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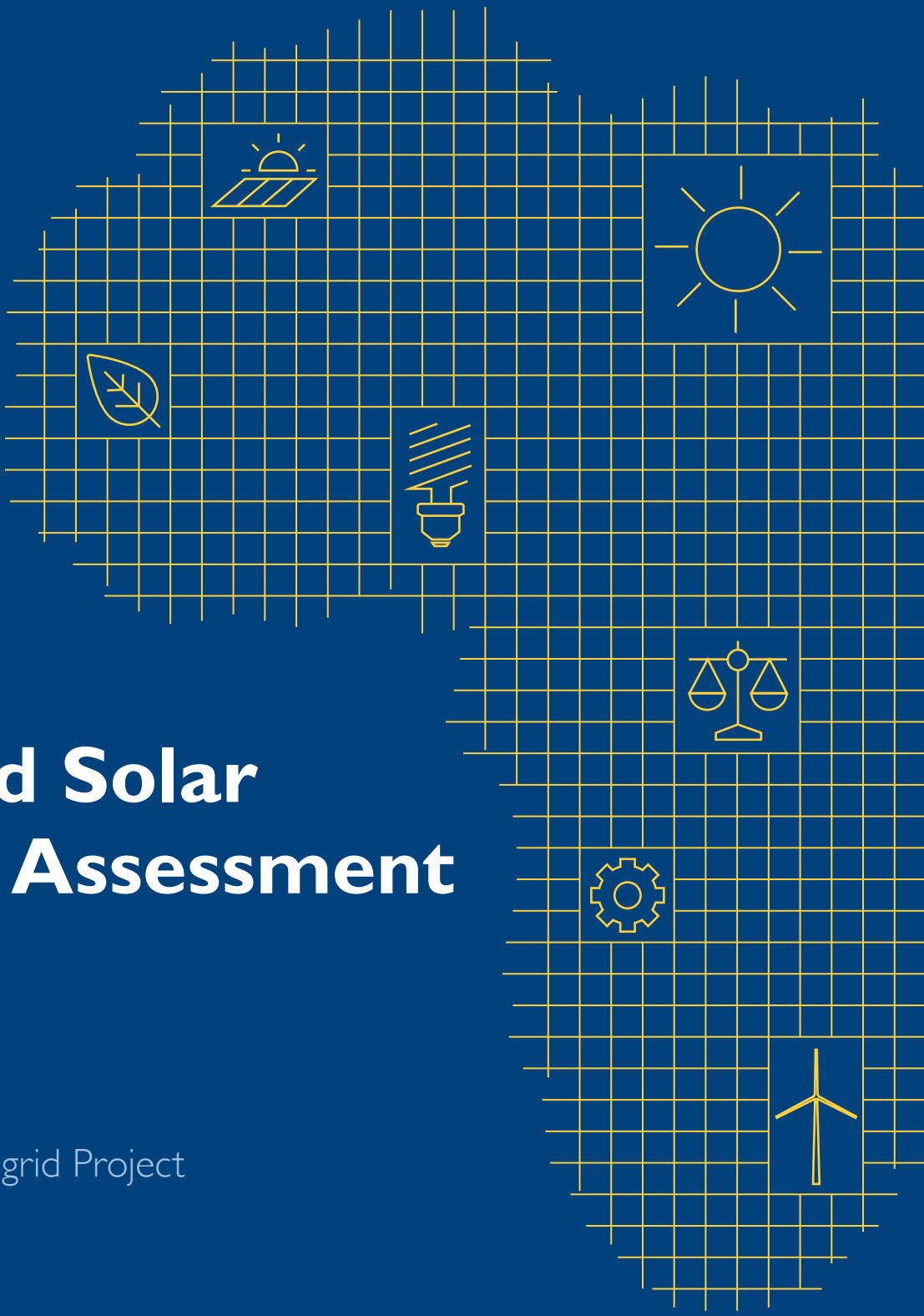

OCTOBER 2019

Off-Grid Solar Market Assessment

Senegal

Power Africa Off-grid Project

ABOUT POWER AFRICA

The Power Africa Off-grid Project is a four-year program that launched in November 2018 to accelerate off-grid electrification across sub-Saharan Africa. RTI International implements the project in collaboration with Fraym. Norton Rose Fulbright, Practical Action Consulting, and Tetra Tech. Power Africa is comprised of 12 U.S. Government agencies, over 145 private companies, and 18 bilateral and multilateral development partners that work together, supporting sub-Saharan governments to increase the number of people with access to power.

> *Power Africa aims to achieve 30,000 megawatts of new generated power, create 60 million new connections, and reach 300 million Africans by 2030.*

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Abbreviations and Acronyms

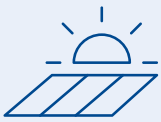
AEME	Agency for Energy Efficiency and Management (Agence pour l'Économie et la Maîtrise de l'Énergie)
AFD	French Development Agency (Agence Française de Développement)
ANER	National Agency for Renewable Energy (Agence Nationale pour les Energies Renouvelables)
ASER	Senegalese Agency for Rural Electrification (Agence Sénégalaise d'Électrification Rurale)
ASN	Standards Association of Senegal (Association Sénégalaise de Normalisation)
BICIS	International Bank of Commerce and Industry of Senegal (Banque Internationale pour le Commerce et l'Industrie du Sénégal
CAPEX	Capital expense
CMS	Senegal Mutual Credit (Credit Mutuel de Senegal)
CNCAS	National Agricultural Credit Bank of Senegal (Caisse Nationale de Crédit Agricole du Sénégal)
COPERES	Council of Professionals of Renewable Energies in Senegal (Conseil Patronal des Energies Renouvelables du Sénégal)
CRSE	Electricity Sector Regulatory Commission (Commission de Régulation du Secteur de l'Électricité)
DC	Direct current
ECOWAS	Economic Community of West African States
ECOW-GEN	ECOWAS Program on Gender Mainstreaming in Energy Access
ECREEE	ECOWAS Centre for Renewable Energies and Energy Efficiency
EPC	Engineering, procurement, and construction
ERIL	Local Rural Electrification Initiative (Electrification Rurale d'Initiative Locale
EU	European Union
FONGIP	Priority Investment Guarantee Fund (Fonds de Garantie des Investissements Prioritaires)
FONSIS	Sovereign Strategic Investment Fund (Fonds Souverain d'Investissements Stratégiques)
GDP	Gross domestic product
GIZ	German Society for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
GOGLA	Global Off-Grid Lighting Association

Hz	Hertz
kWh	Kilowatt hour
LPDSE	Letter of Development for the Energy Sector (Lettre de Développement du Secteur de l'Énergie)
MCC	Millennium Challenge Corporation
MEDER	Ministry of Energy and Development of Renewable Energy
MEP	Ministry of Energy and Petroleum
MFI	Microfinance institutions
NGO	Nongovernmental organization
O&M	Operations and maintenance
PAOP	Power Africa Off-grid Project

PAYGO	Pay-as-you-go
PNER	National Rural Electrification Program (Programme National d'Électrification Rurale)
PPER	Priority Rural Electrification Program (Programme Prioritaire de l'Électrification Rurale)
PUDC	Emergency Community Development Program (Programme d'Urgence de Développement Communautaire)
PV	Photovoltaic
ROGEP	Regional Off-Grid Electrification Project
SHS	Solar home system
VAT	Value-added tax
W	Watt

INTRODUCTION

This report by Power Africa provides insights into the opportunities and risks associated with Senegal's off-grid solar energy market and gives companies, investors, governments, and other stakeholders a deeper understanding of the market. While other stakeholders (i.e., development partners) have conducted market assessments, Power Africa has identified market information gaps and seeks to bridge those gaps in the following ways:



This report provides a comprehensive and detailed review of solar home systems (SHSs), mini-grids, productive use of energy, and other aspects of the off-grid solar value chain. Additionally, this report includes details on policy and regulatory issues, the structure and historical context of the energy sector, and gender mainstreaming.

This report draws upon the most up-to-date sales and investment data from GOGLA in order to keep pace with the ever-changing dynamics of the off-grid solar sector.

Insights in this report help Power Africa Off-grid Project (PAOP) plan and prioritize activities across work streams of policy and regulations, market intelligence, business performance, access to finance, and cross-sectoral integration throughout sub-Saharan Africa.

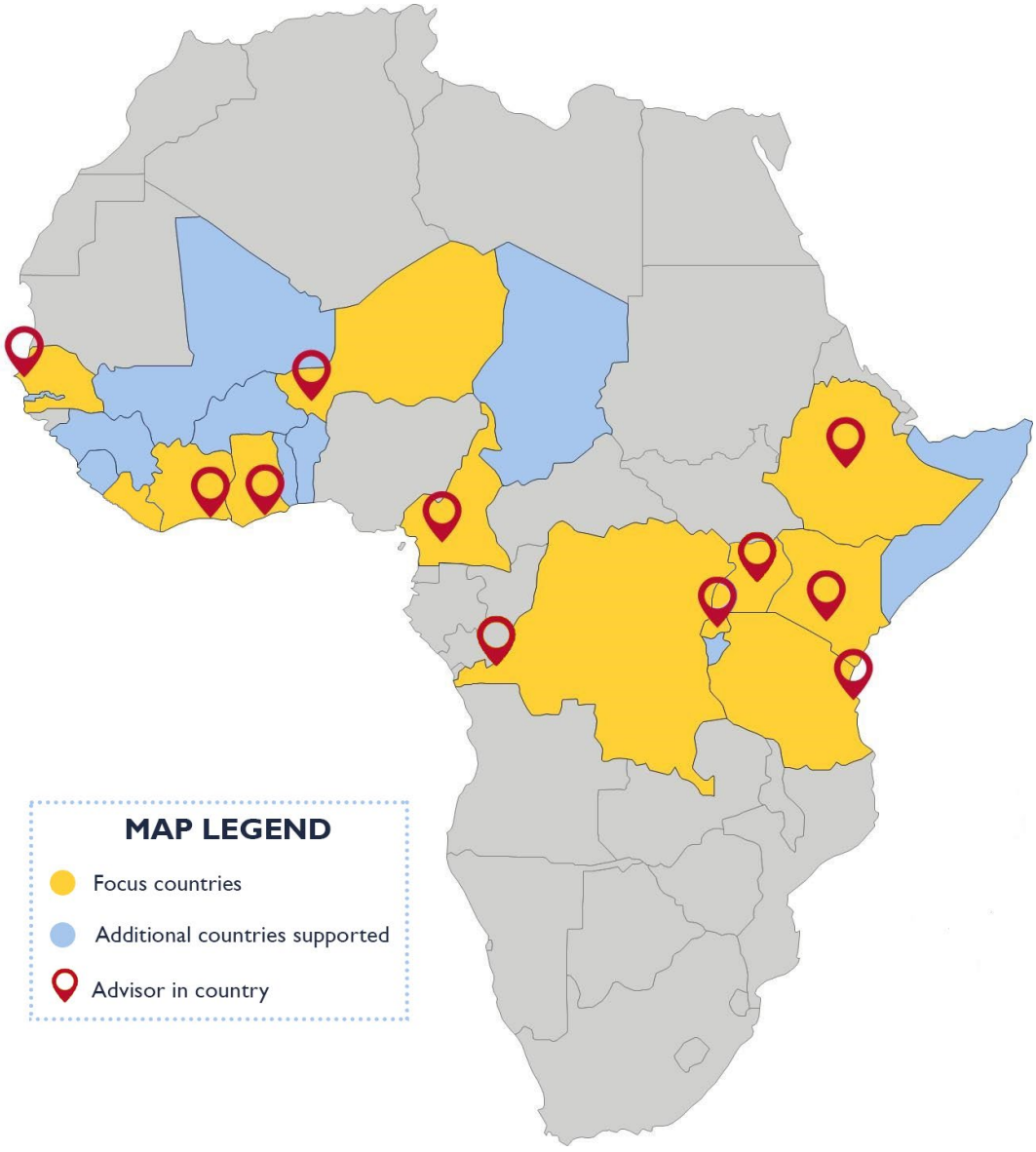
The report also serves as a baseline for Power Africa's technical advisors to guide their continuing work and provides a snapshot that can be used to determine growth and changing dynamics of the market over time. Insights provided in this report include characteristics of Senegals's electricity sector, electrification targets, government regulations, donor-funded activities, and details on subsectors of the off-grid solar energy market. Additionally, this report includes expert knowledge from Power Africa lead advisors, information gathered from stakeholder interviews, and data from the Global Off-Grid Lighting Association (GOGLA). For five countries (Cameroon, Côte d'Ivoire, the Democratic Republic of the Congo, Ethiopia, and Niger), a geospatial analysis was performed that leveraged machine learning to identify the potential local markets for off-grid solar energy. The geospatial analysis provides granular details (i.e., latent electricity demand by household income) that will assist companies seeking to expand into new geographic markets.

About Power Africa and the Power Africa Off-grid Project (PAOP)

Power Africa aims to accelerate off-grid electrification across sub-Saharan Africa through targeted, context-specific interventions with private-sector companies, governments, investors, and donors. Power Africa's goal is to increase electricity access by adding 30MW of new generation capacity, and 60 million new connections through grid and off-grid solutions by 2030. The goal of the Power Africa Off-grid Project is to provide support to private off-grid companies and make the markets in sub-Saharan Africa more attractive for investment and operations. Power Africa defines "access" as the direct or actual number of new households and businesses connected to electricity via an on- or off-grid solution. The project focuses on accelerating off-grid energy access through household SHSs and mini-grids, with the goal of facilitating

six million new connections by 2022. The project aims to accelerate off-grid electrification across ten focus countries in Africa: Cameroon, the Democratic Republic of the Congo, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Niger, Rwanda, Senegal, and Tanzania. Figure ES-1 identifies the countries in Africa receiving Power Africa support, with the focus countries highlighted. The pins represent the locations of the project's in-country advisors.

FIGURE ES-1. THE PROJECT PROVIDES SUPPORT TO 20 COUNTRIES IN AFRICA



The Power Africa Off-grid Project (PAOP) is a Power Africa project funded by the U.S. Agency for International Development (USAID). Power Africa brings together technical experts with stakeholders from the public and private sectors to increase energy access rates in sub-Saharan Africa. The Power Africa Off-grid Project is implemented by RTI International and headquartered in Pretoria, South Africa.

1 EXECUTIVE SUMMARY

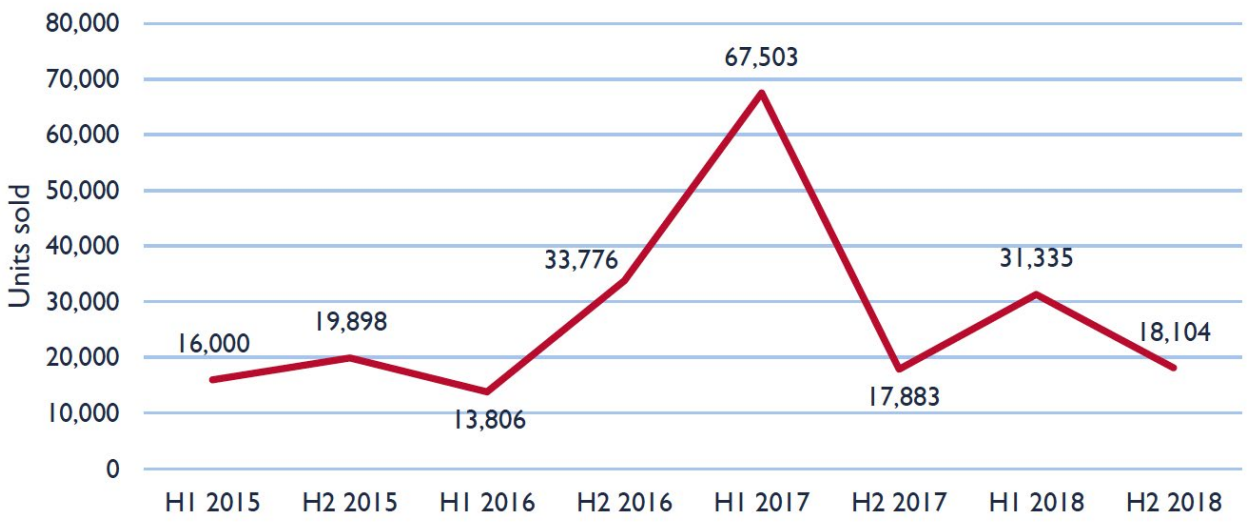
Energy sector overview. Senegal is home to one of West Africa's leading off-grid power sectors. The country's private-sector solar home system (SHS) companies have been at the forefront of adopting proven business models and technologies from East Africa, while also innovating through partnerships with microfinance institutions. Contributing to Senegal's position as a regional leader are a relatively strong human resource pool and good transportation links to neighboring countries. Professionals in Senegal are experienced in business and have networks spanning the region.

At the same time, government policies, originally developed in the late 1990s, have provided an official framework for private development and financing of large-scale grid infrastructure, mini-grids, and stand-alone power systems. Although this framework has not entirely delivered on expected results, it has helped to attract large quantities of donor finance.

Pico-solar sector overview. Senegal is a hub for SHS companies operating in francophone West Africa, with development of the sector being led by two major local companies: Oolu Solar and Baobab+. Senegal's SHS sector is also notable for the number of women in leadership positions. Three major companies operating in Senegal were founded by women (i.e., Bonergie, Vitalite, and Ellesolaire), and a woman co-owns Oolu Solar.

Despite its regional leadership, the Senegalese market remains in an early stage, at approximately 19 percent penetration of the off-grid market, and is prone to fluctuation. [1] Senegal experienced a sharp spike in sales in 2017 before leveling off in 2018, according to data from the Global Off-Grid Lighting Association (GOGLA), as shown in Figure ES-1. Contributing factors likely include growing market saturation in terms of product affordability and geographic coverage.

FIGURE ES - 2. GOGLA SALES DATA FROM 2015-2018



The entrance of major international players, such as Orange Energie and PEG, is likely to bring new interest from large development finance institutions and impact investors that usually require relatively large investment sizes. Meanwhile, smaller companies and local actors will continue to rely on sector-specific

[1] GOGLA, "Standardized Impact Metrics for the Off-Grid Solar Energy Sector."

debt providers (e.g., Lendable, SIMA Funds, SunFunder) and crowdfunding platforms (e.g., Lendahand, Solylend, Bettervest).

Mini-grid sector overview. Government-driven mini-grid development, financed by donors, is an important feature of the country's overall electrification approach, and hundreds of new sites are currently in some phase of development (Table ES-1). Technically, private companies may finance, own, and operate mini-grids, but, to date, no private companies have successfully navigated the licensing process, and private participation has been limited to an operational role.

TABLE ES - 1. ERIL MINI GRID PROGRAMS

YEAR BUILT	PROGRAM/DONOR	# GRIDS	STATUS	ISSUES
1996	Project Nippon/Government of Japan	3	No longer operational	Tariffs did not permit sustainable O&M
2000	Project Convention/Government of Senegal (GoS)	53	No longer operational	O&M contracted not finalized
2005-2006	Project Isofoton/Government of Spain	9	No longer operational	Undersized; unsustainable O&M
2008	PERACOD and Government of Netherlands	18	No longer operational	Undersized; no metering
2010	PERACOD and Government of Netherlands	70	Significant number no longer operational	Undersized; no metering
2011	Project Daye Owens/Government of Netherlands	10	Operational	No major issues
2011	Autrichian Project/GoS	27	No longer operational	No O&M contract
2018	ECREEE and European Union	40	Not yet operational	Have been built, but O&M tender is delayed
2020	European Union	70	Not yet built	EPC tender is delayed
2020	Islamic Development Bank, West African Development Bank, ECREEE, ASER	188	Not yet built	EPC tender is delayed
2020	Projet European Renewable Energy Federation, ASER	2	Under construction	EPC has been selected
2020	PUDC/UN Development Programme	122	20 built, but not yet operational	Remaining EPC not funded; O&M contract not yet funded
2020	Abu Dabi Fund and International Renewable Energy Agency	30	Not yet built	Design study underway
2020	Gauff/Kreditanstalt für Wiederaufbau (KfW)	300	Not yet built	Design study underway

Note: ASER = Senegalese Rural Electrification Agency (Agence Sénégalaise d'Électrification Rurale); ECREEE = ECOWAS Centre for Renewable Energies and Energy Efficiency; EPC = engineering, procurement, and construction; ERIL = Local Initiative for Rural Electrification (Electrification Rural d'Initiative Local); O&M = operations and maintenance; PERACOD = Programme for the Promotion of Renewable Energy, Energy Efficiency and Access to Energy Services; PUDC = Emergency Community Development Program (Programme d'Urgence de Développement Communautaire).

Current policies pose a number of barriers to increased private mini-grid investment. The inability to obtain a license, despite an official process, is a major challenge. Without a license, when a grid arrives, operators have no claim on the site, and they are unable to obtain loans to invest in major maintenance or upgrades.

Another barrier is tariff uncertainty. Senegal is in the midst of a tariff harmonization process that will bring all electricity tariffs in the country in line with those charged by the national utility. Private mini-grid operators would receive a government subsidy as well, but the exact levels of the subsidy and process for obtaining the subsidy have yet to be determined.

Productive use sector overview. Productive use has seen relatively little attention in terms of government policy, and no comprehensive strategy is being contemplated for the sector; however, this may change. In its latest draft Sector Policy Letter for 2019–2022, the Government of Senegal mentions productive uses as a component toward achieving universal energy access.

Despite the lack of an overarching framework, however, private companies and donors are realizing success. In Senegal, activity in the sector is dominated by pumping. However, limited development has occurred around solar mills or regarding cold chain applications; these issues may be due to the ease with which pumps align to existing off-grid business models, and the potential for significant cost savings they hold for farmers.

2 SENEGAL ENERGY SECTOR OVERVIEW

2.1 COUNTRY INTRODUCTION

Senegal is a regional leader for West Africa, with a reputation of economic and political stability and a long track record of peaceful democratic elections. The country is expected to maintain its strong rate of economic growth, having registered over 6 percent for the last four years.[2] These factors make Senegal a popular target for donor support to a wide swath of social, institutional, and infrastructure developments. Investments in these areas are important to ensuring inclusive economic growth, especially with regard to the urban-rural divide.

Electricity sector strengthening is central to government and donor objectives. With a highly urban population—roughly half is concentrated around cities—grid electrification and densification efforts hold a high potential for impact. Evidence of this opportunity can be seen in the recent award of four, largely peri-urban, concession zones to Senelec, the national power utility, or in the Government of Senegal's (GoS) latest Energy Compact with the Millennium Challenge Corporation (MCC), which includes electrification work in the relatively populous central and southern parts of the country.

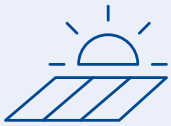
Rural populations, low density and remotely located, present more challenges than opportunities regarding energy access. The GoS's long standing framework for private concessions and mini-grid development is designed ostensibly to ensure that these areas are not left behind. In practice, however, this framework has proven difficult to manage, and competing priorities between government agencies, Senelec, concessionaires, and small-scale developers have meant that the policy has fallen short of its objectives of rapid rural electrification and increased private investment.

These issues may be best exemplified by Senegal's mini-grid sector. While GoS policy is meant to support private ownership of mini-grids, most of those developed to date have been government or donor-funded, with private companies taking engineering, procurement, and construction (EPC) and operations and maintenance (O&M) contracts. Contributing to this situation are a non-functioning private licensing process, an opaque grid extension process, and uncertainty around the implementation of public subsidy for private mini-grids.

Meanwhile, Senegal has become a regional hub in the off-grid solar home system (SHS) sector and hosts several prominent local and international companies. These companies have been at the forefront of key technologies and business models, such as pay-as-you-go (PAYGO) and partnerships with micro-finance institutions (MFIs). Thus, private sector off-grid products have helped to fill the gaps left by government electrification efforts.

Deepening presence into Senegal's most remote regions is also a challenge for the private SHS companies. However, as the sector grows more competitive and business models drive greater product affordability, it is anticipated that private companies will begin to reach more rural consumers. Being the first to market represents an important opportunity to capture long-term customer value and to further contribute to Senegal's overall energy access rate.

[2] The World Bank, "Senegal Overview."



Despite challenges, Senegal's private sector off-grid industry is dynamic on multiple fronts: business model innovation, adoption of new products, fundraising, and local and women founders. These attributes, and their impact on last-mile distribution and funding potential, are important to capturing relatively untapped rural markets.

Agricultural productive use, especially solar pumping, is emerging as a key opportunity for SHS companies to exploit if they mean to reach remote customers. The sector's potential to side-step government policy frameworks positions the sector to play a major role in achieving the country's overall energy access goals.

2.2 ELECTRIFICATION

2.2.1 GRID ELECTRIFICATION STATUS

Senegal's electrification policy is marked by a complex strategy involving government-led programs headed by Senelec, the national utility; the Priority Rural Electrification Program (Programme Prioritaire de l'Électrification Rurale [PPER]), a private concessions scheme; and the Local Rural Electrification Initiative (Electrification Rurale d'Initiative Locale [ERIL]), a mechanism for rural electrification via small, independent mini-grid and standalone power developers (also referred to as ERILs).

This approach, first established in the late 1990s, has developed steadily despite changing dynamics—and acknowledged shortfalls. Today, while electrification rates have increased, the model has proved cumbersome, has failed to attract significant private financing, and has seen only mixed results in terms of grid expansion.

As part of the PPER and ERIL framework, the National Rural Electrification Program (Programme National d'Électrification Rurale [PNER]) stands as Senegal's current electrification strategy document. PNER targets universal access, defined as 100 percent coverage in urban and 90 percent coverage in rural areas, by the year 2025. The plan's intermediate target of 95 percent/60 percent urban/rural coverage for the year 2017 was not met. The most recent published electrification rates are 90.1 percent urban (2009) and 30.4 percent rural (2015). While likely falling short of targets, current rates still represent great strides over the past 10–20 years. In 2000 rates stood at 57.8 percent/8.6 percent urban/rural.[3]

To reinvigorate the push toward universal access to 2025, the Government and Senegalese Agency for Rural Electrification (Agence Sénégalaise d'Électrification Rurale [ASER]) hired a consultant, Gesto Energy Consulting (Gesto), to develop a revised expansion plan. This plan calls for a greater role by Senelec and carves out specific villages for coverage via mini-grids and SHS (discussed in detail in Section 2.2.2), through ERILs and the national utility.

2.2.2 RURAL ELECTRIFICATION STRATEGY

The basis for Senegal's electrification strategy is provided by two key policies, described below.

PPER. Under PPER, Senegal is divided into 11 overall services territories: those belonging to Senelec and 10 territories slated for concession to private operators. Operators for each territory are responsible for all generation, transmission, and distribution within those territories and are mandated to undertake grid

[3] The World Bank and ESMAP, "Senegal's SE4ALL Rural Electrificaton: Action Agenda and Investment Prospectus."

extension. From 2008–2013, six of these concessions were successfully auctioned to private consortiums,[4] while the remaining four concessions were officially granted to Senelec in late 2018.[5]

ERIL. Recognizing that the concession scheme envisioned under PPER would likely leave gaps in grid coverage, ERIL provides for small, local mini-grid development or SHS distribution to supplement larger-scale extension. Local small and medium enterprises and nongovernmental organizations (NGOs) are permitted to become "ERILs" responsible for electricity provision in any communities not targeted for grid expansion within a three-year timeframe.

Central to these polices are three main institutions:

Senelec. Senelec is the vertically integrated, state-owned grid operator, serving the majority of urban centers and their surrounding areas. While always critical to Senegal's path to universal electrification, Senelec has grown in importance in recent years. With the development of the Gesto expansion plan and the recent allocation of the four previously unawarded concessions, Senelec is undoubtedly the most important vehicle for grid expansion. This shift may result in more rapid development, but also poses a challenge to the functioning and spirit of the PPER. While heavily donor funded, PPER concessions are nominally private sector ventures meant to attract long-term private capital. Expansion under Senelec, by contrast, will be dependent on donor and government subsidy and disincentivizes further investment into the concession consortiums.

Concessions. Concessionaires are private consortiums of local and international energy companies operating within the concession territories. Under PPER, concession rights are auctioned, with bidders evaluated based on their proposed level of investment, subsidy, and new connection targets. Of the six concession territories successfully awarded, a consortium between the National Office of Electricity (Office National de l'Electricité) and Comasel hold two; a further two are held by Enco and Isofoton consortium; one is held by the consortium of French Electricity (Electricité de France)/African Rural Energy (Energie Rurale Africaine) and Matforce; and the final territory is held by STEG and Coselec. All are backed by funding from various donors, including the World Bank, African Development Bank, French Development Agency (Agence Française de Développement [AFD]), and the European Union (EU).

Success of the PPER concessions in meeting expansion targets has been mixed. Of the six concessions, two are still struggling to start up, and the remaining four have fallen short of their initial electrification commitments. In fact, progress toward connections targets has been made in only three concession zones: Dagana-Podor at 22 percent of the target, Louga at 42 percent, and Kaffrine-Tambacounda-Kédougou at 15 percent.[6] Difficulty in accessing financing for new connections, as well as a high cost of connection and high tariff as compared to Senelec, have contributed to these poor results.

ERILs. ERILs are private, small-scale electricity providers. Most ERILs are mini-grid developers, and several have rights to develop in multiple villages. Under the Gesto scheme, villages set aside for mini-grid and SHS solutions are categorized by size and density. Grid extension is considered viable for villages of any size, while mini-grids are considered viable based on their generation type. Publicly supported SHS are defined only for villages with low population density. Under this plan, mini-grids are planned for only 8.5 percent of villages, and SHS cover only 3.3 percent. ERILs will be discussed in greater detail in the mini-grids section (Section 4).

[4] USAID and Power Africa, "Scaling Up Commercial Off Grid Solutions in Senegal."
[5] Dakaractu, "Concessions d'électrification rurale."
[6] USAID and Power Africa, "Scaling Up Commercial Off Grid Solutions in Senegal."

Several other important government policies and programs impact off-grid energy development.

Emergency Community Development Program (Programme d'Urgence de Développement Communautaire [PUDC]). PUDC is an implementing program targeting rural development under the government's Plan for an Emerging Senegal, a broad, medium to long-term economic growth plan adopted in 2014. PUDC, therefore, has a broad remit around infrastructure and socioeconomic development in rural regions in the areas of water, health, transportation, and electricity, among others. In the area of electrification, the program undertakes village mini-grid projects marked for priority electrification outside of the normal ERIL process.

Energy Sector Development Policy Letter (Lettre Politique de Développement du Secteur de l'Énergie [LPDSE]). The LPDSE comprises the government's high-level strategy for energy sector development and is intended to inform all other sector-facing policies and programs. Periodically updated, the LPDSE's next iteration will cover 2019–2022.

2.3 DEMAND FOR ENERGY

Senegal has an urban electrification rate of over 90 percent, which is entirely attributable to Senelec. In 2017, Senelec's customer base was over 1.3 million, up 34 percent since 2013. At the same time, grid quality is fairly high, with grid interruptions in 2017 totaling only 72 hours and averaging a frequency of 50.2 hertz (Hz).[7]

A survey conducted by MCC gathered consumption data for grid-connected households and businesses, as presented in Table 1.

TABLE 1. MEAN ELECTRICITY USAGE METRICS FOR GRID CONNECTED HOUSEHOLDS AND BUSINESSES

	HOUSEHOLDS	BUSINESSES	
USAGE METRICS		INFORMAL	FORMAL
Average electricity access per day (hours)	13.9		
Lighting (kilowatt hours [kWh]/day)	3.24	1.23	7.71
Small appliances, e.g., radio, TV (kWh/day)	2.67	1.45	6.03
Large appliances, e.g., refrigerator (kWh/day)	4.78	6.38	29.61
Electricity cost [$/2 months]	35.12	69.33	448.41
Average price per kWh [$]	0.24	0.29	0.42

Source: [8]

The study notes that formal businesses are likelier than informal businesses to be charged medium voltage commercial rates. This factor combined with taxes, Senelec's progressive rate structure, and the considerably higher consumption levels of formal businesses, may account for their higher apparent kWh rate.

[7] Senelec, "Rapport Annuel."

[8] Almanzar and Ulimwengu, "Willingness to Pay for Improved Electricity Services in Senegal."

2.4 ENERGY SECTOR INSTITUTIONS

2.4.1 GOVERNMENT INSTITUTIONS

FIGURE 1. SENEGAL'S OFF-GRID INSTITUTIONAL FRAMEWORK

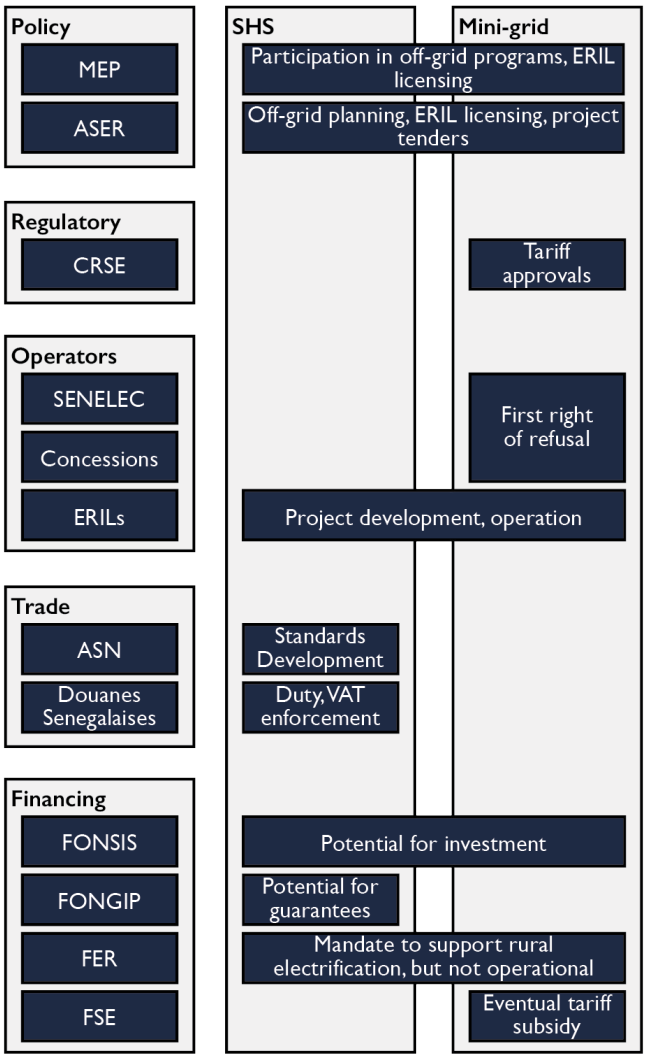


Figure 1 represents the structure of the GoS's institutional framework for the off-grid electricity sector. Key institutions are described below.

Ministry of Energy and Petroleum (MEP). MEP, formerly the Ministry of Energy and Development of Renewable Energy (MEDER), leads the development of overall sector strategy and policy. Within MEP sits a directorate of electricity focused exclusively on the sector, including the off-grid mini-grid and SHS sectors.

ASER. ASER oversees all rural electrification efforts, including the administration of the PPER and ERIL policy frameworks. ASER also spearheads its own electrification programs, including off-grid mini-grids. Mini-grid work is donor-funded and tendered through an EPC model. Recent projects include a 2018 tender for 78 mini-grids in Matam and Bakel departments and an EPC with the German GAUFF Engineering to construct 300 mini-grids.

National Agency for Renewable Energy (Agence Nationale pour les Energies Renouvelables [ANER]). ANER, which is in the process of being absorbed into Senelec, was chiefly responsible for on-grid project promotion, but its off-grid interests included street lighting, public buildings, and pumping.

Agency for Energy Efficiency and Management (Agence pour l'Économie et la Maîtrise de l'Énergie [AEME]). AEME was also recently absorbed into Senelec and oversaw energy efficiency programs.

Electricity Sector Regulatory Commission (Commission de Régulation du Secteur de l'Électricité [CRSE]). CRSE is Senegal's electricity regulator responsible for the preparation of licenses and tariff approvals for all industry actors, including mini-grids. While CRSE is involved in the licensing process, final approval is required from MEP.

Standards Association of Senegal (Association Sénégalaise de Normalisation [ASN]). ASN is responsible for developing and promoting national and international standards.

Senegalese Customs (Douanes Sénégalaises). Senegalese Customs is responsible for import inspection and tariffs enforcement, including categorization of SHS and other energy equipment.

Sovereign Funds Strategic Investment (Fonds Souverain d'Investissements Stratégiques [FONSIS]). FONSIS is Senegal's sovereign investment fund. FONSIS has expressed considerable interest in supporting the off-grid sector and has held informational interviews with some actors.

Priority Investment Guarantee Fund (Fonds de Garantie des Investissements Prioritaires [FONGIP]). FONGIP seeks to improve access to credit for small enterprises. FONGIP has a guarantee program in place for pumping projects that replace diesel and has expressed some interest in supporting SHS companies.

Rural Energy Fund (Fonds d'Energie Rurale [FER]). The Rural Energy Fund was created in 2006 through government decree. The fund intended a number of subsidies and loans to banks, developers, and operators to help spur both on- and off-grid rural electrification projects. The fund, however, was never endowed.

Special Fund for Support to the Energy Sector (Fonds spécial de Soutien au Secteur de l'Énergie [FSE]). FSE is used to support a number of energy sector subsidies, including transport of petroleum products. In the electricity sector, FSE is used to subsidize the government's tariff harmonization scheme, providing funds to both Senelec and concession operators to ensure that they can charge the same tariffs. FSE will also offer such subsidies to mini-grid ERILs, though this development has yet to take place.

2.4.2 INTERNATIONAL DONORS

International donors are very active in Senegal's energy sector, and are an important source of funds for both on-grid and off-grid electrification projects. Although Senegal has a donor coordination group, led by the EU and AFD, the group has not been active in the off-grid energy sector.

Economic Community of West African States (ECOWAS) Centre for Renewable Energies and Energy Efficiency (ECREEE). ECREEE supports Senegal's off-grid sector through its Regional Off-Grid Electrification Project (ROGEP), a World Bank-funded project targeting solar lanterns, SHS, solar water pumping, and solar-driven agricultural processing. ROGEP provides technical assistance to the GoS to integrate off-grid models into policy, prepares market intelligence for the private sector, and has a debt fund directed at off-grid companies. ECREEE has also supported companies directly through grants.

ECREEE implements the ECOWAS Program on Gender Mainstreaming in Energy Access (ECOW-GEN). In 2015, ECOWAS member states adopted the ECOWAS Policy for Gender Mainstreaming in Energy Access to address existing barriers that may hinder the equal participation of women and men in expanding energy access in West Africa. Currently, ECOW-GEN is undertaking a feasibility study on business opportunities for women in a changing energy value chain in West Africa.

German Society for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ]. GIZ is supporting off-grid in Senegal through two programs. The first, Being Successful in Senegal, has supported off-grid companies to create jobs in rural areas, with some companies hiring dozens of sales agents through the program. The second, Sustainable Energy Program, supports scalable productive use pilots in the areas of milling, pumping, and refrigeration.

Energizing Development Program (EnDev). EnDev has been working in Senegal's off-grid sector for many years, with emphasis on support of the ERIL model. In 2019, they will launch a project to promote SHS distribution through local youth associations.

Dutch Embassy. The Dutch Embassy has given considerable support to ANER's efforts to install standalone solar in public buildings, including a feasibility study for off-grid options to electrify public schools in the Casamance region.

MCC. In December 2018, Senegal signed its second MCC Energy Compact, amounting to $550 million in energy sector funding. Electrification is among the compact's components, and it will focus on increasing access in rural and peri-urban areas of the central and southern parts of the country.

2.4.3 SOLAR/RENEWABLE ENERGY ASSOCIATION(S)

Senegal has one major renewable energy association, the Council of Professionals of Renewable Energies in Senegal (Conseil Patronal des Energies Renouvelables du Sénégal [COPERES]). COPERES is involved in policy advocacy and government interface and hosts internal working groups to generate policy reflective of its members' interests. Aside from two off-grid companies, Coser and Bonergie, COPERES is comprised entirely of EPCs and importers, thus its efforts are primarily focused on on-grid development.

3 PICO-SOLAR SECTOR

3.1 STATE OF PRIVATE COMPANIES

Senegal is a hub for SHS companies operating in francophone West Africa and has served as a launching point for the adoption of new business models throughout the region. Development of the sector has been led by two major local companies: Oolu Solar and Baobab+. These companies have been at the forefront of technology transfers from East Africa, such as PAYGO, as well as pioneering new models like MFI partnerships.

Contributing to Senegal's position as a regional leader are a relatively strong human resource pool and good transportation links. Professionals in Senegal are experienced in business and have networks spanning the region. Regarding logistics, long-haul transportation networks reach through Mali and Burkina Faso, as well as northern Guinea and Mauritania. Senegal's SHS sector is also notable for the number of women in leadership positions; three major companies operating in Senegal have women founders: Bonergie, Vitalite, and Ellesolaire, while Oolu has a woman co-owner.

Despite these strengths, Senegal has yet to reach its full potential in terms of SHS penetration, and SHS availability across the country's departments remains patchy. Global Off-Grid Lighting Association (GOGLA) data suggest that SHS have reached approximately 19 percent of Senegal's unelectrified population. Greatest coverage is seen in the western departments, such as Mbour, Tambacounda, Ziguinchor-Sedihou, and Louga-St Louis-Dagana, while eastern departments, like Matam, Ferloo Regions, Casamance, and Kedougou, are relatively untouched. Despite low levels of grid electrification, these areas remain underserved by off-grid solutions due to their relatively high operational and supply costs.

3.1.1 COMPANY MATURITY

Table 2 presents SHS companies active in Senegal, their years of operations, and approximate sales.

TABLE 2. SENEGALESE SHS COMPANY MATURITY

COMPANY LOGO	COMPANY NAME	YEAR ESTABLISHED
BONERGIE energie pour vos ambitions	Bonergie	2010
BAOBAB+	Baobab+	2015
ElleSolaire WOMEN'S ENTREPRENEURSHIP INITIATIVE	Elle Solaire	2017
Ilemel Energy Solutions	Ilemel	2015

[9] GOGLA, "Standardized Impact Metrics for the Off-Grid Solar Energy Sector."

	Lagazel	2017
	Little Sun	2019
	Nadii Bi	2014
	Oolu	2015
	Orange Energie	2018
	PEG Africa	2018
	Sunna Design	2016
	Suntaeg	2015
	Schneider/Energie R	2018
	Vitalite	2014

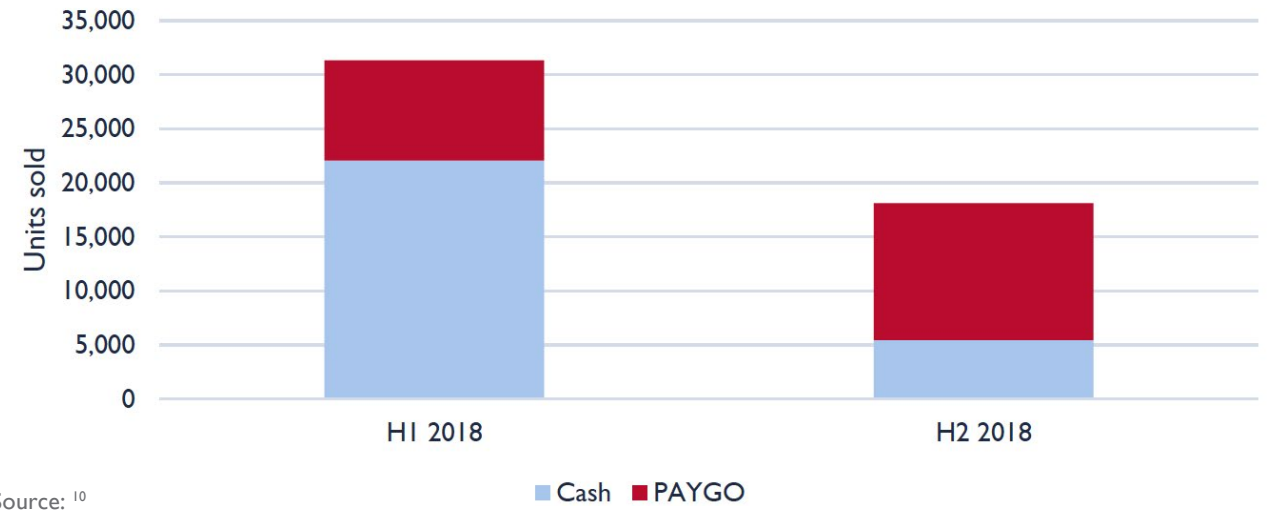
3.1.2 DISTRIBUTION AND PAYMENT MODELS

PAYGO

The introduction of PAYGO business models in Senegal has been met with success in terms of sales, investment, and cultural acceptance. Figure 2 presents GOGLA data on PAYGO vs. cash sales for each half of 2018. While the data remain too limited to discern a trend, they do demonstrate a 44 percent market share for PAYGO products over the year.

The key players leading this dynamic have been Oolu Solar and Baobab+, which, since first introducing the technology in 2016, have reached over 50,000 customers and raised more than $10 million in grants, debt, and equity. Benefiting all companies, the Senegalese consumer has been receptive of PAYGO products through acceptance of weekly and monthly payment and quick uptake of mobile payment mechanisms. Furthermore, customers in Senegal are increasingly aspirational in their demand for higher-tier energy systems and appliances like TVs. Ability to pay, however, is a counter to this increase in demand, which will need to be addressed through new payment structures and favorable government policy.

FIGURE 2. PROPORTION OF PAYGO SALES IN 2018



Source: [10]

Cash-and-Carry

Despite successful market penetration by PAYGO companies, cash-and-carry sales models still predominate in Senegal. Indeed, cash sales have likely benefited from the popularity of PAYGO products, which have raised the profile of SHS and lanterns generally among both customers and distributors. However, companies that rely completely on cash sales remain limited by product affordability and lack of financing for customers in target last-mile markets.

Manufacturers are addressing these barriers through new partnerships, first, by broadening their base of distribution partners to include local companies in the eastern departments. Whereas early distributor partnerships were exclusive to a single distributor, manufacturers are now restructuring their teams to build an array of partnerships covering a wider geographical range. Second, partnerships with MFIs have emerged as a means of offering consumer credit to rural customers.

Nadji.Bi is the most prominent company using a pure cash-and-carry model. Nadji.Bi serves over 10 West African countries, where affordability constraints are greater than in Senegal. Thus, adhering to a cash-and-carry model is a way to minimize financing costs and working capital needs, and keep overhead and product costs low.

MFI Partnership

MFI partnership has been a significant feature of the Senegalese market for several years and continues to grow in importance. Most major SHS players have some level of MFI partnership in effect, ranging from wholly owned subsidiaries, as Baobab+ is to Microcred, to loose affiliations.

Baobab+ is the earliest example of a SHS-MFI partnership in Senegal. Microcred launched Baobab+ as a way of offering energy systems (in addition to health and education products) to its existing client base, while at the same time attracting new clients through SHS sales.

Bonergie has also been ahead of the market due to its relationship with Caurie Microfinance. Their collaboration is focused on selling solar refrigerators, but they also intend to expand to TVs. Through this partnership, Bonergie is able to access consumer credit for higher-end appliances, while Caurie Microfinance has improved its ability to use PAYGO technology. of Savings and Credit in Senegal (Partenariat pour la Mobilisation de l'Épargne et du Crédit Au Sénégal [PAMECAS]), respectively.

[10] GOGLA.

Suntaeg has a program with Senegal Mutual Credit (Credit Mutuel de Senegal [CMS]) to provide credit for a wider range of system sizes, including customized systems, than it would be able to finance under its own capacity as PAYGO provider.

These MFI partnership models can be placed into three categories: (i) the MFI develops and maintains ownership of the SHS company (Baobab+); (ii) the MFI includes solar products as add-ons to loans for existing clients; and (iii) the MFI provides loans on its own balance sheet, while the SHS company generates sales and performs installations and after sales service (e.g., Caurie or CMS). One challenge with the latter two MFI models is the high level of coordination required to ensure fast loan approval by the field offices of the MFI, which may be especially difficult in remote areas.

Government Programs

The ERIL framework provides for both standalone solar and mini-grid interventions, all of which have been government led to date. Private SHS companies participating in ERIL projects are likely to benefit from planned subsidies as a part of the tariff harmonization policy, which will see all ERILs charge Senelec rates. At present, tariff harmonization is not yet effective for ERILs; however, it is applied to the concessions. While it remains unclear just how the harmonization process will be rolled out, it could become a disruptive dynamic over the coming year.

Table 3 shows company product types and distribution and sales models, while Table 4 presents their partners and departments of operation.

TABLE 3. COMPANY MODELS

COMPANY	PRODUCTS	DISTRIBUTION MODELS	PAYMENTS MODEL
Bonergie	Solar pumps (Lorentz and Grundfos), solar fridge, solar dryers, backup systems, SHS (Niwa)	Kiosk outlets, direct sales through agents, MFI	Cash and carry
Baobab+	SHS	Direct sales through agents, MFI	PAYGO
Elle Solaire	SHS, lanterns, TV, fans (Omnivoltaic)	Women's groups	Cash and PAYGO
Ilemel	Lanterns, SHS (Greenlight Planet)	Distributors, cooperatives	Cash and carry
Nadji.Bi	Solar pumps, solar fridge, SHS, lanterns		Cash and carry
Oolu Solar	SHS, TV (Amped Innovation)	Direct sales through agents, MFI	PAYGO
Orange Energie	SHS (BBOXX)	Direct sales through agents	PAYGO
PEG	Lanterns, SHS, TV	Direct sales through agents	PAYGO
Schneider Electric/Energie R	SHS	Retail, direct sales through agents	Cash and carry
Sunna Designs	SHS (Greenlight Planet)	Retail, direct sales through agents	PAYGO
Suntaeg	SHS	Direct sales through agents, MFI	Cash and carry
Vitalite	Solar pumps (SolarWorks!), SHS, TV (Fosera)	Direct sales through agents	Cash and carry

TABLE 4. COMPANY PARTNERSHIPS		
COMPANY	PARTNERS	REGIONAL OPERATIONS
Bonergie	Caurie Microfinance	Dakar, Tambacounda, Ziguinchor, Louga, Kedougou
Baobab+	Microcred	All areas except Kedougou and Matam
Elle Solaire	Women's groups	Palmarin
Ilemel	Cooperative la Société des Coopératives d'Energies Citoyennes du Sénégal (SCEC)	Fatick, Matam, Sine Saloum
Nadji.Bi	Caurie Microfinance, PAMECAS	Mbour and surrounding area
Oolu Solar	PAMECAS	Fatick, Kaolack
Orange Energie	Orange	Fatick, Mbour
PEG	None	Kaolack, Kafrine, Fatick, Ziguinchor, Bignona
Schneider Electric	Energie R	Fatick, Kaolack, Sédhiou, Kolda, Ziguinchor et l'île de Carabane
Sunna Designs	None	Ziguinchor, Bignona
Suntaeg	Credit Mutuel du Senegal	Kedougou
Vitalite	None	Thies

3.2 MARKET TRENDS AND BARRIERS

3.2.1 EVOLUTION OF THE SENEGALESE MARKET

As mentioned previously, PAYGO reached the Senegalese market in two distinct waves. The first wave, in 2016, was led by Oolu Solar and Baobab+ selling simple, 3-lamp/charger SHS systems. These pioneers in West Africa benefited from innovations in PAYGO from East Africa, leveraging savvy manufacturers and PAYGO platforms like Greenlight Planet and Angaza. These companies also benefited from incubators (e.g., Y-Combinator, in the case of Oolu) and equity investors already comfortable with the sector.

Adopting readymade models and gaining the support of experienced manufacturers and investors allowed the early PAYGO companies to focus on the development of distribution and customer care functions. In their first two years of operation, Oolu and Baobab+ combined grew to over 200 employees and more than 50,000 in sales.

Senegal's second wave of PAYGO providers, arriving in mid-2018, is characterized by a greater number of companies and an emphasis on larger, Tier 2 SHS. Companies entering the market at this point included Suntaeg, Vitalite, PEG, and BBOXX.[11] Following an industry-wide trend, these companies introduced larger capacity systems and a more diverse range of appliances to the market, especially TVs. GOGLA data indicate that its member manufacturers sold around 1,400 off-grid TV systems in the second half of 2018, or 8 percent of total SHS sales.

[11] GOGLA.

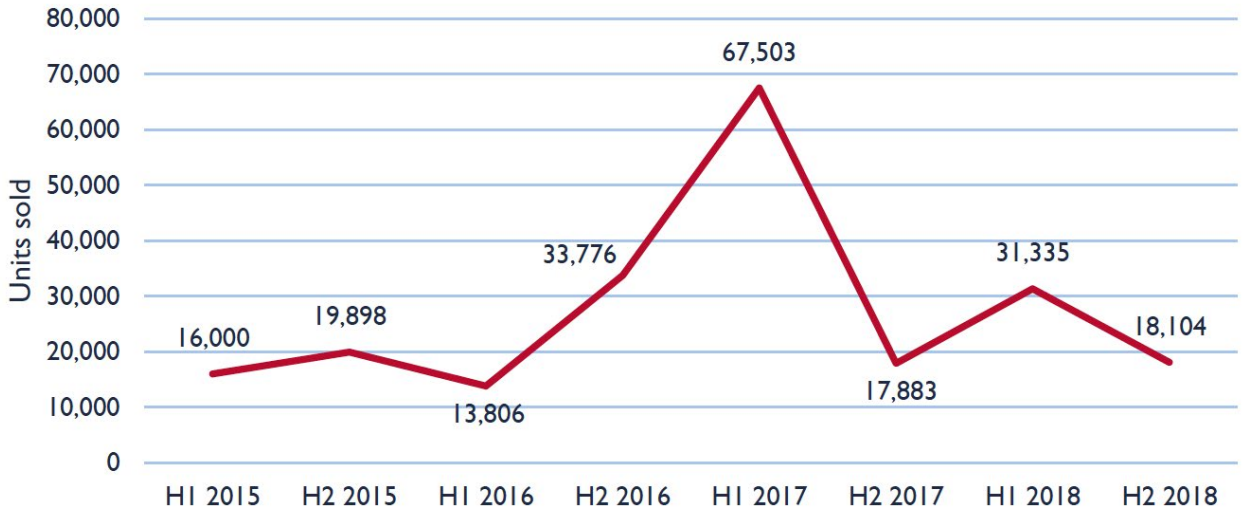
This trend toward TV kits, however, is not exclusive of second wave international companies. GOGLA data likely understate the importance of TV sales, with interviews suggesting that they accounted for 20 percent of new sales in the second half of 2018. Local players like Ilemel and Nadji.Bi were, in fact, the first to market with TV pilots, and Oolu Solar was the most successful in quickly scaling its TV offering. Companies offering TVs report that customers prefer such units and will even seek out financial support from family to purchase one. That said, the importance of TVs varies widely by company. For instance, PEG in Senegal sells only TV kits, while Baobab+ are still mainly focused on basic, Tier 1 SHS.

Diversification of system sizes and appliances is not limited to TVs, with several companies now experimenting with both modular and high-capacity systems (in the range of 50–300 watts [W]).

Oolu Solar and Baobab+ are selling modular systems from Amped Innovation and Biolite, respectively. Such systems open the door to greater uptake of productive appliances, such as hair clippers. Amped Innovation, in particular, offers a variety of appliances. Vitalite is working with both Fosera and Solarworx to pilot small refrigerators and modular SHS. Additionally, Bonergie is in partnership with NIWA to offer a catalogue of appliances including TVs, refrigerators, and pumps.

For all of its exciting developments, the Senegalese market remains early stage and prone to fluctuation. Figure 3 presents GOGLA sales data from 2015–2018. After strong growth in 2017, GOGLA statistics show a slowdown to just under 50,000 units in 2018, compared to over 85,000 in 2017. Reasons for this are unclear, but contributing factors likely include growing market saturation in terms of product affordability and department coverage. Another factor reported by companies is that customers may delay the purchase of an SHS until they can afford a kit that includes a TV. Strong sales in the first half of 2017 may also simply be an outlier in an otherwise relatively steady sales pattern.

FIGURE 3. GOGLA SALES DATA 2015–2018



Source: [12]

[12]GOGLA.

3.2.2 DISTRIBUTION COSTS

Few companies in Senegal can claim a national presence, with most sales taking place in the western or central areas of the country. Meanwhile, the eastern region, the most remote, remains relatively untouched. Last-mile distribution for rural customers will always be more expensive. Lower population densities increase sales and services expense—due to higher transport and agent travel costs—and relatively low incomes reduce overall sales potential. While this will remain a barrier in Senegal, greater penetration into remote eastern districts should be expected due to increasing competition country-wide.

Original focus areas for early PAYGO pilots were Thies and Mbour departments, despite their relatively high grid coverage. Subsequent expansions reached the west-central departments of Fatick, Kaolack, and Kaffrine; Tambacounda in the east; Ziguinchor and Sedihou in the south; and Louga, St Louis, and Dagana in the north. Today, these are competitive areas, with three or more PAYGO providers operating in each. While a geographically representative spread, it should be noted that these departments are relatively populous in their respective regions.

By contrast, PAYGO companies have not made significant traction in more remote and logistically challenging departments, even where grid coverage is low. Matam, Ferloo, and Kedougou stand out among the poorly electrified regions that many SHS companies have yet to penetrate. Vitalite and ToubaSolar, however, are exceptions, and have focused primarily in the east of the country (notably Kedougou).

3.2.3 MOBILE MONEY

Compounding the challenges of last-mile distribution for PAYGO companies is access to, and awareness of, mobile payment technology. Remote areas of Ferloo, Matam, and Kedougou present incomplete mobile coverage.

Poor PAYGO-Unstructured Supplementary Service Data integration is another key barrier.[13] Until 2018, mobile money operators like Tigo and Orange provided limited options for application programming interface integration. While companies are still in the process of taking advantage of this development, it is likely to have a strong positive effect on the market by increasing PAYGO transactions and leading to lower mobile money fees.

Awareness of mobile money is significantly lower in rural departments (Kedougou, 54 percent; Kolda, 55 percent; Kaffrine, 40 percent; Tambacounda, 46 percent), compared to urban zones,[14] and most rural customers do not have e-wallets. Coverage and lack of interoperability are key constraints that have left some companies, such as Sunna Designs, to develop their own e-wallets. That process, however, is complex and expensive, which means that the sector as a whole is reliant on the initiative of the major mobile money operators to expand their presence.

3.2.4 WILLINGNESS TO PAY

A survey conducted by MCC found that off-grid households and businesses in both very rural and peri-urban areas have a high willingness to pay for reliable electricity. However, low incomes among these target populations still limit the types of systems they can afford and the payment plans that will be applicable to them.[15] Table 5 presents data from this study.

[13] USAID and Power Africa, "Scaling Up Commercial Off Grid Solutions in Senegal."
[14] UNCDF, "Digital Financial Services Research Review MM4P Senegal."
[15] Almanzar and Ulimwengu, "Willingness to Pay for Improved Electricity Services in Senegal."

TABLE 5. WILLINGNESS TO PAY AMONG NON GRID CONNECTED HOUSEHOLDS AND INFORMAL BUSINESSES			
WILLINGNESS TO PAY METRIC	HOUSEHOLD		INFORMAL BUSINESS
	Men	Women	
Current energy cost per month (candles, batteries, etc.) ($)	12.86		4.63
Connection fee ($)	32.78	25.50	32.84
2-month bill ($)	27.09	23.24	36.68
$/kWh	0.31	0.22	0.28

Source: [16]

Generally, willingness to pay is greatest around urban centers like Dakar, with lowest willingness to pay in regions that are both relatively populated and electrified, but not necessarily urban. Willingness to pay outside of urban settings increases as geography becomes more remote, as exemplified by data from the Kedougou department.

3.2.5 TAXES AND IMPORT DUTIES

Import duties and value-added tax (VAT) applied to off-grid solar products increase the overall cost to the consumer by around 40 percent. Since VAT, at 18 percent, is applied on top of import duties and all other fees, it has a multiplying effect on the end-user cost. Furthermore, the underlying import duties are not consistently applied.

Duties are set at the component level, with special exemptions in place for photovoltaic (PV) panels and certain direct current (DC) appliances. In the case of an SHS kit, these various duty rates are applied to the proportion of the final product cost attributable to any given component, resulting in a weighted average for the entire system. See Table 6 and Table 7 for SHS and appliance duty rates, respectively. Uncertainty in the application of these rates—which are applied, and to what proportion of the kit's cost—make it difficult for SHS companies to effectively price their systems.

TABLE 6. SHS DUTY AND VAT					
	PV	LIGHTS, CABLES	CIRCUITS	BATTERIES	SHS TOTAL
Share of Kit Cost	15%	10%	35%	40%	100%
Duty	2.5%	22.5%	12.5%	22.5%	16%
VAT	18%	18%	18%	18%	18%
Total					37%

[16] Almanzar and Ulimwengu.

TABLE 7. DC APPLIANCE DUTY AND VAT

	LANTERNS	RADIOS	FANS	TVS	SOLAR REFRIGERATORS	SMARTPHONES	SOLAR PUMPS
Duty	22.5%	20%	20%	20%	20%	10%	5-20%
Other		2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
VAT	18%	18%	18%	18%	18%	18%	18%
Total	45%	45%	45%	45%	45%	33%	27%-45%

3.3 FINANCING

Little publicly available data exists to quantify the level of investment into Senegal's SHS sector. Financing to the sector has come in the form of international concessional debt, impact investment, grants, founder equity, and angel equity.

The entrance of major international players, such as Orange Energie and PEG, is likely to bring new interest from large development finance institutions and impact investors that usually require relatively large ticket sizes of $5 million and up. Meanwhile, smaller companies and local actors will continue to rely on sector-specific debt providers, such as Lendable, SIMA Funds, and SunFunder, and crowdfunding platforms like Lendahand, Solylend, and Bettervest.

In West Africa, broadly, 2018 was an exceptionally positive year for fundraising for the off-grid solar sector, with amounts invested continuing to rise precipitously compared with previous years. The year witnessed a growth primarily in equity, while debt transactions lagged behind substantially in comparison.

Another impressive shift was the increase in the number of off-grid transactions, which went up to 24 in 2018 from 4 reported in 2017. As more actors in West Africa are able to access financing, the median reported transaction size actually decreased dramatically as new players and smaller companies were able to close financing transactions.

Geographic market expansion and the addition of new products was the primary use of funds for West African companies, accounting for 89 percent of funding. A smaller portion of funds (9 percent) was used for bridging working capital needs. For-profit financial institutions dominated the sources of funding, with some notable capital coming from crowdfunders and unknown or unspecified sources.

Despite these positive signs, supply of equity for early stage SHS companies in West Africa has not met founder expectations. International investors have, to date, limited their presence in the region (many are overexposed in East African markets like Kenya, Uganda, and Tanzania), leaving most companies to rely on angel investors for seed equity funding.

4 MINI-GRID SECTOR

4.1 ERIL MINI-GRIDS

Mini-grid development in Senegal is defined by the ERIL framework, which incorporates several principles meant to ensure continuity with the PPER's top-down concession model:

- A bottom up electrification driven by small and medium enterprises, NGOs, and communities
- Applicability only to villages not included in the three-year electrification plans submitted by the concessions
- Cost-reflective tariffs and a mechanism for absorption into concessions upon grid arrival
- Eligible villages defined by number of households

In practice, mini-grid development has been financed predominately by donor organizations, with final ownership falling on the GoS (either Senelec or ASER). Private participation has been limited to an operational role but has not been sustainable in many cases.

Nor has private financing been forthcoming. For instance, while some portion of the ERILs financed under GIZ's Programme for the Promotion of Renewable Energy, Energy Efficiency and Access to Energy Services (Programme pour la Promotion des Énergie Renouvelables, de l'Electrifcation Rurale et l'Approvisionnement Durable en Combustibles Domestiques [PERACOD]) left room for a minority of developer capital expense (CAPEX) financing, many others have not seen any private sector financing at all.[17]

A number of entities may serve as owners or operators of ERIL mini-grids. Senelec and concessionaires have the first right to develop mini-grids within their service territories, but to date, neither actor has shown interest. Nominally, ERIL policy promotes mini-grids that are privately financed, owned, and operated. However, no private companies have successfully navigated the process of developing and owning a mini-grid.

[17] USAID and Power Africa, "Scaling Up Commercial Off Grid Solutions in Senegal."

Table 8 provides an overview of mini-grids built under the ERIL framework over the past 20 years and a brief description of issues faced in their operational status.

TABLE 8. ERIL MINI GRID PROGRAMS

YEAR BUILT	PROGRAM/DONOR	# GRIDS	STATUS	ISSUES
1996	Project Nippon/Government of Japan	3	No longer operational	Tariffs did not permit sustainable O&M
2000	Project Convention/GoS	53	No longer operational	O&M contracted not finalized
2005-2006	Project Isofoton/Government of Spain	9	No longer operational	Undersized; unsustainable O&M
2008	PERACOD and Government of Netherlands	18	No longer operational	Undersized; no metering
2010	PERACOD and Government of Netherlands	70	Significant number no longer operational	Undersized; no metering
2011	Project Daye Owens/Government of Netherlands	10	Operational	No major issues
2011	Autrichian Project/GoS	27	No longer operational	No O&M conract
2018	ECREEE and European Union	40	Not yet operational	Have been built, but O&M tender is delayed
2020	European Union	70	Not yet built	EPC tender is delayed
2020	Islamic Development Bank, West African Development Bank, ECREEE, ASER	188	Not yet built	EPC tender is delayed
2020	Project European Renewable Energy Federation, ASER	2	Under construction	EPC has been selected
2020	PUDC/UN Development Programme	122	20 built, but not yet operational	Remaining EPC not funded; O&M contract not yet funded
2020	Abu Dabi Fund and International Renewable Energy Agency	30	Not yet built	Design study underway
2020	Gauff/Kreditanstalt für Wiederaufbau (KfW)	300	Not yet built	Design study underway

Non-operational mini-grids demonstrate a pattern of poor O&M planning. Failure to ensure long-term operation is especially problematic, as capital expenditure for the above listed mini-grid programs range between $100,000 and $250,000 per site. Issues contributing to the unsustainability of O&M include non-cost-reflective tariffs, under-sizing of the grid, and lack of metering and monitoring.

Underpinning all of these issues is the unsustainable tariff rate. While operators (Table 9) do not own their mini-grid systems, they are responsible for maintenance and upgrades, which entails a capital expense. The cost of major upgrades—to increase generation capacity, extend the grid, or install meters—are not contemplated in the tariff-setting process. Thus, ERILs often fail to meet the needs of their communities, generate significant income for their operators, or offer attractive social benefits to their GoS owners.

TABLE 9. ERIL OPERATORS

COMPANY NAME	YEARS OF OPERATION	MINI-GRIDS UNDER OPERATION
EnergieR	10 years	13
ENERSA	10 years	2
Faye Solaire_Sud Energie	10 years	7
NS RESIF	10 years	30
SALENSOL	10 years	10
Sud Solar System	10 years	35

4.2 ERIL DEVELOPMENT PROCESS

While lack of sustainable operational arrangements has been a critical factor in the long-term viability of many mini-grid programs, several other barriers stand in the way of effective development. Tariff setting, licensing, and clarity on grid extension are challenges faced even by the GoS agencies that own the ERIL mini-grids. Table 10 outlines the overall process for mini-grid development under ERIL and offers context on the difficulties confronted at various steps.

TABLE 10. ERIL PROCESS

NOMINAL ERIL IMPLEMENTATION PROCESS	COMMENTS
Present mini-grid concept to ASER. If in agreement, ASER signs an agreement with the company. ASER provides a list of potential villages. Company performs site assessments and presents findings in a technical offer to ASER. If ASER agrees with technical offer, the company may present a full business plan. If ASER agrees with the business plan, they will send the plan on the CRSE and MEP. CRSE examines the business plan and invites the company to present the project for approval.	To date, only donors have completed this process in full, and then, on behalf of the GoS that will ultimately take ownership of the systems.
If the CRSE agrees with the business plan, they determine an appropriate tariff and approve a license for 25 years.	Only one company, nearly 10 years ago, has ever received a license.
Government tenders for an EPC. Mini-grids are built and GoS tenders for an operator.	This is the first phase of the process with private sector involvement.

Government planning. Site selection is an iterative process, ultimately controlled by ASER. Under ERIL, only villages of fewer than 200 households that are not slated for grid electrification in the next three years qualify for mini-grid development. ASER, as the entity governing the process, identifies the sites that should be targeted by any given developer. As described above, developers must approach ASER to receive site recommendations and then perform their own technical and financial analysis of those sites. ASER, however, does not have a comprehensive dataset of grid electrification plans across Senelec and all concessions. Generally, it is recommendable to cross-check ASER site suggestions with PUDC planning. The most recent grid-planning study for Senegal was performed in 2015 by Gesto, but this study is in need of update. Overall, grid planning is an opaque process, and plans are not available to the public or parties outside of the GoS.

Licensing. Only one ERIL has a license, and that one was granted approximately 10 years ago. While the inability to obtain licenses has not impeded the construction of new mini-grids, it does pose a major challenge to operators. Without a license, contracted operators have no claim on the site in the event of grid arrival, regardless of the duration of their government contract. In the few cases of grid arrival so far, operators have been told to move to another village, and no compensation has been made as stipulated in their contracts. Operators that want to invest CAPEX in their systems (e.g., to install meters) are unable to obtain loans without a license.

Tariff harmonization. Senegal is in the midst of a tariff harmonization process that will bring all electricity tariffs in the country in-line with those charged by Senelec (Table 11). So far, the process has only been applied to concessions under the PPER, but it is also intended for ERILs, though the process for doing so has not been defined. The concept behind harmonization is that the government will compensate operators for the difference between their cost-reflective tariff and the harmonized tariff. The GoS would pay this compensation through its Special Fund for Energy Sector Support (Fonds Special de Soutien au Secteur de l'Energie).

There are several issues that must be addressed before such a scheme is rolled out for mini-grids. Current mini-grid tariffs are structured in tiers based on appliance use, rather than charged by kWh. As such, many mini-grids do not have meters. In contrast, the harmonized tariff is based on kWh, so mini-grid operators would need to install meters and translate their current tariff structure to a kWh basis before any compensation levels can be determined. Another impending issue is that of compensation levels. Since current mini-grid operators do not own the mini-grids they run, their tariffs are only reflective of O&M cost, thus the prospective cost of compensation to the GoS is currently limited. But as private companies look to both own and operate their mini-grids, it is unclear that the GoS is prepared to pay higher compensation for operator-owned sites.

If successful, tariff harmonization will bring benefits to concessions and ERILs. The differential tariff between Senelec and the concessions and ERILs has had a particularly adverse effect on the perception of the entire model and has led the Government to pursue its tariff harmonization policy. While concession tariffs are subsidized, they are still significantly higher than Senelec rates. This dynamic has led many communities that border Senelec territory to refuse service via the concessions and press for coverage under Senelec instead.

TABLE 11. SENELEC TARIFFS	
CUSTOMER CATEGORY	BASE TARIFF, LOW VOLTAGE ($)*
Domestic	0.154
Commercial	0.22

Source: Senelec
*before VAT and other fees

4.3 PRIVATE SECTOR ATTEMPTS

Despite the fact that all mini-grids to date are government-owned and donor-funded, private sector developers do have interest in the Senegalese market. Companies currently pursuing the development of their own mini-grids include Engie, Ilemel, Valerium, Power Africa Trade, Enekio, Thelozez, Coselec, and Prosolia. This pipeline, however, has stalled due to the licensing and tariff subsidy issues described above. Navigating the ERIL process can be time consuming, sometimes taking several years. To be successful, companies require technical support, financial resources, and political support.

In addition to the challenges outlined above, private sector companies need to take extra steps to ensure buy-in. Community support is essential, and the mayor of any target village should be asked to submit a letter of support to ASER. Furthermore, private developers are more likely to find sites within Senelec territory, as Senelec has been more willing to cede these areas to ERILs than have concessionaires.

5 AGRICULTURAL AND PRODUCTIVE USE SOLAR COMPANIES

5.1 SECTOR OVERVIEW

Off-grid productive use in Senegal is dominated by pumping. Solar pumps offer a great deal of potential cost-saving to farmers. Traditional pumping technologies, such as manual pumps, diesel pumps, and even electric pumps, entail high operating costs. Diesel pumping costs, in particular, may absorb a large portion of farmer revenues, are maintenance intensive, and rely on diesel supplies that are subject to shortages and theft.

Despite this apparent potential, no comprehensive study has been conducted for the sector. Private companies and donors alike are approaching the sector without an overarching framework, but are seeing success nonetheless. Meanwhile, the GoS views the development of productive uses as a component toward achieving universal energy access.

Local banks, especially those experienced in the agricultural sector, like National Agricultural Credit Fund of Senegal (Caisse Nationale de Crédit Agricole du Sénégal [CNCAS]), Locafrique, Banque Atlantique, International Bank of Commerce and Industry of Senegal (Banque Internationale pour le Commerce et l'Industrie du Sénégal [BICIS]), and Orabank, are taking a closer look at the off-grid productive use sector. But their ability to offer favorable terms to the sector, even with an 80 percent guarantee instrument like that of FONGIP, remains unclear.

Solar pumping has become a priority for off-grid and agricultural suppliers over the past five years, especially large capacity pumps upward of 500 W. The latest innovation in the sector are PAYGO solar pumps, which several companies are currently piloting.

Companies active in off-grid productive use include the following.

- Bonergie: Bonergie has been operating in rural Senegal for 7 years, specializing in energy and agricultural products, including solar pumps (Lorentz, Grundfos, and SunCulture), water tanks, solar cold storage, and solar fruit dryers. It has 15 regional offices with 52 employees (30 percent of whom are women), and around 1,000 customers including more than 200 solar pump installations. 80 percent of sales are on credit, and they have a 95 percent reimbursement rate.
- E3C: E3C is a consulting and engineering firm that also develops climate change projects. It has recently developed a pilot project in Senegal to solar-hybridize 7,000 pumps and are seeking to expand the project throughout the country. The project has received a guarantee from FONGIP and is funded by CNCAS for more than XOF 400 million ($800,000).
- Flex NRJ: Flex NRJ is an official distributor and service partner of Grundfos. It specializes in the design, deployment, and maintenance of hydropower and other renewable energy.
- Soleil Eau Vie: Soleil Eau Vie is a solar pump distributor and installer for Lorentz since 2011. It has over 1,000 customers and 15 employees across the country.

- Nadji.Bi: Nadji.Bi has developed its own PAYGO solar pumps and solar mills. The products are offered on a subscription basis covering O&M, with agents making a commission on payments made on the PAYGO platform. Sale of data is also being explored as an additional revenue stream. It is currently piloting in collaboration with Columbia University's Earth Institute.
- Vitalite: Vitalite distributes Solarworx PAYGO solar pumps, with an initial pilot in Thies. This builds on Vitalite's considerable experience in PAYGO pumping distribution in Zambia.
- Equipplus: Equipplus is in the process of developing its own solar mills.
- Many solar productive use projects have been set up and financed by donors. Current donor programs include the following.
- ANER: ANER is the main government agency working in productive use. Among its activities to promote renewable energy, ANER is instituting a program to replace diesel water pumps with solar pumps for irrigation and drinking water applications. ANER is also working with women's groups to adopt solar productive use. In collaboration with Action Solidarity International and the Albert Schweitzer Ecological Center, ANER is helping women in the fish processing industry acquire solar dryers.
- PUDC: Distribution of solar mills.
- ENDA Energy: ENDA is a platform for the development of a variety of productive use of energy projects.
- GIZ PED: Supports productive uses in cold chain and pumping. The program works with Sun Water Life on the issue of pumping.
- Energy 4 Impact Women's Productive and Self-Empowered Entrepreneurs in Rural Regions in Senegal: This project is supported by a grant from the Swedish Postcode Lottery Foundation.

ANNEX A COUNTRY STATISTICS

Table A- 1 provides high-level demographic data for Senegal.

TABLE A - 1. DEMOGRAPHIC INDICATORS

DEMOGRAPHIC INDICATOR	DESCRIPTION
Population size	16.7 million [18]
Population density and growth rate	68/square kilometers (km^2) overall, ranging from 77/km^2 in dense urban areas to 2/km^2 in the eastern region.
Growth rate of 2.8% in 2019	10 years
Household size	8.3 [19]
Urban and rural populations	45% urban and 55% rural
Number of woman-headed households	30.6% [20]
Languages spoken	Wolof, French

Source: [21]

Table A- 2 provides high-level economic data for Senegal.

TABLE A - 2. ECONOMIC INDICATORS

ECONOMIC INDICATORS	DESCRIPTION
Gross domestic product (GDP)	GDP was $21 billion and grew at 7.1% in 2017 (CIA n.d.).[22]
Exports	Mining, construction, tourism, fishing, and agriculture are key industries.[23] Main export products include fish, phosphates, and mineral products. Exports were worth US$4.3 million and were 29% of GDP in 2016.[24]
Employment	In rural areas, mining, construction, tourism, fisheries, and agriculture are the primary sources of employment. 77.5% of the 7 million-person labor force is employed in agriculture, while 23% are employed in industry and 23% in services.[25] 28% of women's employment was in agriculture, compared to 36% of men's employment; 6% of the women's labor force was in industry compared to 18% of men's, and 67% of women's employment was in services compared to 46% of men's.[26]
Land use	196,722 km^2, 47% is used for agriculture.[27]
Main crops being grown and main livestock in different rural areas	Peanuts, gum arabic, sugarcane, and cotton are important cash crops. Rice, millet, sorghum, corn, and fonio are important cereal and subsistence crops. Fishing is an important part of the coastal economy. Pastoralists and agro-pastoralists raise cattle, sheep, and goats, and many rural households raise poultry. [28]

[19] United Nations Population Division, "Senegal Household: Size and Composition 2018 - Countries."
[20] Index Mundi, "Senegal - Female Headed Households."
[21] The World Bank and ESMAP, "Senegal's SE4ALL Rural Electrificaton: Action Agenda and Investment Prospectus."
[22] CIA, "Africa : Senegal — The World Factbook - Central Intelligence Agency."
[23] CIA.
[24] Index Mundi, "Senegal - Exports of Goods and Services."
[25] CIA, "Africa : Senegal — The World Factbook - Central Intelligence Agency."
[26] The World Bank, "Gender Data Portal | Country - Senegal."
[27] CIA, "Africa : Senegal — The World Factbook - Central Intelligence Agency."
[28] Food and Agriculture Organization of the United Nations, "Livestock Sector Brief."

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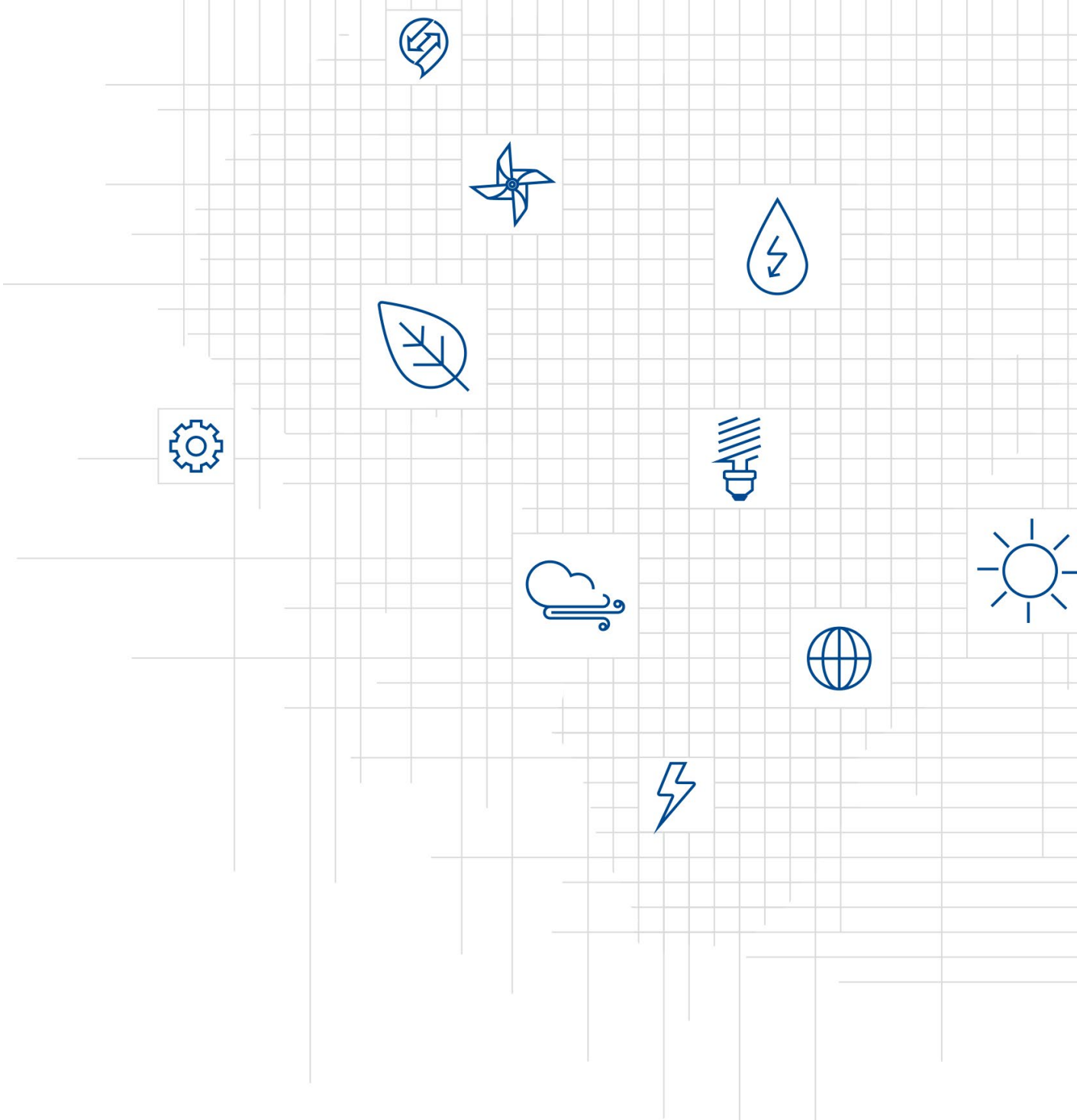

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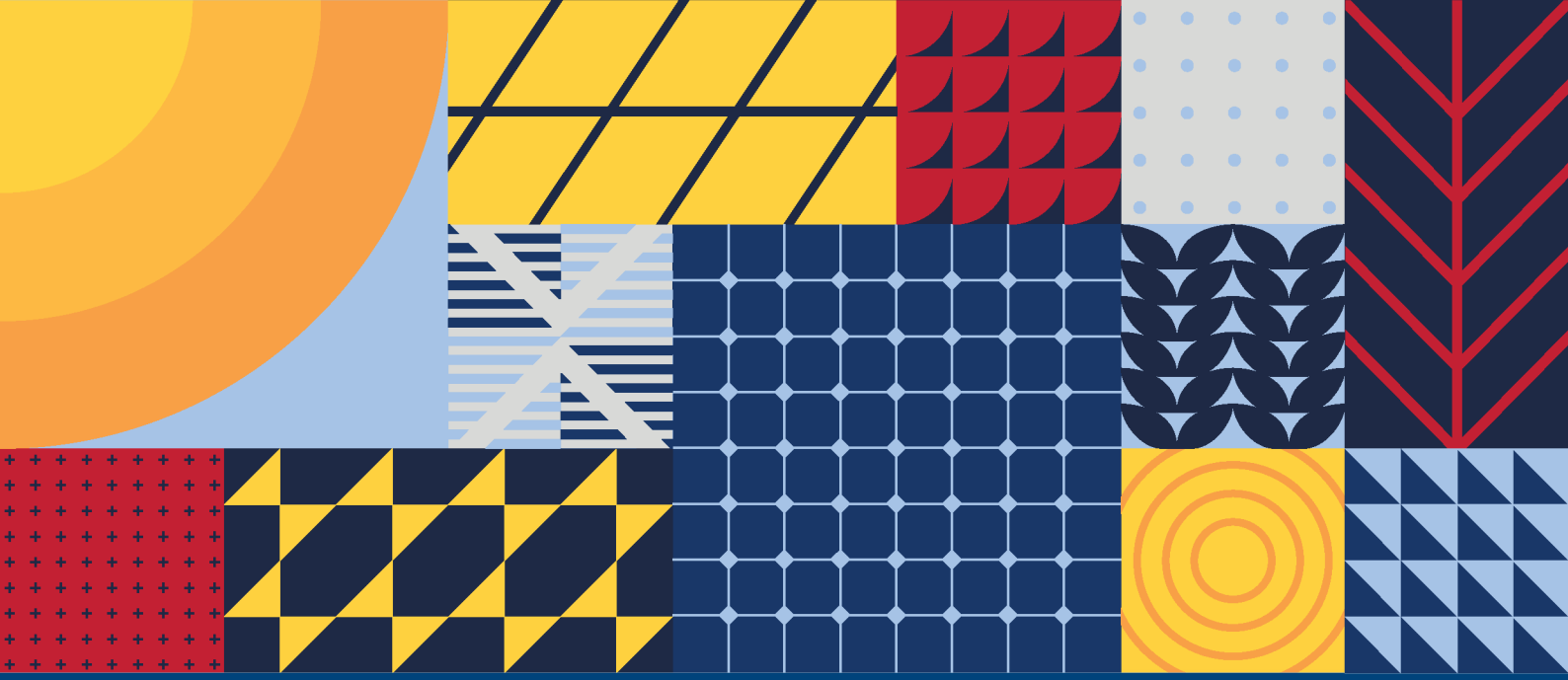

Power Africa aims to achieve 30,000 megawatts of new generated power, create 60 million new connections, and reach 300 million Africans by 2030.