 2016 (% of rural households)[101]



Source: World Bank

[101]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 ANPER and the electricity market regulator, ARSE, among others, will play key roles in establishing a supportive policy and regulatory framework. Additional reforms to the power sector may be required to provide the incentives necessary to increase private sector participation. Local FIs and MFIs will need incentives and support to develop and implement new financial products and administrative procedures to lend to the off-grid sector. International and local solar companies will need policy and financial support. Local technical capacity of the solar sector will need to be developed to ensure long-term O&M services are available and sustainable. Above all, financing and TA will be critical for all market actors – government, financial institutions, end-users, suppliers and service providers – in order to accelerate growth.

Table 7below identifies some of the policy/regulatory challenges facing off-grid market development in Niger and the proposed mitigation measures/TA interventions to overcome these gaps.

Table 7: Gaps in the Off-Grid Policy and Regulatory Framework[102]

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. **Specific National Policies, Laws and Programs**	**A. Lack of National Electricity / Electrification Policy**	
	a. Government is subsidizing fossil fuel electricity production	a. Help Government analyze where fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives
	B. Lack of Integrated National Electrification Plan	
	a. No integrated plan exists	a. Help Governmentdevelop a comprehensive, least cost, integrated plan for all rural electrification options (grid, mini-grid and off-grid) with clear and consistent targets and policies[103]
	b. Insufficient focus on or understanding of framework to support private sector participation	b. Help Government developa planning framework 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 revise legal framework (2016 Electricity Act)to ensure that it is flexible and helps create appropriate incentives for private sector participation in off-grid market development (e.g. to initiate the process of electricity market liberalization).
	D. Insufficient national policies, laws, programs and/or action	

[102] "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 Niger (**Table 2**), including the Ministry of Energy (MoE), the Energy Sector Regulatory Agency (ARSE), the National Office of Solar Energy (ONERSOL), the National Solar Energy Center (CNES), the Nigerian Rural Electrification Promotion Agency (ANPER), and the national utility, NIGELEC, among other national and local authorities.
[103]The National Electrification Strategy is currently under development.

	plans targeting off-grid market development a. Insufficient focus on or understanding of framework to support private sector participation	a. Help Government strengthen the existing medium-long term rural electrification strategy (NES) in the country through development and implementation of a rural electrification Master Plan and help the Government improve off-grid framework to create appropriate incentives for private sector participation
2. Financial Incentives (import duties, taxes, etc.)	**A. Insufficiently supportive financial incentives / tax regime**	a. Help Government expand existing financial incentives[104] 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 which require private funding matches and are predictable and not overly bureaucratic d. Help Government create PPP schemes to share high project development and market entry costs particularly with developers in remote areas e. Help Governmentanalyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede development of clean energy solutions
3. Standards and Quality	**A. Insufficient Market Data**	a. Help Government establish a Special Task Forceresponsible for collaborating with the private sector to compile and regularly update a database of critical off-grid market data (including inter alia solar product imports, costs, sales volumes, resource potential etc., GIS data and other key demographic and socioeconomic indicators) that can be (i) utilized by policymakers to make informed electrification planning decisions based on accurate/updated market information, and (ii) made easily accessible to interested off-grid developers, investors and other key industry stakeholders
	B. Unclear / lack of quality standards	a. Help Government establish international quality standards for off-grid stand-alone solar products, including minimum technical standards (IEC Technical Specifications), warranties, required availability of and cost guidelines for post-sale services/O&M, etc. b. Help Government integrate standards with appropriate oversight agencies (ARSE) to ensure quality-verification procedures are in place 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

[104]The GoN has reduced import taxes by 30% for solar equipment

		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 (e.g. through ANPER, ANERSOL) b. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through ANPER, ANERSOL)
	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 implementation of a repair and recycling framework for off-grid solar systems and equipment
	E. Insufficient public awareness	a. Support Government, trade associations and civic society organizations to develop and implement consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related national programs (e.g. by building on public awareness efforts of CODDAE) b. Support development and implementation of programs to educate consumers, retailers and distributors on the benefits of quality certified solar products
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
	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 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	b. Help Government to understand and develop approaches to

[105] Different models used to grant geographic concessions to SHS providers can yield wide-ranging results. Some observers have lauded approaches used in Rwanda, Nigeria, Togo and DRC as successful, while there has been criticism of the approach deployed in Senegal

	emerging models for 'Integrated Private Utilities' or 'Energy Companies of the Future'	facilitate pilots of 'Integrated Private Utility' or 'Energy Company of the Future' schemes.[106]
	c. Public procurement or public finance/budget laws that hamper deployment of energy services models for public facilities	c. Help Government develop procurement and public finance laws that will facilitate stand-alone solar system investment for public facilities (schools, health care facilities, etc.)
	d. Lack of standardized contracts for energy services provided by private system operators to public facilities	d. Help Government trade associations or civic society organizations develop model bilateral PPA and Energy Services Contracts for small scale IPPs and ESCOs to sell power or deliver energy services to public facilities (i.e. schools, health care facilities) or deliver solar street lighting services to municipalities
	e. Insufficient protection for stranded investments	e. Help Government develop proper procedures and guidelines to protect against stranded investments from competition among all on-grid and off-grid rural electrification approaches[107]
5. Business Model Regulation	**A. Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers**	a. Support capacity building of regulators, Government, and non-Government stakeholders about different pricing schemes[108] offered by stand-alone solar system providers to improve understanding and help avoid unnecessary interventions to regulate. b. Support regulators and off-grid enterprises to collaborate specifically on developing pricing schemes for productive use market segment[109] c. Support off-grid entrepreneurs and telecommunications companies in building the capacity of and fostering linkages between telecommunications companies / mobile money providers and off-grid solar companies to help roll out technology platforms and PAYG business models

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

[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.

[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 an area where TA support is much needed to help all stakeholders sort out fair and practical approaches.

1.4 Development Initiatives

1.4.1 National Government Initiatives

The GoN plans to significantly increase electricity access in urban, semi-urban and rural areas, and has set a target to achieveuniversal access by 2035.[110] To meet this target, the GoN is working to: (i) expand its electricity supply to limit its dependency on electricity imports, (ii) improve rural and urban electricity access, (iii) create a more enabling market environment to attract investment by eliminating taxes on solar energy products and equipment.

To date, ANPER has already developed the following mini-grid projects in the country: Malmawa Kaka mini-grid (Maradi); Gabouri mini-grid (Maradi); Guidan Wari mini-grid (Maradi); Maisou Samé mini-grid (Maradi); Gandou Goriba mini-grid (Zinder); Yagagi mini-grid (Zinder); Dinney mini-grid (Zinder); Boucheri mini-grid (Zinder); Ingouna mini-grid (Zinder); Boure Sarkin Arewa mini-grid (Zinder). The private sector has also developed the following mini-grids: (i) Gorou I mini-grid (in Kourtey/Tillabery); (ii) Amaloul mini-grid (in Affala/Tahoua); and (iii) Boki mini-grid (in Tamou/Say).[111]

Off-grid stand-alone systems (solar home systems and pico solar lanterns) have also been distributed in dozens of villages, including Safo (Madarounfa municipality), Maikalgo (Koré Mai Rouwa), and Tondi Gamey (Hamdallaye, Kollo). There are also several ongoing off-grid sector initiatives, including the construction of 122 micro-grids and the distribution of solar kits in 128 locations in Attri (Tchirozerine) and other regions.

TheNiger Solar Electricity Access Project (NESAP) is a specificGoN project supported by the World Bank to increase energy access in rural and semi-urban areas and promote solar off-grid solutions (households and agriculture uses).[112]Under NESAP, complementary off-grid solutions, greenfield and hybridized mini-grids, and stand-alone systems will also be deployed to meet rural energy needs.NESAP includes the following components:[113]

- Support to off-grid PV product supply chain and uphold “Lighting Africa’s” aims to foster the commercialization and adoption of kits, solar lanterns, SHS, solar pumps and address current issues related service quality (warranty, after-sales service);
- Off-grid provisions to promote a new off-grid concession model (public service delegation contract between private operators and NIGELEC), and develop solar-diesel hybrid systems;
- The hybridization of existing NIGELEC off-grid diesel power plants (PV/diesel);
- Technical assistance to public institutions, the private sector, the banking sector and the beneficiary population to enable effective project implementation

In addition, with the support of the World Bank, the GoN is in the process of adopting the recently completed National Electrification Strategy (NES).[114] This strategy, which will be finalized in 2021, will address the conditions necessary for expanding electricity access using grid extensions, isolated mini-grids, and individual solar systems including pico-solar PV and SHS. The NES will include quality standards and cost-recovery tariffs aligned with the consumer’s ability to pay.

[110]“Niger: Power Africa Fact Sheet,” USAID, (2018): https://www.usaid.gov/powerafrica/niger
[111]“Atelier régional d’électrification hors réseau,” ANPER, The Ministry of Energy of Niger, ECREEE, (2018).
[112]“Niger Solar Electricity Access Project,” World Bank, (2017): http://documents.worldbank.org/curated/en/184321492035663284/pdf/ITM00194-P160170-04-12-2017-1492035661106.pdf
[113]Projet d’accès à l’énergie solaire au Niger, NIGELEC, World Bank Documents, (2016): http://documents.banquemondiale.org/curated/fr/705161492064925159/pdf/SFG3260-EA-FRENCH-P160170-Box402901B-PUBLIC-Disclosed-4-10-2017.pdf
[114] Ibid.

The NES will update, strengthen and harmonize the following GoN energy access initiatives already in place:

- The National Strategy for Access to Modern Energy Services (PASE), which aims to reduce poverty rates through infrastructure to improve access to modern energy services. The first phase of PASE, PASE-Safo, was funded by the EU, UNDP and GEF[115] and provided energy services (including Pico and SHS) to public facilities (schools and health centers), agriculture businesses, households and developed microcredit solutions in the locality of Safo (52 villages).
- The National Strategy for Domestic Energies (Stratégie Nationale pour les Energies Domestiques, SNED) intends to create a coherent framework for domestic energies by: (i) assuring the sustainable use of forest resources and better reforestation, (ii) promoting alternative sources of energy (other than wood) and improving appliance efficiency, (iii) strengthening the capacity of main market actors for better sector management, and (iv) creating modes of communication to inform and educate actors on issues related to the production and use of energies.
- Strategy for Rural Development (Stratégie de Développement Rural, SDR) and its sub-program "Renewable Energy and Rural Electrification" aim to improve electricity access in rural areas. The Strategy also promotes alternative energy sources through the "Environmental Protection" program.

1.4.2 DFI and Donor Programs

Like many member-states of the West African Power Pool, most electricity projects and programs in Niger are financed by multilateral and bilateral donors. The World Bank, AfDB, the EU, West African Development Bank and the Islamic Development Bank are major contributorsto grid-connected electricity infrastructure projects in the country.[116] On a bilateral level, AFD supports the expansion of urban electricity distribution in Niamey and its neighboring cities. AFD also provided financing for the first solar PV power plant of Niger (in Gorou Banda) as well as a hydride solar/thermal power plant (in Agadez).[117]

Between 2013 and 2017, ECREEE and the West African Economic and Monetary Union have also distributed solar kits in different locations in Niger,[118] while the World Bank provides institutional support to NIGELEC and the NESAP. The World Bank's Electricity Access Expansion Project (NELACEP) focuses on grid-connected network expansion and includes a key component on the preparation of the National Electrification Strategy. At the bilateral level,[119] Exim Bank India has contributed to the development of photovoltaic solutions and the electrification of 30 villages in Niger,[120] while Niger has joined the recently established International Solar Alliance (headquarters in New Delhi).[121] AFD has supported several solar water pumping projects to provide water to remote communities but does not have a specific program dedicated to solar system development.

[115] Amélioration de l'accès aux services énergétiques modernes au Niger, Initiatives Climat, (2016) : http://www.initiativesclimat.org/Toutes-les-initiatives/Amelioration-de-l-acces-aux-services-energetiques-modernes
[116] "Niger: Projet d'électrification rurale et périurbaine (PEPERN)," African Development Bank, (2016): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Niger-_RE-__Projet_d_électrification_rurale_périurbaine_et_urbaine_PEPER....pdf
[117] L'Agence Française de Développement (AFD) présente son bilan au Niger," Ambassade de France au Niger, (2017): https://ne.ambafrance.org/L-AGENCE-FRANCAISE-DE-DEVELOPPEMENT-AFD-PRESENTE-SON-BILAN
[118] "Présentation de l'expérience du Niger en équipements solaires,"CNES, ECREEE, (2017)
[119] Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[120]"Enhancing Trade Relations with ECOWAS, A Brief Analysis: Paper No.38," Exim Bank India, (2015): https://www.eximbankindia.in/Assets/Dynamic/PDF/Publication-Resources/ResearchPapers/38file.pdf
[121] International Solar Alliance: http://isolaralliance.org

Development Finance Institution (DFI) and donor programs and initiatives supporting development of the off-grid sector are summarized in **Table 8**.

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

Project/Program	Sponsor	Timeline	Market Segment(s)	Description
Solar Electricity Access Project (NESAP)	World Bank /IDA (USD 49.9 million grant)	2017-2024 (ongoing)	Mini-grids, solar PV, stand-alone solar systems	There are three components to the project: • Market development of stand-alone solar systems, rural electrification through service-based solar hybrid mini-grids, to be implemented by ANPER • Solar PV hybridization of isolated thermal mini-grids to be implemented byNIGELEC will increase the hours of operation of the isolated systems and/or to decrease diesel consumption • Implementation support and technical assistance, aims to support project management and implementation, capacity building, and technical assistance to key off-grid electrification sector stakeholders, as well as monitoring and evaluation
Electricity Access Expansion Project (NELACEP)	World Bank/IDA (USD 65 million blend loan/grant)	2016-2021 (ongoing)	Electricity Access	• The overall objective is to increase electricity access by connecting 330,000 people to the national grid in seven areas (including households, small business and public institutions); includes support to help the GoN to adopt the National Electrification Strategy (NES), currently under preparation
International Solar Alliance	Initiated by France and India during COP21	2017 (recently created)	Solar Energy	• Promote the development of solar (agriculture productive use, mini-grids and SHS) in 121 countries with high solar potential, including Niger • Mobilize USD 1,000 billion by 2030, with 100 priority projects already identified
SNV Solar Pico Project	SNV (Dutch NGO)	2014-2019	Off-grid / solar lantern	• Distribution of 1.2 million solar lanterns in Niger
Exim Bank India Solar Project	Exim Bank India	N/A	On-grid and Off-Grid	• On-grid: Rehabilitation of power stations • Off-grid: Electrification of 50 villages using solar PV
Power Africa	USAID	2013 - present		• Power Africa is providing TA in multiple areas including mini-grid development, off-grid electrification and policy development. Through USAID transaction advisor, Power Africa supports private sector expansion into the off-grid market and has facilitated 28,053 solar connections since 2013.
Lighting Africa	World Bank	2018 – present	Pico solar	• Niger will receive a USD 7 million line of credit through Lighting Africa in 2018 to stimulate the development of a SHS market for products meeting Lighting Global Quality Standards.
Tondigamey Solar Kits Project	ECREEE and WAEMU	2013	Off-grid/solar kits	• Electrification of Tondigamey by PV solar kits
Sabongari Foga Barra Solar Kits Project	Conseil de l'Entente	2015	Off-grid/solar kits	• Electrification of Sabongari Foga Barra by PV solar kits (106 solar kits distributed)
Nakigaza Solar Kits Project	Conseil de l'Entente	2016	Off-grid/solar kits	• Electrification of Nakigaza by PV solar kits (120 solar kits distributed)
Angoual Gaja Solar Kits Project	Conseil de l'Entente	2017	Off-grid/solar kits	• Electrification of Angoual Gaja by PV solar kits (109 solar kits distributed)

1.4.3 Other Initiatives

Outside of the Government and DFI/donor initiatives mentioned above, there are also several non-governmental organization (NGO) programs and other related initiatives in Niger's off-grid sector.

- The Dutch NGO SNV has been a leader in the OGS sector in Niger, bringing more than 1.2 million pico solar devices to the market under its 2014-2019 program[122]

- NGO Plan International, with the support of a grant from ECOWAS/ECREEE, has commissioned a 27.5 kWc solar mini-grid for the village of Gorou in Tillaberi Region in June 2018[123]

- Niger's subsidiary of the NGO Right to Energy, the Collective Organization for the Defense of the Right to Energy (Collectif des Organisations pour la Défense du Droit à L'Energie CODDAE),works to provide energy access in rural areas and to increase awareness about the benefits of renewable energy. The NGO, in partnership with French energy company, ORANO, has notably contributed to the electrification of four districts in the town of Arlit.[124]

[122] "SNV Newsletter Connect, July 2014," SNV, (2014): http://www.snv.org/public/cms/sites/default/files/explore/download/snv_annual_review_-_connect_2014.pdf
[123] "Inauguration of a Solar Mini-Grid Project in Niger," SEforALL Network, (2018): https://www.se4allnetwork.org/news/inauguration-solar-mini-grid-project-niger
[124] "De l'électricité pour tous, AREVA au Niger," AREVA, http://niger.areva.com/FR/niger-316/droit-lnergie.html

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

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

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

For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution 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 9: Indicative Total Cash Market Potential for Off-Grid Solar PV Products in Niger, 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	538,662	1,616	$24,239,805	$0.00
Plug and play	150,077	1,501	$18,759,627	$24,264,069
Small SHS	0	0	$0.00	$82,983,117
Medium and Large SHS	0	0	$0.00	$56,278,881
Household Subtotal			**$42,999,432**	**$163,526,067**
Institutional				
Water supply	50,843	173,350	$432,473,750	-
Healthcare facilities	10,151	9,535	$38,137,200	-
Primary and secondary schools	17,171	10,948	$51,857,500	-
Public lighting	3,598	1,439	$6,476,505	-
Institutional Subtotal			**$528,944,955**	-
Productive Use				
SME applications for microenterprises	3,517	-	$771,841	-
Value-added applications	-	-	$1,295,612,166	-
Connectivity / ICT (phone charging)	5,500,000	-	$38,527,785	-
Productive Use Subtotal			**$1,334,911,792**	-
TOTAL			**$1,906,856,179**	

Source: African Solar Designs analysis

2.1 Demand – Households

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

2.1.1 Overview of Household Market Segment

According to the International Energy Agency (IEA), in 2016 there were 2.7 million households (19.1 million people)[125]in Niger without access to electricity.[126]In that year, an estimated 11% of the population had access to electricity, with the rate of access at 54% in urban areas and 1% in rural areas.

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

[125] See Annex 2 for methodology regarding population without access to electricity.
[126]See **Annex 2** for more details.

Table 10: Household Consumer Market Segments[127]

Income Quintile	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# of HHs w/o Access	Avg. GDP per HH per year	Energy Tier	Geographic segments	Description
	2018 Scenario				2023 Scenario				2030 Scenario					
Highest 20%	77%	450,231	$5,678	Tier 3	1%	6,953	$6,448	Tier 3	1%	9,028	$7,082	Tier 3	High income rural	• Small portion of rural households using a petrol generator set • Has a demonstrated ability to pay for solar off-grid systems
													Mid to high income urban	• Professionals, business owners and salaried people are likely to be connected to the grid. • Small portion without grid access desire replacement to generator power[128]
Fourth 20%	90%	524,104	$2,979	Tier 2	9%	61,715	$3,382	Tier 2	2%	18,055	$3,715	Tier 2	Low income peri-urban / urban "under-grid"	• Low income urban population engaged in SME work or casual labor • Lives near grid but cannot afford or does not have access to connection
Third 20%	95%	553,221	$2,255	Tier 2	90%	625,794	$2,560	Tier 2	3%	27,083	$2,812	Tier 2		
Second 20%	100%	582,338	$1,768	Tier 1.5	99%	688,374	$2,007	Tier 1.5	58%	521,053	$2,204	Tier 1.5	Low income rural	• Engaged in farming, or SME • Lives more than 15km from the nearest grid connection.
Lowest 20%	100%	582,338	$1,239	Tiers 1,1.5	100%	695,327	$1,407	Tiers 1,1.5	100%	902,756	$1,545	Tiers 1,1.5		
Total Households without Access to Electricity		**2,692,231**			**Total**	**2,078,163**			**Total**	**1,477,974**				

Source: IEA and World Bank; African Solar Designs analysis

[127] See **Annex 1** and **Annex2** for more details.

[128] 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**

Niger has a high level of extreme poverty (households living below $1.90 a day). As shown in **Table 11**, the vast majority of the country's households have a low income.

Table 11: Poverty Headcount in Niger, 2015

Poverty headcount ratio	% of population
Lives at or below $1.90 a day*	44.5%
Lives at or below $3.20 a day*	76.9%
Lives at or below $5.50 a day*	93.4%

*2011 PPP

Source: World Bank

Niger is consistently ranked one of poorest countries in the world, with a very low human development index. Off-grid households in Niger rely largely on subsistence agriculture and pastoralism. The country also mines and exports significant amounts of uranium, cotton and rice.

Agricultural production is concentrated in the south of the country, with pastoralism dominating in the arid central region, while desert coversmost of the north of the country. Uranium exploration and mining occurs in the central northern territory around Agadez. Households in the Agadez region generally have higher income than those in other districts.

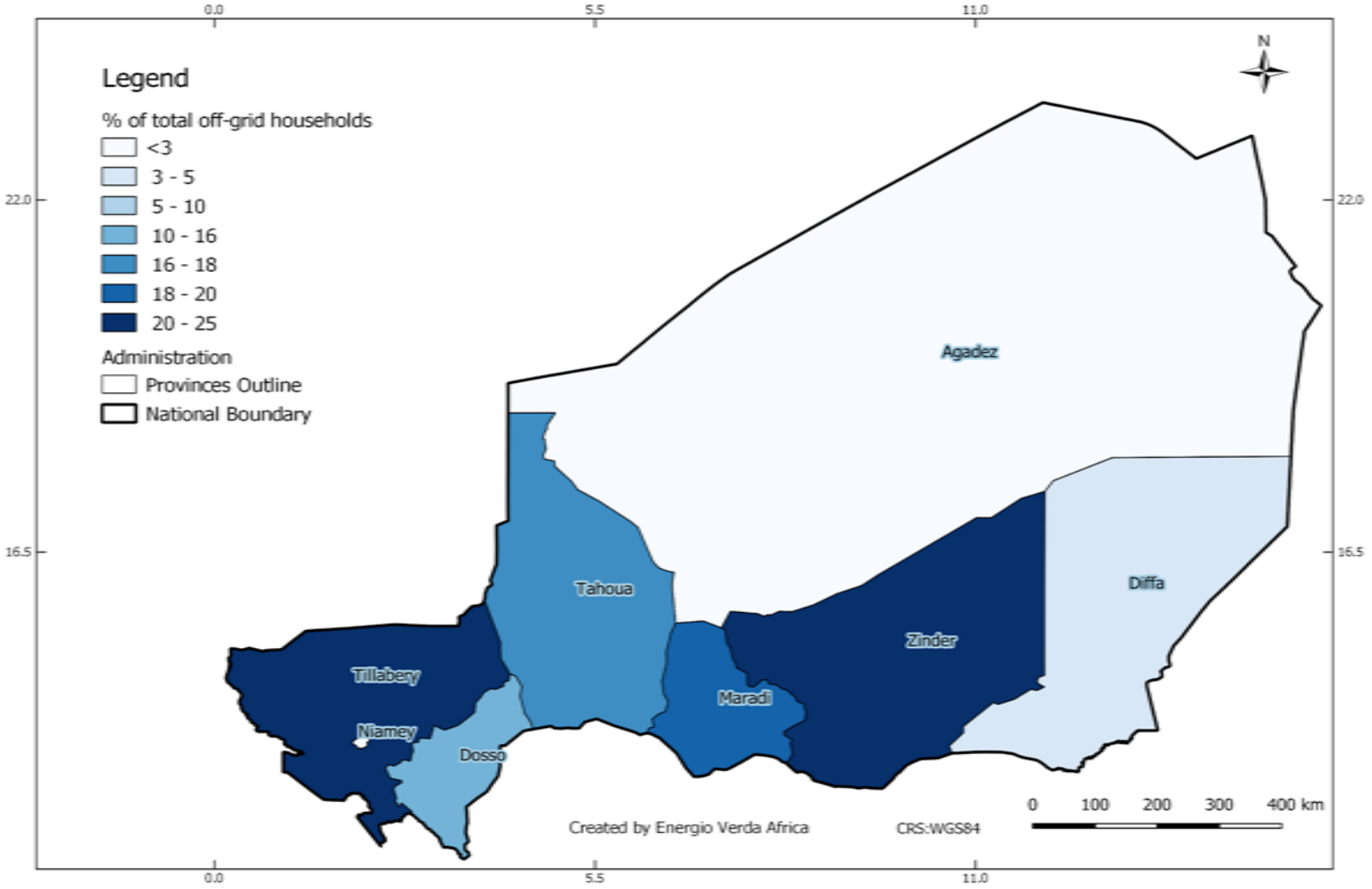
- **Geographic Components of the Solar Market**

The total number of off-grid households and their geographic distribution can 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 17-20)** 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 17-20)**, the total size of the OGS market will decrease over time, with distribution of off-grid households across districts remaining much the same through 2030.

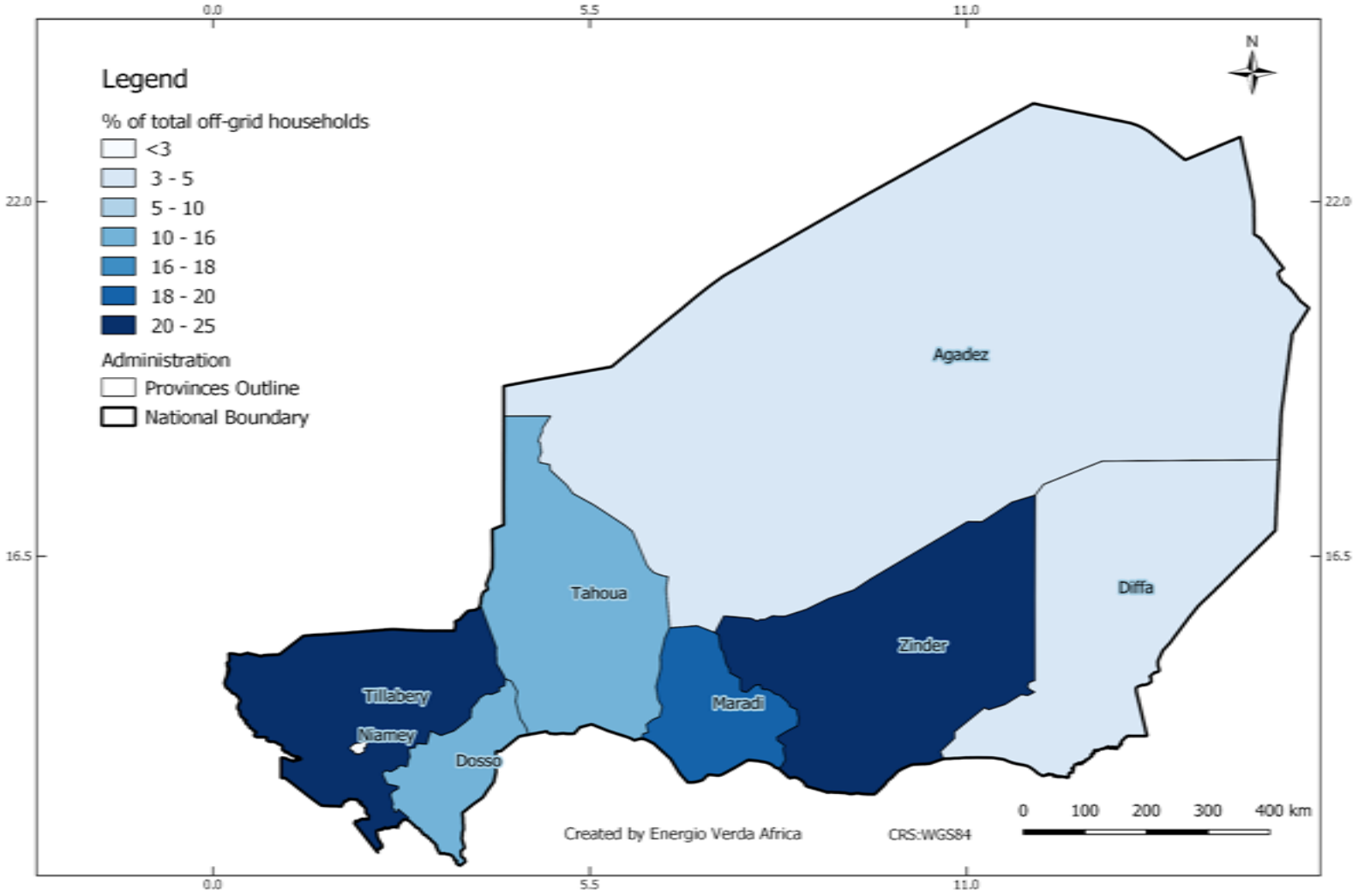
Figure 17: Distribution of Potential Off-Grid Households by Region, 2023[129]



Source: Energio Verda Africa GIS analysis

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

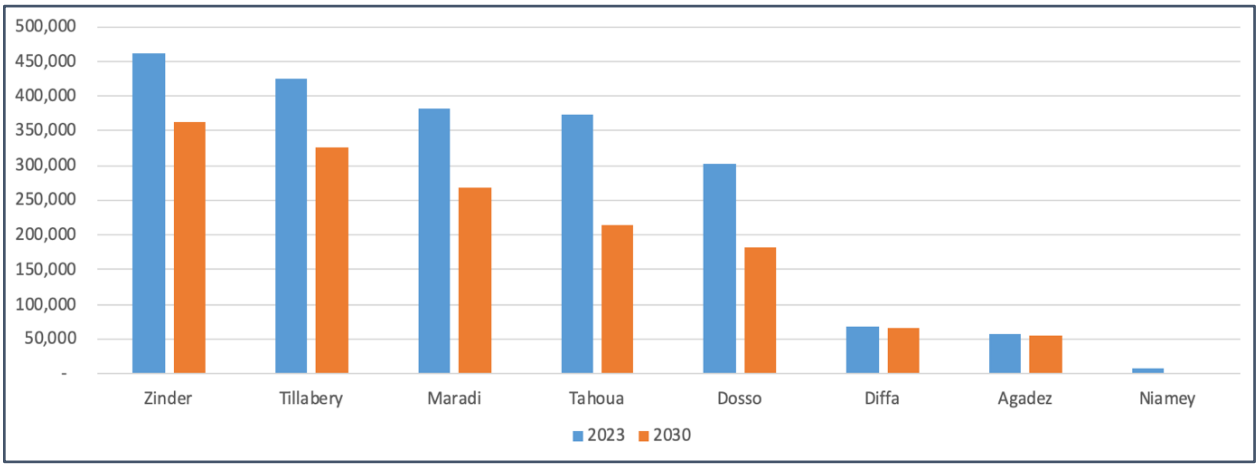
Figure 18: Distribution of Potential Off-Grid Households by Region, 2030[130]



Source: Energio Africa GIS analysis

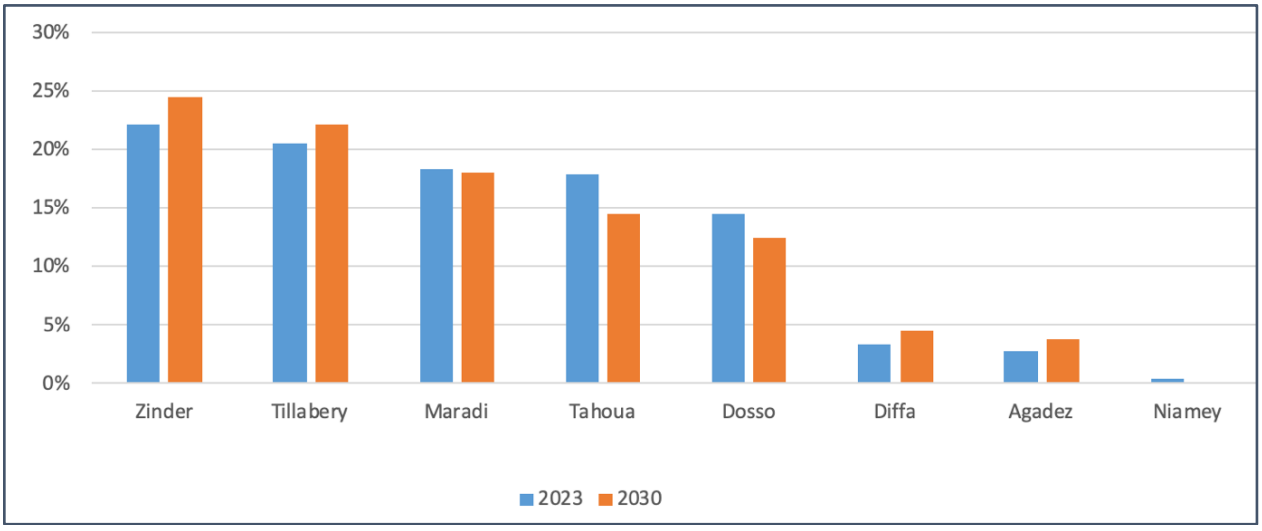
[130] See **Annex 1** for more details, including data sources.

Figure 19: Estimated Number of Off-Grid Households by Region, 2023 and 2030



Source:Energio Verda Africa GIS analysis

Figure 20: 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 analyzes several things:

- 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 at the end of this section for both cash purchases and financed purchases.

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

According to feedback from focus group discussion (FGD) participants, common sources of electricity used in off-grid rural households include solar PV, diesel generators, and lead acid batteries. **Table 12** presents the national mean energy expenditure for rural households.

Table 12: Typical Energy Expenditures for Rural Households

Energy use	Cost per month (USD)
Candle	$4.30
Dry cell	$4.70
Car battery	$2.70
Kerosene	$3.60
Diesel	$28.00
Phone charge	$0.50

Appliance	Cost per month (USD)
PV System	$5.00
Generator	$7.00
Battery	$3.00

Overall, the typical household monthly energy expenditure is estimated as USD10, with USD12 in the summer. Energy expenditure for rural households in the Agadez region is higher, estimated at about USD 13.

Table 13 shows the typical monthly cost of using common rural energy technologies. Household use of different types and amounts of energy technologies is associated with different energy access tiers, as defined in the Multi-Tier Energy Access Framework. For example, a household using one battery powered lantern and one charged cell phone would fall under the Tier 1 level of energy access. A household using two lanterns, one cell phone and a radio would be in Tier 1.5.

These tiers are defined in **Table 14**. Establishing an average monthly household expenditure for each energy tier using common rural technologies shows how household income level aligns with energy tiers. Secondly, it provides a basis to compare these costs to solar products that can offer an equivalent level of service by energy tier. This in turn reveals potential household savings by switching to solar products, as shown in**Figure 21**and**Table 15**.

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

Table 13: Rural Energy Technology and Costs[131]

Technology	Details	Average Life (Years)	# of Units/ Month	Unit Operating Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)
					2018 Scenario		2023 Scenario		2030 Scenario	
Torch lights/Electric Lanterns	Torch lights/electric lanterns powered by D-type, AA-type or AAA-type batteries	0.5	16	$0.14	$2.00	$2.24	$2.12	$2.38	$2.44	$2.73
Cell Phone Charging	Done at a charging station	-	8	$0.14	$0.00	$1.12	$0.00	$1.19	$0.00	$1.37
Smart Phone Charging	Done at a charging station	-	16	$0.14	$0.00	$2.24	$0.00	$2.38	$0.00	$2.73
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	$0.14	$0.00	$1.12	$0.00	$1.19	$0.00	$1.37
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	$0.90	$50.00	$3.60	$53.06	$3.82	$60.95	$4.39
Small Petrol Generator	The most popular rural generator for basic use is 0.9kW generator (for phone charging, lighting, TV, fan and music system)	2	30	$0.95	$100.00	$28.50	$106.10	$30.24	$121.90	$34.74

Source: African Solar Designs analysis

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

Table 14: Typical Tier-Based Energy Costs

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Typical Monthly Cost (USD) 2018	Typical Monthly Cost (USD) 2023	Typical Monthly Cost (USD) 2030
Tier 0 No electricity	• Characterized by complete lack of electricity services • Many cash-poor consumers are in this situation part of each month when they don't have money to buy dry cells or charge phones	• Rely solely on kerosene, wood and other fuel sources for cooking and lighting	• Subsistence level of energy • Absolute energy poverty	• Subsistence level of energy • Absolute energy poverty	• Subsistence level of energy • Absolute energy poverty
Tier 1 Range: 1 to 20 Wh/day	• Access to one torch powered by dry cell batteries • One cell phone powered by charging service	• One battery-powered light requires dry cell replacement on weekly basis • One cell phone charged 8 times per month	$3.36	$3.57	$4.10
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	$6.72	$7.13	$8.19
Tier 2 Range: 55 to 500 Wh/day	• One torch and two lanterns powered by dry cells • One cell phone and one smart phone powered by charge service • Radio • DC TV	• Three battery light points require dry cell replacement on weekly basis • One cell phone charged 8 times per month and one smart phone charged 16 times per month • TV/Radio powered by lead acid battery recharged once per week	$13.68	$14.52	$16.68
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	$28.50	$30.24	$34.74

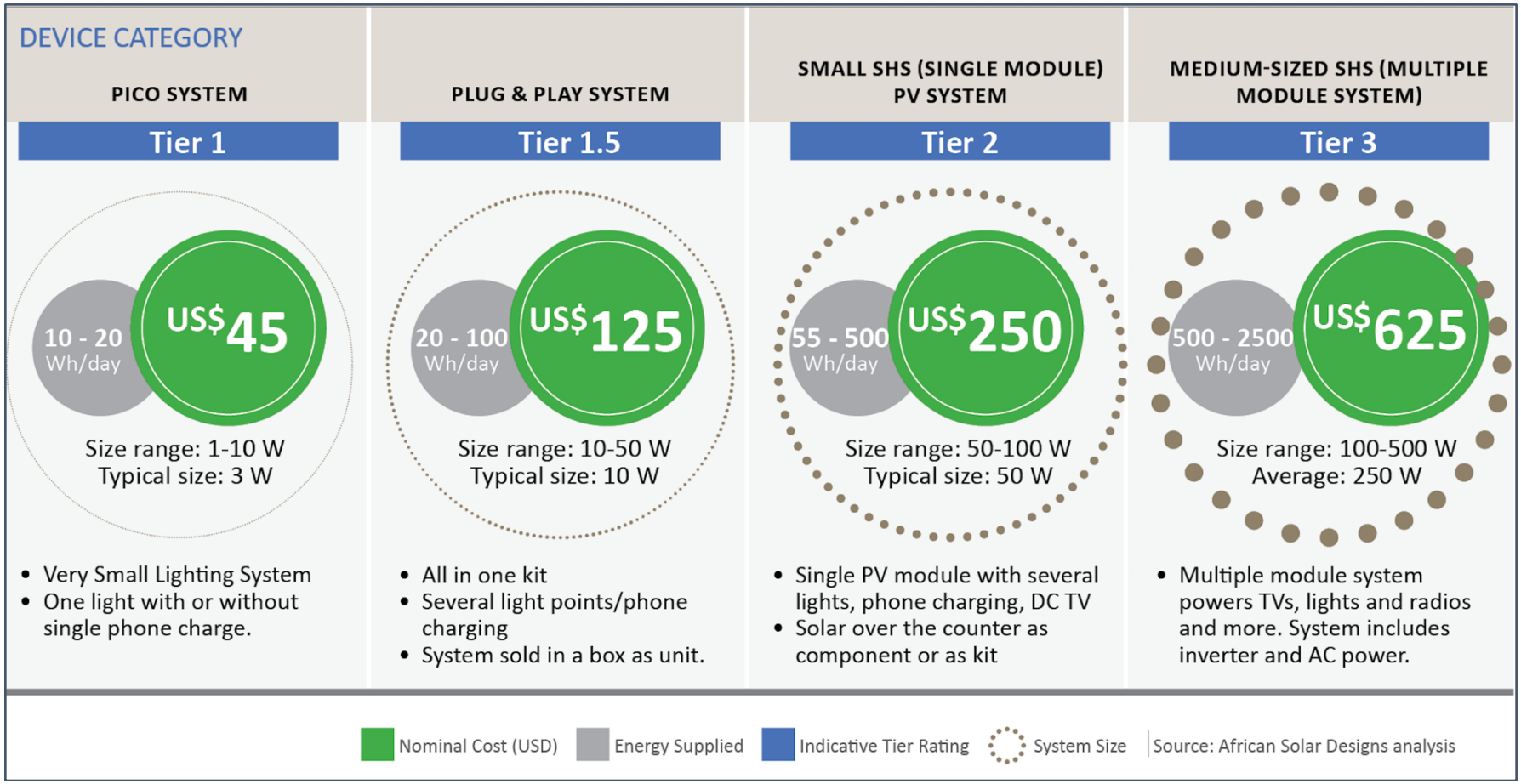
Source: African Solar Designs analysis

Per **Table 14**, it can be seen that, given the purchase price of dry cells and the cost of phone charging, the "ideal" electricity availability is extremely difficult to sustain. This is especially true where there is a high incidence of poverty in rural areas and lack of regular incomes. In reality, households often must reduce their energy consumption when cash is not available. This means that even a Tier 2 level family might drop to Tier 1 for a week each month when cash is not available to pay for phone charging or dry cell purchase.

- **Household Solar PV System Types**

Solar PV systems can provide lower cost and higher levels of service than existing dry cell, phone charging and generator options. In order to model how solar systems can meet existing energy use categories, levels of service and ability to pay, four types of household solar systems are configured to match the tier-based demands of off-grid communities. The system descriptions, energy outputs, prices, tier ratings and target consumer groups are listed in **Figure 21**.

Figure 21: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

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

According to feedback from focus group meetings, the share of the population using solar systems remains very low. Very few solar programs are being carried out by the Government or NGOs in the off-grid sector; as of 2018, the only solar projects being carried out by the Government were the distribution of household solar products in rural areas by ANPER. The GoN does not generally regulate or engage in off-grid solar industry.

Off-grid households generally lack knowledge about OGS solutions. Some households see solar products as an opportunity, but quality, access and cost are limiting factors. Focus group participants noted that most people believe solar pricing is not fair compared to the general income of households in the region.

The most active sales areas for solar products include Agadez, Maradi, Tahoua and Niamey. Most of the OGS product suppliers cannot adequately design, install or maintain solar systems. Suppliers also lack access to quality-certified solar products, which remains a major challenge in the country.

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

Looking beyond current use of off-grid solar products by households, this study analyzes potential for OGS market development by estimating potential household demand based on household income. Household income shown in **Table 15** is sourced from World Bank demographic data based on household surveys, which reports income by population quintiles. From household income, potential for energy spending is estimated as 10% of monthly income (see **Annex 2**). Future scenarios project higher energy budgets as household incomes rise with economic development over time. In all scenarios, the large majority of off-grid households will fall under the lowest income quintile.

Table 15: Energy Expenditure of Different Income Groups

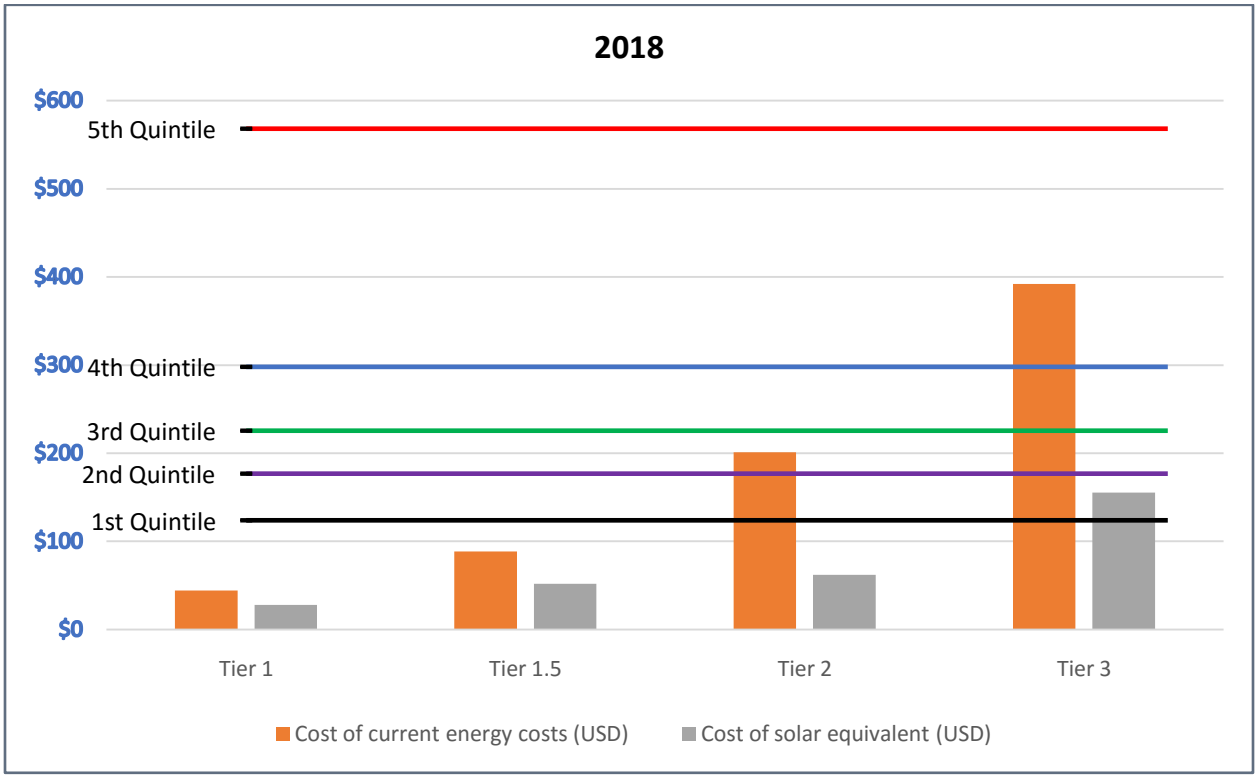
Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	$14.54	$103.25	10%	$10.32
2nd Quintile of Population	$20.75	$147.33	10%	$14.73
3rd Quintile of Population	$26.47	$187.94	10%	$18.79
4th Quintile of Population	$34.97	$248.26	10%	$24.83
Highest Quintile of Population	$66.67	$473.32	10%	$47.33
2023 Scenario				
Lowest Quintile of Population	$16.51	$117.21	10%	$11.72
2nd Quintile of Population	$23.56	$167.26	10%	$16.73
3rd Quintile of Population	$30.05	$213.35	10%	$21.34
4th Quintile of Population	$39.69	$281.83	10%	$28.18
Highest Quintile of Population	$75.68	$537.33	10%	$53.73
2030 Scenario				
Lowest Quintile of Population	$18.13	$128.74	10%	$12.87
2nd Quintile of Population	$25.87	$183.70	10%	$18.37
3rd Quintile of Population	$33.00	$234.33	10%	$23.43
4th Quintile of Population	$43.60	$309.54	10%	$30.95
Highest Quintile of Population	$83.12	$590.16	10%	$59.02

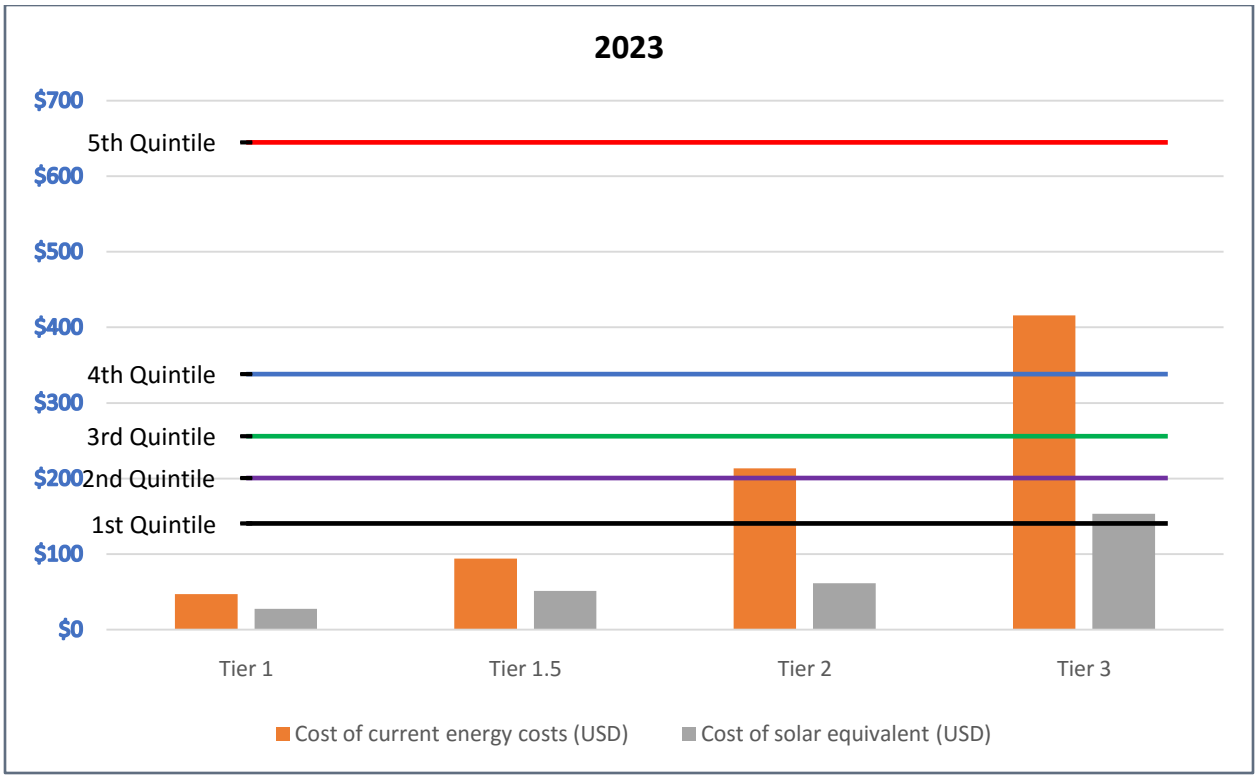
Source: African Solar Designs analysis

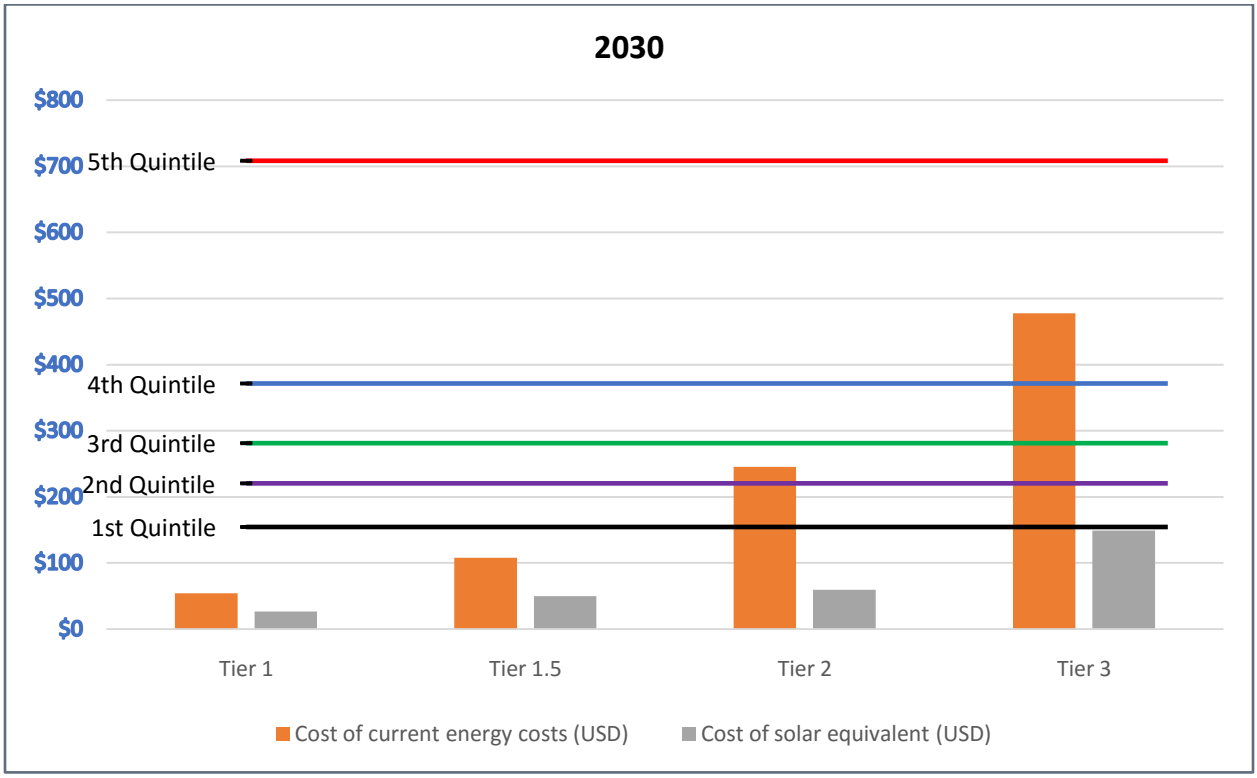
Figure 22summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual 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 22: Annual Household Energy Budget by Quintile, Annual Energy Costs and Cost of Solar Equivalents







Source: African Solar Designs analysis

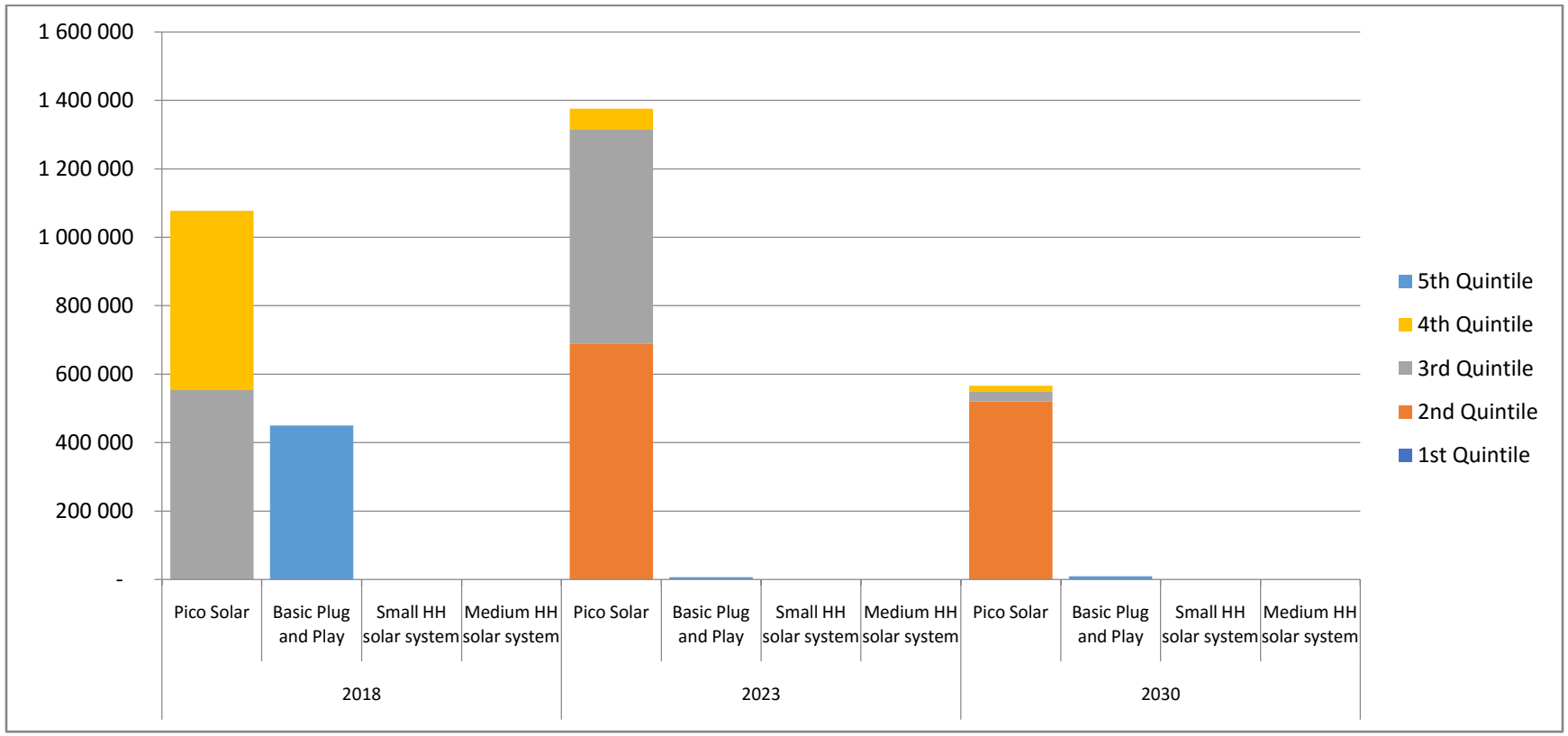
2.1.3 The Market for Household Devices without Consumer Finance

This section analyzes the cash market for various income levels and the corresponding energy services powered by OGS systems they can afford. Modelling of the viable market was based on income quintiles associated with data from the World Bank. The calculations and assumptions made are presented in **Table 15**. It was assumed that for a cash purchase a household is willing to save three months of their current energy expenditure to purchase the OGS system.

Based on the income quintiles and corresponding estimated current energy expenditure, in the 2018 scenario, households without electricity access in all but the two lowest income quintiles can afford a solar product unfinanced. Affordability increases significantly over time. However, the need for financing solutions for the lower income quintiles is clear.

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

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



Source: African Solar Designs analysis

Based on the analysis described in this section, **Table 16** presents the total potential annual cash market for off-grid solar product sales in the country's household sector.

Table 16: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	538,662	1,616	$24,239,805
Basic Plug and Play	150,077	1,501	$18,759,627
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**688,739**	**3,117**	**$42,999,432**
2023 Scenario			
Pico Solar	687,941	2,064	$30,580,721
Basic Plug and Play	2,318	23	$286,195
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**690,259**	**2,087**	**$30,866,916**
2030 Scenario			
Pico Solar	283,095	849	$12,229,944
Basic Plug and Play	3,009	30	$361,109
Small HH solar system	0	0	$0.00
Medium HH solar system	0	0	$0.00
Total	**286,104**	**879**	**$12,591,053**

Source: African Solar Designs analysis

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

- The most common type of systems which the market can afford on a cash basis are pico systems. Based on available income figures Tiers 1.5, 2 and 3 solutions are less viable for the vast majority of the population in the near term. However, this picture changes significantly with the introduction of 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.

2.1.4 The Financed Market for Off-Grid Solutions

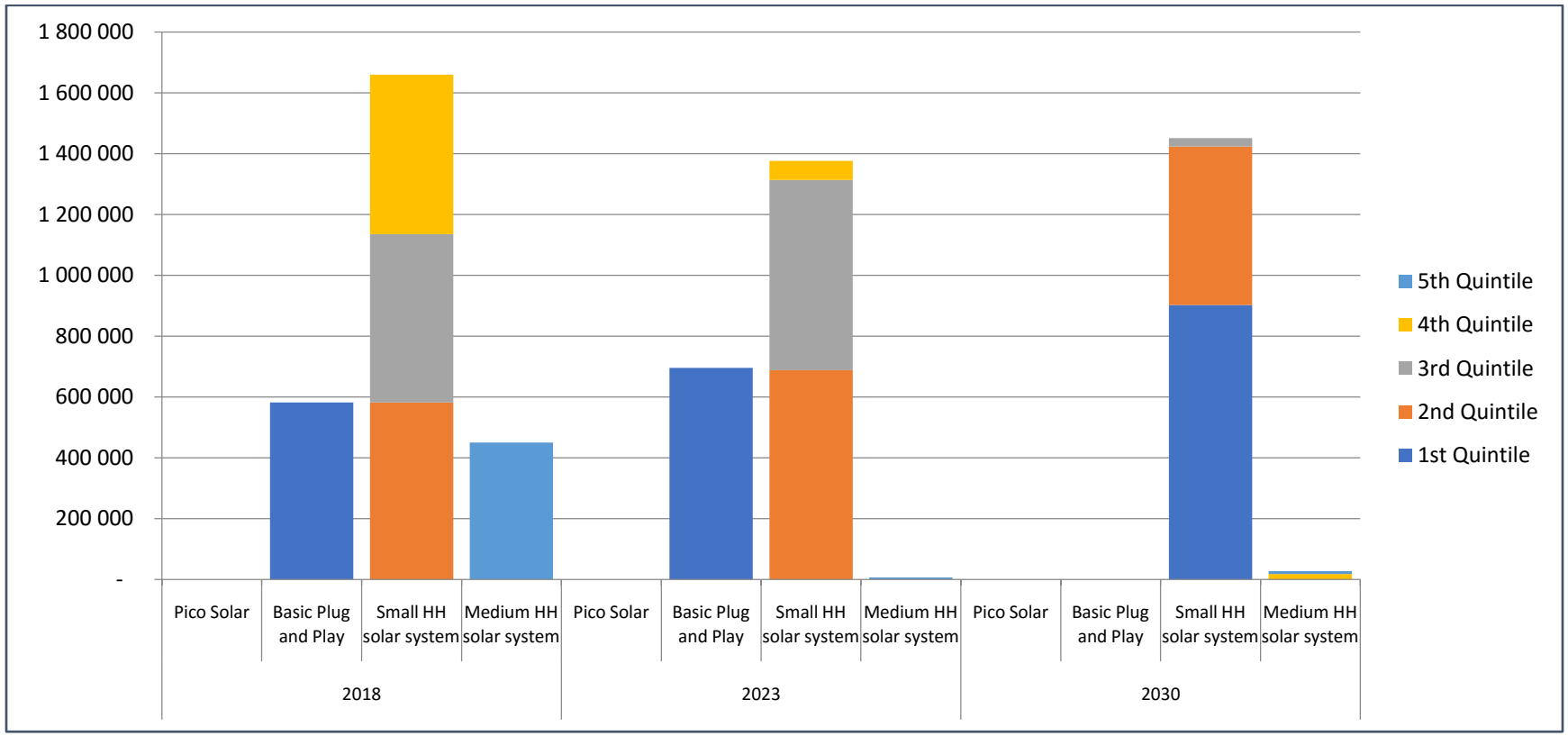
- **Financial Model**

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[132] and a 24-month term. The financial model assumes that the households would be willing to save for three months of their current energy expenditure to cover a small upfront deposit of 10% of the system and their current energy expenditure would be used to pay the monthly installments.

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

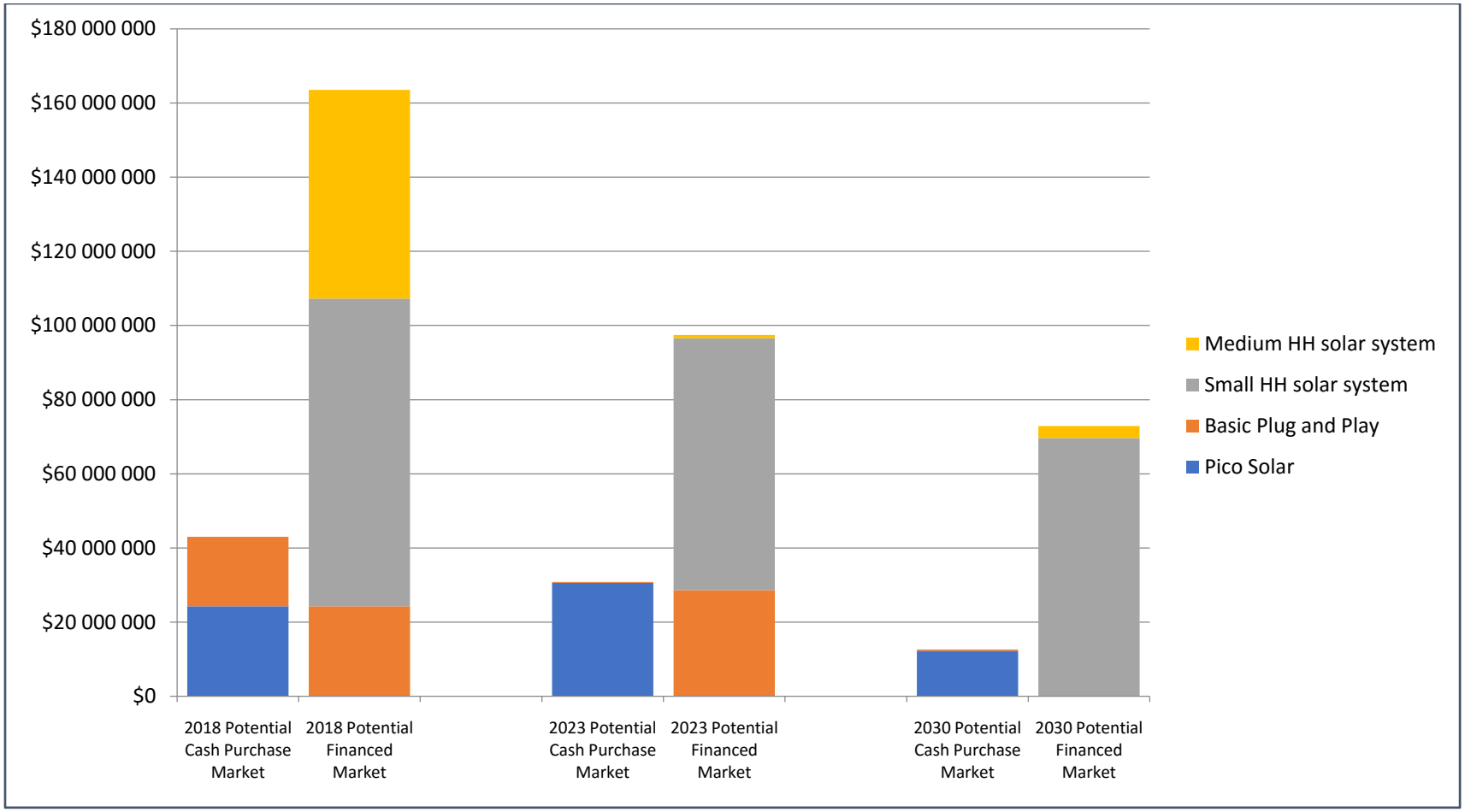
[132] Ferrari, A., Masetti, O., Ren, J., "Interest Rate Caps: The Theory and the Practice," World Bank Policy Research Working Paper, (April 2018): http://documents.worldbank.org/curated/en/244551522770775674/pdf/WPS8398.pdf

Figure 24: Estimated Number of Households Able to Afford Financed OGS Systems by Income Group



Source: African Solar Designs analysis

Figure 25: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

In 2018, without financing, 1,527,556 households (56.7% of the households without electricity access) could afford an OGS system. However, with financing, 2,692,231 households (100% of the households without electricity access) could afford an OGS system as the 1,164,675 off-grid HH in the two lowest income quintiles are enabled to acquire at least one OGS system. Consequently, the annualized potential market size increases from USD 42,999,432 to USD 163,526,067 (**Figure 25**).

The least-cost electrification 2023 scenario calculates that2,078,163 households could be electrified by stand-alone systems.Under this scenario, with financing, the number of households with the ability to acquire at least one OGS system increases from 1,382,836 (66.5% of the total households without electricity access) to 2,078,163 (100% of all households without electricity access) as the 695,327 households without electricity access in the lowest income quintile are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 30,866,915 to USD 97,435,209 (**Figure 25**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems woulddrop to 1,477,974. Under this scenario, with financing, the number of households with the ability to acquire at least one OGS system increases from 575,218 (38.9% of the total households without electricity access) to 1,477,974 (100% of all households without electricity access) as the 902,756 off-grid HH in the lowest income quintile are enabled to acquire at least one OGS system. The annualized potential market size increases from USD 12,591,053 to USD 72,894,085 (**Figure 25**).

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

Table 17: Estimated Financed Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	194,113	1,941	$24,264,069
Small HH solar system	331,932	16,597	$82,983,117
Medium HH solar system	90,046	22,512	$56,278,881
Total	**616,091**	**41,050**	**$163,526,067**
2023 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	231,776	2,318	$28,619,468
Small HH solar system	275,177	13,759	$67,957,157
Medium HH solar system	1,391	348	$858,584
Total	**508,344**	**16,425**	**$97,435,209**
2030 Scenario			
Pico Solar	0	0	$0.00
Basic Plug and Play	0	0	$0.00
Small HH solar system	290,178	14,509	$69,644,102
Medium HH solar system	5,417	1,354	$3,249,983
Total	**295,595**	**15,863**	**$72,894,085**

Source: African Solar Designs analysis

2.1.5 Consumer Perceptions, Interest and Awareness

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

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

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

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

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

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

- Some consumers have 'investment fatigue' from buying multiple solar products of low or unknown quality and are unwilling to make further investments.

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

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

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

2.2 Demand – Institutional

2.2.1 Overview of Institutional Market Segment

This section estimates the market potential for off-grid solar products for institutional users in Niger. 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 18shows the total estimated demand for institutional users in Niger. This estimation is calculated using available GIS data, secondary research, and primary source field data. The analysis is based on available information from planned expansion of the sectors and typical usage patterns and costs of existing systems in the country.There was insufficient GIS data available to properly estimate the market size; as a result, per capita comparisons were made with similar countries to analyze certain sectors as described below.[133]

Table 18: Indicative Total Cash Market Potential for Institutional Sector

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	26,397	39,956	$98,988,750
	Medium power pumping system	18,511	74,044	$185,110,000
	High power pumping system	5,935	59,350	$148,375,000
		50,843	**173,350**	**$432,473,750**
Healthcare	Health post (HC1)	6,305	1,892	7,566,000
	Basic healthcare facility (HC2)	3,152	4,728	18,912,000
	Enhanced healthcare facility (HC3)	694	2,915	11,659,200
		10,151	**9,535**	**$38,137,200**
Education	Primary schools	15,571	7,876	$39,377,500
	Secondary schools	1,600	3,072	$12,480,000
		17,171	**10,948**	**$51,857,500**
Public lighting	Public lighting (excluding street lighting)	**3,598**	**1,439**	**$6,476,505**
TOTAL		**81,763**	**195,272**	**$528,944,955**

Source: African Solar Designs analysis

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

- **Water Supply**

Table 19: Key Assumptions for Water Supply Sector Analysis

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

The water supply sector analysis considered the electricity needs for water supply for communities and households 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.

Although GIS data was unavailable, a 2017 market assessment undertaken by Open Capital Advisors with financing from the World Bank[134] provided data that was used to assess Niger's water supply sector. Based on analysis of the identified water points, the estimated market potential for the water supply sector is presented in **Table 20**.[135]

Table 20: Estimated Cash Market Potential for Water Supply

Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	26,397	39,956	$98,988,750
Medium power	18,511	74,044	$185,110,000
High power	5,935	59,350	$148,375,000
Total	**50,843**	**173,350**	**$432,473,750**

Source: African Solar Designs analysis

[134] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[135] See **Annex 2** for more details.

- **Healthcare**

Table 21: Key Assumptions for Healthcare Sector Analysis

Sector	System Sizes	Key Assumptions
Healthcare	• HC1: Dispensary health post (300 W) • HC2: Basic health facility (1,500 W) • HC3: Enhanced health facility (4,200 W)	A per capita comparison identified 10,151 off-grid healthcare facilities that could be electrified by stand-alone systems

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

As available GIS data was not sufficient to conduct the analysis, a per capita comparison made using data from Guinea[136] identified 10,151 off-grid healthcare facilities categorized according to their size (HC1, HC2, and HC3)[137] that could be electrified by stand-alone systems.To establish electricity demand, an assessment of equipment found within each category of healthcare facility was undertaken, with the daily demand of each used to calculate the system size required to cater to the load of the facility (**Table 22**). The assumptions of system size below are based on the services offered at each of these facilities.

Table 22: Healthcare Facility Categorization and Electricity Demand[138]

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	**300**
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

[136]Guinea was grouped in the same category as Niger; See **Annex 2** for more details.
[137] NOTE: This represents a small subset of the overall health infrastructure in the country; See **Annex 2** for more details.
[138] "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

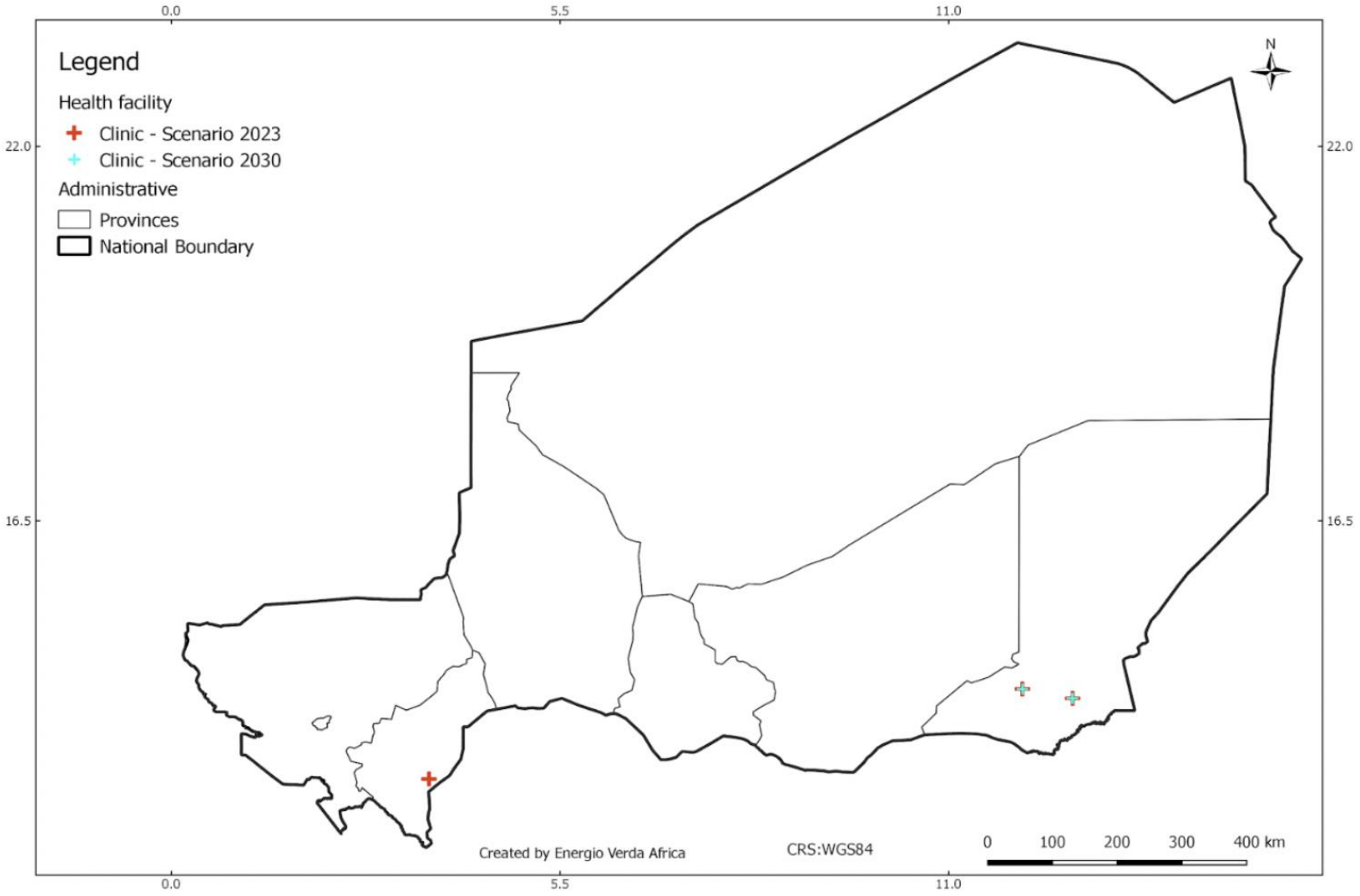
Based on these assumptions, the estimated market potential for the healthcare sector is presented in **Table 23**. The distribution of potential off-grid health facilities is shown in **Figure 26**.

Table 23: Estimated Cash Market Potential for Healthcare Facilities

Type of Facility	Units	kW Equivalent	Cash value (USD)
Health post (HC1)	6,305	1,892	7,566,000
Basic healthcare facility (HC2)	3,152	4,728	18,912,000
Enhanced healthcare facility (HC3)	694	2,915	11,659,200
Total	**10,151**	**9,535**	**$38,137,200**

Source: African Solar Designs analysis

Figure 26: Distribution of Potential Off-Grid Healthcare Facilities, 2023 and 2030[139]



Source: Energio Verda Africa GIS analysis

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

- **Education**

Table 24: Key Assumptions for Education Sector Analysis[140]

Sector	System Sizes	Key Assumptions
Education	• Elementary schools (500 W) • Secondary schools (1,920 W)	15,571 off-grid primary schools and 1,600 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.[141] 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 a total of 17,171 off-grid schools (15,571 primary schools and 1,600 secondary schools) that could be electrified by stand-alone systems. To establish electricity demand, an assessment of equipment found within each type of school was undertaken, with the daily demand of each used to calculate the system size required to cater to the load of the school (**Table 25**).

Table 25: Education Center Categorization and Electricity Demand[142]

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

Source: GIZ; African Solar Designs analysis

Based on these assumptions, the estimated market potential for primary and secondary schools is presented in **Table 26**.The distribution of potential off-grid primary and secondary schools is shown in **Figure 27**.

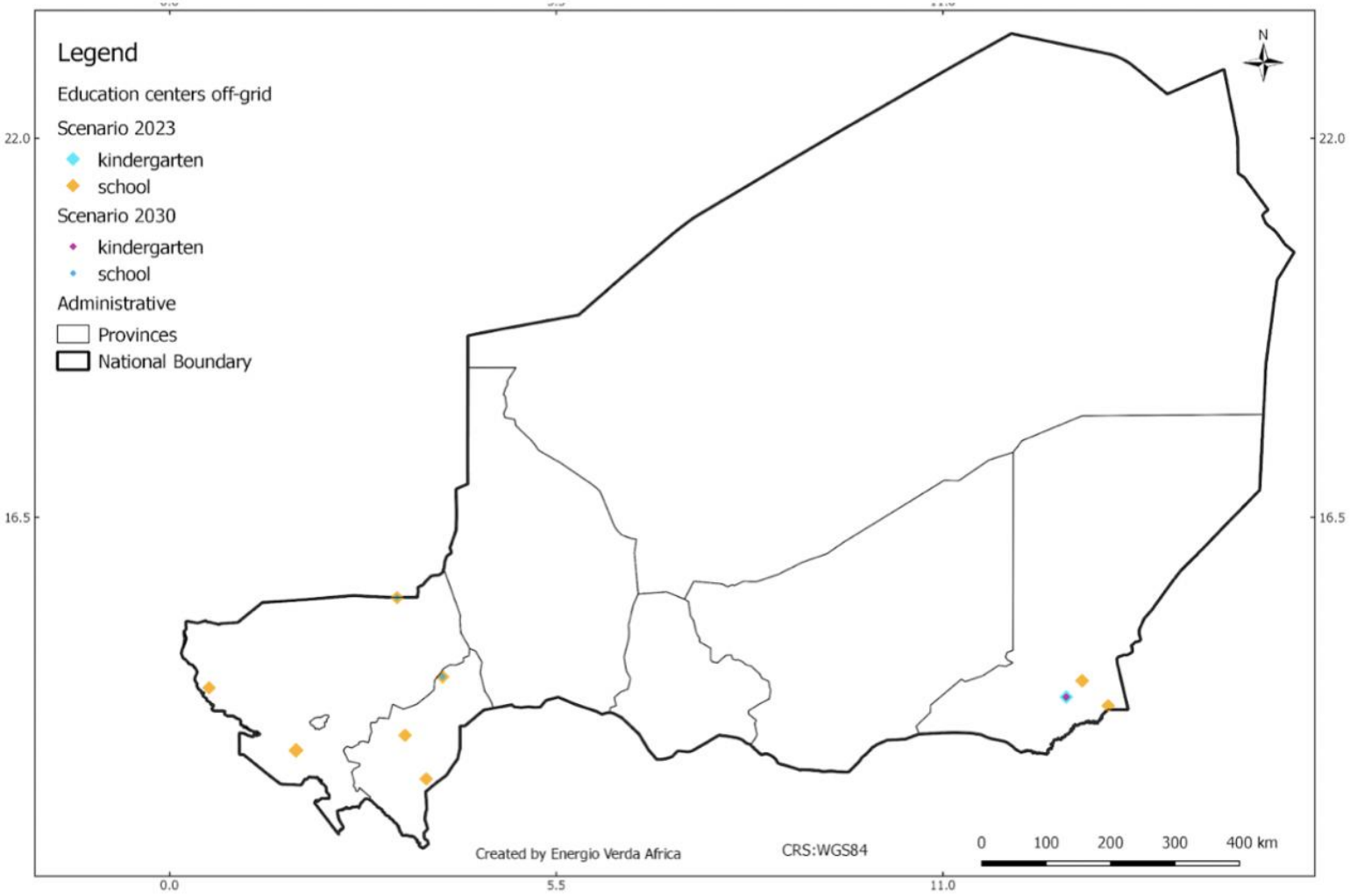
Table 26: Estimated Cash Market Potential for Primary and Secondary Schools

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	15,571	7,876	$39,377,500
Secondary school	1,600	3,072	$12,480,000
Total	**17,171**	**10,948**	**$51,857,500**

[140]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 **Annex2**).
[141] 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.
[142] "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

Source: African Solar Designs analysis

Figure 27: Distribution of Potential Off-Grid Primary and Secondary Schools, 2023 and 2030[143]



Source: Energio Verda Africa GIS analysis

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

- **Public Lighting**

Table 27: Key Assumptions for Public Lighting Sector Analysis

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 market potential for the public lighting sector is presented in **Table 28**.

Table 28: Estimated Cash Market Potential for Public Lighting

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	3,598	1,439	$6,476,505

Source: African Solar Designs analysis

2.2.3 Ability to Pay and Access to Finance

Financing for institutional off-grid systems in Niger 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.

An ability-to-pay analysis is intended to estimate the capacity of institutional users to purchase solar systems and pay monthly fees for maintenance based on an evaluation of user expenditures that can be replaced by off-grid solar PV. Due to lack of field data and published sources, a detailed analysis of operation and maintenance costs for institutional systems was not possible. **Table 29**indicates the budgetary allowance for 2017 for each institutional sector.

Table 29: Budgetary Allocations by Institutional Sector, 2017[144]

Institutional Market Segment	Category	Budget Allocation (Ability to Pay)
Healthcare	HC1, HC2, HC3	• The budgetary allocation for healthcare is USD 750,000.
Education	Primary and secondary Schools	• The budgetary allocation for education is USD 4.9 million
Water supply	Low power, medium power, high power	• The total budgetary allocation for the water and sanitation is 670,000 million

[144] Niger National Budget, 2017: http://yourbudgit.com/data/niger/

The assumption, however, is that these allocations of funding would be used for the purchase and installation of solar systems for health facilities, schools and/or water supply. Yet, there is no explicit budgetary allocation specifically for this purpose, so there is no guarantee that funding would be utilized for solar electrification.

This would imply that some combination of the private sector and the local communities would have to be involved in bearing these costs. In the event that donor funding is made available to cover the initial capital expenditure, there is still a need to raise funds for the maintenance of the systems. A market standard of 5-10% of the CAPEX is accepted as a rate for annual maintenance of the systems.[145]

Possible measures to counter these costs in what are mostly rural communities include *inter alia*:

- Fund-raising activities involving local communities and crowd funders, impact investors etc.
- Charging a minimal tariff to customers of the health facilities and water pumping zones to facilitate fund raising for the maintenance of the systems
- Lobbying for funding from local government to facilitate the maintenance fees of the systems

Given these budgetary constraints, some institutional sectors may present more viable market potential than others. Advanced health centers for example, may be prioritized by governments and communities for solar-related costs because electricity is required to run 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, schools can be run more easily without access to energy and may therefore present a lower priority market. Similarly, water points can often be pumped manually where funding is not available, presenting a no cost (if less efficient) alternative to paying for solar products.

Based on the results of the analysis presented in **Table 17**and **Table 29**, the institutional market segment in Niger with the most potential is the water supply sector. However, it is evident that the Government would nothave the ability to meet off-grid solar demand for water pumping systems without additional sources of funding from its development partners.

[145] 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

This section provides an overview of the main characteristics of productive use of energy (PUE) and how off-grid solar applications have the potential to create jobs and transform rural livelihoods in Niger. The analysis includes an assessment of rural sectors that benefit most from OGS applications and an estimation of current/future demand for these systems.

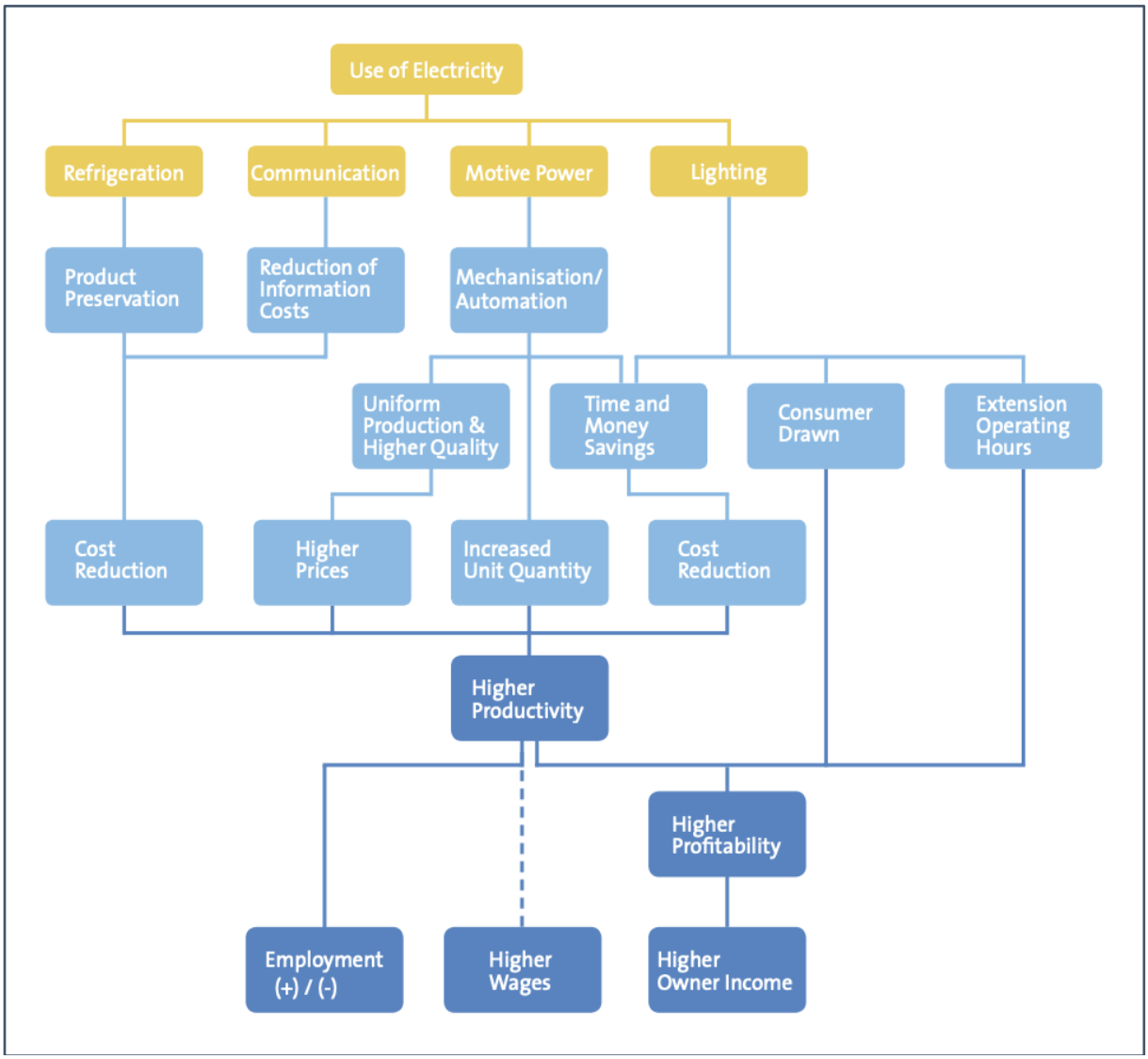
Focus group discussions provided encouraging feedback with regard to PUE, especially for its potential to support rural communities. Participants highlighted the important applicability of solar appliances to the agricultural sector, which contributes 39.7% to the GDP and employs 81% of the population.[146]Rice and millet production for solar water pumping and solar dryers for agro-processing were identified as applications with the highest potential. Although several productive uses have already emerged within the country, FGDs noted a need for greater policy support and increased awareness for PUE, particularly in isolated rural villages.

The Nigerien economy is characterized by a large informal sector that relies heavily on the agricultural sector, a dynamic that is not expected to change in the coming years despite an increasing share of secondary industries in GDP.[147] As a result, industrializing agricultural production has the potential to transform the country and reduce its reliance on mineral exports, which are susceptible to global market fluctuations. Furthermore, improved agricultural technology and favorable regulatory conditions can reduce constraints such as the cost of doing business in Niger and in turn attract private sector investment. Nevertheless, investments in infrastructure and natural resources alone will not be enough and will require investments in human capital and pro-poor policies which result in inclusive and sustainable growth.

The country's economy is also hindered by limited access to electricity and frequent power outages. It is important to note that the impact of electricity use on SMEs depends on a variety of external and internal factors, especially access to markets, the location of the firm, supply of inputs and financial capability. Therefore, the extent to which firms can afford to invest in off-grid solar solutions is determined largely by increases in productivity, profitability, and employment/wages from the investment in the off-grid appliance (**Figure 28**).

[146] "Niger, Priorities for Ending Poverty and Boosting Shared Prosperity, Systematic Country Diagnostic", World Bank (November 2017): http://documents.worldbank.org/curated/en/998751512408491271/pdf/NIGER-SCD-12012017.pdf
[147] Ibid.

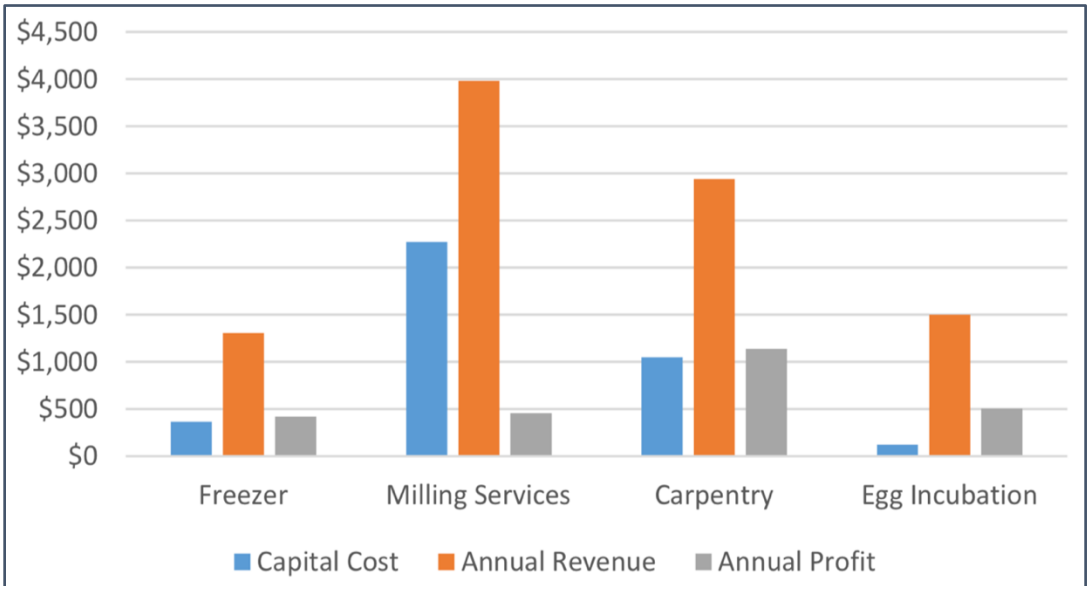
Figure 28: Pathways from Electricity to Income Generation[148]



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

[148] 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[149]



NOTE: Annual profit does not include recovery of cost capital

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

In order to organize and simplify this analysis and to deliver meaningful insights on country-level market sizing, productive solar applications have been divided into three main groups (**Table 30**).

Table 30: 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 (including agriculture)	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

[149] "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**

Based on feedback from the focus group discussion, PUE sector activities will take place in rural off-grid areas in Niger, particularly in the Agadez, Maradi, Tahoua, Tilabery, Dosso, Diffa, Zinder and Niamey regions of the country. These include areas where there are low levels of grid penetration / connectivity and where rural agricultural livelihoods are the predominant means of income generation.

2.3.2 Analysis of Productive Use Market Segment Demand

In general, there is little formal data available on the potential for solar in the productive sector in Niger. Census data, data from the World Bank, International Monetary Fund (IMF), International Trade Centre, Food and Agriculture Organization of the UN (FAO) and reports about the SME and agricultural sector were used to assess the overall market. In order to conduct the assessment, several key assumptions were made about PUE applications, which are presented in the sections below and in **Annex 2** in greater detail.**Table 31** presents the estimated total cash market potential for productive use sector in Niger.

Table 31: Indicative Total Cash Market Potential for Productive Use Sector

Productive Use Sector		Units	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	3,517	**$771,841**
Value-added Applications	Irrigation		$575,203,659
	Refrigeration and Chilling		$306,958,812
	Milling		$413,449,694
			$1,295,612,166
Connectivity / ICT	Phone Charging	5,500,000	**$38,527,785**
TOTAL			**$1,334,911,792**

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

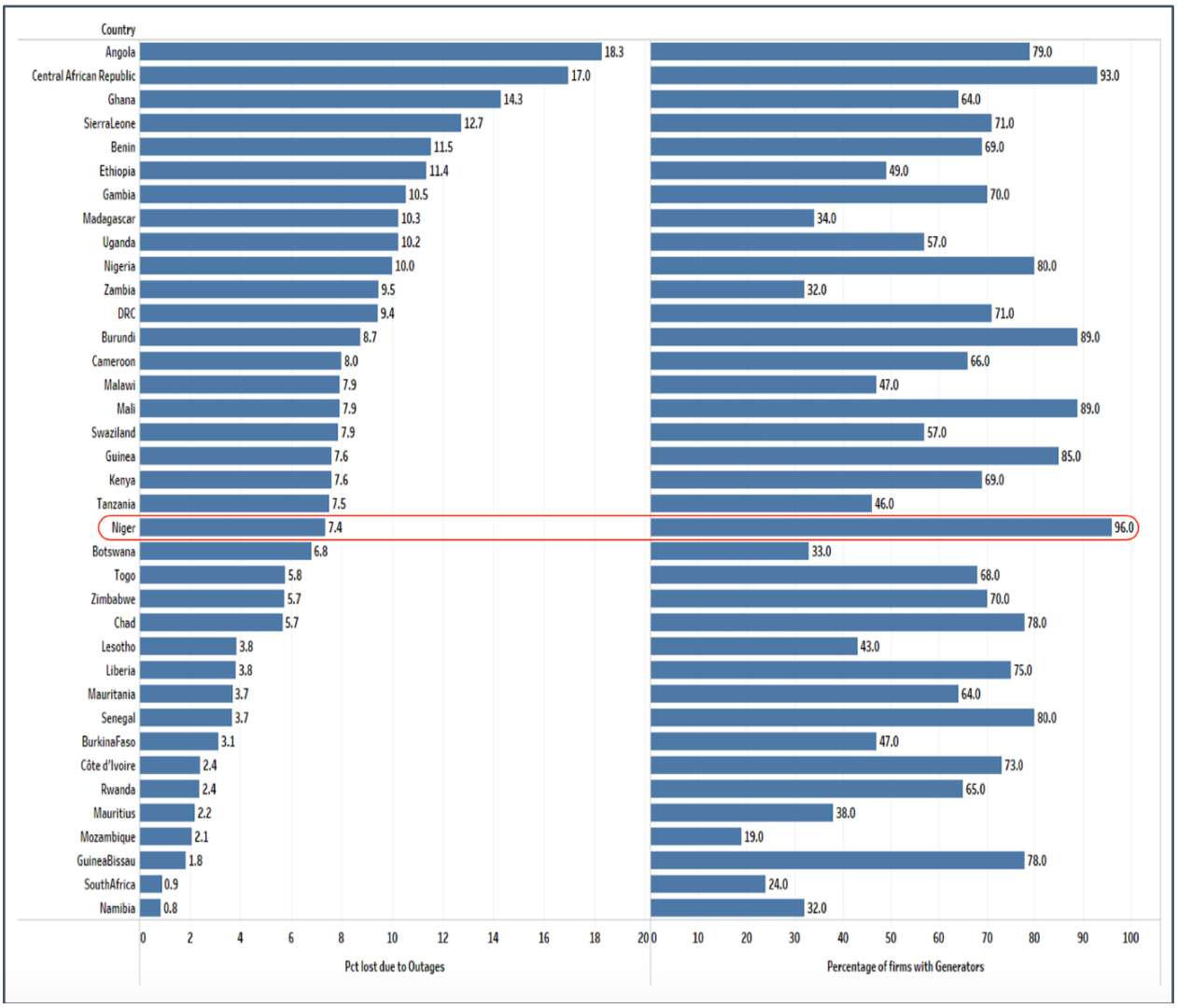
- **SME Applications for Village Businesses**

Access to solar powered appliances can have a wide-ranging impact on SMEs, many of which would otherwise rely on diesel generators to power their enterprises. Close to 33% of SMEs in emerging markets use fossil fuel powered generators in order to address energy insecurity.[150] For ECOWAS countries, independent power generation via fossil fuel powered generators is especially prevalent.[151]

This practice is extremely common in Niger, where power outages have accounted for more than 7.4% of annual sales lost and where 96% of firms own generators (**Figure 30**). Further, the cost of backup power in Niger is typically in the range of USD 0.30-0.40/kWh, and thus significantly handicaps productive industries.[152] Off-grid solar solutions could therefore play a large role in addressing the challenges of power quality for Nigerien firms.

[150] Foster, V., and Steinbuks, J., "Paying the Price for Unreliable Power Supplies: In-House Generation of Electricity by Firms in Africa," World Bank Policy Research Working Paper, (2009): https://openknowledge.worldbank.org/handle/10986/4116
[151] Ibid.
[152] "Niger Renewables Readiness Assessment," International Renewable Energy Agency, (2013): https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/RRA_Niger.pdf

Figure 30: Percentage of Sales Lost due to Power Outages and Percentage of Firms with Generator[153]



Source: Center for Global Development

While many enterprises would benefit from access to solar power, it may not be a requirement for a commercial enterprise to have access to powered appliances. Further, while petit trade is greatly facilitated by availability of electricity (kiosks and market stalls can be open longer hours and sell more and fresher products), electricity is not absolutely essential for SMEs because even without lighting, small shops can still sell their merchandise. Additionally, unlike value-added applications, there is little 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 generators, 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 closely tied to the revenue generation of SMEs. Investments

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

in such appliances in off-grid and low-income settings are more likely to be sustainable. Tailoring and barbering appliances (i.e. sewing machines and hair clippers designed or marketed for off-grid solar powered settings) were analyzed with respect to microenterprises that face difficulty in accessing outside capital, as the two appliances would provide an economic opportunity for such entrepreneurs that are demographically most likely to be in off-grid communities. A study undertaken in West Africa that found little correlation between electricity access and a firm's profitability did, however, find that tailors do consistently benefit from electricity access. .[154]

FGDs also highlighted the potential for solar power to support service-based industries, specifically those participating in poultry production, welding shops, beverage chilling, powering water pumps and water filtration The calculation of the estimated OGS market focuses only on barbering and tailoring appliances (**Table 32**), 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 much more complex analysis would be necessary to assess realistic demand from all SMEs.

Table 32: Estimated Market Potential for SMEs – Barbers and Tailors[155]

Number of Microenterprises with Constrained Access to Finance	Available Cash Market	Available Financed Market (Two-Year Repayment)	Interest Rate (p.a.)
3,517	$771,841	$1,003,393	30%

Source: World Bank

Published values of the current size of the import market for Niger for relevant off-grid electric machinery and appliances likely under represent what is much stronger latent demand from the SME sector to invest in off-grid solar powered appliances (**Table 33**).

Table 33: Value of Electric Appliance Imports for SMEs[156]

Product	2017 Value of Imports (USD)	2023 Projected Value of Imports (USD)
Electric Clippers	$6,000	$8,268
Sewing Machines	$410,000	$564,967
Petroleum Power Generators	$13,492,000	$18,591,541

Source: International Trade Centre and IMF

- **Value-Added Applications**

Focus group participants noted that milling of crops, irrigation, and poultry production are productive applications that would benefit from solar powered appliances and are well suited to bolster the Nigerien agricultural value chain. This analysis focuses on sizing the country's agriculture sector to assess the scale of the market for off-solar appliances. While 80% of Nigeriens engage in the agricultural sector, and agricultural products are the country's second largest export, Niger faces considerable food security risks

[154] 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

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

[156] Value of Imports was sourced from the International Trade Centre: http://www.intracen.org/itc/market-info-tools/trade-statistics/; value of imports was calculated based on IMF World Economic Outlook, (April 2018): https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx

due to droughts, violence, floods, and lack of climate resiliency.[157]Donor-funded initiatives such as the Millennium Challenge Corporation have recently begun to address the challenge of improving access to water for agriculture to enhance the volume and value of agricultural production.[158]

Solar Powered Irrigation:

It was assumed that for the value-added applications for solar irrigation systems, drip irrigation systems powered by submersible or surface pumps would be used. It is important to note that for most West African countries the national government has carried out irrigation initiatives that have deployed irrigation projects at various scales, which often require the construction of civil works such as dams, canals, embankments and piping. In Niger, donor supported projects have done much to further the awareness and availability of solar powered irrigation systems.[159]Hence, the market sizing approach for solar powered drip irrigation carried out in this analysis, which focuses on private sector driven approaches to support smallholder farmers is not a feasible approach for the diverse and large-scale irrigation challenges faced by the country as a whole.

The solar pumping systems reviewed varied in their wattage depending on the area of land irrigated, the depth of water abstracted and the quality of the soil and crops amongst other factors.[160] GIS analysis demonstrated that access to the water table and surface water is not a major determinant of the costing of applicable solar irrigation systems, as most farming settlements in Niger are within close proximity to either surface water or relatively easily extractable sources of water (**Figure 31**).

It is important to note that Niger's land is governed under formal and customary land tenure frameworks, both of which apply to agricultural and pastoral land. The Rural Code of 1993, which permits the registration of customary rights, but does not provide clarity on which customary rights may be registered or their priority, has resulted in a marked increase in land disputes.[161] This, in turn, has led to increased competition amongst various stakeholders over land and has made investments in irrigation schemes contentious, especially those carried out by the state.[162]

Although this market scoping exercise assumes a private sector driven approach, West African efforts to promote irrigation activities have been dominated by public sector initiatives, which often entail infrastructure investments beyond the scope of the interventions discussed herein.[163] In analyzing the available market for solar powered irrigation, this study focused exclusively on smallholder farmers and the available irrigation technologies to address their needs. In doing so, this analysis considered the emerging experience with small-scale productive use pumping in East Africa. Small pumps of 80 Wp-150 Wp as are being provided by Futurepump and SunCulture[164] make up the bulk of sales, while larger-sized pumps as provided by e.g., Grundfos, are also frequently marketed to address differing water access and

[157] Rodriguez Llanes, J. and Kayitakire, F., "Food security resilience to shocks in Niger: preliminary findings on potential measurement, drivers and challenges," LSMS-ISA data, Office of the European Union, Luxembourg, 2018.
[158] Niger, Millennium Challenge Corporation: https://www.mcc.gov/where-we-work/program/niger-compact
[159] "Water Mobilization Project to Enhance Food Security in Maradi, Tahoua and Zinder Regions," African Development Bank, https://www.afdb.org/en/projects-and-operations/selected-projects/afdb-helps-to-enhance-food-security-in-niger-24/
[160]*See* GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS
[161] Land Links: Niger Country Profile: https://land-links.org/country-profile/niger/#land
[162] "Niger: securing land rights in irrigated areas," International Union for Conservation of Nature, (14 May 2014): https://www.iucn.org/content/niger-securing-land-rights-irrigated-areas
[163] "Sahel Irrigation Initiative Support Project," World Bank International Development Association Project Appraisal Document on Proposed Grants, (November 10, 2017): http://documents.worldbank.org/curated/en/515131512702151121/pdf/WESTERN-AFRICA-PADnew-11142017.pdf; and
"Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa," World Bank, (June 2011): http://siteresources.worldbank.org/INTARD/Resources/West_Africa_web_fc.pdf
[164]http://sunculture.com; https://futurepump.com

crop conditions. Importantly, the cost of piping for drip irrigation systems makes up over one-third of system costs.

The provided tables analyzed the available cash and financed market for solar irrigation by both deriving the amount of available expenditures for investments in irrigation as well as the cost for the country to be fully irrigated based on prevailing costs of pumps and drip irrigation kits. Although drip irrigation is regarded as the most cost-effective approach for small-scale farmers, at scale it may prove to be prohibitively expensive and impractical to adopt.

Other Value-Added Applications:

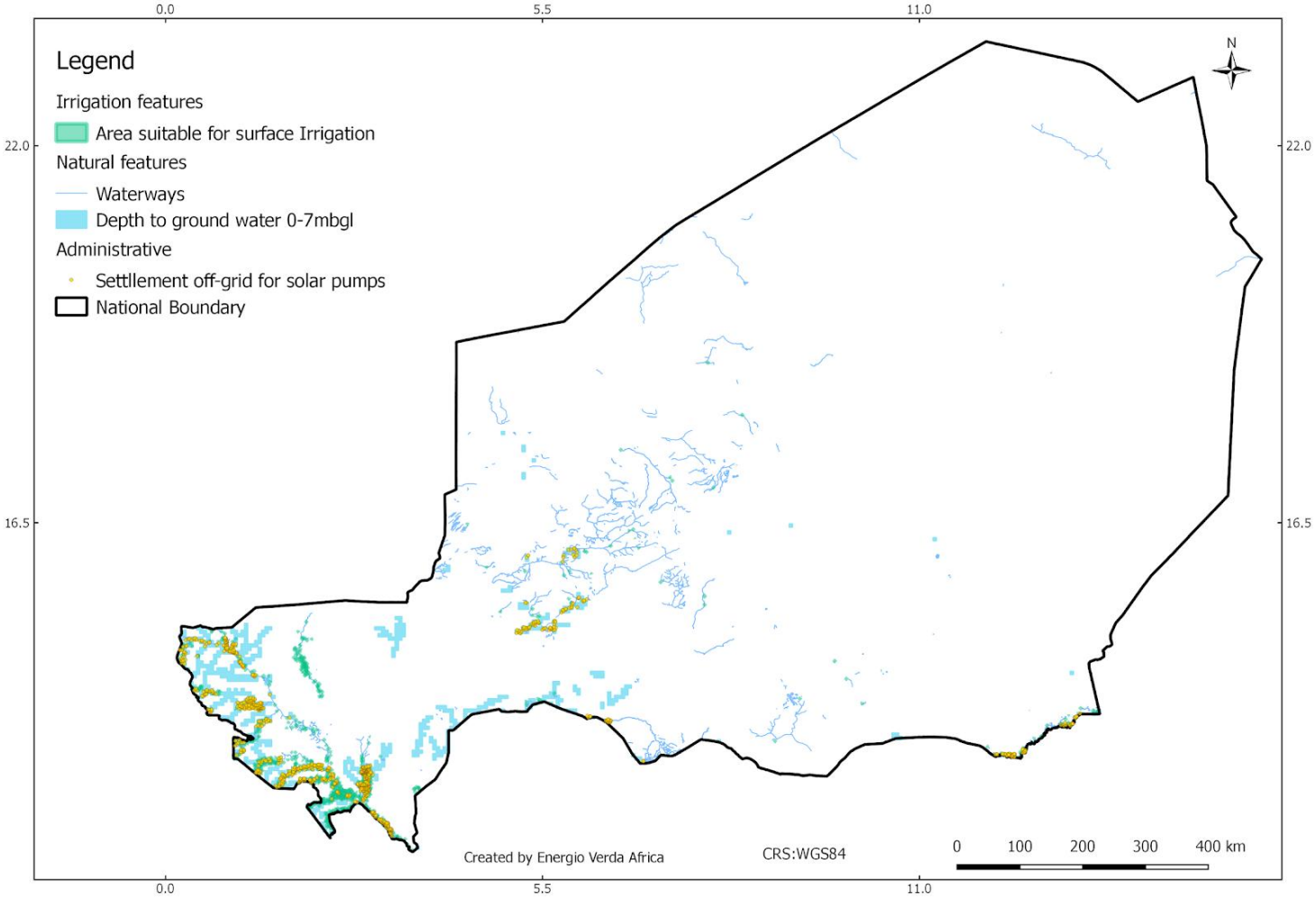
Table 34 presents the estimated cash and financed market potential for off-grid solar value-added applications. This analysis focused on three key market segments – solar milling, chilling/refrigeration, and irrigation.

Agricultural practices, especially for smallholder farmers, would benefit from a wide range of off-grid solar technologies. Much of Niger's agricultural processing takes places at the small firm scale. Thus, solar powered processing equipment would serve as an important and widely applicable productive use of OGS power. While Niger can derive much of its GDP from export of extractive products such as oil and uranium, it is hampered by unfavorable business environment, limited infrastructure, and low levels of agricultural processing. Solar powered agro-processing, especially for edible oils and staples such as cassava, could play an important role in revitalizing the Nigerien economy.[165]

Since the level at which such investments are made varies widely based on each agricultural product, demographics and socioeconomic factors, the size of the available markets for these appliances was calculated at a national economic level. This is based on the reasoning that the amount that the production of an agricultural product contributed to national economy would dictate the amount that could be expended on off-grid solar appliances for that agricultural product. The rate of how much of agricultural incomes were spent on inputs was taken from representative countries. For Niger the ratio of national agricultural product income to expenditures on crop inputs and household income was taken from the FAO dataset. An assortment of relevant crops and their incomes was analyzed in order to correlate economic activity to the appropriate appliances (see **Annex 2**).

[165] Fleur Wouterse and Ousmane Badiane, "Fostering Transformation and Growth in Niger's Agricultural Sector," Wageningen Academic Publishers, 2018.

Figure 31: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps[166]



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

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

Table 34: Estimated Market Potential for Off-Grid Solar Value-added Applications

EstimatedSize of Market for Smallholder Farmers for Value-added Appliances[167]					
Number of Households[168]	Median Household Income (USD)	Expenditure for Inputs on Value Production (%)	Size of Available Cash Market (USD)	Available Financed Market (two-year repayment)	Interest[169] Rate (p.a.)
3,132,929	$3,302	15%	$1,551,739,682	$2,017,261,587	30%

EstimatedSize of Market for Smallholder Value-added Appliances for Refrigeration and Chilling				
National Income Refrigeration and Cooling (USD)[170]	Expenditure on Agricultural Inputs (%)	Size of Available Cash Market (USD)	Available Financed Market (two-year repayment)	Interest Rate (p.a.)
$2,046,392,083	15%	$306,958,813	$399,046,456	30%

EstimatedSize of Market for Smallholder Value-added Appliances for Milling				
National Income Products for Milling (USD)[171]	Expenditure on Agricultural Inputs (%)	Size of Available Cash Market (USD)	Available Financed Market (two-year repayment)	Interest Rate (p.a.)
$2,756,331,296	15%	$413,449,694	$537,484,603	30%

EstimatedSize of Market for Smallholder Value-added Investment for Irrigation				
National Income for Agricultural Products for Irrigation[172]	Expenditure on Agricultural Inputs (%)	Size of Available Cash Market (USD)	Available Financed Market (two-year repayment)	Interest Rate (p.a.)
$3,834,691,059	15%	$575,203,659	$747,764,757	30%

EstimatedMarket for Solar Drip Irrigation					
Irrigation Potential (hectare)[173]	Amount Equipped for Irrigation Actually Irrigated (hectare)[174]	Price of Submersible Pump and Solar PV Power System per Hectare (USD)[175]	Price of Drip Irrigation System Per Hectare (USD)[176]	Percentage of Land to be Irrigated	Size of Available Market for Solar Powered Drip Irrigation (USD)
270,000	87,870	6,351.30	4,132.23	68%	$1,909,365,319

Source: Food and Agriculture Organization; African Solar Designs analysis

[167] "Family Farming Knowledge Platform, Smallholders DataPortrait," FAO: http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/
NOTE: Database was used for median household incomes and percentage of expenditure on agricultural inputs values.
[168] "World Development Indicators, Population," World Bank, (2016): https://data.worldbank.org/indicator/SP.POP.TOTL
[169] This rate was applied to all countries due to the fact that there is too much diversity in the market to pick one representative number with the same methodology across all the countries: https://www.emfc-loans.com/files/EMFC%20-%20Loan%20Market%20W%20AFRICA%20-%20Apr%202018.pdf
[170] National income products for refrigeration calculated using data from FAO. Products for refrigeration market include high quality proteins and fruits and vegetables: http://www.fao.org/faostat/en/#data/RF
[171] National income products for milling calculated using data from FAO. Products for milling market include cereals, and roots and tubers, http://www.fao.org/faostat/en/#data/RF
[172] National income for agricultural products for irrigation calculated using data from FAO. Products for this market include cereals, roots and tubers, and fruits and vegetables
[173] FAO: http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/
[174] Ibid.
[175] "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
[176] Ibid.

Table 35: Indicative Pricing for Value-Added Applications

Appliance	Average Cost of Appliances (USD)[177]	Wh/day[178]	Size of PV System (W) *
Surface and submersible (80M head)	$624	480	120
Grain Mills (milling 25 - 160 kgs./hr.)	$6,903	4500 - 14500	1125 - 3600
Refrigerator (cooling volume 165 -240 Liters)	$1,136	109 - 168	28 - 42
Milk Cooler (cooling volume 38-45 liters)	$4,250	185 - 1500	47 - 375

* Size of PV Systems calculated by multiplying Wh/24 hrs. by peak daily sun hours of 4 hrs.

Source: GIZ; African Solar Designs analysis

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

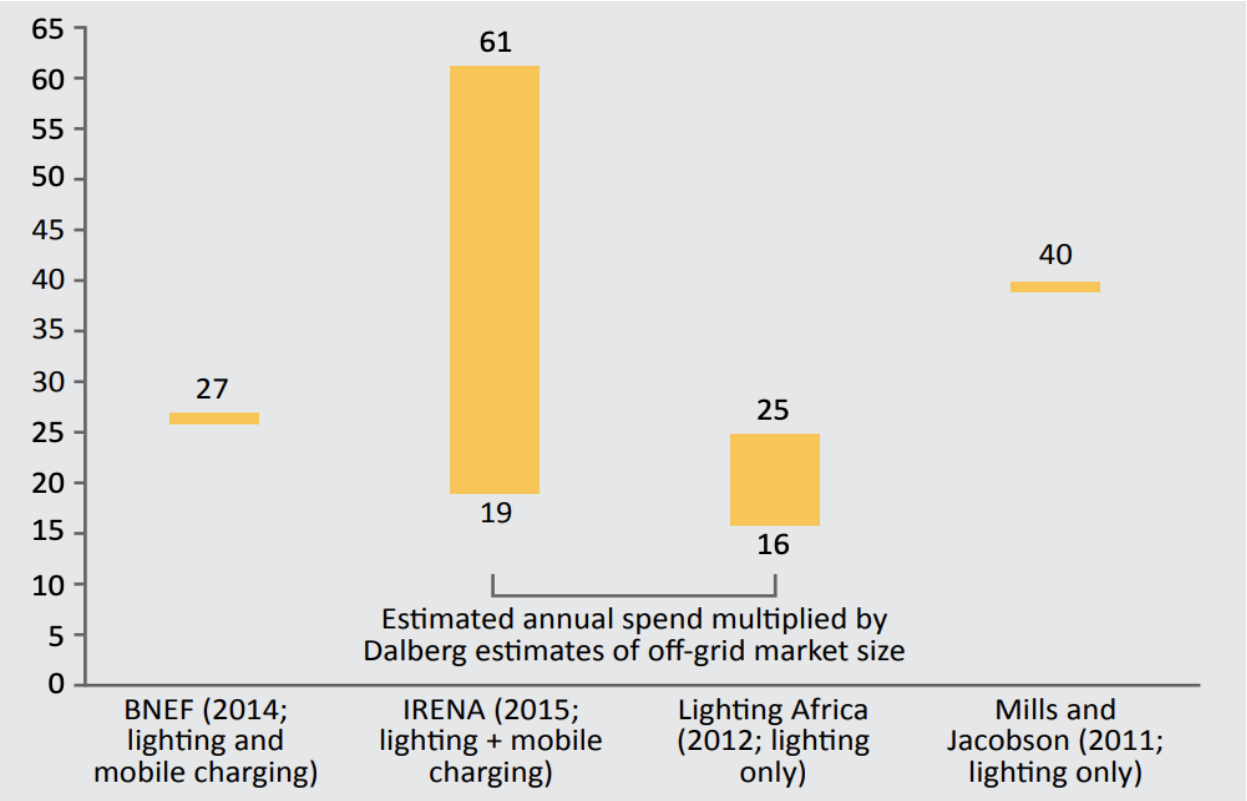
- **Connectivity/ICT Applications**

Phone charging stations / kiosks make up a critical demand element. Internationally, the market for solar phone charging is expected to grow over the near term spurred by growing awareness of the environmental, cost and energy saving benefits of such devices. The household rates of mobile phone ownership in Niger exceed the rates of electricity access (**Figure 16**). Moreover, Nigerien households spend more than USD 140 per year on lighting and phone charging.[179] However, this estimation is complicated and likely underestimates costs due expenditures on fuels and transportation (**Figure 32**). Increasingly, off-grid solar devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

Though Niger lacks ICT infrastructure, some players in the PUE sector have found ways to overcome this challenge. For example, an entrepreneur in Niger has recently developed a remotely controlled low-water-use irrigation system that is controlled by SMS protocols, rather than data, to start and stop the system.[180]

[177] "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
[178] For pumps, Wh/24 hrs. calculated using 6hr/day pumping based on future pumps specifications datasheet: https://futurepump.com/wp-content/uploads/2018/02/SF2-Datasheet.pdf; for Mills, the 6hrs/day running time used for all mills was provided by Solar Milling Stone's mill datasheet: http://solarmilling.com/wp-content/uploads/2018/09/technical_sheet_solar_milling_GRU.pdf
[179] "Solar PV in Africa: Costs and Markets," International Renewable Energy Agency, (2016): http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Solar_PV_Costs_Africa_2016.pdf
[180] Wouterse and Badiane, 2018.

Figure 32: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging[181]



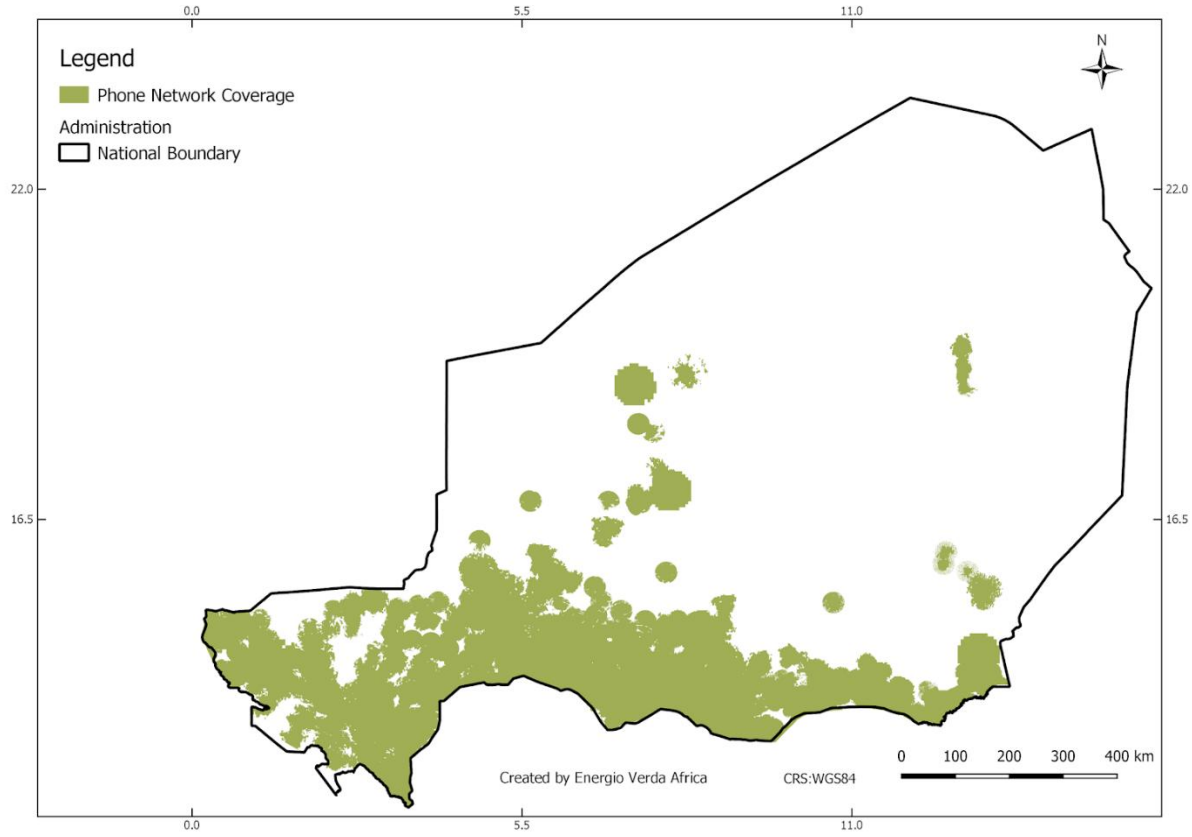
NOTE: Figures in Billion USD

Source: Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, 2018

Figure 33shows the relatively wide coverage of cellular signals in Niger. Cellular connectivity is important for solar PV markets for a number of reasons. First, the availability of mobile phones drives demand for off-grid phone charging; in many African countries mobile phone charging provides a major productive use application for off-grid solar. Next, mobile phone access – and more importantly connectivity – helps drive commerce and employment in rural areas. Mobile payment platforms are also increasingly important economic drivers, as they further financial inclusion amongst marginalized communities. Finally, mobile phones and connectivity are a necessary pre-cursor to mobile money and PAYG solutions in the OGS sector. Countries with expanding mobile phone and especially broadband internet use are more attractive to PAYG solar companies (**Figure 15**).

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

Figure 33: Mobile Phone Network Geographic Coverage[182]



Source: GSMA

Table 36 presents the estimated cash and financed market potential for off-grid solar and connectivity applications. **Table 37** shows the indicative pricing for OGS phone charging stations.

Table 36: Estimated Market Potential for Off-Grid Solar Connectivity Applications

Estimated Market Potential for Off-Grid Solar Connectivity Applications				
Rural Population (%)[183]	Mobile Subscribers[184]	Size of Available Cash Market (USD)	Available Financed Market (two-year repayment)	Interest Rate (p.a.)
81.30%	5,500,000	$38,527,785	$50,086,121	30%

Source: GSMA and World Bank

[182] See **Annex 2** for more details
[183] "World Development Indicators, Population," World Bank, (2016):https://data.worldbank.org/indicator/SP.POP.TOTL
[184]"The Mobile Economy: Sub-Saharan Africa," GSMA, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download

Table 37: Indicative Pricing for Phone Charging Stations[185]

Charging Stations	Cost Per Unit (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; African Solar Designs analysis

2.3.3 Ability to Pay and Access to Finance

The above analysis illustrates that for each of the value-added OGS productive use appliances, solar water pumps and irrigation, there exists a sizeable cash and financed market for off-grid appliance users. Especially for irrigation, the increased revenues from the use of solar appliances almost always justify the expenditure. Such increases in agricultural product revenue are highly specific to environmental and market factors.

With regard to microenterprises further study would need to be done to determine the effect of off-grid appliances, especially the ones analyzed (phone charging, barbers and tailoring), on incomes, and therefore affordability. Solar powered irrigation systems may require a financed solution to be profitable investments for Nigerien farmers, as their cost may exceed their benefits depending on how the systems are designed and what components are used.[186]

Focus group participantsindicated that awareness raising was critical to growth of the sector. The FGDs also called attention to a lack of available financing for rural solar retailers and suppliers, who cannot afford to stock solar products.A potential solution for this would be implementing consignment schemes to allow distributors to better engage retailers for solar appliances and power systems in remote areas.

[185] "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

[186] Merrey, D. J.; Lefore, N, "Improving the availability and effectiveness of rural and Microfinance for small-scale irrigation in Sub-Saharan Africa: A review of lessons learned," International Water Management Institute (Working Paper 185), 2018.

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Niger, 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

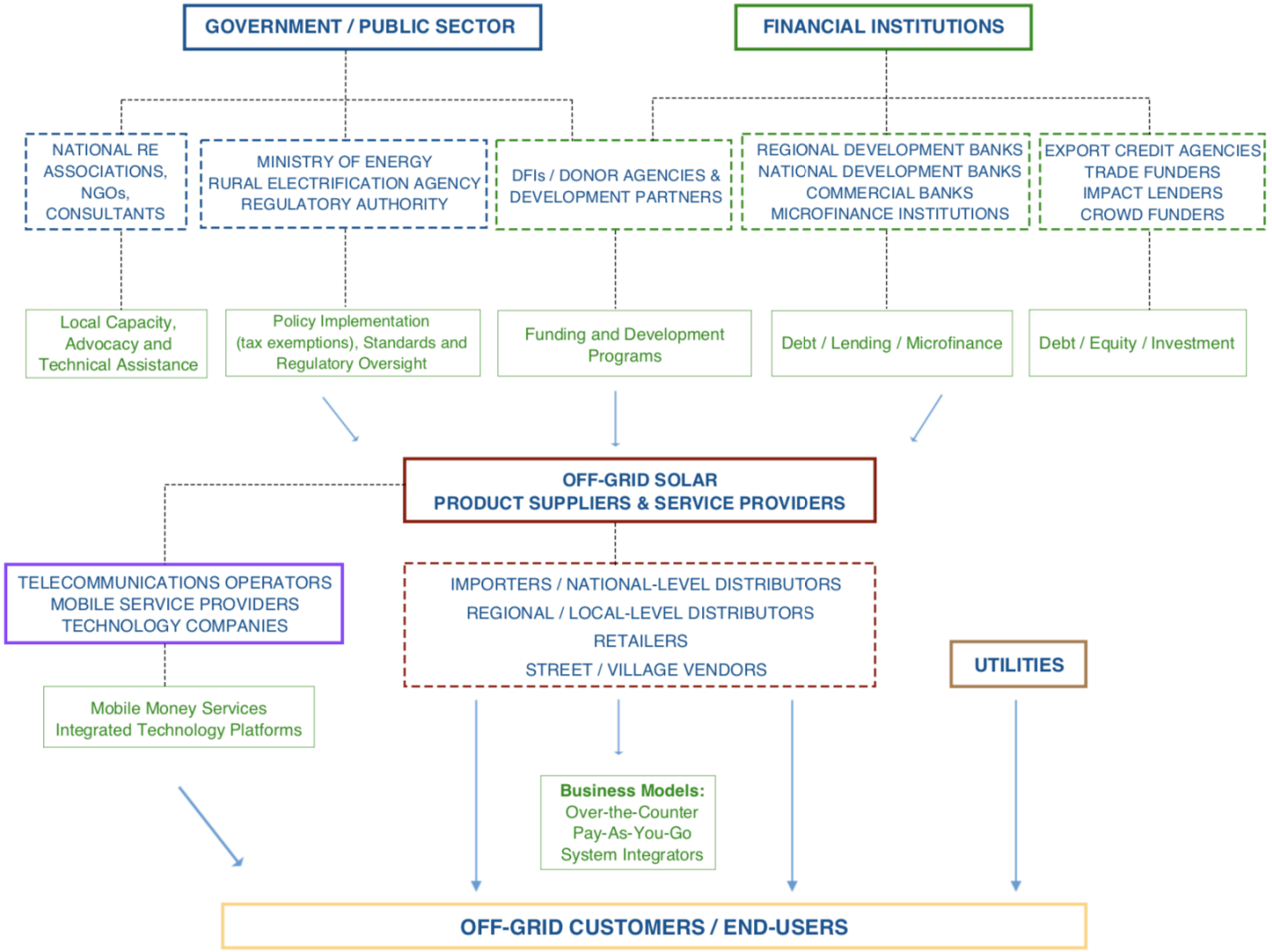
2.4.1 Overview of Commercial Market for Solar PV Equipment

The off-grid solar supply chain in Niger is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 34**). The GoN has prioritized development of the off-grid solar sector, as the country's overall market environment and opportunity for solar companies has improved significantly in recent years (**Figure 12**).The OGS sector is most developed in the regions of Agadez, Tahoua and Maradi.

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, power supply is often not sufficient, continuous, or reliable (**Figure 4**), further supporting expanded use of solar PV equipment by this consumer segment.

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

Figure 34: 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.[187]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.

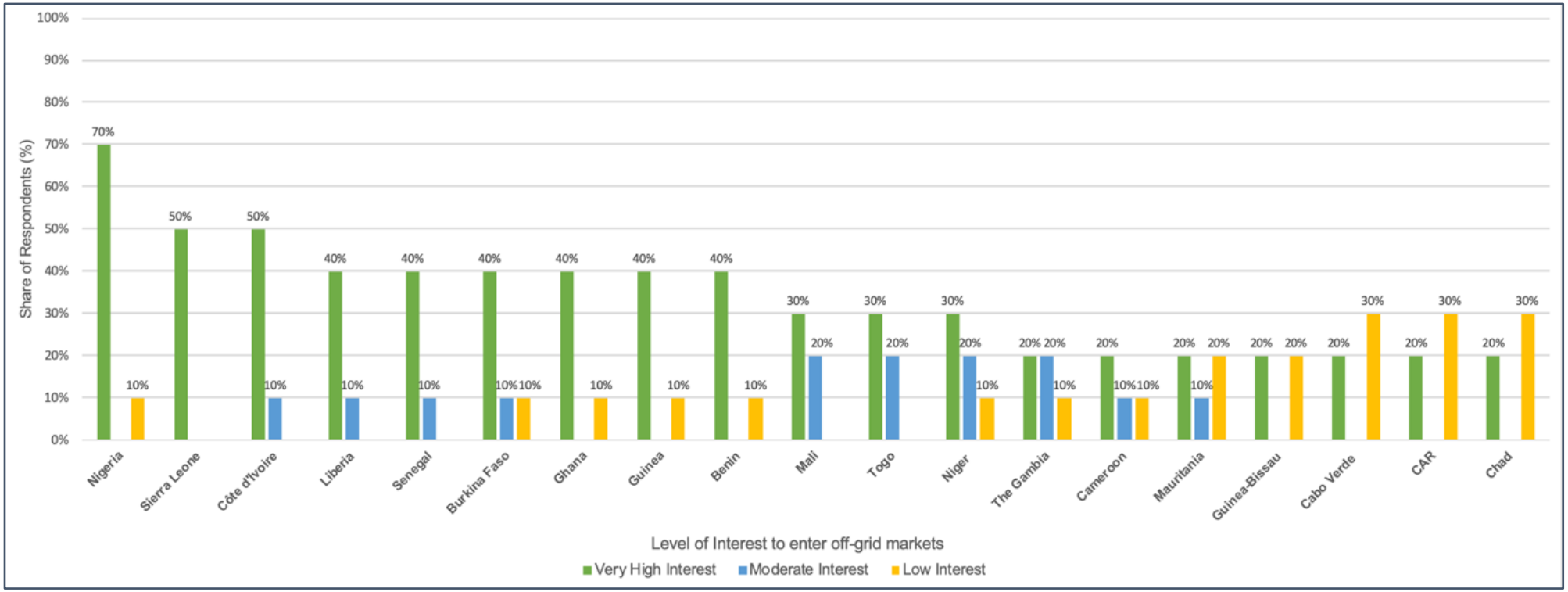
Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money 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 2million systems sold in 2017.[188]

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.[189]

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 35**. 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.

[187] "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
[188] Ibid.
[189] "Insights from Interviews with Off-Grid Energy Companies," ECREEE, (June 2018).

Figure 35: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers[190]



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

[190] 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 Niger

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 30 companies operating in Niger's solar sector, offering a wide range of products and services to consumers throughout the country (see **Annex 2** for a complete list of identified companies). In addition to local firms, the formal market includes international players that primarily bid on donor-funded projects. As of 2018, most of the solar companies operating in Niger were Tier 1 companies, with only six firms identified as Tier 2 and Tier 3 companies.

While there is no solar manufacturer or assembler in Niger, there are many experienced EPC companies that work with large institutional and social clients (GoN, NGOs, donors) to implement solar solutions. A few large companies have the technical capacity to install, operate and maintain systems even though local capacity is lacking for most. Large local and international Tier 2 and Tier 3 companies, work with institutional clients and include Consultations Plus, Benalya Group, Tessa Power, La Sahélienne du Génie Électrique, SES, Benafsol and Yandalux. They are all international brand manufacturer representatives and wholesalers, selling multiple and very large solar systems. These companies also act as system integrators, participating in procurement tenders for supply and installation of larger systems. Most of solar firms utilize their own funds to grow their business. A few companies offer consumer finance to their customers, while external sources of finance are also available to their customers (e.g. MFI loans).

Total, Kanf Electronics, Ets Lumière du Sahel, and Boutique Elhadji Yellow are other major companies (manufacturer representatives, wholesalers and retailers) active in the country. These four companies utilize cash sales over-the-counter transactions, focusing on households and/or businesses. Total is the only large international distributor selling directly pico solar products to end-users in Niger.[191] The French petroleum company has formed a partnership with U.S. company d.light to launch its program, Awango, across several countries in West Africa. Since 2013, Total sells Pico lanterns (for lighting and phone charging) through its established petrol stations distribution network in Niger. Kanf Electronics is also a manufacturer representative and a wholesaler, who like most major solar player in Niger, does not offer Pico lanterns but only SHS over 220W. Kanf Electronics has started to avail PAYG consumer finance to customers. Ets Lumière du Sahel is a local company, both wholesaler and retailer, who sells a wide range of solar home systems and plug and play systems, while Boutique Elhadji Yellow deals in single and multiple modular systems.

Other Tier 1 companies interviewed are mostly retailers – including smaller hardware and electronic stores (e.g. Ets Maman Sani). These companies sell a wide range of pico solar and/or solar home system products to a variety of clients (households, institutional/social users and businesses). ETS Ténéré and ETS Yacouba Mahama were identified as the most active Pico products distributors. A few companies offer installation and O&M services for the products they sell to customers, while a majority outsources these services.

- **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.

[191] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/

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**; very limited data was available for Niger. It is also 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 Niger.

Table 39: Total Sales Volume and Cash Revenue for Stand-alone Systems in Niger, 2016-2017[192]

Sales Volume / Revenue	2016	2017	Total
Total Volume of Products Sold (Units)			
Total Volume of Products Sold	no data	3,640	**3,640**
Pico Solar	no data	3,422	**3,422**
SHS	no data	18	**18**
Total Cash Sales Revenue (USD)			
Total Cash Sales Revenue	no data	no data	no data
Pico Solar	no data	no data	no data
SHS	no data	no data	no data

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

NOTE: The volume of products sold and cash sales revenue for each product category (Pico solar and SHS) are estimates based on regional average figures from West Africa – in 2017, 85% of the overall share of products sold and 96% of total sales revenue in the region were pico solar products compared to 15% of products sold and 4% of sales revenue were SHS; In 2016, 94% of the overall share of products sold and 86% of total sales revenue in the region were pico solar products compared to 6% of products sold and 14% of sales revenue were SHS.

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

Table 40: Cash and PAYG Sales Volume and Revenue for Pico Solar Products, H1 2018[193]

Sales Volume / Revenue	Cash	Share (%)	PAYG	Share (%)	Total
Total Volume Sales Niger	**3,955**	**100%**	**no data**	**0%**	**3,955**
Total Sales Volume West Africa and the Sahel	348,756	100%	108,747	35.0%	457,503
% of Total Sales Volume in West Africa and the Sahel	1.1%	-	no data	-	4.7%
Total Cash Sales Revenue Niger	**no data**	**no data**	**no data**	**no data**	**no data**
Total Sales Revenue West Africa and the Sahel	$15,496,746	49.7%	$15,662,920	50.3%	$31,159,666
% of Total Sales Revenue in West Africa and the Sahel	no data	-	no data	-	no data

NOTE: H1 = First half of year

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

[192] "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

[193] "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

- **In 2017, 3,640 units were sold in Niger, the lowest volume in the West Africa and Sahel region**. Data on sales revenue was not available. No sales or revenue data was available for 2016.
- **In the first half of 2018, cash sales increased to 3,955 units sold, while no PAYG sales were recorded**. Niger recorded the lowest sales volume, behind Togo (4,505 units) and Benin (5.733 units) in H1 2018. However, Niger sales volume in H1 2018 have already increased by 9% compared to the year 2017. Cash sales remain the dominant transaction business model, and no PAYG sales were reported during the period.
- **Pico PV products represent the vast majority of products sold**. Based on regional sales data on product categories, pico solar products accounted for 96% of sales volume in 2017.

➢ Main Solar Products and Components

Table 41 lists the brands of common solar products and components in Niger. The list does not include non-certified brands that are also common in the country's grey market.[194]

Table 41: Off-Grid Solar Products and Components in Niger

Systems	Companies
Pico Solar lanterns distributors	Groupe Benalya, ETS Ténéré, ETS Yacouba Mahaman
Single Module distributors	ETS Moussa Elhadji Abbasse, ETS Lumière du Sahel, Kanf Electronics
Multi module system distributors	ETS Maman Sani, Global Energy Solaire
Very large system supplier	La Sahélienne du Génie Electrique (SGE), Yandalux, Consultation Plus
Systems/Components	**Brands**
Pico solar lanterns	Sunking (China), Suntech (China), Lagazel (France), Ningbo Solar (China), GD Lite (China), Su-Kam (India), Omega (China), In2Brands (South Africa)
Single Module	Suntech (China), Atersa (Spain), Canadian Solar (Canada)
Multi module system	Solutex (Germany), Ningbo Solar (China)
Very large system	Aleo Solar (Germany)
Solar modules	Aleo Solar (Germany), Ningbo Solar (China), Suntech (China), Canadian Solar (Canada), Atersa (Spain), Solar World (Spain), Omega (China)
Inverters	Voltronic (Taiwan), Okey pure sine wawe (China), Victron (Belgium), Power (China), SMA (Germany), Huawei (China)
Lead Acid Batteries	Exide (Germany), CS Power (China), Victron (Belgium), Storace (China), Sunstonepower (China), GS Yuasa (Japan), Toyo (Japan)

Source: African Solar Designs analysis; Stakeholder interviews

➢ Market Prices

Table 42 presents average prices for off-grid systems and components in Niger's solar market. Although sales volumes are growing rapidly, product prices for consumers are still higher than in mature markets.

[194] 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.

Table 42: Estimated Prices of Solar Systems and Components in Niger

Off-Grid System / Component	Price range (USD / per unit)
Pico solar (5W-8W)	$8.5-$10
Pico / Plug and Play (10 W)	$13-$370
Single module SHS (20W-100W)	$30-$900
Multiple module SHS (130W-150W)	$68-$100
Solar Module (150W-2200W)	$120-$400
Inverter (500W-5kW)	$27-$2,500
Lead Acid Battery (75Ah-300Ah)	$54-$800

Source: Stakeholder interviews

- **Importation Clearance Processes**

The Customs and the Tax Authorities are the two main government agencies involved in the importation of solar products into the country. In Niger, despite custom duty exemption, other taxes including VAT are still applied on off-grid products. Indeed, solar products and components are taxed a 1% statistical fee, a 1% Community Solidarity Levy and a 1% import tax and all products are taxed at 19% VAT. It takes about 60 business days for importers to get solar products into Niger and about one additional two months for customs clearance. GOGLA and Lighting Africa standards are not applied in the country but the IEC (International Electronic Commission) standards are for some products imported. To date, there is no agency in charge of making the standardization process more efficient at national level.

2.4.4 Overview of Business Models

- **Company Approach to Market**

Off-grid solar supply is at nascent stages and until now, companies in Niger are essentially working under the Engineering Procurement and Construction (EPC) model. They utilize procurement for large institutional clients (donors, GoN and NGOs), covering a wide range of activities, from solar irrigation and water pumping, to street lighting, and rural communities' electrification programs.[195] Until very recently, off-grid solar was part of a larger business or even a side business, while enterprises were not specialized in that sector in particular. As a result, 90% of surveyed solar providers are experienced companies who have been active in the industry for over five years (Benafsol, Yacouba Mahaman, Kanf Electronics, Ets Maman Sani, Global Energy Solaire, Ets Moussa Elhadji Abbasse, Ets Ténéré, La Sahélienne du Génie Électrique, Ets Lumière du Sahel).

Solar enterprises in Niger have slowly started to diversify their services, targeting a range of end-users. Benalya and La Sahélienne du Génie Électrique are examples of EPC companies thatare now offering pico products to households and businesses. La Sahélienne du Génie Électrique is now a distributor of Lagazel brand of Pico products in Niger. While most companies continue to sell multiple modular and very large solar systems to large institutional clients, a few companies overpico solar products (Benalya, ETS Yacouba Mahaman) and single modular systems (ETS Moussa Elhadji Abbasse, ETS Lumière du Sahel, Kanf Electronics) to households, NGOs and public institutions.

The main business model utilized is cash/over-the-counter sales, as only a small number of firms have started to utilize PAYG (e.g. Benalya, Kanf Electronics) to target low-income households.

[195] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/

Nevertheless,most companies do not want to manage consumer financing for their customers but prefer forming partnerships with external sources of financing (e.g. FIs, MFIs).[196]

- **Business Models**

There are four primary business models used 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. 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. In Niger, most companies active in the solar sector are engineering, procurement and construction (EPC) companies.
- **Plug and play and pico suppliers** cooperate with many of the major OGS brands to distribute products in the country. Sellers of plug and play systems target customers who can afford more than simple pico lanterns (products are usually sold through PAYG). A few companies have started providing plug and play systems in Niger (e.g. Benalya, Ets Yacouba Mahaman, Ets Lumière du Sahel, Ets Maman Sani).
- The **PAYG** sector is still in its early stages in Niger. Under this business model, suppliers are gradually 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. 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. Only major Tier 2 and Tier 3 off-grid solar providers Benalya and Kanf Electronics were offering PAYG consumer finance in Niger.

[196] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/

Table 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 Niger are mostly small-scale (with the exception Total Awango and a few local companies) and mainly located in Niamey. They sell lighting/electrical products, including solar, pico systems and also large panels for urban customers. **Informal:** Kiosks, street vendors form a key pico-product retailer segment (that has not been fully explored). They sell low-priced products which are often short-lived. They have been seen as the entry points for black market low quality solar products.	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.While very few companies utilize PAYG, MFI loans among other sources of consumer finance are available in Niger for a small number of consumers	Early stage commercial development
Energy-as-a-service / Fee-for-a-Service	The energy-as-a-service model is relatively new, launched recently in Mali and in Nigeria. While this concept offers consumer finance to bottom-of-the-pyramid customers like PAYG, customers pay a monthly fee to access energy service, not to buy SHS/solar products. While the solar provider maintains ownership of the systems, he is responsible for providing installation, maintenance, solving technical issues, repairs, upgrade of the systems. In Niger, this model has not been launched yet but was mentioned as a potential business model to develop. Focus group meeting stakeholders indicated that it would be particularly well-suited for Niger rural areas dispersed communities (where micro-grid/mini-grid are not viable).	Early stage commercial development

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

- **Company Financing**

With overall lack of financial assistance and dedicated financing mechanisms available for the off-grid sector, it can become difficult for companies to finance their operations and grow their business. In addition to financing customer payment options (hire purchase), suppliers also require significant working capital to purchase equipment, conduct marketing campaigns, cover field costs, high cost of merchandise transportation from supplier and estimated high risk of theft. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited. Feedback from focus group participants and company surveys indicated that nearly all companies are self-financed in Niger, with cash flow covered by shareholders and founders and from on-going business transaction. A few firms are supported by FI/MFI loans and donor funding/grants but these resources are limited for most.

As the majority of players are local companies operating in the country, they do not have access to loans, equity and other international funds to finance their growth and development. As a result, most of the solar companies in Niger are unable to raise funds to expand their business. Local financiers have yet to develop an appetite for the solar sector. Local banks are extremely conservative with regard to solar

enterprises. Commercial financiers – including banks and MFIs – are not set up to service solar distributor financing requirements. Local SME financing is not available to support businesses in their growth phase. If it was available, companies would make use of cash-flow/credit line financing against the signed contracts with major commercial clients, large NGOs or donors.

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

- **Evolving Business Models**

The development of new models in Niger will require partnerships between developers, solar distributors, telco companies, commercial finance and the retail sector. One of the results of the focus group 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 Niger 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 GoN 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 were not able to estimate the size of the over-the-counter informal market. Informal traders sell modules, inverters, batteries and pico-products. Given that informal sellers are largely unregulated and do not report sales figures, very little data is available on this sector. The sector, however, is very influential as it also controls the delivery of lighting products imported mainly from East Asia. Informal traders understand growing consumer interest in solar solutions and sell

competitively-priced low-quality products. Informal traders do not actively cooperate with the GoN 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

Niger's solar market is largely dominated by informal market players, selling equipment through electronics shops, hardware stores, kiosks and even street vendors. The over-the-counter sales strategies of this group is to provide low-cost, fast moving products. As a sector, informal retailers provide widely-used lighting products mainly from East Asia to rural customers. However, most of their product range does not meet Lighting Global standards. Moreover, given that the most of their lighting products are low-cost and short-lived, they also ignore and avoid regulations and their products lack warrantees. In Niger, feedback from focus group meetings indicated that high-quality products are too expensive for the majority of households and businesses. European and American brands especially are perceived as un-affordable and therefore almost exclusively sold to larger institutional clients (NGOs and telecommunication companies). Local industry stakeholders expressed that product quality is a major issue in the market.

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.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

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

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

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

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

2.4.8 Capacity Building Needs of the Supplier Market Segment

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

- Custom duty exemption is not applied effectively in Niger, while the 19% VAT tax – still applied to solar products – is a major barrier to market growth.
- Local financing is largely not available (or affordable) to support the sector's development, except for a minority of large local companies; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations.
- Reasons for denied finance by financial institutions included lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion.
- An improved regulatory framework is necessary to ensure product quality. The lack of control of product quality and import process has led to an increase in low-quality equipment, which negatively impacts perceptions of solar. There are no standards in place (outside of donor-related equipment) to address this critical issue. Tackling this challenge also requires harmonization of pricing in the market.
- Capacity building efforts are also lacking. The main areas that would require capacity building are at the technical level (installation, operation and maintenance of systems), and also marketing and sales.
- Knowledge, technical capacity and expertise is 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.
- Consumer awareness remains very low. Focus group meeting indicated that a relatively small share of rural households are aware of the benefits of off-grid solar products and solutions.

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

- **Importers/Suppliers**: Reduce the cost of importing solar PV products and components must be a priority as a lack of financial incentives is a major barrier to market growth. Make financing available for importers and distributors to allow suppliers to more easily stock and renew inventory. The way the market is currently structure inhibits their growth. In Niger, there are very few Tier 3 companies and Tier 2 companies, yet most Tier 1 companies have been in the industry for many years. Financing should also be made available to end-users to enable them to purchase OGS systems.
- **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 end-users and the political and financial arrangements of the market. Like most countries in the region, various counterfeit solar PV products have infiltrated the market. Implementation of the regulations and quality/standards to ensure product quality (not just for donor projects) could significantly boost market growth.

Table 45: Capacity Building and Technical Assistance for the OGS Supply Chain in Niger[197]

Area of Support	Description	Rationale
Tax exemptions on solar technology	• Implementation import duty exemption and VAT exemption on all solar products,	• Costs of solar products are inflated by VAT (19%); costs are passed on to customers, making solar less affordable.
Quality control/certification center	• Suppliers are able to effectively monitor the quality of products imported in Niger • Ensure that imported products are suitable/relevant to the local context (local standards)	• Ensure the quality of products and face the influx of low-quality products • Maintain the trust established between solar industry and customers
Consumer education programs	• Supplier and consumer education and benefit awareness campaigns, targeting both segments, distributors and retailers, with a focus on rural populations	• Overcome negative perceptions and strengthen trust established over the years • Influence purchase decisions, with a focus on rural areas and ease access to distribution channels
Inventory financing facility	• Concessionary credit line so financial institutions can access liquidity for solar market lending; create frameworks that avail loans to solar companies (small household systems, larger PV installations, and mini-grids), pilot with aim of scaling out	• Long inventory financing periods present a key challenge to growth for solar lantern and solar home system distributors • High upfront financing requirements present a key challenge to distributors of larger PV systems (including pumps)
Credit guarantee scheme for inventory financing	• Private sector lending portfolio is de-risked through guarantees and effect loss sharing agreements to cover irrecoverable inventory loans	• De-risking encourages private sector lending to solar sector • Initial security until the proof case of economic viability of lending to solar businesses has been established
Market entry and expansion grants	• Combination of upfront grants and results-based financing to invest in infrastructure and working capital	• Significant upfront investment to build distribution network and source inventories to serve household market
Technical assistance	• Help solar companiesset up technology platforms for PAYG • Incubation and acceleration of early-stage businesses • Capacity building for solar technicians to enable installation and O&M of equipment • Assess rural communities needs to inform the right business model case by case • Capacity building for suppliers in rural areas	• Make the business environment more conducive and profitable • Strengthen the overall ecosystem surrounding the solar market • Strengthen capacity across the sector (vs having capacity centralized in the capital only) • Ensure knowledge transfer from abroad for faster, more cost-efficient progress

[197]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.

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

2.5 Key Market Characteristics

This section reviews the main characteristics of the off-grid solar market in Niger, 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** above 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 Niger

Market Barrier	Description
Demand[198]	
Consumers are unable to afford solar systems	• Low-income consumers, particularly in rural areas, lack of access to finance • Purchasing solar products of all varieties among end-consumers remains relatively low.
Lack of initial funding by HHs, businesses and institutions for the initial capital investment	• Relatively high costs of OGS systems (compared to more mature markets in the region) • Consumers rather choose cheaper one-off solutions – like generators and fuel – rather than more expensive up-front solutions that will be cheaper long-term (especially with incremental payments, e.g. PAYG)
A lack of understanding of and trust in solar solutions among consumers impedes development of the market	• There is still 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 counterfeit / inferior over-the-counter products. 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

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

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

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

2.5.2 Drivers of Off-Grid Solar Market Growth

Table 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 Niger

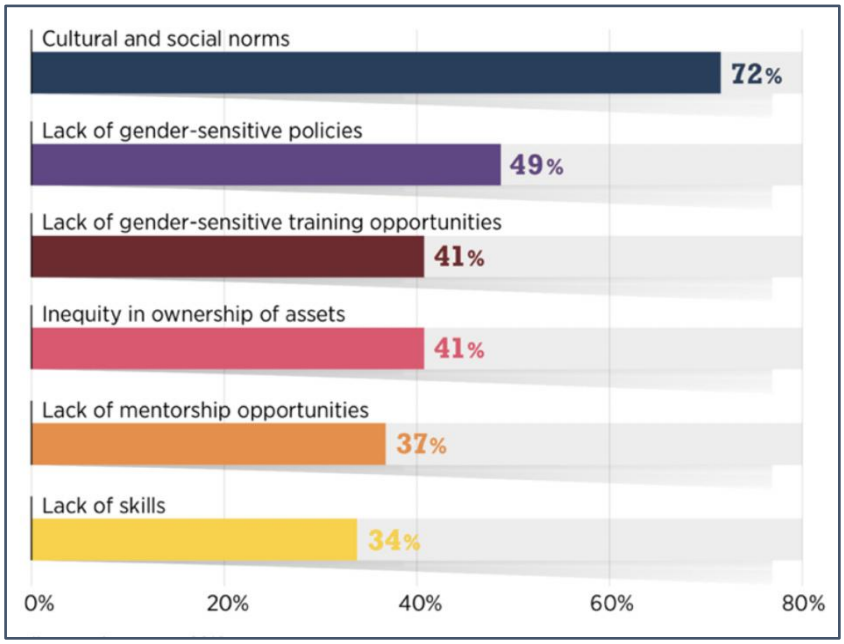
Market Driver	Description
Strong off-grid electricity demand	• Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	• The Government is viewed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

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

2.5.3 Inclusive Participation[199]

Given that the off-grid market is only beginning to emerge in Niger, 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.[200]

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.[201] 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.[202]

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,

[199] See **Annex 4** for more details
[200] "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
[201] "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
[202] "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.[203] 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.[204]

The gender analysis undertaken in Niger 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)[205]
- Extensive household responsibilities reduce their ability to generate income and service credit
- Financial literacy among women remains low and there is a lack of education and information available to women on access to financial resources

One initiative at the regional level isseeking to address these challenges and improve the rate of participation among women in Niger's off-grid sector. In 2018, ECREEE and the AfDBlaunched a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of inclusion of women in the energy value chain – only 2% of energy sector entrepreneurs in West Africa today are women. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Niger.[206]

[203] "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

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

[205] 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.**

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

III. ANALYSIS OF THE ROLE OF FINANCIAL INSTITUTIONS

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

3.1 Introduction to Financial Products for the Off-Grid Sector

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

3.1.1 Financial Products for End-Users

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

- **Households**

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

- **Public Institutions**

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

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

- **Productive Use**

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

- **Commercial and Industrial**

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

3.1.2 Financial Products for Suppliers/Service Providers

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

- **Working Capital**

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

- **Inventory and Trade Finance**

To fulfill orders, solar system providers need inventory on hand. Equipment suppliers to the off-grid sector in West Africa and the Sahel are usually unwilling or unable to offer generous terms, often requiring down payments with balance due in full at cash-on-delivery (COD). Therefore, these businesses are in dire need of short-term loans of 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.[207]

- **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.[208]

[207] 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.

[208] 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), Niger shares a currency with seven other countries in the economic community, the West African CFA Franc, which is pegged to the euro. FIs in Niger 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, Niger 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%.[209]

The Nigerien financial market is constrained by several factors; above all, limited access to finance in the country continues to hinder economic activity.[210] According to BCEAO, in 2015 Niger had 12 commercial banks and 42 microfinance institutions. The country's financial system is among the weakest in Sub-Saharan Africa and WAEMU. In 2010, its money supply represented 18.8% of GDP, which is far lower than the Sub-Saharan average of 41%. The ratio of deposits to GDP is also among the lowest in WAEMU, and the overall balance of the country's banking sector accounted for just 5.3% of the WAEMU zone total.[211]

Since 2012, the microfinance sector has experienced modest growth, with a reduction in the number of MFIs from 51 in 2012 to 42 in 2015.[212] In terms of assets, the country's largest MFIs compete with commercial banks and in 2015 alone, Asusu-SA (the largest MFI) had total assets comparable to the eight largest banks combined.[213] Despite the presence of these institutions, access to finance remains very limited in Niger. **Table 48** shows the number of approved financial institutions in Niger in 2018.[214]

Table 48: Licensed Financial Institutions

License Type	Number of FIs
Currency exchange offices	15
Commercial banks	12
Other financial institutions	3
Development finance institutions	12
Electronic money institutions	1
Brokerages	15
Business banks	1
Micro-credits banks	42
Islamic banks	1

Source: BCEAO

[209] "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
[210] "Niger: Financial Sector Profile," Making Finance Work for Africa, (2013): https://www.mfw4a.org/index.php?id=471
[211] 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
[212] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[213] Ibid.
[214] "Paysage bancaire," BCEAO, (September 2018): https://www.bceao.int/fr/content/paysage-bancaire

The Regional Stock Exchange (Bourse Régionale des Valeurs Mobilières, BRVM) is the only stock exchange admitted into WAEMU. Although based in Abidjan, the BRVM has a small branch in Niamey. Bonds and treasury bills are issued mainly by the BCEAO, but the exchange is also increasingly being used by regional banks and governments to finance public expenditures. Niger was not granted a sovereign credit rating until 2011 and the regional and national fixed income markets are still in early stages of development. Many legal barriers to participate in the financial sector remain, but investors can access primary markets directly. Access to secondary markets is only possible with certified intermediaries.[215]

- **Banking Industry Financial Soundness Indicators**

Asset-Based Indicators: In 2016, WAEMU statistics show a 12.5% increase for listed securities, or CFA 10.2 billion (USD 17.6 million) compared to CFA 9 billion (USD 15.5 million) in 2015, with a 2.75% increase in capitalization over the same period. The bond capital increased over the same period from 58.89% to CFA 2.5 billion (USD 4.2. million) and the overall value of transactions increased by 21.84% to CFA 409 billion (USD 705 million).[216] Despite the growth, there was a decline in stock market activity at the end of 2016, with a decline in the overall BRVM composite index.

Table 49presents key financial indicators for Niger's main banks. Of a total of CFA 720,421 billion (USD 1.2 billion) in loans, Sonibank (the Nigerian Bank Corporation, La Société Nigérienne de Banque) and Bank of Africa-Niger (BOA-Niger) hold the largest shares, followed by Ecobank-Niger and Banque Atlantique.

Table 49: Banking Sector Financial Indicators, 2015

Commercial Banks	Share Capital	Total balance sheet	Deposits	Loans	Profit	Market share
	Amount (CFA million)					%
Bank of Africa - Niger	9,500	263,068	140,428	154,320	5.795	21%
Nigerien Bank Corporation	12,000	236,391	149,989	152,281	5.036	21%
Ecobank - Niger	5,100	223,285	140,487	107,635	3.405	15%
Atlantic Bank Group	7,500	132,147	69,423	76,669	1.061	11%
BIA Niger	14,000	152,433	131,074	64,925	4.123	9%
BSIC	7,255	105,118	54,597	63,764	1.635	9%

Source: BCEAO

Capital-Based Indicators: Niger's financial system has remained relatively stable in recent years. **Table 50**provides an overview of the banking sector's financial soundness indicators.[217]

Table 50: Banking Sector Financial Soundness Indicators (%)

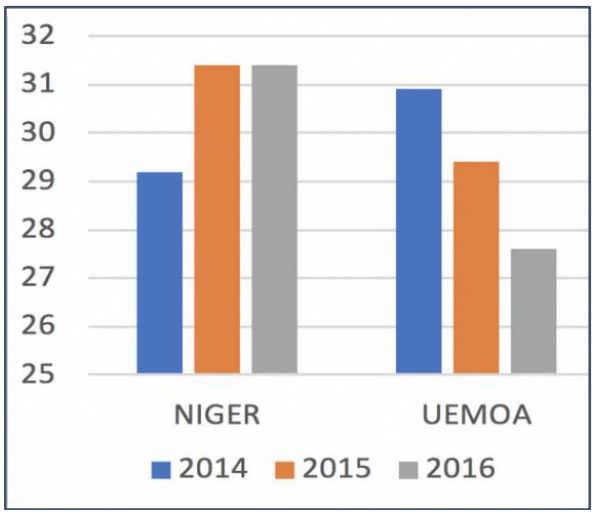
2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
NPL≤10%			CAR≥ 8%			ROE			ROA		
17.6%	15.5%	17.2%	14.4%	7.7%	14.4%	20.5%	26.0%	20.8%	1,8%	2.5%	2.0%

Sources: West African Monetary Agency

[215] "Niger: Financial Sector Profile," Making Finance Work for Africa, (2013): https://www.mfw4a.org/index.php?id=471
[216] "Financial Sector Developments and Stability in ECOWAS, 2016 Report," West African Monetary Agency, (August 2017): https://amao-wama.org/wp-content/uploads/2017/11/Financial-Stability-2016-Report.pdf
[217] Ibid.

Regarding liquidity, which also measures the ability of banks to respond to planned or unplanned requests for funds, Niger is in a strong position vis-a-vis the WAEMU average (**Figure 37**).[218]

Figure 37: Banking Sector Liquidity Ratio (%)



Source: West African Monetary Agency

- **Distribution of Credit by Sector**

Table 51 outlines the distribution of credit from 2016 to 2017 by recipient.[219]**Table 52** details the distribution of loans by sector over the same period.[220]

Table 51: Distribution of Credit by Recipient (CFA billion)

Indicator	2016	2017
Government of Niger	41.5	16.9
Individuals	117.4	125.4
Financial groups	3.3	0.6
Parastals and EPIC[221]	12.6	6.1
Pension fund insurance	9.5	10.5
Private enterprises in the productive sector	160.2	125.4
Individual companies	213.2	213.4
Cooperatives and village groups	1.5	2.0
Various (NGOs, unions, etc.)	2.7	2.1
Personal banking	4.5	6.1
TOTAL	**566.4**	**508.5**

Source: West African Monetary Agency

[218] "Financial sector developments and stability in ECOWAS report, "West African Monetary Agency, (August 2017): https://amao-wama.org/wp-content/uploads/2017/11/Financial-Stability-2016-Report.pdf
[219]"Report on Banking Conditions," BCEAO, (2018): https://www.bceao.int/sites/default/files/2018-08/Rapport%20sur%20les%20conditions%20de%20banque%20dans%20l%27UEMOA%20-%202017.pdf
[220] Ibid.
[221] Public Industrial and Commerical Establishments (Établissements Publics à Caractère Industriel et Commercial, EPIC)

Table 52: Distribution of Credit by Sector (CFA billion)

Sector	2016	2017
Housing	13.1	17.9
Trade	6.8	3.9
Equipment	31.9	25.4
Consumption	149.3	62.9
Cash	336.2	347.8
Other	29.2	50.6
Total	**566.4**	**508.5**

Source: BCEAO

3.2.2 Financial Inclusion

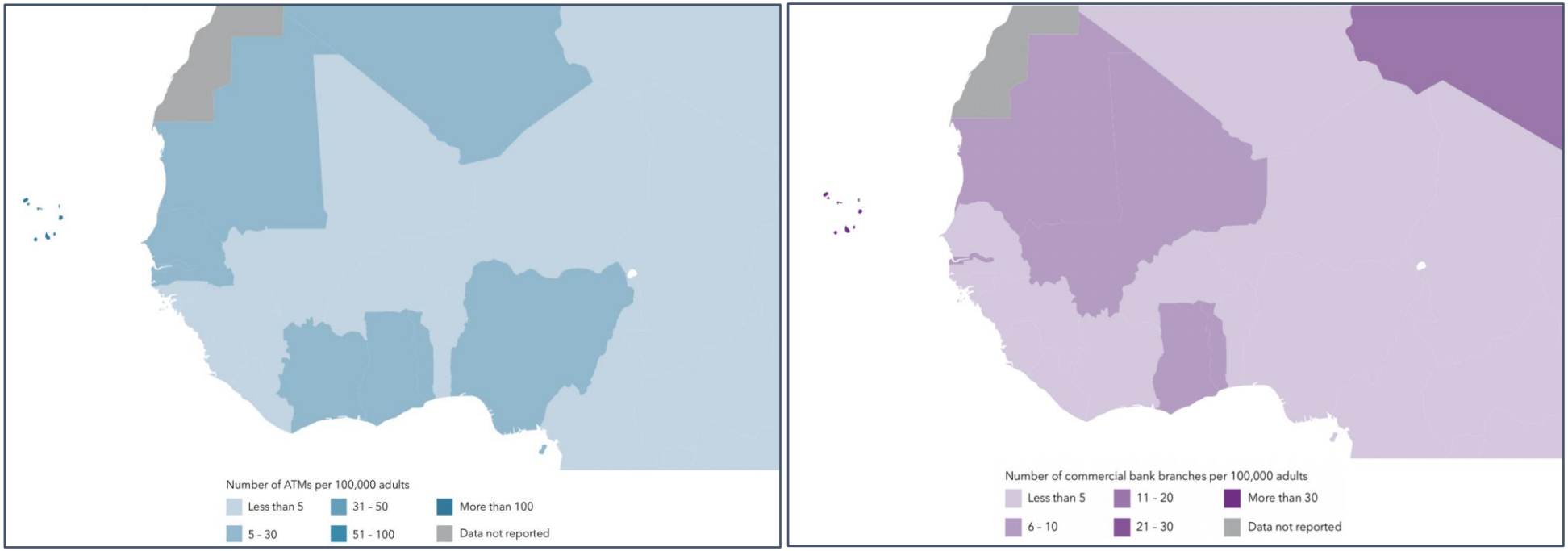
- **Access to Financial Services**

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 38**).[222] 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%.[223] Many countries across the region, including Niger, have also seen a sharp increase in mobile money account ownership (**Figure 39**) and transaction volume (**Figure 40**).

[222] "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

[223] 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 38: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017[224]



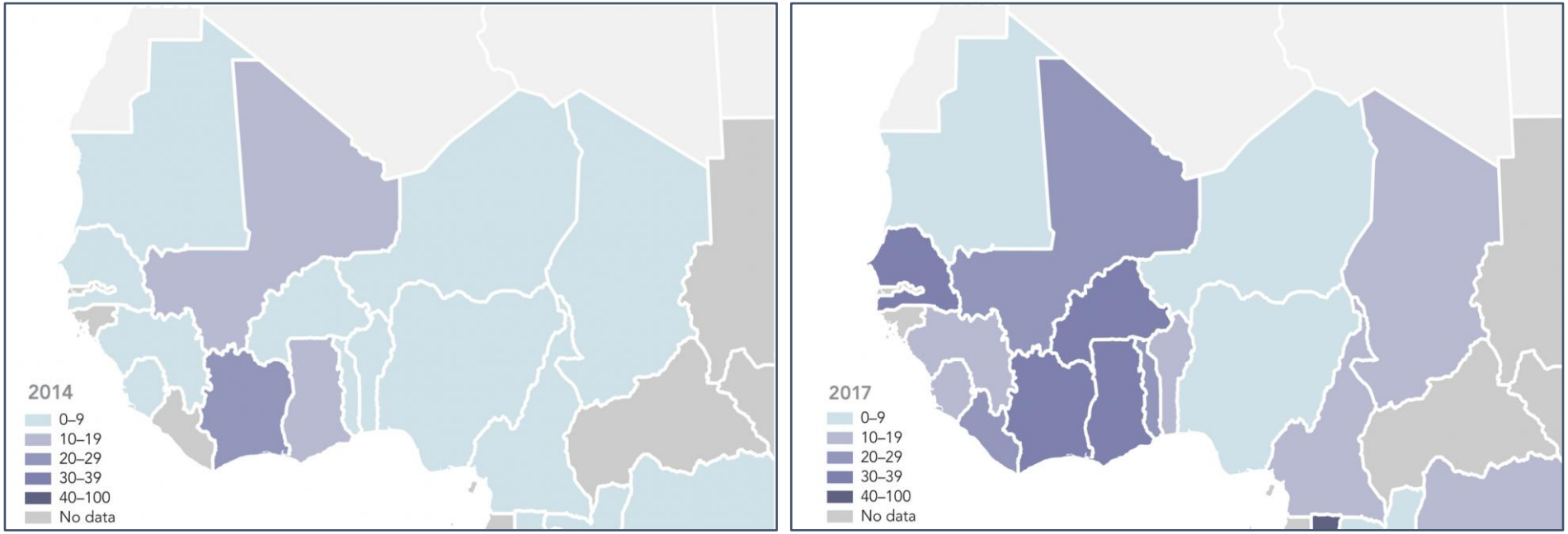
Source: International Monetary Fund

Figure 38shows 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.

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

Figure 39: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017[225]

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



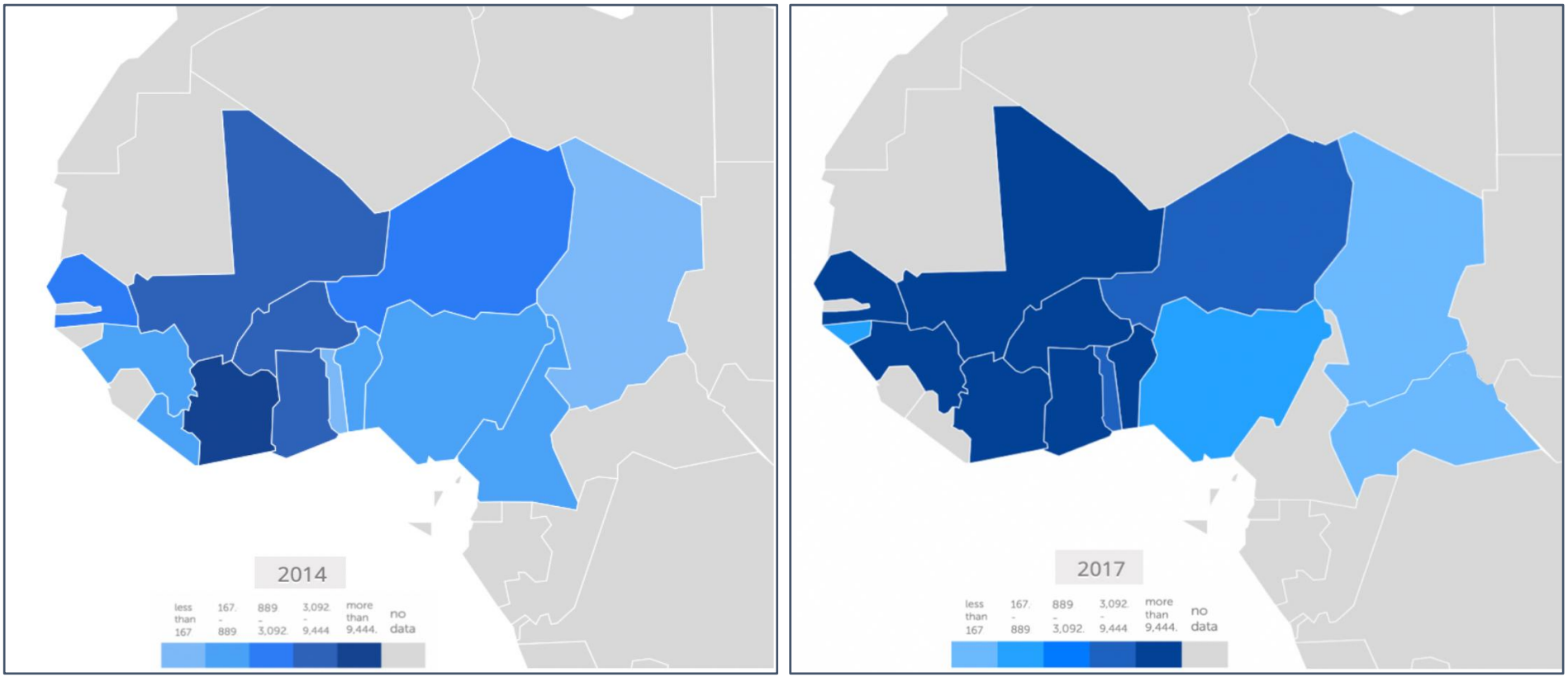
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 39shows 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.

Figure 40: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017[226]

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



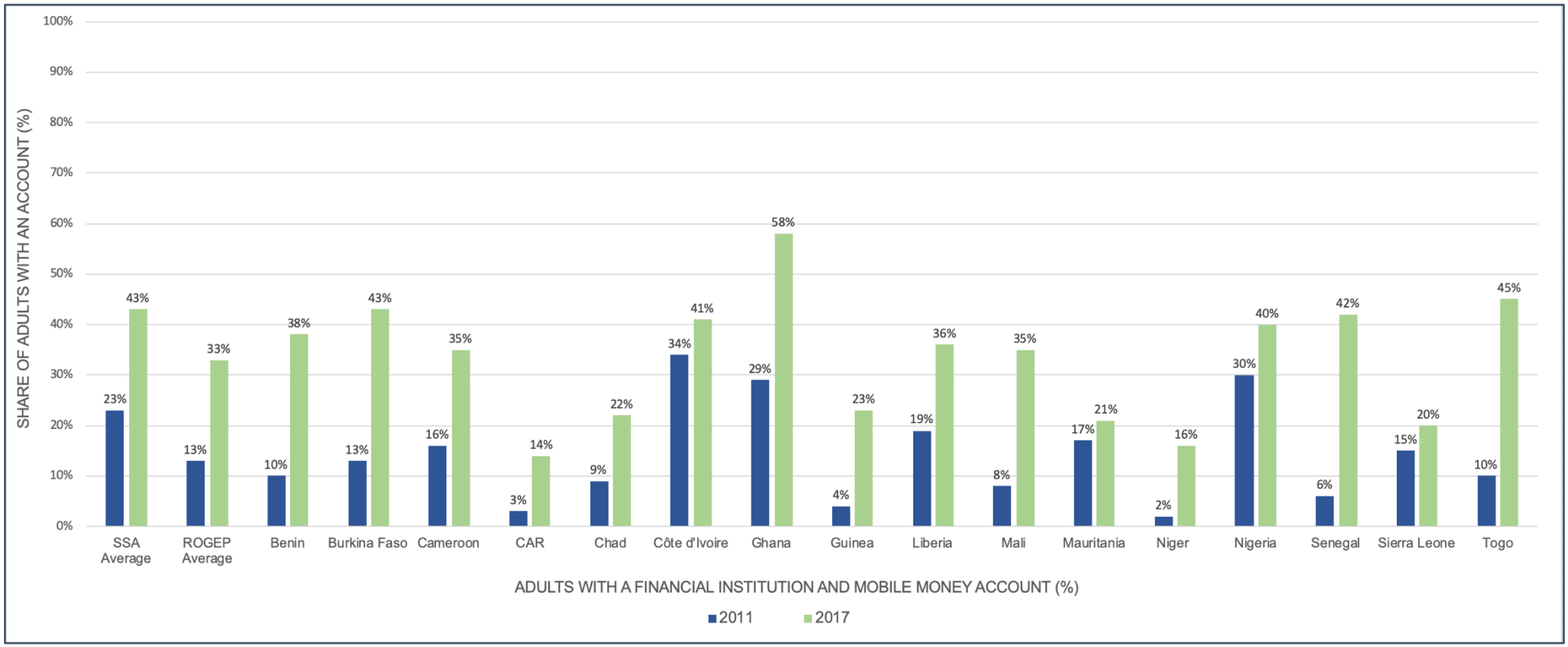
NOTE: Maps exclude Cabo Verde (no data)

Source: International Monetary Fund

Figure 40shows 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.

In 2017, 16% of Niger's adult population had an account at a financial institution or with a mobile money service provider, up from 2% in 2011. Despite this improvement, in 2017, the country had the second lowest rate of financial inclusion in West Africa and the Sahel, 17% below the region's average and 27% below the average for Sub-Saharan Africa (**Figure 41**).

Figure 41: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017[227]



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

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

The financial inclusion rate in Niger is estimated to be 15%, but this figure is not reflective of the penetration of banking services in the population, which is only 5%, the lowest rate in the WAEMU zone.[228]**Table 53**shows that 28% of companies in Niger have a bank loan and/or a line of credit compared to just 22% of companies in Sub-Saharan Africa. Loans require an average guarantee of 88% in Niger versus 85% across Sub-Saharan Africa. Investments financed by banks in Niger are at 14% compared to 10% for Sub-Saharan Africa.[229]

Table 53: Access to FinanceIndicators, 2016

	Companies with a line of credit / bank loan (%)	Loans requiring a guarantee (%)	Value of collateral required (% of loan amount)	Companies using banks to finance their investments (%)	Internally funded investments (%)	Investments financed by banks (%)	Companies using banks to finance working capital (%)	Companies having identified access to finance as a major constraint (%)
Niger	28	88	160	22	73	14	29	27
SSA	22	85	215	21	74	10	23	38

Source: European Investment Bank

Financial inclusion with mobile money is the presage of a promising future. Mobile money has contributed significantly to financial inclusion in UEMOA with a revealing rate of 65% against 10% in Niger in 2015.[230] Financial inclusion being a sensitive topic for all countries; UEMOA has adopted it through a regional strategy with a roadmap, which represents a reference framework for all national financial inclusion strategies in the Member States.[231]

Widespread mobile phone ownership (**Figure 16**), growing mobile internet usage (**Figure 15**) and network coverage (**Figure 33**), 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 Niger. Mobile money technology also plays a critical role in the application of off-grid solar solutions, particularly for Pay-As-You-Go systems that rely on the interoperability between digital financial services and stand-alone solar devices.

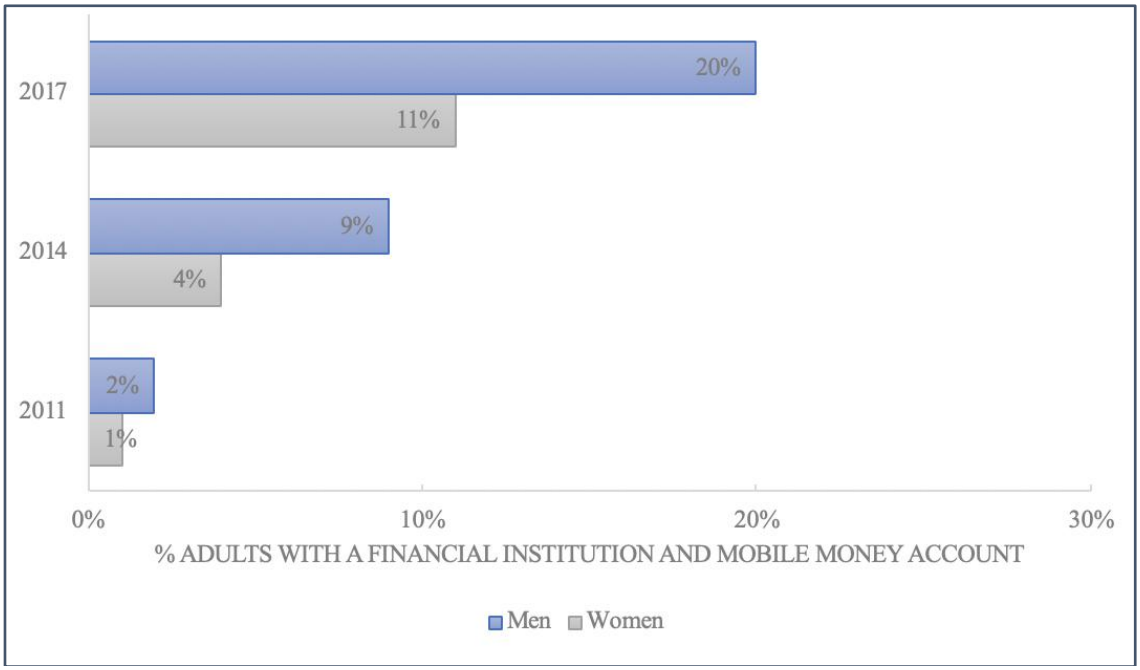
- **Gender and Women's Financial Inclusion**

According to data from the World Bank's 2017 Global Findex survey – which examines, among many things, the extent of financial inclusion in Sub-Saharan Africa (SSA) – women in the region are about 10% less likely to have an account at a financial institution or with a mobile money service provider than men. In Niger (**Figure 42)**, the gender gap is slightly smaller than the regional average, with 9% of women compared to 20% of men holding an account. The size of the financial inclusion gender gap has increased steadily since 2011, in contrast to regional trends that show the gender gap shrinking between 2014 and 2017. However, in absolute terms as of 2017, 11% of women had financial and mobile money accounts in Niger, 10 percentage points higher than in 2011, but still well below the region's average of 37%.[232]

[228] "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
[229] Ibid.
[230] BCEAO, 2018 and European Investment Bank, 2018.
[231] "STRATEGIE REGIONALE D'INCLUSION FINANCIERE DANS L'UEMOA," BCEAO, (September 2017): https://www.bceao.int/sites/default/files/2017-12/note_information_n3_strategie_inclusions_financiere_uemoa.pdf
[232] 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

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.[233]

Figure 42: Financial Inclusion Gender Gap in Niger[234]

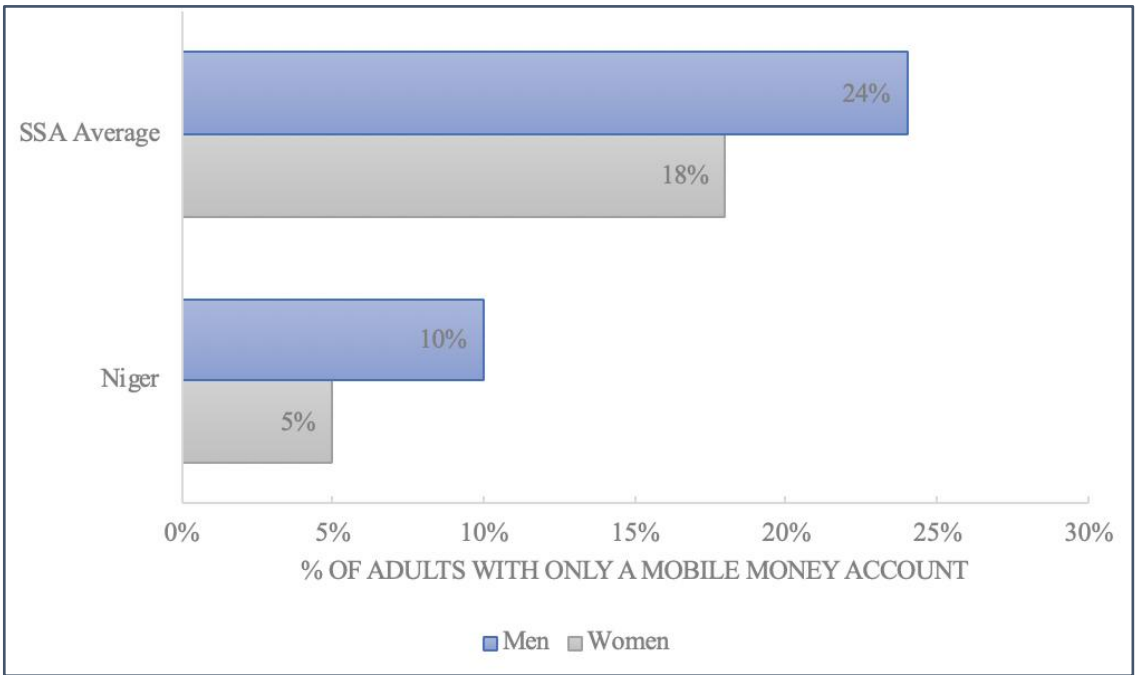


Source: World Bank Global Findex Database

The growth in the financial inclusion gender gap could be related to the weakness of Niger's market for digital financial services (DFS) and the disparity in mobile technology between men and women. Expanding DFS, 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. As of 2017, 10% of adult men only had a mobile money account, compared to 5% of women, which is well below the regional average (**Figure 43**). Recent research by the Global System for Mobile Communications Association Connected Women program suggests that women in Niger are 45% less likely to own a mobile phone than men.[235]

[233] 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
[234] Demirguc-Kunt et. al., 2017.
[235] "Country Partnership Framework for the Republic of Niger for the Period of FY18-FY23," World Bank, (13 March 2018): http://documents.worldbank.org/curated/en/466811523970978067/pdf/123736-CORRIGENDUM-PUBLIC-NIGER-CPF-04112018.pdf

Figure 43: Gender Gap in Mobile Money, 2017



Source: World Bank Global Findex Database

3.2.3 Commercial Lending Environment

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

Table 54 presents the cumulative annual deposits for the banking sector in 2016-2017. **Table 55**and **Table 56**summarize the volume and maturity structure of deposits, respectively, over the same period. In 2017, the vast majority of deposits in Nigerien banks (82%) were short-term. The short-term maturity structure of deposits impedes banks from offering long-term credit (**Table 55**).[236]

Table 54: Certificates of Deposit (CFA billion)

Indicator	2016	2017	Change (%)
Niger	213.4	198	-7,2%
UEMOA	8,058.8	8,396.2	4,2%

Source: BCEAO

Table 55: Maturity Structure of Bank Deposits (CFA billion)

Indicator	2016	2017
Short-term (1 year< and ≤2 years)	18	12.6
Medium-term (2 years< and ≤5 years)	34.7	62.8
Long-term (5 years< and ≤10 years)	0.4	0.1
Longer-term (10< years)	14.4	5.2

Source: BCEAO

[236] BCEAO, 2018.

Table 56: Maturity Structure of Bank Loans (CFA billion)

Duration	2016	2017
Short-term (1 year< and ≤2 years)	53.0	35.5
Medium-term (2 years< and ≤5 years)	101.2	75.5
Long-term (5 years< and ≤10 years)	28.1	34.8
Longer-term (10< years)	6.6	11.2

Source: BCEAO

- **Interest Rates**

As a member state of WAEMU, Niger'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.[237] 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. BCEAO also has two types of standard lending: (i) lending through one to seven-day refinancing, and (ii) lending through a 90 to 360-day refinancing against government securities and credit claims. In the latter, maturities range from 5 to 20 years at the demand of the banks. The facilities are priced 200 basis points above the policy rate.[238]

Niger witnessed a downward trend in interest rates between 2016 and 2017. The interest rates on term deposits also decreased by 0.28% over the same period, which was also true for the WAEMU zone (**Table 57**).[239] Interest rates for short-term loans remained the highest (**Table 58**).[240]

Table 57: Interest Rates on Deposits

Indicator	2016	2017	Change (%)
Niger	5.98%	5.7%	-0.28%
UEMOA	5.37%	5.28%	-0.09%

Source: BCEAO

Table 58: Interest Rates on Loans by Duration

Indicator	2016	2017
Short Term (1 year< and ≤2 years)	9.23%	9.46%
Medium Term (2 years< and ≤5 years)	8.98%	9.42%
Long Term (5 years< and ≤10 years)	9.35%	9.05%
Longer Term (10< years)	7.29%	5.90%

Source: BCEAO

[237] "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
[238] BCEAO, 2018.
[239] Ibid.
[240] Ibid.

- **Foreign Exchange Market**

As a member state of WAEMU, Niger'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.[241] In general, the CFA franc monetary zone consistently outperforms other Sub-Saharan countries in terms of inflation rate and overall macroeconomic stability.

The CFA franc is backed by a guarantee from the French treasury for the convertibility of the CFA franc into euros at the fixed exchange rate at the Paris Stock Exchange.[242]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.[243]

Table 59: Official Exchange Rate (CFA-USD)[244]

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

Source: International Monetary Fund

- **Collateral Requirements**

A common problem in the West African Economic and Monetary Union is poor judicial processes regarding collateral registry and recovery, as well as a lack of available credit information about the borrower. Hence, most commercial banks require high amounts of collateral in order to mitigate consumer credit risk.As a result, a majority of firms in the country are unable to access loans due to high costs of credit, insufficient funds offered, the short maturity of the loans, and/or the amount of required collateral.In 2017, the average collateral requirement to obtain a loan in Niger was 159.5% of the loan amount, while 87.7% of loans required collateral.[245]

- **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

[241] 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/
[242] 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
[243] 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
[244] International Financial Statistics (IMF): http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B
[245] "Enterprise Surveys: Niger," World Bank Group, (2017): http://www.enterprisesurveys.org/~/media/GIAWB/EnterpriseSurveys/Documents/Profiles/English/niger-2017.pdf

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.[246] Niger adopted these regulations in 2016.

3.2.4 Lending to the Off-Grid Solar Sector

The size of the off-grid solar market in Niger is estimated to be USD 200 million (CFA 116 billion) per year.[247]While there are several donor and DFI-funded programs and initiatives that have provided financing to support development of the country's off-grid solar market, these funds have not been channeled through local commercial banks or MFIs. ROGEP is therefore a pioneering initiative in the country, as it endeavors to boost OGS lending via engagement with local financial partners. Local FIs are increasingly becoming more aware of the opportunities in the off-grid space, and interviews FIs revealed a willingness to participate in providing financing to the sector.

3.2.4.1 Programs Supporting Financial Institutions in Off-Grid Solar Lending

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

The CEADIR engagement in West Africa took place from 2016 to 2018. The program's objective was to strengthen the capacity of FIs for clean energy lending in eight West African countries (Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone) addressing their common challenges by developing the capacity of bank staff to provide loans for various clean energy technologies and business models and adapting their support to the specific context each country. CEADIR supported local banks by 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.[248]

As part of this project, several local FIs, including Sonibank, Banque Atlantique-Niger, and Bank of Africa-Niger among others, developed internal capacity to support PAYGO solar, mini-grid and roof top solar lending. Over the course of the two-year engagement, CEADIR conducted workshops in Niamey with these FIs focused on developing their clean energy lending capacity.[249]

- **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

[246] "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
[247] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[248] USAID CEADIR: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
[249] "Market Assessment Report on Clean Energy: Niger," USAID Climate Economic Analysis for Development, Investment and Resilience (CEADIR), (June 2018): https://www.climatelinks.org/resources/renewable-energy-lending-west-africa

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).[250]

- **Lighting Africa / Niger Solar Electricity Access Project**

Lighting Africa is working in Niger through the Niger Solar Electricity Access Project (NESAP) sponsored by the World Bank.[251] As part of the NESAP program, Lighting Africa conducted a market intelligence survey to gather information on the current state of energy access in Niger and the potential market for off-grid solar energy. The findings of this study indicate that lack of access to finance is the main bottleneck in the market. For example, a USD 7 million (CFA 4 billion) credit line to stimulate the development of the sector was launched in March 2018. This credit line will be implemented by the GoN through eligible national financial institutions, with support from the Lighting Africa program, the National Center for Energy Efficiency Solar Energy (CNES) and the Nigerien Agency for Rural Electrification (ANPER). To date, Sonibank (commercial bank) and Capital Finance (microfinance institution) have been identified to access these funds and provide financing to importers and distributors of solar kits and water pumps.[252] The CNES supports these activities by providing technical assistance to build the capacity of private companies through an incubator. CNES also conducts national communications and outreach campaigns targeting FIs and end-users to market the NESAP initiative and highlight the benefits of OGS solutions.[253]

3.2.4.2 Key Barriers to Off-Grid Solar Lending

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

Much like other African markets, local FIs in Niger 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.

[250] SUNREF: https://www.sunref.org/en/sunref-elue-meilleure-solution-financiere-pour-lenergie-durable-en-afrique-de-louest/
[251] "Lightning Africa," World Bank ,(2019): https://www.lightingafrica.org/country/niger/
[252] "Une ligne de crédit de 7 millions de dollars US pour l'électricité solaire hors réseau va être lancée au Niger," World Bank, (5 March 2018): https://www.lightingafrica.org/une-ligne-de-credit-de-7-millions-de-dollars-us-pour-lelectricite-solaire-hors-reseau-va-etre-lancee-au-niger/
[253] "Un centre de dimension mondiale, "Le Centre National d'Energie Solaire," (CNES), (7 February 2014): http://news.aniamey.com/h/12094.html

- **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 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 Niger face very 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.[254]

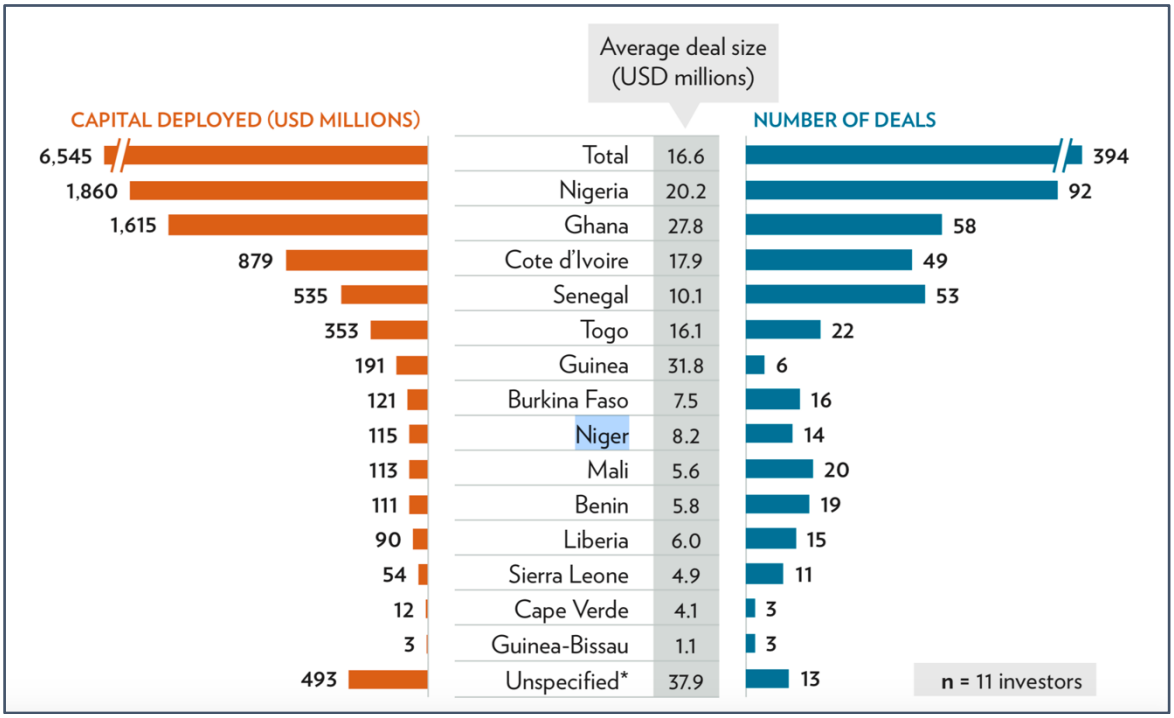
[254]It is worth noting that several guarantee programs are already available for Nigerien banks to stimulate lending in various sectors.These include AFD's 50% partial credit guarantee program for SMEs as well as various government guarantee schemes intended mainly for the construction of roads and other large-scale infrastructures. To date, none of these instruments have targeted the OGS sector.

3.3 Financial Institutions[255]

3.1.1 Development Finance Institutions

Between 2005 and 2015, Niger received a total of USD 115 million in DFI funds with an average deal size of USD 8.2 million; the amount comprised about 2% of the total DFI investment across West Africa over this period (**Figure 44**).[256]

Figure 44: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Apart from the above-mentioned AFD/PROPARCO SUNREF program, DFI programs that are relevant to the OGS sector in Niger are described below.

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

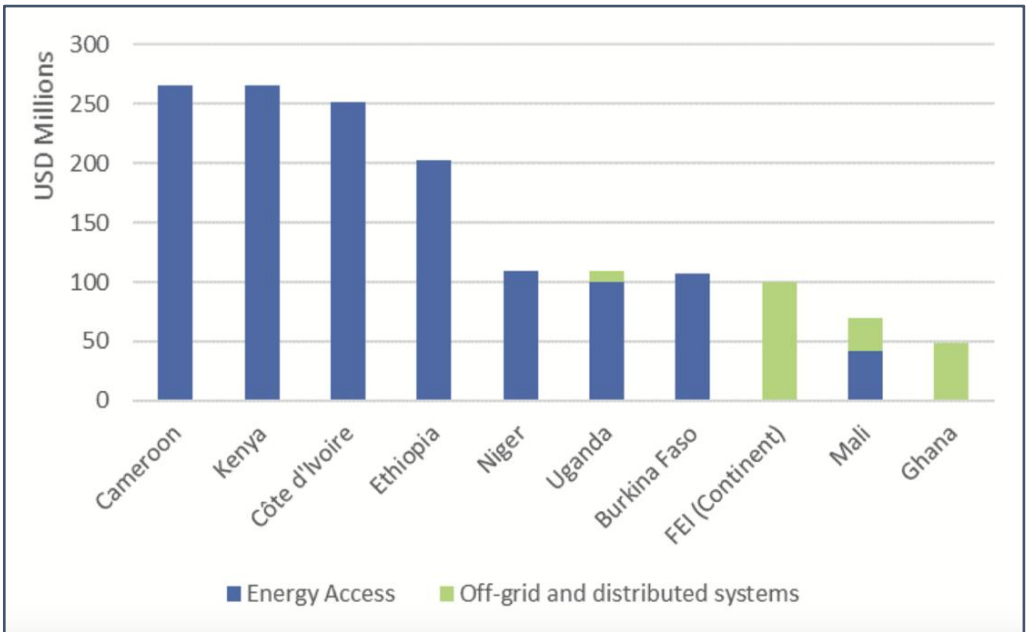
The **Sustainable Energy Fund for Africa (SEFA)** is a USD 60 million multi-donor trust fund administered by the African Development Bank with the objective of supporting sustainable private sector led economic growth in African countries through the efficient utilization of clean energy resources and support small- and medium-scale renewable energy project development.[257]

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

[255] Excluding commercial banks, which are reviewed in detail in **Section 3.2**.
[256] "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
[257] "Sustainable Energy Fund for Africa," African Development Bank, (2018): https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/

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. Niger received approximately USD 100 million in energy access financing from AfDB between 2014 and 2017 (**Figure 45**).

Figure 45: Distribution of AfDB Energy Access Financing in Sub-Saharan Africa, 2014-2017[258]



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.[259]The FEI OGEF, which launched in 2018, will initially focus on East Africa, Côte d'Ivoire, Ghana and Nigeria.[260]

- **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 Niger. 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.[261]

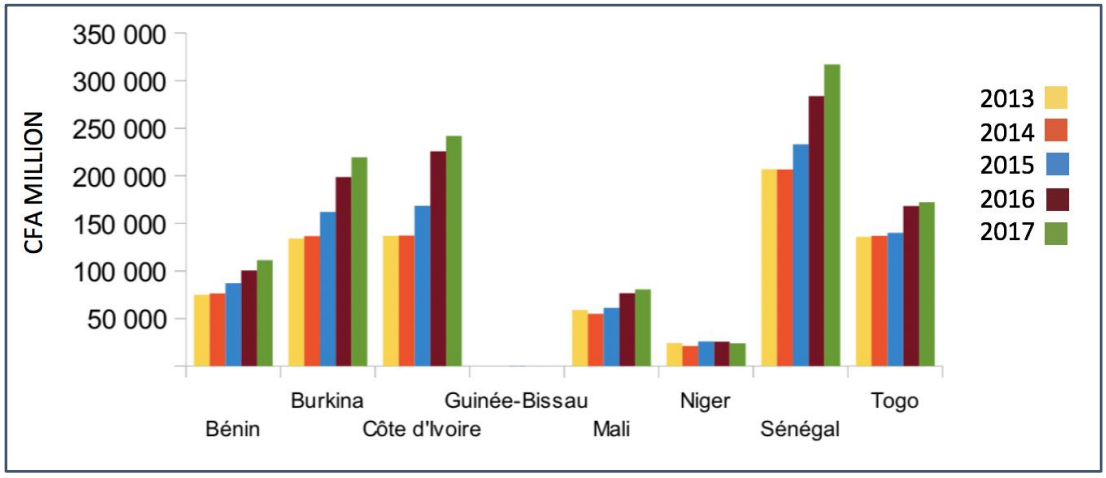
[258] Lee, A. Doukas, A. and DeAngelis, K., "The African Development Bank and Energy Access Finance in Sub-Saharan Africa: Trends and Insights from Recent Data," Oil Change International and Friends of the Earth U.S., (November 2018): http://priceofoil.org/content/uploads/2018/11/AfDB-Energy-Access-Finance-report-high-quality.pdf
[259] Facility for Energy Inclusion – Off-Grid Energy Access Fund: https://www.ogefafrica.com
[260] "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/
[261] "IFC Invests in Bank of Africa to Expand SME Lending in Eight Countries," International Finance Corporation, (4 June 2018): https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/947B76E4C106A246852582A200440E1C?OpenDocument

3.1.2 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.[262]

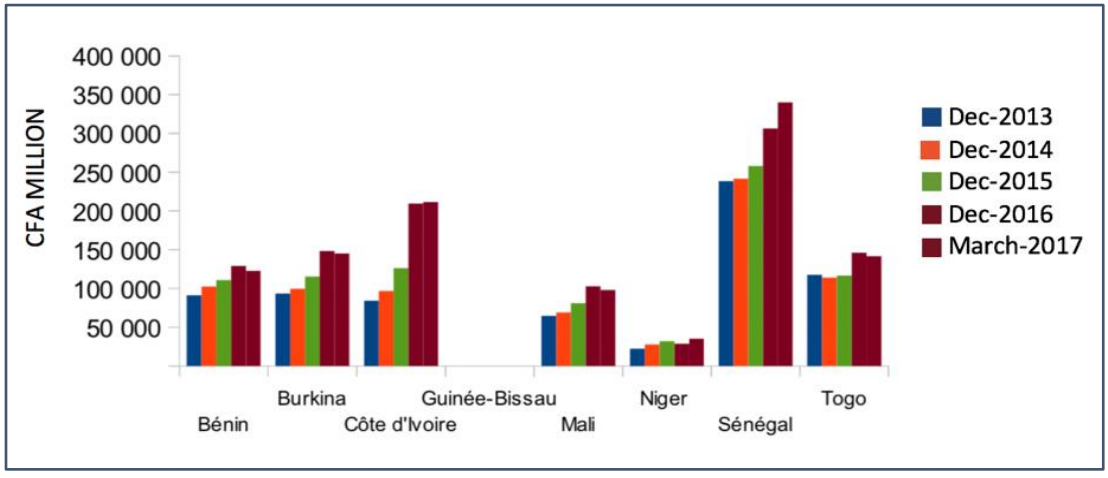
Figure 46 and **Figure 47**below illustrate trends in MFI deposits and loans, respectively, in WAEMU between 2013 and 2017. The rate of MFI deposits and loans in Niger has remained stagnant over this period, while the country's MFI sector is much smaller than other WAEMU zone countries.

Figure 46: Microfinance Deposits in WAEMU



Source: BCEAO

Figure 47: Microfinance Loans in WAEMU



Source: BCEAO

[262] "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

Niger's MFI sector consists of public limited companies, associations, and cooperatives. MFIs in the country have a higher level of financial penetration and asset base than some commercial banks. The sector is dominated by ASUSU SA, which represents approximately three-quarters of MFI accounts, with the remaining amounts held by a network of small institutions and savings cooperatives.[263] As of December 2016, there were 40 MFIs in the country but a low rate of MFI country coverage. **Table 60** details some of the sector's performance indicators from 2015 to 2016.[264]

Table 60: MFI Sector Performance Indicators

Indicator	2015	2016	Growth (%)
Number of MFIs	42	40	-5%
Number of branches	162	163	1%
Number of members/customers	404	479	19%
Outstanding Savings (CFA billion)	24.6	25.1	2%
Outstanding credit (CFA billion)	38	38.8	2%
Delayed loans (CFA billion)	3	3	0%
Delayed loans (%)	9%	8%	-
Own funds (CFA billion)	15.4	15.8	2%
Total assets (CFA billion)	57.1	58.3	2%

Source: Nigerien Microfinance Regulatory Agency

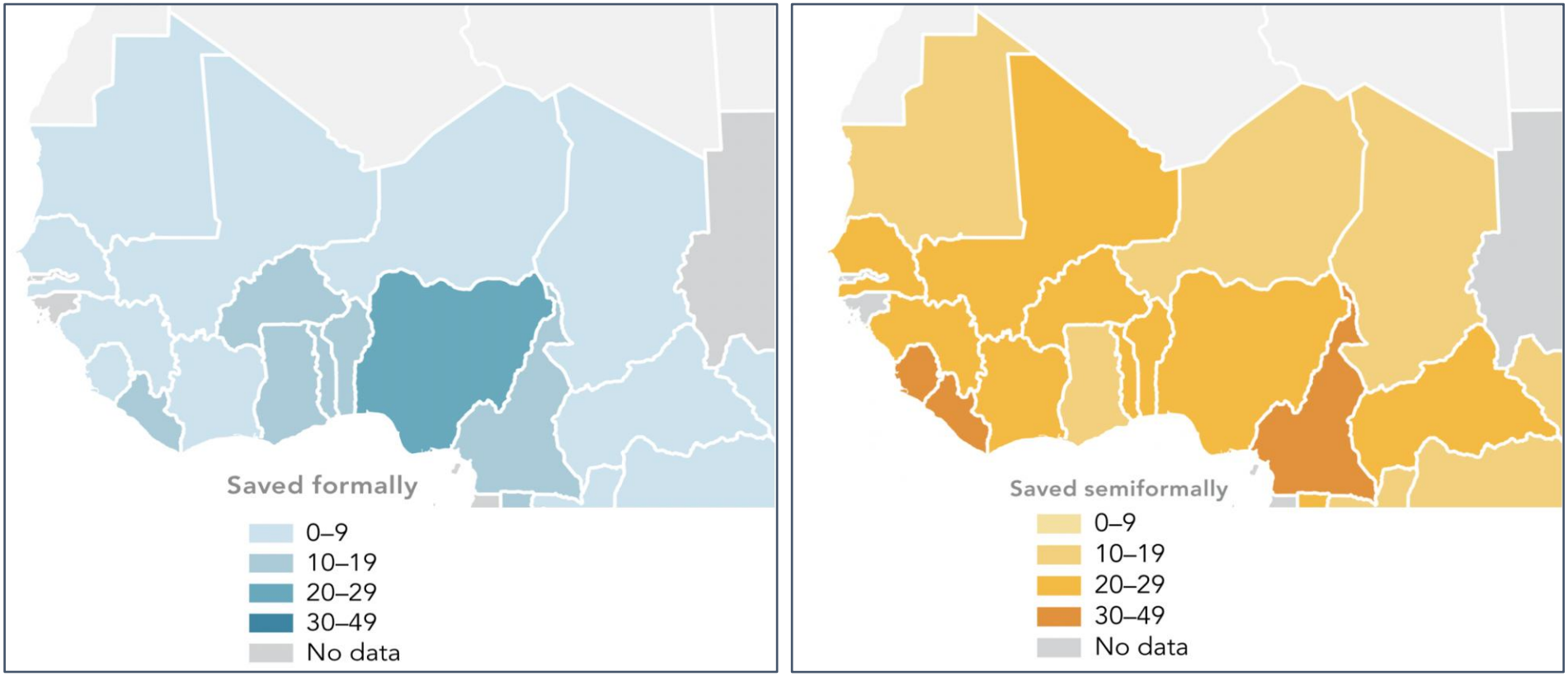
3.1.3 Informal Financial Institutions

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.[265] 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.[266]

Much like in other African states, there is a large informal financial sector in Niger (**Figure 48**).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 found that between 2011 and 2014, while borrowing from private informal lenders decreased, Niger had the highest rate of borrowing from family or friends in the WAEUMU zone (**Figure 49**).

[263] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[264] "RAPPORT ANNUEL D'ACTIVITES DE L'ARSM AU TITRE DE L'ANNEE 2016," Nigerien Microfinance Regulatory Agency (Agence de Regulation du Secteur de la Microfinance (December 2016): http://www.arsm.ne/Files/rapport_2016.pdf
[265] "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
[266] 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 48: Share of Adults Saving in the Past Year (%), 2017[267]



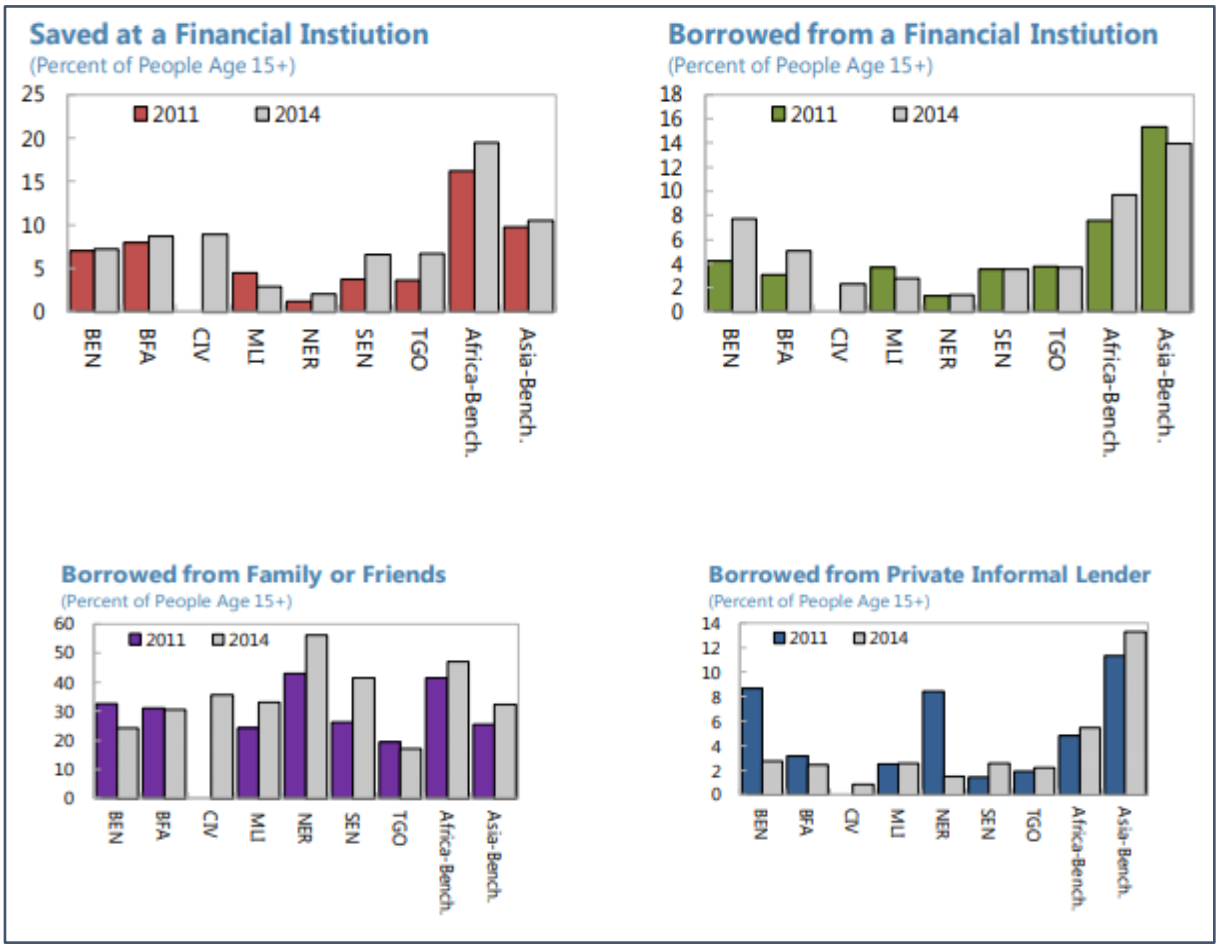
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 48 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 Niger.

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

Figure 49: Informal Financial Sector Indicators in WAEMU, 2011-2014[268]



Source: International Monetary Fund

3.1.4 Impact Investors

Accessing non-bank funding in Niger is a challenge. An assessment carried out by the Global Impact Investing Network (GIIN) found that while impact investing steadily increased across Africa between 2005-2015, most of the investment in West Africa has been highly concentrated, with Nigeria and Ghana being the two largest recipients of all impact capital deployed in the region. Moreover, investments are largely focused on the financial services industry and the agriculture sector.[269]Although Niger has attracted nearly USD 120 million (CFA 70 billion) in impact capital over the last decade, most of this capital is in the form of large investments in debt securities and equities from international DFIs. Two identified impact investors that are active in Niger are described below.

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

[269] "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

- **Investors and Partners**

Investors and Partners (I&P**)** supports SMEs and start-ups based in Sub-Saharan Africa. Through the I&P Development program, I&P sponsors and collaborates with African investment teams based in Niamey (SINERGI Niger), as well as in four other African cities.I&P plans to deploy at least 600 projects over the next ten years, and at least 20,000 direct jobs to help change the lives of at least 200,000 people, but also demonstrate sustainability and a develop a replicable model.[270] I&P and USAID have started an innovative three-year program to provide access to seed capital for 52 young SMEs in Niger and other countries in the sub-region. I&P and USAID started from the observation that in the Sahelian region, the ecosystem of support for start-ups and SMEs is still underdeveloped and there are still very few incubators able to bring out SMEs ready to be financed by a fund. In order to maximize their chances of raising funds, the program will combine seed financing, in the form of interest-free repayable advances, and personalized support for companies by investment experts, including the Investment Management and Initiatives Company of Niger (Societe d'Investissement de Gestion et d'Initiatives au Niger, SINERGI) Niger funds. With USAID support, this approach will have a strong leverage effect on private capital flows in Africa. Nearly EUR 5 million (CFA 3.2 billion) should be raised in debt and capital from funds, banks, and business angels over the period for the benefit of young SMEs whose needs are between EUR 30,000 and EUR 300,000.[271]

- **SINERGI Niger**

The Investment Management and Initiatives Company of Niger (Societe d'Investissement de Gestion et d'Initiatives au Niger, SINERGI), was created in 2006 and is the first investment company in Niger whose objective is the financing of SMEs through a private equity approach. SINERGI is a public limited company financed by equity. Accompanied by the Investors and Partners (I&P) group, SINERGI NIGER is generally intended for SMEs with a financing need of between CFA 20 and 170 million (USD 34,000 to 290,000 million) by taking minority equity stakes and granting shareholder loans. SINERGI also provides local support as part of a long-term partnership. SINERGI has invested in seven SMEs since the start of its activities in 2008; 75% of these companies were being created at the time of SINERGI's investments, and all required a long-term, formalized partnership to be developed. Despite the very high-risk level of these small start-ups, 100% of the companies in the portfolio have been profitable.[272]

[270] "I&P et USAID nouent un partenariat pour accélerer la croissance des PME au Sahel," Investisseurs & Partenaires (I&P), (October 2016): http://www.ietp.com/fr/node/40/

[271] "Investisseurs & Partenaires (I&P)," (October 2016): http://www.ietp.com/fr/content/ip-et-usaid-nouent-un-partenariat-pour-acc%C3%A9lerer-la-croissance-des-pme-au-sahel

[272] "Sinergi, "Investisseurs & Partenaires (I&P), (October 2016): https://sinerginiger.com/teranga-capital/

3.4 Summary of Findings

- **Opportunity for ROGEP Credit Lines:** Nigerien 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 that are either already engaged in the off-grid solar sector (e.g. Orabank, SONIBANK, ASUSU and Capital Finance) or looking to enter the market.

- **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 Niger, 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.

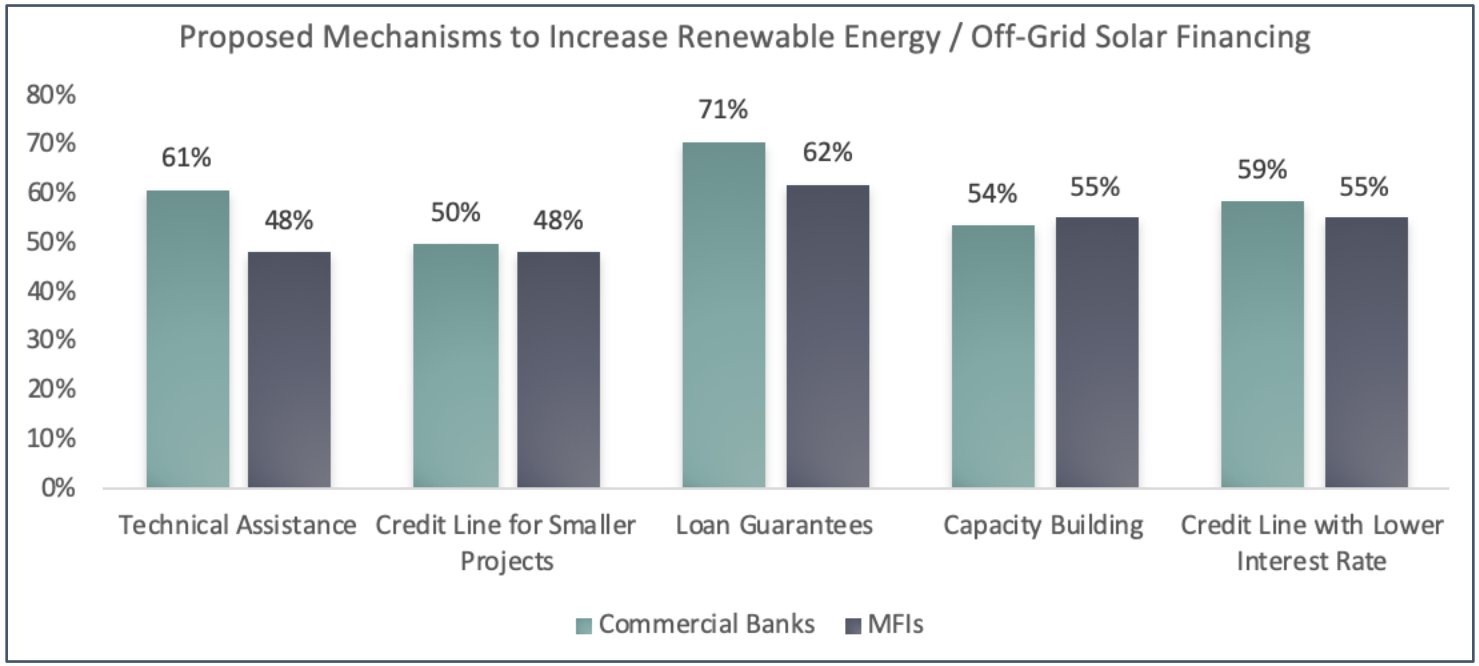
- **Collateral Requirements**: The collateral requirements of commercial banks in Niger are extremely high, particularly for small firms. Moreover, lenders already in the space are deeply constrained from originating loans where the borrower cannot meet these requirements. Hence, the use of third-party *pari-passu* guarantees as an alternative form of collateral would enable banks to extend loans to borrowers without such high collateral requirements. Accordingly, many of the interviewed commercial banks emphasized the need for partial credit guarantees to encourage lending to the OGS sector (50% coverage is helpful; 70-80% coverage could be transformative). However, pricing from most available third-party guarantors can be in the range of 3%+ per annum, which some lenders view as too high to remain competitive. This creates an opportunity for ROGEP to either provide low-cost guarantees directly or to subsidize the premiums offered by existing third-party guarantors such as GuarantCo, Afrexim and Africa Guarantee Fund.

- **Risk Perception of New Lenders**: In order to attract additional lenders into the off-grid solar market segment, there is need for strong, reasonably priced credit enhancement mechanisms. In order to cover "market entry" risks for lenders unwilling to enter this market, guarantee instruments that cover first loss are needed. However, first-loss coverage, while necessary for attracting new lenders to the off-grid sector, does not address the key issue of collateral and is therefore likely insufficient on its own to stimulate growth in FI engagement unless coupled with third-party guarantee coverage.

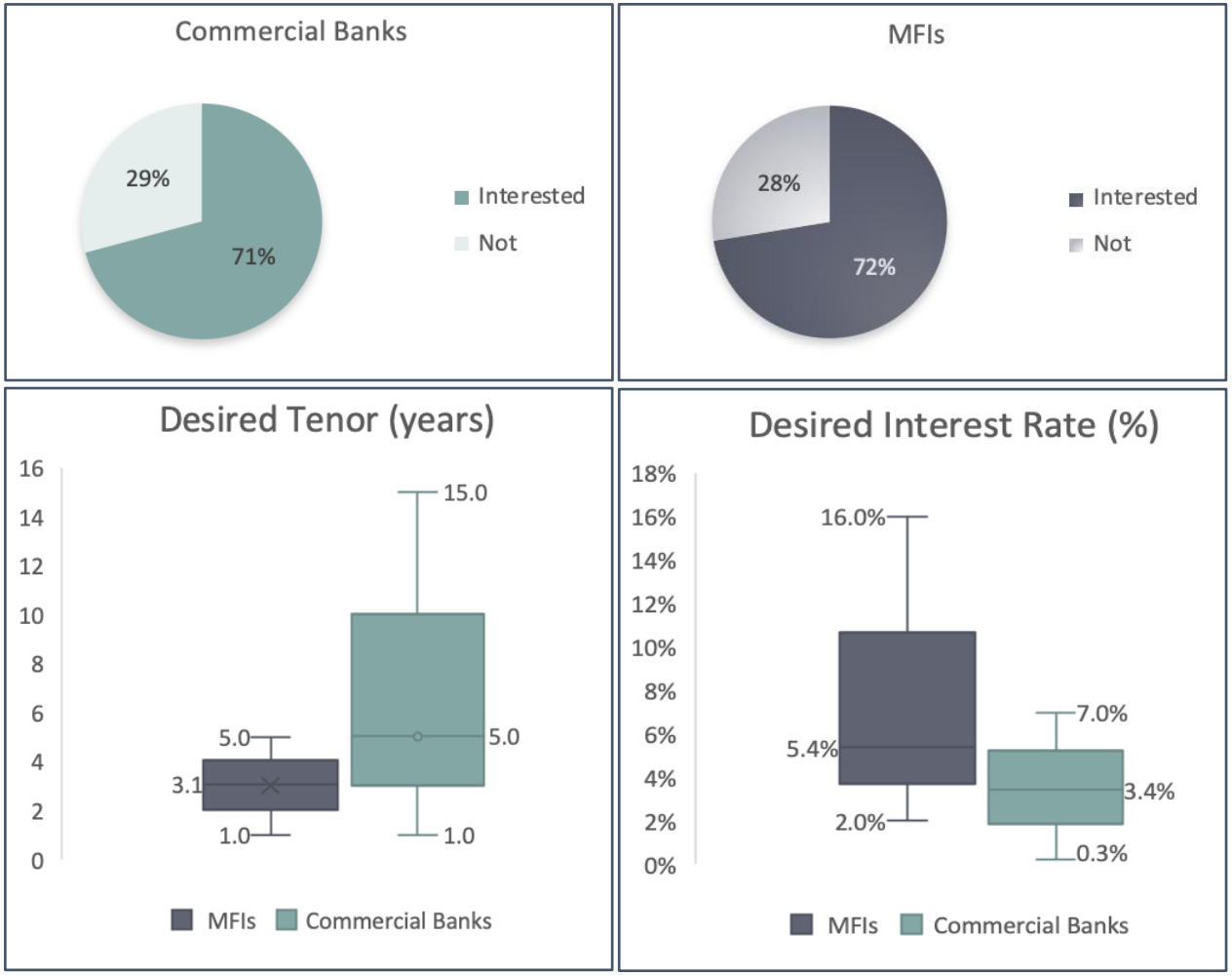
- **Technical Assistance:** A well designed TA intervention is critical to accelerating OGS lending in the country. Stakeholder interviews revealed the following key areas of support: training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of stand-alone solar firms and projects; extensive due diligence support to qualify products and approve vendors; and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. The TA intervention should build upon previous and existing programs (e.g. CEADUR, SUNREF and NESAP) 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 DFS 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.

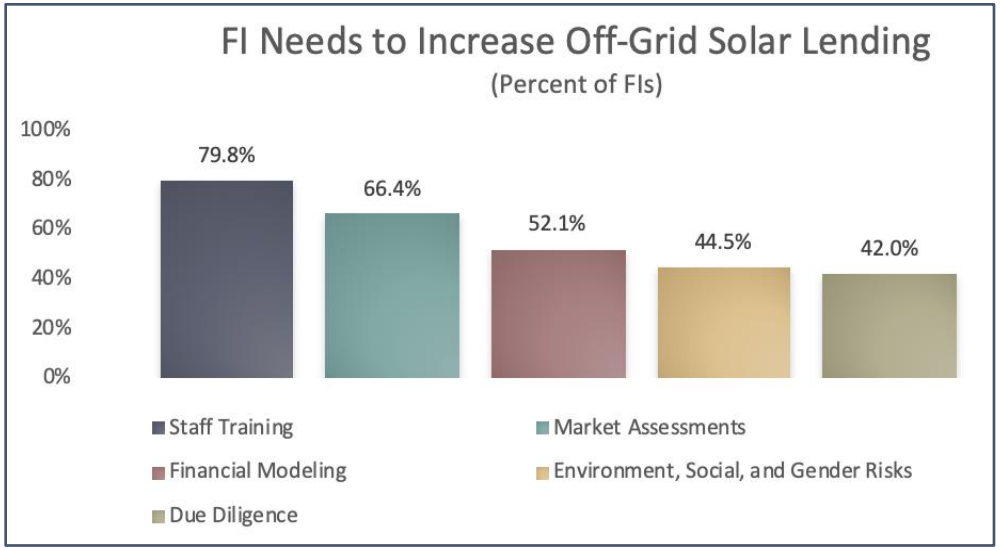
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from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



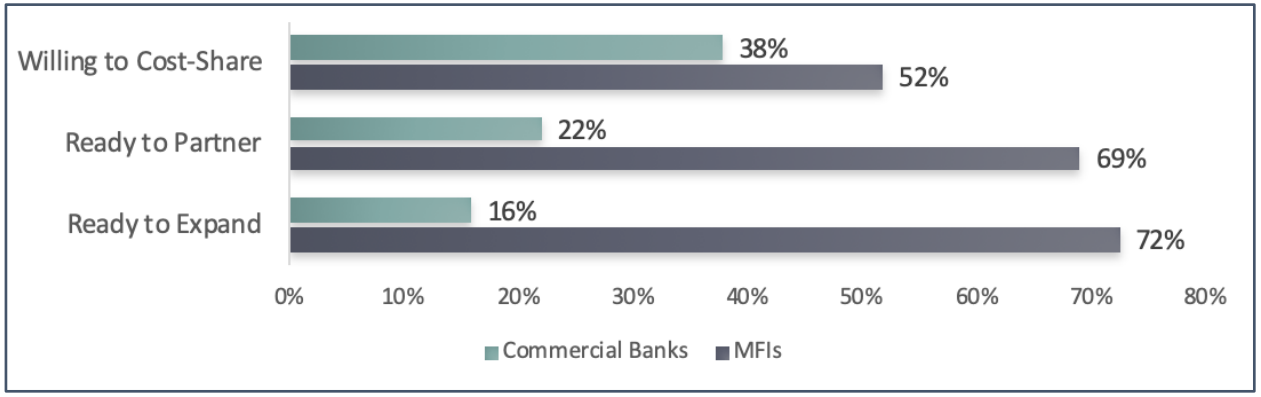
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy 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[273] (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)[274] and outside the buffer area established for the electrification by grid extension
- Are located within areas that have a population density of more than 350 people per km^2 (as defined by Eurostat for rural areas),[275] plus an additional 50 people per km^2 for greater feasibility of mini-grids[276] and are within 1 km[277] of a social facility (education center or health facility) and existing mini-grids of 2018.

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

1.2. Categorization/definition of settlements: Scenario 2030

1.2.1. *Electrification by grid extension* – settlements which are located within 15 km of the current electrical grid network (according to NIGELEC in a personal interview) or within 5 km of planned future line extensions[278]

[273] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)
[274] 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
[275] http://ec.europa.eu/eurostat/web/rural-development/methodology
[276] Identified in discussions with different international mini-grid developer.
[277] Preferred maximum distance for mini-grids from discussions with different international developer.
[278] NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

1.2.2. *Electrification by mini-grid* – settlements that:
- Were defined as mini-grid settlements in the 2023 scenario
- Are located within 1 km of the above mini-grid settlements, which is the preferred distance of mini-grid developers for their grid according to discussions with several international developers.
- Are located within 15 km of economic growth centers – airports, mines and urban areas; average worker distance in Africa is 10 km, a distance of 5 km is added to include the growth of businesses in the periphery of the growth centers.[279]

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

1.3. Definition of un-electrified settlements within grid areas

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

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

1.4. Determination of population per settlement

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

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

"New data sources and recent methodological advances made by the WorldPop program now provide high resolution, open and contemporary data on human population distributions, allowing accurate measurement of local population distributions, compositions, characteristics, growth and dynamics, across national and regional scales. Statistical assessments suggest that the resultant maps are consistently more accurate than existing population map products, as well as the simple gridding of census data."[280]

A Voronoi polygon analysis[281] was used to create boundaries for each identified settlement. These boundaries were then used in combination with the population density layer to estimate the total settlement population of the given year. The current annual national population growth rate of 3.8%[282]was applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses.

[279] 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.
[280] https://www.worldpop.org
[281] To learn more about Voronoi polygons, see wikidot: http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons
[282] The World Bank: https://data.worldbank.org/indicator/SP.POP.GROW?locations=NE

2. Summary of Key Datasets

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

Overview of Key Datasets of the Least-Cost Electrification Analysis								
Dataset	Description	Criteria used by technology						Source and Year
		Scenario 2023			Scenario 2030			
		On-grid	Mini-grid	Off-grid	On-grid	Mini-grid	Off-grid	
Electricity grid network (current)	Current national grid network (HV & MV lines)	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	NIGELEC, 2017[283]; ECOWREX,[284] 2015
Electricity grid network (planned)	Future network planned to be built (HV & MV lines)	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	NIGELEC, 2017[285] ; ECOWREX,[286] 2015
Power Stations	Energy generator connected to the main national grid or isolated grids	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 5km distance	≥ 5km distance	≥ 5km distance	ECOWREX, 2018
Mini-grids	One PV mini-grid available for analysis; potential mini-grids from scenario 2023 analysis were used in scenario 2030 to establish potential growth of mini-grids.	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 [287]	≥ 350 people per km^2	≤ 350 people per km^2	Not considered	Not considered	Not considered	WorldPop, 2015

[283] Georeferenced from grid map
[284] Source: http://www.ecowrex.org/mapView/index.php?lang=eng
[285] Georeferenced from grid map
[286] Source: http://www.ecowrex.org/mapView/index.php?lang=eng
[287] Based on Eurostat definition plus an additional 50 people per km2 for greater feasibility of mini-grids as identified in discussions with different international mini-grid developer. Source: http://ec.europa.eu/eurostat/web/rural-development/methodology

Settlements	Settlement layer giving location of settlements across Niger (cities, towns, villages, hamlets)	Used	Used	Used	Used	Used	Used	Humanitarian Data Exchange (HDX), 2015
Social facility: education centers	Education centers (kindergarten and schools) with GPS coordinates; Indicator of active local economy	Not considered	≤ 1km distance[288]	≥ 1km distance	Not considered	Not considered	Not considered	OpenStreetMap, 2018
Social facility: health centers	Clinics as collected by the Global Health sites Mapping Project; Indicator of active local economy	Not considered	≤ 1km distance[289]	≥ 1km distance	Not considered	Not considered	Not considered	HDX, 2018
Growth center: airport, mines, urban areas & development center	Economic growth centers for the analysis up to 2030; Urban areas as defined by Electricity Demand and known development center	Not used	Not used	Not used	Not considered	≤ 15km distance	≥ 15km distance	airports: Humanitarian Data Exchange (HDX), 2017 mines: HDX, 2015 urban areas: ECOWREX website, 2015[290] development center: Interviews with experts

[288] Preferred maximum distance for mini-grids from discussions with different international developer.
[289] Preferred maximum distance for mini-grids from discussions with different international developer.
[290] 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 Niamey 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,[291] multiplied by electricity access rates from the International Energy Agency (IEA),[292] 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.

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

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

1.1.4 Tier 4 is not included in this analysis since the off-grid solar systems that can provide a Tier 4 level of service are beyond the reach of the vast majority of the population.

1.2 Household energy expenditure and potential savings

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

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

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

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

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

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

1.2.6.1 Solar system sizes and costs:

- Cost per watt on solar systems vary greatly and have changed rapidly in the past five years. Smaller pico and plug and play systems have a much higher per cost per watt. The USD/Watt prices are based on sample cost ranges from Lighting Global equipment available on the open market.
- Average system size by watts: values are chosen as representative values for solar systems from each of the Tier values. They are intended to represent system sizes that typical members of each group would purchase.
- Average system life values represent typical expected operating life of Lighting Global products.

1.2.6.2 Current household energy usage:

Current Household Energy Usage (# Units/HH)				
Technology	**Tier 1**	**Tier 1.5**	**Tier 2**	**Tier 3**
Torch lights/Lanterns	1	2	3	
Mobile Phone Charging	1	1	2	
DC Radio	-	1	-	-
DC TV	-	-	1	-
Small Generator	-	-	-	1

- Numbers of units of torch lights/lanterns, cell phones, dc radio, dc TV and small generator represent the numbers of appliances that are demonstrated to be in use in typical households of each tier based on FGDs and multiple survey documents.

1.2.6.3 Current household energy costs

- Typical purchase and operation costs of HH off-grid appliances were based on FGDs, field energy surveys and reports.

1.3 Total Cash and Financed Market for Off-Grid Solar

1.3.1 Beginning with World Bank demographic and population data for Niger, 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%	77.3%
Fourth 20%	90%
Third 20%	95%
Second 20%	100%
Lowest 20%	100%

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

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

Average rural household expenditure on energy varies considerably. A study from Sierra Leone found that the "cost of lighting, on average, occupied between 10-15% of household incomes. Households using generators were found to spend a greater proportion of their income (upward of 20%) on lighting."[293] Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.[294] 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.

[293] 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).
[294] 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/

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.
- **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 Niger, 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.[295]

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

1. The GIS analysis[296] estimated that by 2023, 32.7% of the population will be grid connected, 7.5% will be connected by mini-grids while 59.8% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 58.3% of the population will be grid connected, 9.0% will be connected by mini-grids while only 32.7% 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:

[295] 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
[296] See Annex 1 for GIS methodology

- In the 2023 scenario, it was assumed that as the grid gets extended and mini-grids are deployed (based on GIS data), the households in the quintiles with the highest income will be given priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest quintile was assumed to have only 1% off-grid households, while the second highest quintile was assumed to have 9% off-grid households. The percentages of off-grid households in the bottom three quintiles remain unchanged. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2023 estimate.
- Similarly, in the 2030 scenario, it was assumed that the higher income quintiles will be prioritized for electrification, based on economic considerations, above the lower quintiles. Hence, the highest four quintiles were assumed to have only 1%, 2%, 3%, and 58% off-grid households respectively, while the lowest quintile was assumed to have 100% off-grid households. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2030 estimate.

Quintile	% Off-Grid (2023)	% Off-Grid (2030)
Highest 20%	1%	1%
Fourth 20%	9%	2%
Third 20%	90%	3%
Second 20%	99%	58%
Lowest 20%	100%	100%

2. Inflation rates for Niger: According to the IMF World Economic Outlook data, inflation in Niger 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 3.8% population growth rate from the World Bank[297] and the population density dataset used in the study, the estimated total population will be 24,684,102 in 2023 and 32,047,843 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 81.6% in 2023 and 93.6% in 2030.

5. To estimate GDP, it was assumed that the current annual GDP growth rate of 5.2% will be maintained through 2023 and 2030:

Parameter	2023	2030
Population	24,684,102 (GIS estimate)	32,047,843 (GIS estimate)
GDP (constant 2010 USD)	$10,988,760,599	$15,669,635,372

6. According to the Lighting Global Off-Grid Solar Market Trends Report 2018,[298] 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

[297] https://data.worldbank.org/indicator/SP.POP.GROW?locations=BJ
[298] "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

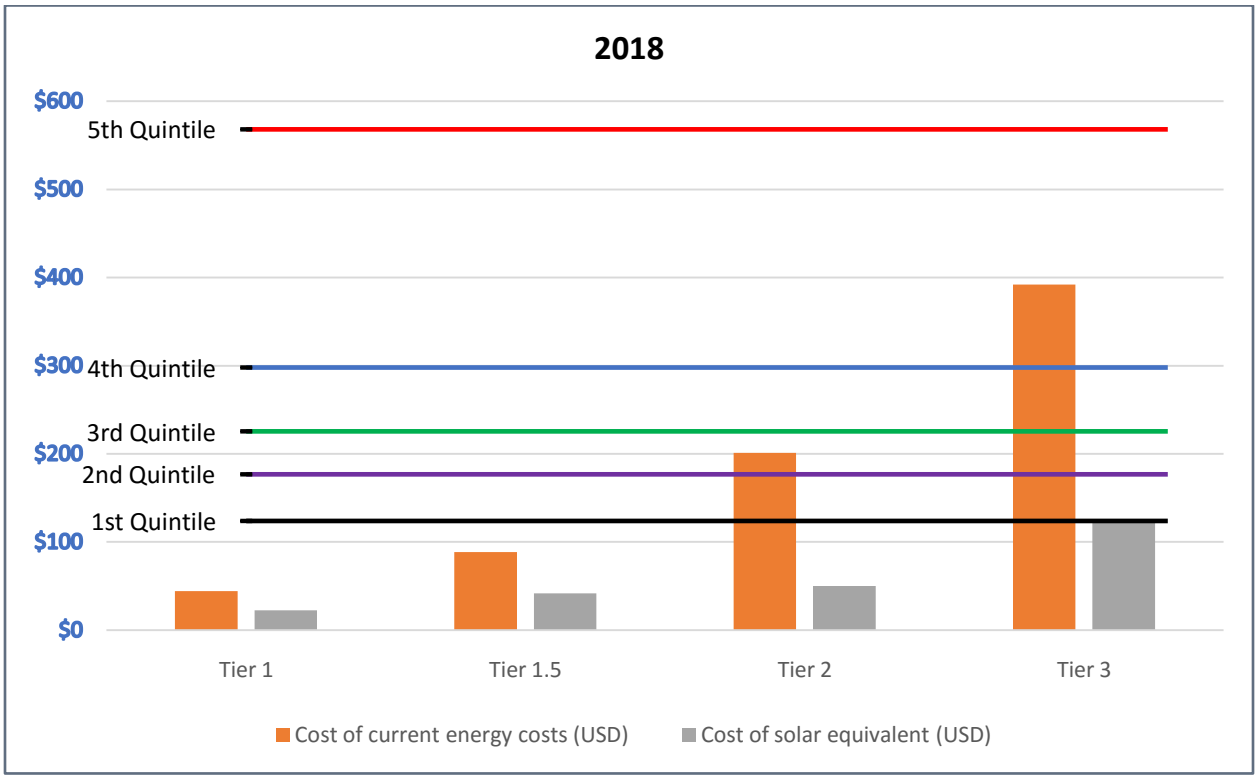
2020 was estimated at 2.36%. It was assumed that the annual price decrease will be maintained at this rate through 2030 (annual cost reduction factor of 0.98).

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

7. It was assumed the maximum interest rates in Niger 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 alsocompleted 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:

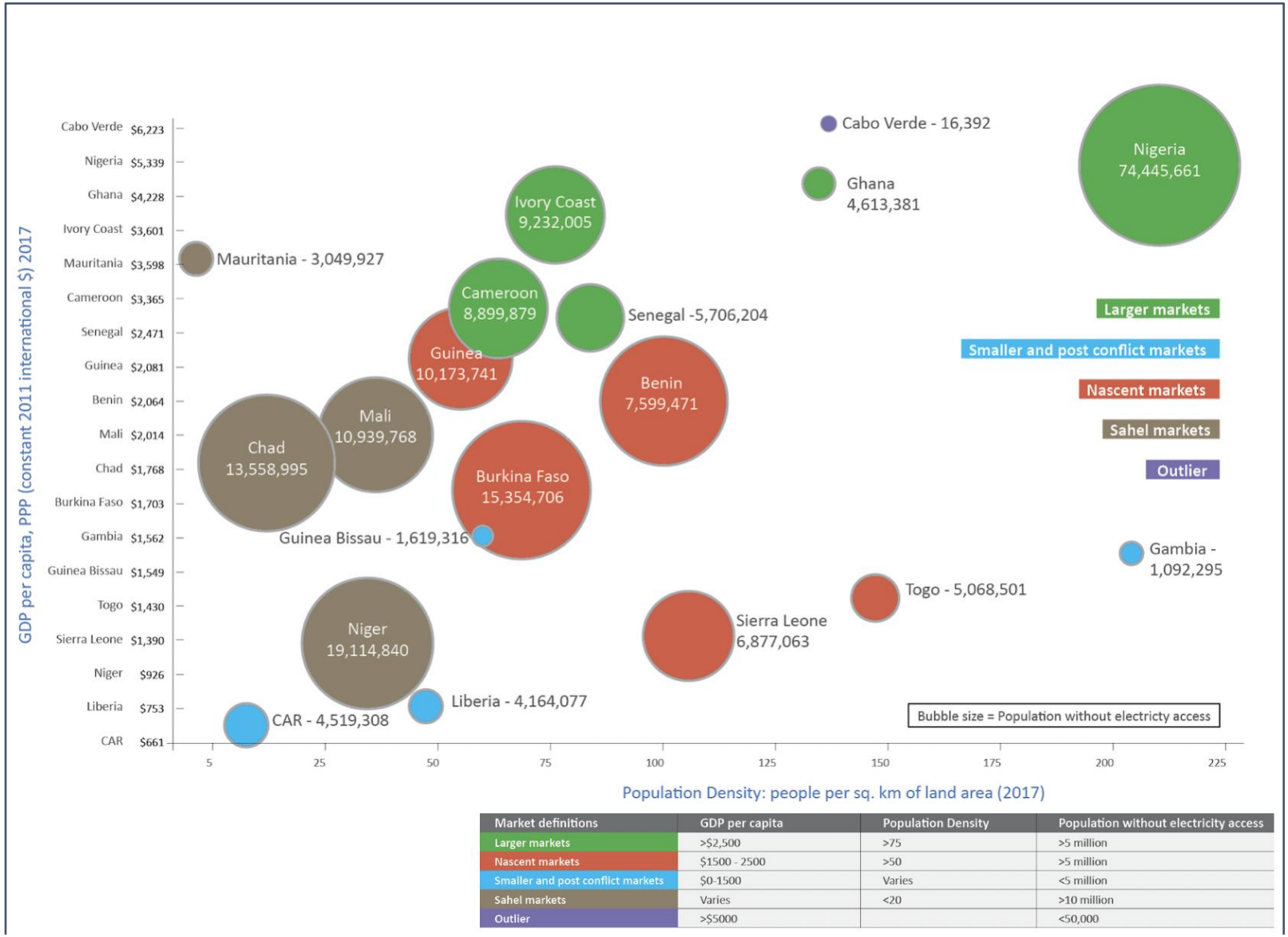
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	**Category 2:** Low-income / high population density	**Category 3:** High-income/ low population density	**Category 4:** High-income / high population density
Niger	Benin	Cameroon	Nigeria
Burkina 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	300
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	400

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

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

[299] "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

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

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

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

2.3 Institutional Market Sizing Calculations

Household systems, cost and price per watt:

System Type	Tier Rating	USD/Watt[300]	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	200	$500.00

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	300	Six [6] Tier 2
	HC2	1,500	Eight [8] Tier 3
	HC3	4,200	21 Tier 3
Education	Primary	500	10 Tier 2
	Secondary	1,920	10 Tier 3
Public lighting		400	Two [2] Tier 3

Institutional Sector Market Sizing Calculations:

Water Supply						
# of water pumps	X	Size of pump (low, medium, high power)	X	Cost per watt for pumping ($2.50)	=	Estimated Potential Size of Market for Water Supply Sector

Healthcare						
# of healthcare facilities	X		X		=	Estimated Potential Size of Market for Healthcare Sector
HC 1		Cost per tier 2 system ($250)		6		
HC 2		Cost per tier 3 system ($500)		8		
HC 3				21		

[300] 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

Education						
# of schools	X	Cost per tier 2 system ($250)	X	10	=	Estimated Potential Size of Market for Education Sector
Primary						
Secondary		Cost per tier 3 system ($500)		10		

Public Lighting						
# of lights required	X	Cost per tier 3 system ($500)	X	2	=	Estimated Potential Size of Market for Public Lighting Sector

2.4 Data Collection Approach by Institutional Market Segment

NIGER			
Water Supply	**Healthcare**	**Education**	**Public Lighting**
World Bank 2017 Market Assessment[301]	GIS data + per capita assumption	GIS data	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Niger 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:[302]

- **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.

[301] "Off-grid Solar Market Assessment in Niger & Design of Market-based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/
[302] 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

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.

3. PRODUCTIVE USE DEMAND

3.1 Value-added

Value-added productive use of energy (PUE) was calculated at the national level of production and yield for various agricultural outputs taken from the Food and Agriculture Organization (FAO) of the UN databases. The types and categories of rural products sourced were determined based on analysis of the FAO Food Balance Sheet.[303] The types of off-grid solar value-added appliances include: (i) solar milling, (ii) solar refrigeration and chilling, and (iii) solar water pumping for irrigation. These broad categories of off-grid solar appliances were sourced from a review of available DC appliances applicable to the development of poor off-grid communities.[304]

For each agricultural value chain that may be engaged by an off-grid solar appliance, the following were analyzed: (i) the largest agricultural production capability of the country for certain crops and (ii) the most available/applicable technology to support income generation by small shareholder farmers

3.1.1 Widest Agricultural Applicability: The national production for the following rural products was determined by multiplying the most recent producer prices for crops and agricultural products for which relevant statistics are published by the corresponding year's production quantity.

A. Cereals
    1. Rice
    2. Maize
    3. Millet
    4. Sorghum

B. Roots and Tubers
    1. Cassava
    2. Yam
    3. Potatoes (including sweet)

C. High Quality Protein
    1. Meat
    2. Seafood[305]
    3. Eggs
    4. Poultry
    5. Milk

D. Fruits and Vegetables

[303] "Agricultural Growth in West Africa, Market and Policy Drivers," FAO, (2015): http://www.fao.org/3/a-i4337e.pdf

[304] The selection of these appliances is supported by "Off-Grid Appliance Market Survey
"Global LEAP, Off-Grid Appliance Market Survey," Efficiency 4 Access Coalition, (November 2017): https://static1.squarespace.com/static/56ba427f9f726695ab77ec09/t/5a29bec841920214496ca521/1512685258988/2017+Off-Grid+Appliance+Survey+Summary.pdf

[305] Aquaculture production capture, dollar values were taken for each country from the most recent published values provided by the FAO
"Global Aquaculture Production 1950 – 2016," FAO, (2016): http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en

Supplemental Data Collection:

There were many instances where recent crop price and quantity data were not available from published resources. In such cases, the following approach was taken to approximate the required data for the calculations:

- The most recently available producer price and production quantity were used in order to ensure that quantity and year matched up
- If there was no producer price available for the crop or livestock product, the most recent value of national income in that country for the relevant crop or product was applied

3.1.2 The available market for each off-grid solar technology for each rural product is based on the summation of the national income for each rural product as provided below:

I. Solar Water Pumping and Irrigation: [A +B +D]
II. Refrigeration & Chilling: [C+D]
III. Mills: [A+B]

The formulas for deriving the size of the national market for value-added appliances include the following:

Size of the Market for Smallholder Value-added Machinery (generally):

Number of rural HH	X	Household Income	X	% of expenditure for inputs on value production for representative country	=	Size of Market for Smallholder Value-added Machinery

Size of Market for Refrigeration

Yearly National Income for (C+D)	X	% of expenditure for inputs on value for representative country	=	Size of Market for Refrigeration

Size of Market for Milling

Yearly National Income for (A+B)	X	% Of expenditure for inputs on value for representative country	=	Size of Market for Milling

The FAO database and the Smallholder Data Portrait were used to determine the farmer income from agriculture and percentage of expenditures on agricultural inputs for three ROGEP countries where data was available – Ghana, Niger, Nigeria.[306] The values for these three countries were then applied to the remaining countries as follows:[307]

- Ghana: Benin, Togo, Côte Ivoire, Senegal, Liberia, Guinea, Guinea-Bissau, Sierra Leone
- **Niger**: Central African Republic, Chad, Mali, Mauritania, Burkina Faso and The Gambia
- Nigeria: Cameroon

[306] "Family Farming Knowledge Platform," FAO: http://www.fao.org/family-farming/data-sources/dataportrait/indicator-details/en/?ind=83480
[307] Cabo Verde is excluded from this categorization as its PUE analysis was unique from the rest of the countries in the region given its characteristics as an island nation.

3.2 Available Market for Solar Drip Irrigation

The method used for calculating the available market size for solar irrigation required calculating the amount of irrigable land that is not irrigated for the country[308] and multiplying this by the average cost of installing solar water pumps and drip irrigation systems per hectare.[309] The calculations for the cost of solar drip irrigation per a hectare were based on a sampling of prices found in a 2011 World Bank report.[310]

The specifications for solar irrigation pumps are generally the same within the 7-meter head range. The leading submersible pump marketed by Sunculture has a maximum head of 80-meter. The applicability for such pumps is almost universal to agriculture since in all cases it seems that irrigation increases productivity drastically and therefore "pays for itself" (see Sunfunder & Futurepump promotional material and Powering Agriculture reports).

Cost of Drip Irrigation Kits[311]

COUNTRY	SUPPLIER	ORIGIN	AREA (M^2)	COST (CFAF, US$1.00=CFAF 484)
Niger	Nétafim	Israel	80	39,410
			500	141,500
	NaanDan Jain	Israel	500	150,000
Mali	IDE	India	20	12,000
			100	21,000
			200	35,000
			500	72,000
Burkina Faso	Chapin	United States	500	150,000
	Nétafim	Israel	500	131,000

Cost Description	Cost (USD)
Average cost per Meter Sq.	$307.40
Average Cost of Drip Irrigation Per Hectare	$6,351.30
Cost of Solar PV System and Pump per Hectare	$4,132.23
Drip Irrigation & Solar Pumping Per Hectare	**$10,484**

Source: World Bank

[308] "AQUASTAT," FAO, (2018): http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
[309] "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
[310] Ibid.
[311] Drip irrigation kits, though more expensive, more efficiently distribute water to irrigated plants. The water-use efficiency of drip irrigation is between 90 to 95 percent versus 40 to 50 percent for gravity-fed irrigation and 70 to 80 percent for spray systems.

Methodology for identifying areas suitable for irrigation activities on farms:

The areas for potential irrigation activities were calculated using the visible cropland[312] adjacent to permanent surface water sources. As identified by experts in a study in Zambia[313] and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure31** is a map of the cropland within a 5 km distance from permanent surface water.

3.3 Productive Use for Off-Grid SMEs

To calculate the available market for PUE by barbers and tailors (i.e. the available market for hair-trimmers and sewing machines), the number of financially constrained microenterprises[314] was multiplied by the average price for a selection of hair-trimming and tailoring off-grid appliances from recent industry reports (see below). It was assumed that hair cutting and sewing appliances are a *sine qua non* for barbering and tailoring businesses (as opposed to lighting and refrigeration, since businesses making use of such appliances could still exist without them). The pricing for barbering and tailoring appliances was assumed to reflect the level of capital expenditure that could be supported by an off-grid rural African microenterprise. By using a single price for all of the ROGEP countries, this methodology does not take into account supply chain constraints. Nonetheless, it reflects that the cost of solar appliances depends on the ability to import appliances, rather than sourcing them locally. This is a common issue for entrepreneurs throughout the region. The appliances included in determining the average price were all DC.

Hair Clippers	**Cost per Unit (USD)**	**Company**
21-Piece Haircut Kit Custom Cut® with Case (model: HC200GB)	$24	Conair-Store.com
Professional 20-Piece Haircutting Kit Fast Cut Pro, model: HC1000	$50	Conair-Store.com
Shaver Carmen USB C82002	$39	Carmen Products
Barber Kit Ecoboxx 160 DC Plus	$340	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Hair Clippers Average Cost	$113	
Sewing Machines	**Cost per Unit (USD)**	**Company**
Sewing Machine CERAD (solar-powered)	$193	CERAD
Sewing Machine retrofitted with DC motor – SELCO (solar powered)	$279	Selco Solar Light Pvt. ltd
PV-Equipment: Faison Stitch Sewing Machine – SELCO	$505	Selco Solar Light Pvt.ltd.
Sewing Machines Average	$326	
Average SME Appliance Cost	**$219**	

The value of imports was collected from the International Trade Centre database[315] and the increase in imports was calculated from the IMF World Economic Outlook Database, April 2018.[316]

[312] "Prototype Land Cover Map over Africa at 20m Released," Esa, (February 2018): https://www.esa-landcover-cci.org/?q=node/187
[313] "Zambia Electrification Geospatial Model," USAID and Power Africa, (April 2018): https://pdf.usaid.gov/pdf_docs/PA00T2JC.pdf
[314] "MSME Finance Gap," SME Finance Forum: https://www.smefinanceforum.org/data-sites/msme-finance-gap
[315] "International Trade in Goods – Imports 2001 – 2017," International Trade Center, (2017): http://www.intracen.org/itc/market-info-tools/statistics-import-country-product/
[316] "World Economic Outlook Database," International Monetary Fund, (July 2018): https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx

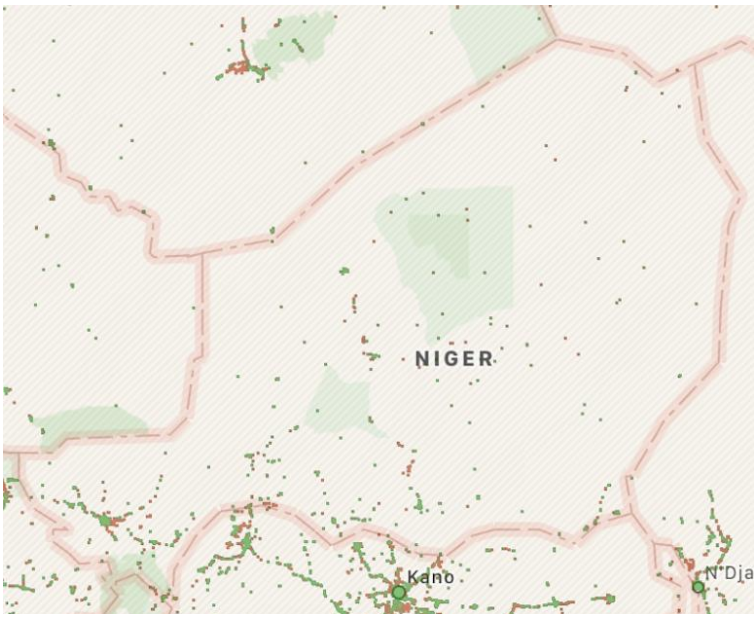
3.4 Productive Use of Energy for Phone Charging Enterprises

Size of the Available Cash Market:

Mobile Phone Subscribers[317]	X	% Of country rural	X	Cost of phone charging Appliances[318]	X	0.01 (assuming 1 phone charger per 100 mobile phone users)	=	Size of the Available Cash Market

Identifying areas of phone network coverage

Figure 33 illustrates the mobile network geographic coverage across the country. The source for this data is GSMA, which gives a radius ranging between 2-30 km. The radius is affected by a number of variables including tower height, power output, frequencies in use, and antenna type. Since this does not indicate the quality of network, the data was compared with data from OpenSignal, which tracks the signal from users registered on the platform (visualized as points in the figure below).



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

3.5 Financed Solution Calculation

For the market sizing for solar irrigation pumping, milling and refrigeration/chilling, and phone charging, the IPMT function was carried out with a present value set as the cash value (the market size for the country), and with an interest rate of 30% (this rate was applied to all countries due to the fact that there is too much diversity in the market to pick one representative number with the same methodology across all the countries).[319]

[317] "The Mobile Economy, Sub-Saharan Africa," GSMA Intelligence, (2017): https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download
[318] "Photovoltaics for Productive Use Applications A Catalogue of DC-Appliances," GIZ, (2016): https://www.gogla.org/sites/default/files/resource_docs/catalogue_pv_dc_appliances_giz_2016.pdf
[319] "Select West Africa Loan Market Overview," EMFC, (April 2018): https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx

4. SUPPLY CHAIN ANALYSIS

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

- Supplier focus group discussions held in Niamey in July 2018
- Survey of 10 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- GOGLA semi-annual sales reports[320]
- 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 Niger is included below:

1	Benafsol
2	Belko Hydraulique
3	Benalya S2e
4	Boutique Elhadji Yellow
5	Consultation Plus
6	D.E.P.E.
7	Ets Lumière Du Sahel
8	Ets Maman Sani
9	Ets Moussa Elhadji Abasse
10	Ets Ténéré
11	Ets Yacouba Mahaman
12	Global Energies Solaires
13	Kanf Electronic
14	Gimafor Engineering
15	Global Énergies Solaires
16	Groupe Énergie Et Équipements (G2e)
17	La Sahelienne De Genie Electrique
18	Nsesi
19	Sde Technologie Div. Energies Solaires
20	SES
21	S.G.E Sarlu
22	Solektra
23	Soni Niger
24	Tessa Power

[320] "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

25	Total Niger
26	Touthydro
27	Tout Solaire
28	Yandalux-Niger
29	Yaske-Solaire
30	Yasma Sa Yaske-Solaire

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT – APPROACH / METHODOLOGY

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 Niger. 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.[321]

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.[322]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

[321] The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.
[322] 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.[323] 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.[324]

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.[325]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.[326] 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.[327]

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).[328] 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).

[323] "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

[324] 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

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

[326] Ibid.

[327] "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/

[328] "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 Cotonou in July 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Niger to assess the main barriers/constraints for inclusive participation in the country. The survey examined a number of key gender issues, including *inter alia* access to credit, access to education and information, entrepreneurial and income-generating activities for women (including productive use of energy), representation of women in leadership positions in business and government.

- **Gender Questionnaire**

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

HOUSEHOLD

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

COMMUNITY/INSTITUTIONAL

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

PRODUCTIVE USE

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

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

SUPPLIER

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

ADDITIONAL:

What are the main barriers women face to access information?

What are the main barriers/constraints for women entrepreneurs to have access to credit?

Do women have equal access to capacity building and training services (e.g. vocational training/technical education) or do they experience discrimination in access to these services?

What policy, regulatory and institutional framework(s) exist, if any, to address gender mainstreaming[329] (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 Niger

Structural inequalities and gender discrimination against women and girls persist in Niger, as inclusive participation remains an ongoing challenge.. Gender inequality in Niger is quite widespread, although varies in severity between different ethnic groups. The gender assessment found that while there have been modest improvements in recent years to certain social indicators, gender disparities still exist across the economy, particularly in access to resources, higher education, land ownership, and inheritance systems, political power and decision-making. These findings are supported by the UNDP Human Development Index (HDI) on Gender Inequality, where Niger performs abysmally, ranking last in 189 out of 189 countries in the index.[330]

2.2 Gender and Poverty

Poverty remains widespread in Niger, particularly in rural areas where a large share of the country's poor population lives. Poverty remains widespread with around 75% of the population surviving on an income below USD $3.10 a day, and 50 % living below USD $1.90 a day.[331] HDI indicators and income levels are comparatively much lower for women, who constitute a disproportionate share of the country's poor and extremely poor population.

2.3 Gender, Human Capital and Economic Empowerment

2.3.1 Education, Skills Development and Training

Educational attainment inNiger has been lagging in rates of access to education at all levels; only 4.3% of adult women in Niger have attained some level of secondary education compared to 8.9% of men.[332] The gender gap is even worse for tertiary education (see **Section 1.2.2.5** above).

There are also many troubling signs in the primary and secondary education sector. An estimated 50% of children of official primary school age are out of school. Approximately 46% of boys of primary school age are out of school compared to 69% of girls of the same age. Nearly 81% of female youth of secondary school age are out of school compared to 70% of male youth of the same age. Across the entire sector,

[329] **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.

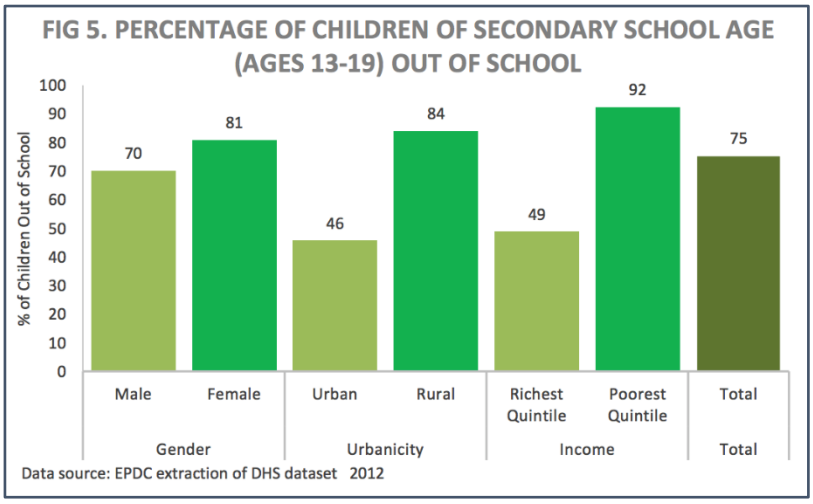
[330] "UN Human Development Reports: Gender Inequality Index (GII)," UN Development Programme, (2018): http://hdr.undp.org/en/composite/GII

[331] "UN Human Development Indicators: Niger," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/NER

[332] Ibid.

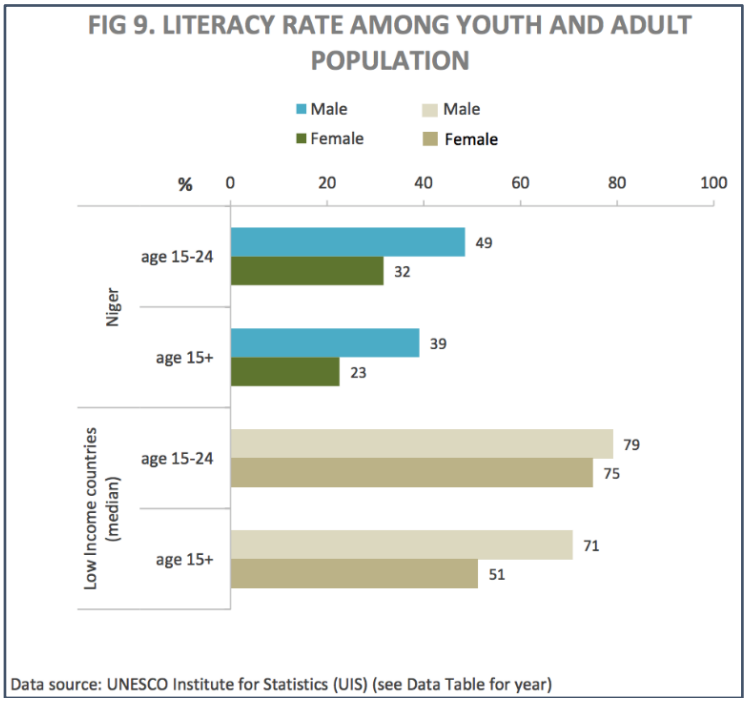
there are huge disparities between the poorest and the richest youth in terms of access to education.[333]This trend remains consistent in literacy rates among Niger's youth and adult populations, as just 23% of the country's female adult population is literate, compared to 39% of the adult male population.[334]

Percentage of Children of Secondary School Age (13-19) Out of School



Source: Education Policy Data Center

Literacy Rate Among Youth and Adult Population



Source: UNESCO Institute for Statistics

[333]"Niger: National Education Profile, 2014 Update," Education Policy and Data Center, (2018): https://www.epdc.org/sites/default/files/documents/EPDC_NEP_2018_Niger_0.pdf f
[334] Ibid.

Public vocational schools are under various ministries; Private vocational secondary schools are under the Ministry of Vocational Education, and for higher levels, they are under the Ministry of Higher and Secondary education. Female promotion and Training Centers are under the Ministry of Population, Female Promotion, and Child Protection. There is no discrimination between men and women for entrance examinations. However, because the completion of lower secondary school is a prerequisite for sitting the examination, female enrollment rate is low.

According to the UN, as of 2017, only 10.9% of women in Niger had an account at a financial institution or with a mobile money service provider.[335] 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.

2.3.2 Fertility Rates and Reproductive Health

As of 2018, Niger has the highest fertility rate in the world at 7.2 children per woman.The country also has a high maternal mortality rate; for every 100,000 live births, 553 women die from pregnancy related causes. An estimated 21.0% of women have an unmet need for family planning.These factors stem from the fact that, traditionally, having a large family is the sign of social success especially when there are several boys (as they are regarded as the family force and source of richness).[336]

2.3.3 Participation and Decision-Making

While gender equality is enshrined in article 21 of the Nigerien constitution, socio-cultural perspectives in Niger remain male-dominatedas conventional gender roles continue to hold women back. This is reflected in household decision-making, which often plays a role in restricting the rights and empowerment of women. These dynamics are also present in the rates of representation of women in the labor market as well as in leadership positions in business and government.

Although women's level of participation in the economy is growing, they still lag behind men, with an adult labor force participation rate of 67.5% compared to 90.7% for men.[337] As of 2018, women held only 17.0% of the country's seats in parliament.[338]

2.4 Gender Policy, Institutional and Legal Framework in Niger

2.4.1 Gender Mainstreaming initiatives by the Government

The GoN has adopted several policies and action plans to promote gender mainstreaming and equality and has signed on to key international and regional framework agreements protecting women's rights.At the international level, Niger has ratified the Convention on the Elimination of All Forms of Discrimination Against Women and is also a signatory to the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa, among others.[339]

[335] "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
[336] Ibid.
[337] "UN Human Development Indicators: Niger," UN Development Programme, (2018): http://hdr.undp.org/en/countries/profiles/NER
[338] Ibid.
[339] Ratification Table : Protocole to the African Charter on Human and People's rights on the Rights of Women in Africa: http://www.achpr.org/instruments/women-protocol/ratification/

Niger's policy framework for promoting gender equality and women's empowerment is guided mainly by two policies: (i) National Gender Policy (Politique Nationale de Genre) and (ii)its 10-year plan (2009-2018) elaborated to monitor and follow-up effective implementation of the policy.[340]Both policies were adopted in 2008 to guide GoN efforts to create an enabling environment to improve inclusive participation in the development process. These policies were reinforced by the Strategy of Poverty Reduction.

The 1999 Constitution of Niger prohibits discrimination based on race, sex and religion, and grants equal economic and social rights to all citizens. A number of favorable global and sectoral policies for the promotion of gender have been developed including Criminalization of the Practice of slavery (2003), Quotas for women in political life (2000) and Reproductive Health Act (2006). Furthermore, the National Observatory for Gender Promotion (Observatoire National pour la Promotion du Genre) in 2015 plays akey rolein strengthening the protection of women's rights.

Niger has implemented both constitutional and election law quotas and in its party platforms alongside voluntary quotas that are adopted by political parties. The existing electoral system is based upon proportional representation in Niger. On this basis, Niger adopted a Political Party Quota for Electoral Candidates. As a result, National Movement for a Society in Development (MNSD-Nassara) has introduced a 20 quota minimum for women.Prior to multiparty elections in the 1990s, the MNSD set aside 5 seats for women through the quota system adopted by the party.

2.4.2 Gaps in the Gender Policy/Legal Framework

Despite the Government's policy initiatives and legislative reforms, gender inequality remains an ongoing challenge across the country's political, economic and socio-cultural landscape, as women still face many barriers to inclusive participation. Niger's legal system consists of statutory, customary, and religious laws, leading to contradictions and inconsistencies among the three. Niger also has two parallel and overlapping judicial codes: one based on western, mainly French, systems and one based on traditional systems. These codes often disagree, particularly in areas related to gender.

As described above, significant gender gaps persist in the areas of education, literacy, access to information and decision-making. There is also still a lack of sex-disaggregated data across all sectors of the economy, which is critical to inform policy decision and promote gender mainstreaming on a national scale.

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.[341]

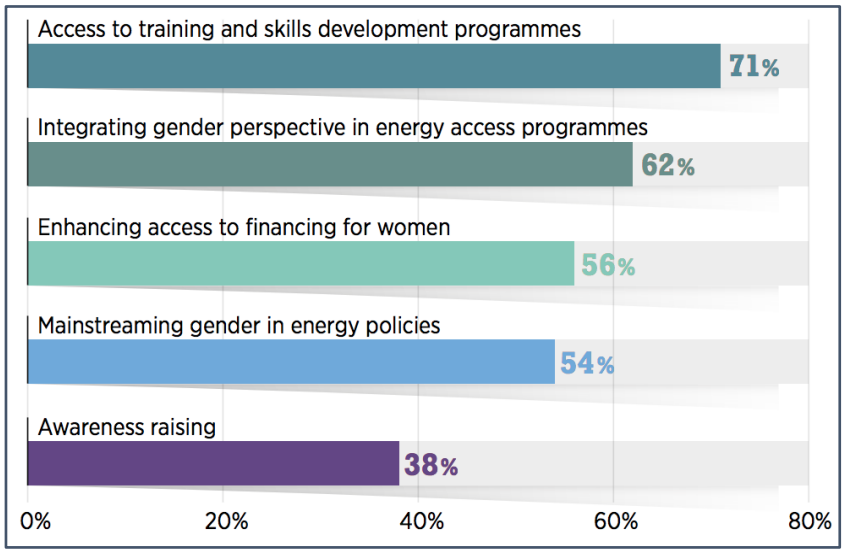
In seeking solutions to improve women's engagement in energy access, a 2018 IRENA survey found that access to necessary technical, business or leadership skills development programs was the single most

[340] Country Gender Profile, Niger, JICA
[341] "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

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.[342]

[342] 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 Niger's energy sector:[343]

- 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.[344]

[343] 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

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

ROGEP focus group discussion in Niamey, Niger, in June 2018.

Pictured above (from left to right): Diaouga Harouna, National Agency for Solar Energy-ANERSOL; Mai Moussa Adam, Ministry of Industry; Cissoko Alioune, Agriculture National Bank-BAGRI; and Mahaman Laouali Ousmane, GreenMax Capital Advisors.

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Banque Centrale des États de l'Afrique de l'Ouest, 2018, Rapport Annuel de la Commission Bancaire de l'UMOA – 2017," https://www.bceao.int/sites/default/files/2019-01/Rapport_Annuel_CB_2017.pdf

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