

OFF-GRID SOLAR MARKET TRENDS REPORT 2020

March 2020



Produced by



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This report is the fifth in a series of biennial assessments of the global off-grid solar market undertaken by the World Bank Group through its Lighting Global Program. Lighting Global is the platform under which the World Bank Group supports the development of the global off-grid solar energy services market and includes a portfolio of country-based market development programs undertaken through Lighting Africa, Lighting Asia, Lighting Pacific, and Energy Sector Management Assistance Program (ESMAP).

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Dear Reader,

In 2009, the World Bank Group's Lighting Africa program launched with an audacious target: to reach 250 million people with off-grid solar products by 2030. Thanks to the vision, innovation, and commitment of a remarkable group of entrepreneurs, the off-grid solar industry surpassed the goal of 250 million in 2019—more than a decade ahead of schedule.

Today, the off-grid solar industry has been embraced globally as the critical component in the fight to eliminate energy poverty. It has become a proven reliable way to provide affordable modern electricity services in rural communities and an important complement in areas with unreliable grid electricity. Yet as this report makes clear, the Sustainable Development Goal 7 target of achieving universal electricity access by 2030 will require a steep acceleration of the off-grid solar market's development.

A decade in, the off-grid solar industry has already delivered quality energy services to hundreds of millions of people – including those that traditional electricity utilities had been unable to serve. Lighting Africa's successful pilot in Kenya has been replicated across the continent and the globe, leading to the creation of Lighting Asia and Lighting Global, which is now active in nearly 40 countries. The Global Off Grid Lighting Association (GOGLA) boasts more than 170 members, serving hundreds of millions of customers globally.

The 2020 edition of the Off-Grid Solar Market Trends Report measures the pulse of the off-grid solar market, and includes the most comprehensive sales and impact data available, in-depth analysis on current market dynamics and an outlook on the future of the industry. As in previous years, we seek to frame the varied trends of a dynamic sector, to inform the range of actors in the market, and to set strategy.

The cross-currents that characterize the evolution of the off-grid solar market are a compelling part of the story told in the Market Trends Report. Technology continues its rapid development, driving improved economics that enable more and more people to access modern electricity services, while expanding the array of services enabled by solar power.

Governments are stepping up their support to the sector, integrating off-grid solutions in their electrification plans, improving the enabling environment, and increasing financial support in order to leave no one behind. While household services, including fans and appliances and internet connectivity, have become a mainstay of the sector, the frontier of productive uses of solar is now firmly in sight, and the report looks at pathways for the market's further expansion. Business models continue to adapt and respond to customer needs, including opportunities for sustainable off-grid services for schools and health facilities.

The future of the off-grid sector heralds a second decade of innovation and impact. As the market matures, the industry's focus on volume of sales has evolved into a more refined focus on unit economics and sustained profitability. This is the lynchpin for attracting the levels of investment needed to grow the sector at scale. And that is the precondition for achieving our ultimate energy access goal: the elimination of energy poverty.

We hope you enjoy reading the story of where we are, and where we're headed.



A handwritten signature in black ink that reads "Rysankova".

Dana Rysankova
Lighting Global
WORLD BANK



A handwritten signature in black ink that reads "Koen Peters".

Koen Peters
Executive Director
GOGLA



A handwritten signature in black ink that reads "Russell Sturm".

Russell Sturm
Lighting Global
INTERNATIONAL
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This report is produced by Lighting Global, GOGLA, and ESMAP, in collaboration with Vivid Economics and Open Capital Advisors.



Lighting Global is the World Bank Group's initiative to rapidly increase access to off-grid solar energy for the 840 million people worldwide living without electricity. Lighting Global - managed by the International

Finance Corporation (IFC) and the World Bank - works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market. Lighting Global programs are funded with support from the Energy Sector Management Assistant Program (ESMAP), The Public – Private Infrastructure Advisory Facility (PPIAF), The Netherlands' Ministry of Foreign Affairs, The Italian Ministry for the Environment, Land, and Sea (IMELS), and the IKEA Foundation.



GOGLA is the global association for the off-grid solar energy industry. Established in 2012, GOGLA now represents over 170 members as a neutral, independent, not-for-profit industry association. Its mission is to help its members build sustainable markets, delivering quality, affordable products and services to as many households, businesses and communities as possible across the developing world. The products and solutions that GOGLA members sell transform lives. They improve health and education, create jobs and income opportunities and help consumers save money. To find out more, go to www.gogla.org.



ESMAP is a multi-donor trust fund administered by the World Bank, anchored in the Energy & Extractives Global Practice in Washington, DC. As a long-standing partnership between the World Bank and bilateral partners, ESMAP helps low- and middle-income countries reduce poverty and boost growth through environmentally sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank Group's country policy dialogue and lending programs in the energy sector. Through the WBG, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable and modern energy for all. It helps to shape WBG strategies and programs to achieve International Development Association (IDA) policy commitments and the WBG's Climate Change Action Plan targets.



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We are a premier consultant in the policy commerce interface and resource- and environment-intensive sectors, where we advise on the most critical and complex policy and commercial questions facing clients around the world. The success we bring to our clients reflects a strong partnership culture, solid foundation of skills and analytical assets, and close cooperation with a large network of contacts across key organizations.



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Abbreviations

Abbreviation	Definition
AC	Alternating current
AECF	Africa Enterprise Challenge Fund
AI	Artificial intelligence
B2B	Business-to-business
B2C	Business-to-consumer
BoP	Bottom of the pyramid
Br	Ethiopian Birr
CAGR	Compound annual growth rate
CO2	Carbon dioxide
COGS	Cost of goods sold
CSR	Corporate social responsibility
DC	Direct current
DFIs	Development finance institutions
EBITDA	Earnings before interest, tax, depreciation, and amortization
EOL	End of life
EPR	Extended producer responsibility
ESMAP	Energy Sector Management Assistance Program
FMCG	Fast-moving consumer goods
FX	Foreign exchange
GEP	Global Electrification Platform
GSM	Global system for mobile communication
HH	Household
HHI	Herfindahl–Hirschmann Index
ICT	Information and communications technology
IoT	Internet of things
KOSAP	Kenya Off-Grid Solar Access Project
KPIs	Key performance indicators
kWh	Kilowatt-hour
LED	Light-emitting diodes
LPWAN	Low-power wireless area networks
M&A	Mergers and acquisitions
M2M	Machine-to-machine
MCC	Milk collection centers
MFI	Microfinance institution
MNO	Mobile network operator


Abbreviation	Definition
MT	Metric tons
MTF	Multi-Tier Framework
NEP	National Electrification Plan
NES	National Electrification Strategy
NESAP	Niger Solar Electricity Access Project
NPV	Net present value
ODM	Original design manufacturer
OEM	Original equipment manufacturer
OGS	Off-grid solar
P2P	Peer-to-peer
PAYGo	Pay-as-you-go
PE	Private equity
PnP	Plug and play
PPP	Public-private partnership
PULSE	Productive Use Leveraging Solar Energy
PVoC	Pre-Verification of Conformity
R&D	Research and development
RBF	Results-based financing
RISE	Regulatory Indicators for Sustainable Energy
ROGEP	Regional Off-Grid Energy Project
RF	Rwandan Francs
SDG	Sustainable Development Goals
SHF	Smallholder farmer
SHS	Solar home systems
SL	Solar lamps
SLS	Solar lighting system
Solar PV	Solar photovoltaic
SWP	Solar water pump
USh	Ugandan Shillings
US\$	United States Dollars
VAT	Value-added tax
VC	Venture capital
W	Watts
Wp	Watt-peak

Context and Key Definitions

Over the past decade, the biennial Lighting Global/GOGLA Market Trends Report has been the anchor of the Lighting Global/GOGLA franchise of market data and trends reports, which are the go-to source of sector information for investors, industry members, policymakers, and other stakeholders in the sector. The series includes semi-annual reports that track sales and impact results by country, region, and worldwide for Lighting Global Quality-Verified and other branded solar devices sold by GOGLA members. The Off-Grid Solar Market Trends Report is where we step back and dive deep into trends in the sector to deepen understanding among market players and illuminate the pathway forward. Geographically, this report covers Sub-Saharan Africa, South Asia, and South-East Asia.

This section provides an overview of key concepts and jargon that appear throughout this report.

Term	Definitions
Off-grid solar (OGS) sector product segments	Broadly, the main OGS household product segments can be classified into three major categories differentiated by price and function: pico, solar home systems (SHS), and appliances. Pico-scale solar devices have the lowest cost of entry for most rural, low-income households. Solar home systems, which can be designed pre-assembled for plug-and-play (PnP) or based on open-market components, provide multiple energy functions, such as powering appliances, at increasingly higher price points. Finally, solar-powered appliances, which are energy-efficient and powered by direct current (DC), include both household appliances (such as televisions and refrigerators) and productive-use appliances (such as water pumps and agricultural cold storage).
Pico products	Pico products include small, portable solar lanterns, flashlights, or lanterns designed to meet basic lighting needs as a direct replacement for kerosene lamps in a small household. These products are typically packaged either as a simple, one-light system with one LED light, an embedded 0.5–3.0 Watt-peak (Wp) solar panel, and an internal rechargeable lithium-ion (Li-ion) battery or as multi-light systems of up to three or four LED lights with a standalone solar panel rated up to 10 Wp and a rechargeable Li-ion battery. Some models include USB charging for mobile phones.
Solar home systems (SHS)	SHS have a solar panel rated 11 Wp and higher and include both home lighting systems and large systems which can power appliances. SHS refer to both plug-and-play and component-based systems, unless specified.
Plug-and-play (PnP)	PnP solar home systems comprise an all-in-one packaged kit. These have LED lights for multiple rooms (as many as 10, depending on size), a solar panel with power rating up to 100 Wp for small SHS and higher for large SHS, and a rechargeable battery. These systems may include assorted energy-efficient appliances, including mobile charging stations, radios, fans, televisions, and, in some higher-end systems, refrigerators.
Component-based systems	In component-based systems, individual components, such as the solar photovoltaic (PV) module, battery, lights, inverter, wiring, and appliances, are sourced and assembled independently by either a product aggregator or an individual for their own household, sometimes even piecemeal over a long period of time. Component-based SHS typically have power ratings above 11 Wp, which classifies them as SHS products, although some are smaller.
Productive use leveraging solar energy (PULSE)	Productive use leveraging solar energy (PULSE) is defined as any agricultural, commercial, or industrial activity that uses solar energy as a direct input to the production of goods or provision of services. PULSE enables or enhances income generation by households and microenterprises, often by mechanizing commercial activities that would otherwise be performed manually or by providing additional hours of lighting in which to work, that would otherwise be unavailable. These activities and lighting might also otherwise utilize non-renewable sources of energy, such as diesel generators or kerosene. ⁱ

Term	Definitions
Appliances	Appliances designed for the off-grid solar sector are categorized by their intended use-case: household or PULSE. Off-grid appliances unlock greater demand for energy access by allowing previously unserved populations to enjoy the full benefits of electrification.
Access to electricity: The Multi-Tier Framework (MTF)	<p>The MTF, developed by ESMAP, represents an effort to build global, aggregable metrics and a database for evaluating electricity access in a non-binary fashion, measuring the quality of access rather than merely access to any source of electricity. Developed in the context of the Sustainable Energy for All (SE4ALL) initiative, the MTF is being used as a more nuanced measure of progress towards Sustainable Development Goal 7 (SDG7), complementary to the binary methodology captured in the Tracking SDG7 report written by major development stakeholders.ⁱⁱ</p> <p>The MTF redefines energy access to a multi-dimensional definition as “the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy and safe for all required energy services.” That is, having an electricity connection does not necessarily imply having access to electricity under the new definition, which takes into account additional aspects, such as reliability and affordability. Energy access is measured on a tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access).ⁱⁱⁱ</p> 
Unconnected households	Households that are unconnected and remote, far from and not connected to national grids. All of these households are potential customers for OGS products.
“Under-the-grid” households	Households that are near to but not connected to national grids. Even where a grid connection is nearby and a connection would be technically realistic, households may choose not to connect because of affordability constraints (either high connection costs to the grid or high tariffs to consume from the grid, or both) and poor reliability of service. All of these households are potential customers for OGS products.
Households with unreliable grid	These households face frequent or lengthy outages of grid electricity or experience voltage fluctuations that can damage electrical appliances.
Households connected to reliable grid	These households rarely or never face outages of grid electricity and do not experience voltage fluctuations that could damage electrical appliances.







i Lighting Global, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa (Washington, DC: Lighting Global, September 2019), <https://www.lightingglobal.org/resource/pulse-market-opportunity/>, 12.

ii International Energy Agency et al., Tracking SDG 7: The Energy Progress Report 2019 (Washington, DC: The World Bank, May 2019), <https://www.irena.org/publications/2019/May/Tracking-SDG7-The-Energy-Progress-Report-2019>.

iii Mikul Bhatia and Nicolina Angelou, Beyond Connections: Energy Access Redefined, Technical Report 008/15 (Washington, DC: ESMAP, July 2015), <https://www.esmap.org/node/56715>.



Term	Definitions
Potential market	The overall market of people (households and microenterprises) that either lack access to an electricity connection (off-grid) or have a poor-quality electricity connection (unreliable-grid), forming the total potential customer base for OGS devices. This estimate includes customers that currently use OGS devices, as they represent a continued market for additional sales, replacements, and upgrades.
Addressable market	The share of the potential market that can be addressed by current OGS business models. This study analyses the affordability of devices against the potential market to arrive at an estimate for the addressable market.
Pay-as-you-go (PAYGo)	PAYGo business models allow users to pay for their products via technology enabled, embedded consumer financing. A PAYGo company will typically offer a solar product (predominantly solar home systems and multi-light pico devices) for which a customer makes a down payment, followed by regular payments for a term ranging from six months to eight years. Payments are usually made via mobile money, though alternative methods include scratch cards, mobile airtime, and cash.
Quality-verified	“Quality-verified” products meet Lighting Global Quality Standards, which implement minimum requirements for off-grid lighting product quality, durability, truth-in-advertising, warranty, and lumen maintenance. Lighting Global offers Quality Standards for both pico products and SHS kits up to 350 W, and compliance is required to participate in Lighting Global support programs. Quality Standards are one component of the Lighting Global Quality Assurance (QA) Program. The International Electrotechnical Commission (IEC) has adopted the Lighting Global testing methods as Technical Specification 62257-9-5. Lighting Global announced the launch of VeraSol, an evolved program of Lighting Global Quality Assurance, in February 2020. VeraSol maintains the strong foundation for quality assurance laid by the World Bank Group, providing quality verification services, comparable product data, and technical assistance to governments and institutions. For more information please visit VeraSol.org.
Affiliate	<p>Affiliate companies are connected to any of the partner organizations involved in the semi-annual GOGLA sales data reporting process. This matrix of companies includes GOGLA members, companies selling products that meet Lighting Global Quality Standards, and appliance companies that participated in the Global LEAP Awards or are engaging with the Low Energy Inclusive Appliances (LEIA) program.</p> <p>It is important to note that not all products produced by affiliate companies meet Lighting Global Quality Standards, but stakeholders assume that all products affiliate companies produce are of reasonably good quality.</p>
Non-affiliate	Companies that are not within the matrix of affiliate companies are considered non-affiliate companies. Products distributed by non-affiliate companies are considered non-affiliate products. These companies do not report their sales to GOGLA, and much less is known about the quality and level of Tier access their products provide.
First-Generation companies	These OGS companies were founded in the early stages of the sector and have since dominated the affiliate market in terms of sales, geographical reach, and value of investments raised. They typically offer PAYGo and are vertically integrated or participate in multiple segments of the value chain, especially distribution, retail, and finance.
Second-and Third-Generation companies	These younger OGS companies followed the First-Generation companies and often focus on specific aspects of the value chain..

Definitions of Key Household Product Segments

Example	Product Category	Definitions	Power Ranges (W)	MTF Level
 SunKing Pico Plus	Portable lanterns	Single light only	0.1-499 (indicative)	Enables Tier 0 (or partial Tier 1) Electricity Access for an individual person
		Single light & mobile charging	1.5 – 2.999 (indicative)	Enables Tier 1 Electricity Access for at least one person and contributes for a full household
 GDLITE 8006-A	Multi-light systems	Multiple light & mobile charging	3 – 10.999 (indicative)	Enables Tier 1 Electricity Access for at least one person and up to a full household
 M-KOPA 6	Entry-level SHS	three to four lights, phone charging and powering a radio	11-20.9	Enables Tier 1 Electricity Access for a household
 d.light X850	Basic-capacity SHS	As above, plus power for a television, more lights, appliances & extended capacity	21-49.9	Enables Tier 2 Electricity Access for a household when coupled with high-efficiency appliances
 Niwa Energy 50	Medium-capacity SHS	As above, but with extended capacities	50-99.9	Enables Tier 2 Electricity Access for a household even using conventional appliances
 Mobisol Bright Future	Higher-capacity SHS	As above, but with extended capacities	100+	Enables Tier 2 Electricity Access for a household, even using conventional appliances ^{iv}

iv A sufficiently large SHS and accompanying appliances are capable of providing Tier 3 access, though in practice this is almost exclusively delivered by a connection to the main grid or a mini-grid.

Definitions of Key Domestic and PULSE Appliance Segments

Product Category	Applications	Price ranges (US\$) ^v
Household appliances		
 <p>Cello Solar TV</p>	<p>Televisions</p> <p>Television sets provide access to entertainment, educational content, and news. Most televisions sold as part of SHS kits are DC-powered, although AC-powered sets can be used with DC-AC solar inverters.</p>	US\$ 56-257
 <p>Steca PF 166-H</p>	<p>Refrigerators</p> <p>Off-grid refrigerators reduce the risk of food contamination and preserve perishable produce and beverages for both households and small mom-and-pop shops in rural, remote communities.</p>	US\$ 160-1,350
 <p>SoXin QM-850</p>	<p>Fans</p> <p>Fans improve household comfort, especially during hot seasons.</p>	US\$ 7-135
 <p>M Luck Solar Radio B29</p>	<p>Other</p> <p>Other, smaller appliances include radios for households and multi-port phone chargers for small businesses.</p>	Variable
PULSE appliances		
 <p>SunCulture Rainmaker 2</p>	<p>Water pumps</p> <p>Solar water pumps improve irrigation and extend the growing season for rural small-holder farmers.</p>	US\$ 495-4,031 ^{vi}
 <p>InspiraFarms cold storage</p>	<p>Cold-storage solutions</p> <p>Solar-powered cold-storage solutions enable larger-scale preservation of produce, meat, and dairy products, targeted mostly at small businesses.</p>	US\$ 160 or more ^{vii}
 <p>Agsol Solar-Powered Hammer Mill</p>	<p>Agro-processing equipment</p> <p>The most common agro-processing application is solar-powered grain milling, given the importance of the maize value chain in Sub-Saharan African markets.</p>	Variable

^v Indicative prices; data derived from the Mangoo marketplace, GOGLA, affiliate and non-affiliate company websites, consultations with off-grid companies and Chinese manufacturers, and industry reports and Lighting Global-commissioned market research, such as Ipsos studies of Kenya, Ethiopia, and Tanzania.

^{vi} Prices for solar water pumps include systems up to 5kW in size. In certain markets, such as India, much larger, more expensive solar-powered systems are used.

^{vii} Refrigeration for productive use ranges from small, household-sized refrigerators to large, walk-in refrigerators that sell for US\$ 100,000 or more.

REPORT SUMMARY



HEADLINE INSIGHTS



**US\$ 1.75 billion market
serving 420 million users**

The off-grid solar sector has grown tremendously over the past 10 years into a vibrant, US\$ 1.75 billion annual market, which remains on a solid growth curve.¹ The sector is currently serving 420 million users. From 2017 to 2019, revenues grew rapidly at 30 percent annually, while sales volumes grew at 10 percent annually. A shift towards higher-priced Pay-As-You-Go (PAYGo)-enabled products that provide higher levels of energy service has driven this rapid growth in sector turnover. While pico products still comprise around 83 percent of all sales since 2010, the growing reach of larger SHS products means that over half of off-grid solar customers now receive “Tier 1” access or higher to a clean, modern, and reliable source of electricity.



**38 percent annual increase
in PAYGo unit sales**

As the sector matures, companies are increasingly focused on financial sustainability. Companies are moving into new geographies and underserved markets as established markets become more saturated. They are also accelerating the shift towards larger, higher-margin SHS sales in response to growing consumer demand for appliances and backup systems, which dovetails with their focus on financial sustainability. In addition, two new business models are solidifying: (1) “beyond energy” companies using consumer PAYGo data to offer financing for non-energy products and services and (2) next-generation off-grid utilities.



**Potential market of 1.8 billion
people and over 70 million
farmers**

The global potential OGS market remains substantial, with 840 million people without electricity access, over 1 billion connected to an unreliable grid, over 70 million farmers who could leverage OGS for productive use and a promising public institutions market. Productive Use Leveraging Solar Energy (PULSE) solutions, such as solar water pumps (SWPs), cold storage, and solar milling, and products servicing public institutions are natural expansions of the traditional OGS market, which serves households and microenterprises. Both of these markets hold tremendous potential opportunities.

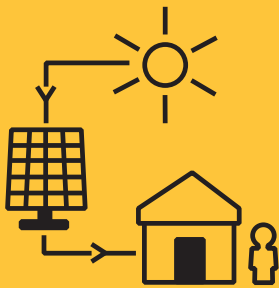
¹ This report follows the convention that 1 billion = 1,000 million.



US\$ 1.5 billion in investment since 2012

Several signs speak to the industry’s growing financial maturity, such as an increase in debt investments and larger ticket sizes.

Despite this progress, funding gaps remain, particularly for Second- and Third-Generation companies, which have been unable to raise equity. Investor types are also shifting, with increased engagement from larger strategic investors, specialized debt providers, and crowdfunding, although a lack of local funding sources persists. To accelerate funding for the sector and attract investors will require innovative financing mechanisms, and companies will need to demonstrate profitability and increase transparency around operational efficiencies.



823 million users by 2030

The OGS sector remains on a strong growth trajectory; the sector is projected to serve 823 million users with OGS products by 2030.

To sustain the current market growth trajectory, the sector will require an investment of US\$ 1.7–2.2 billion in the next five years.



US\$ 6.6–11 billion additional financing to achieve universal access

To achieve universal access, the sector would need to reach as many as 617 million people with Tier 1 OGS products as their main source of electricity; this would require US\$ 6.6–11 billion in additional financing.

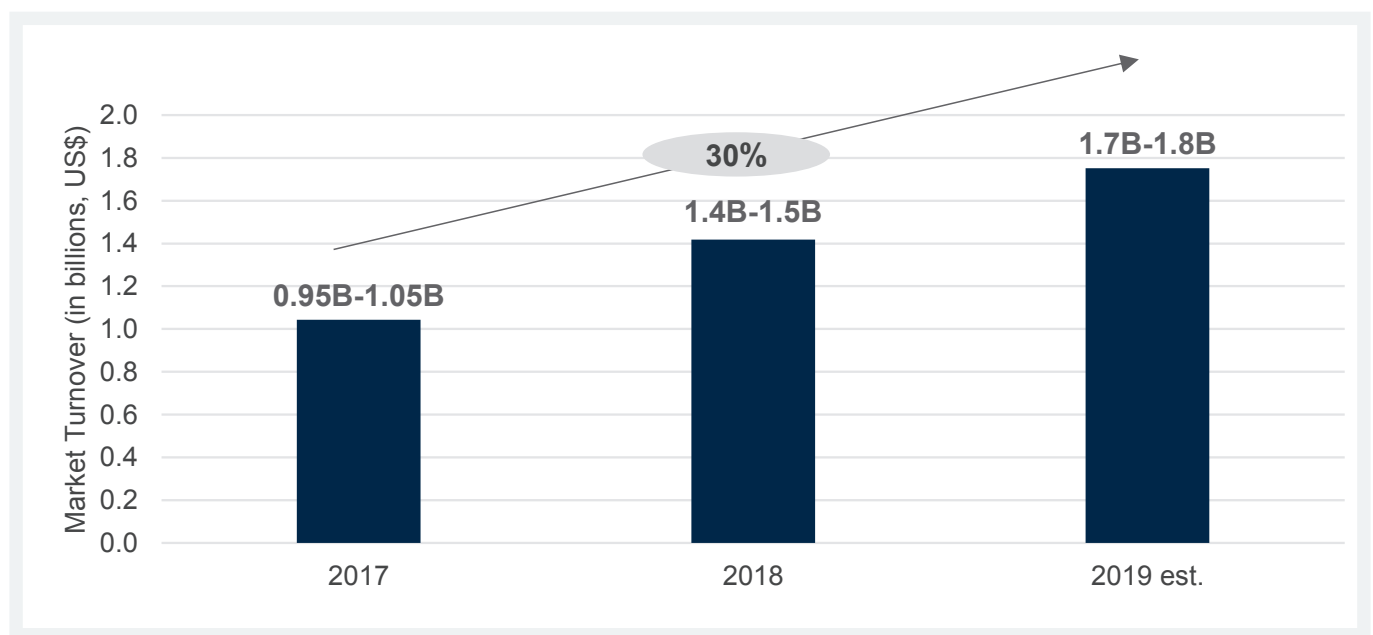
Of this total need, US\$ 6.1 to 7.7 billion comprises required external investment into OGS companies, and up to US\$ 3.4 billion represents public subsidies to bridge the affordability gap. These funds will need to be raised between now and 2030 to unlock commercial opportunities, as well as to reach the poorest people.

THE OFF-GRID SOLAR SECTOR HAS GROWN INTO A VIBRANT US\$ 1.75 BILLION ANNUAL MARKET CURRENTLY SERVING 420 MILLION USERS AND REMAINS ON A SOLID GROWTH CURVE.



Sales revenues are growing rapidly at 30 percent annually due to increased sales of higher-priced, PAYGo-enabled products that provide increased levels of energy service. In 2016, the industry reached a significant milestone, surpassing US\$ 1 billion in annual turnover. Since then, turnover has continued to grow rapidly to reach approximately US\$ 1.75 billion in 2019. This represents an annual growth rate of 30 percent over the period 2017 to 2019 (Figure RS 1). Growth in turnover is bolstered largely by increasing sales of larger systems, predominantly through PAYGo-enabled solar home systems (SHS), that provide higher service levels to customers.

Figure RS 1: Estimated OGS Annual Market Turnover (2017–2019 Estimated)



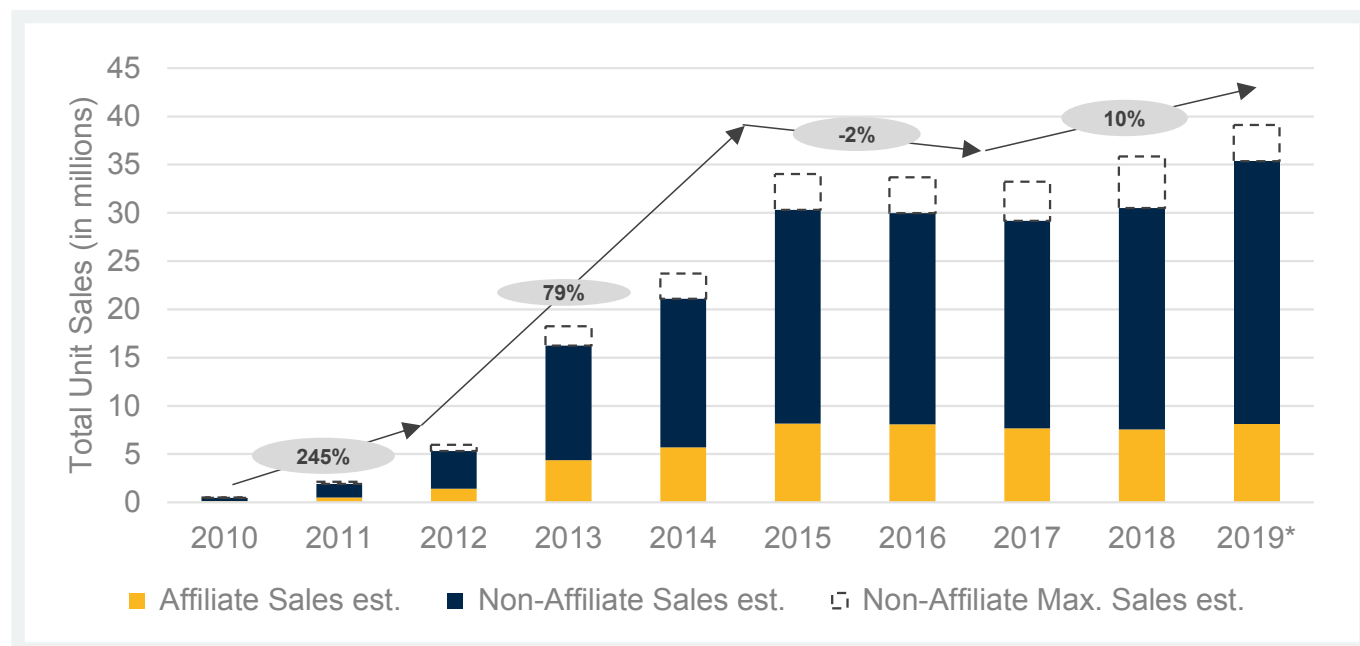
Source: Vivid Economics and Open Capital Advisors analysis of Stiftung Solarenergie. Sendea gGmbH, “Mangoo Marketplace,” <https://www.mangoo.org/>; Aurélien Boyer et al., Pricing Quality: Cost Drivers and Value Add in the Off-Grid Solar Sector (Utrecht: GOGLA, 2019), <https://www.hystra.com/reaching-scale-in-access-to-energy-2017/>; GOGLA data; and MTF data.

Note: Market turnover was derived by a multi-tiered approach. For cash sales, we used conservative price estimates from our pricing analyses for each wattage category, calculating a weighted average price for pico and SHS products based on these estimates. We then multiplied that average combined pico and SHS pricing by global cash sales volumes to estimate an annual market turnover for pico and SHS products bought in cash. For PAYGo, we assume a two-year repayment period, and we recognize revenue in the first year as the revenue collected from the down payment plus revenue collected from ongoing payments expected that year.

Year-on-year unit sales also continue to grow at 10 percent annually, with more than 30 million OGS units sold in 2018 and 2019 on course to exceed this figure.² Following the sector’s rapid acceleration between 2010 and 2015, with annual growth rates of 133 percent, the industry saw a decline in sales leading up to 2017 due to localized shocks in key pico product markets and companies’ adaptations to sector-wide trends. Since then, growth in annual unit sales has stabilized to 10 percent from 2017 to 2019, showing signs of a maturing market (Figure RS 2).

² GOGLA data and MTF analysis.

Figure RS 2: Global Estimated Annual Unit Sales of OGS Products by Segment (2010–2019)



Source: Vivid Economics and Open Capital Advisors analysis of MTF data; GOGLA and Lighting Global., Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data H1 2018 (Utrecht: GOGLA; Washington, DC: Lighting Global, October 2018), <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2018-sales-and-impact-data>; GOGLA and Lighting Global., Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data H2 2018 (Utrecht: GOGLA, May 2019), <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2018-sales-and-impact-data>; GOGLA and Lighting Global., Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data H1 2019 (Utrecht: GOGLA, October 2019), <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2019-sales-and-impact-data>; Lighting Global., Off-Grid Solar Market Trends Report 2018 (Washington, DC: Lighting Global, January 2018), <https://www.lightingglobal.org/resource/2018-global-off-grid-solar-market-trends-report>; and other GOGLA sales data.

This report distinguishes between “affiliate” and “non-affiliate” products available to users. Affiliate products are sold by companies that are connected to any of the partner organizations involved in the semi-annual GOGLA sales data reporting process, including GOGLA members, companies selling products that meet Lighting Global Quality Standards, and appliance companies that participated in the Global LEAP Awards or are engaging with the Low Energy Inclusive Appliances (LEIA) program. Much less data are available on the non-affiliate portion of the market, though it contributes significantly to sales volumes (Figure RS 2).

Recently available data sources confirm that non-affiliate products account for the majority of sales volumes (72 percent).³ Approximately 200 non-affiliate manufacturers of OGS products play an important role in an organic and competitive marketplace.⁴ However, the non-affiliate market is not well understood. While non-affiliate products can represent a cheaper and sometimes quality alternative, they can also be low-quality, which can erode consumer confidence in all OGS products. This report estimates that 23 million non-affiliate products (or 72 percent of total market share) were sold in 2018, compared to 7.6 million affiliate products. While non-affiliate products dominate both the pico and combined (plug-and-play, or PnP, and component-based) SHS markets, we estimate that affiliates represent over 50 percent of the market for PnP SHS specifically. The market share of non-affiliate products varies wildly by country from, for example, 98 percent in Nepal to 3 percent in Rwanda.⁵

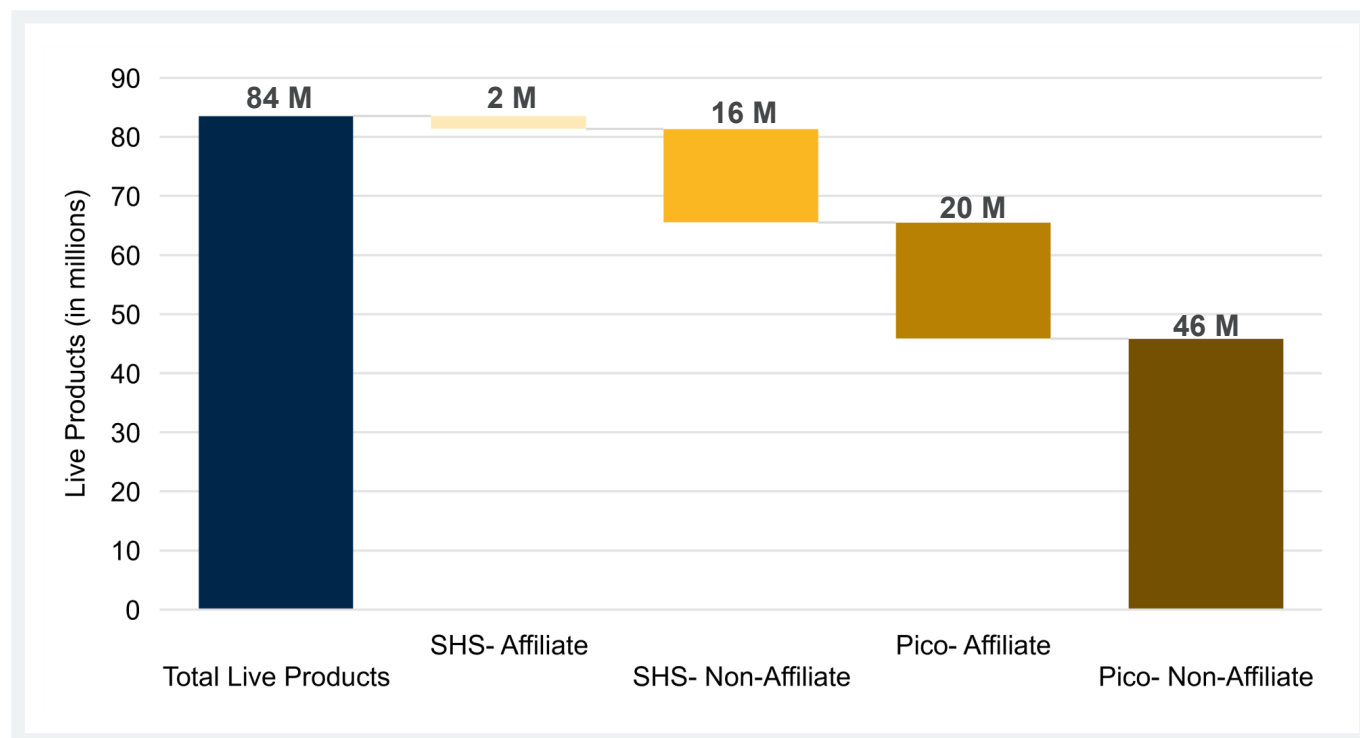
3 Non-affiliate products are those that are not sold by companies involved in the GOGLA sales data reporting process. Little data are collected on this portion of the market, but household survey data reveal the extent of their role in the market.

4 Vivid Economics and Open Capital Advisors analysis and consultations.

5 CLASP, Off-Grid Appliance Market Survey: Perceived Demand and Impact Potential of Household, Productive Use and Healthcare Technologies, 3rd ed. (London and Washington, DC: Efficiency for Access Coalition, September 2018), <https://efficiencyforaccess.org/publications/off-grid-appliance-market-survey>; The World Bank, Open Data, <https://data.worldbank.org/>; Demographic and Health Surveys, DHS Data, <https://dhsprogram.com/data/>; Ipsos market research commissioned by Lighting Global; MTF household survey data; GOGLA live product data; and industry interviews. Notably, the expected lifetime of high-quality affiliate products is higher than that of low-quality, non-affiliate products. Therefore, the use of live product data to calculate the non-affiliate share of sales may underestimate the number of non-affiliate products sold in the market.

In total, around 180 million OGS units have been sold worldwide since 2010, comprising 150 million pico products and 30 million SHS. Accounting for the lifecycle of these products, approximately 84 million units are “live,” that is, in use today, benefiting more than 420 million people (Figure RS 3). This represents an estimated market penetration of 17 percent.

Figure RS 3: Global Estimate of Live Products by Product Segment (as of H1 2019)



Source: Vivid Economics and Open Capital Advisors analysis of GOGLA live product data and MTF data.

Today, the pico product segment is heavily commoditized and competitive, providing users with highly affordable lighting solutions. Non-affiliate manufacturers and unbranded products are firmly established in the market, representing the majority of pico sales. Non-affiliate manufacturers are also expanding their offerings to focus on designing their own brands, in some cases distributing directly to the market. This increased competition has driven down prices and made products more affordable, particularly small pico products that serve as an important entry point for many users to OGS products.

Solar home systems, which currently represent about 17 percent of unit sales, will increasingly drive growth in the years to come. The SHS segment comprises two distinct types of system: (1) PnP integrated systems, mostly using lithium battery technology and marketed by affiliate companies and (2) component-based systems offered by a wide variety of distributors, often unbranded and typically using lead-acid batteries. Affiliate unit sales of SHS have continued to grow strongly in recent years. Unit sales of larger SHS kits, particularly 21–49 Wp systems that can power televisions, increased by 73 percent annually from 2016 to 2018. SHS unit sales for products rated 11 Wp or more are increasing by 53 percent annually.⁶

The PAYGo business model used to finance both SHS and pico solar products is rapidly increasing its market share, reaching 24 percent of unit sales in H1 2019 from 20 percent in H1 2018.⁷ PAYGo boosts affordability, unlocking larger PnP systems that provide higher levels of energy service in addition to a wide variety of high-value, non-energy services that can be offered over PAYGo platforms. Many investors have encouraged companies to enter the PAYGo space in the face of reducing margins for cash sales of pico products. West Africa has seen the fastest increase

⁶ GOGLA data.

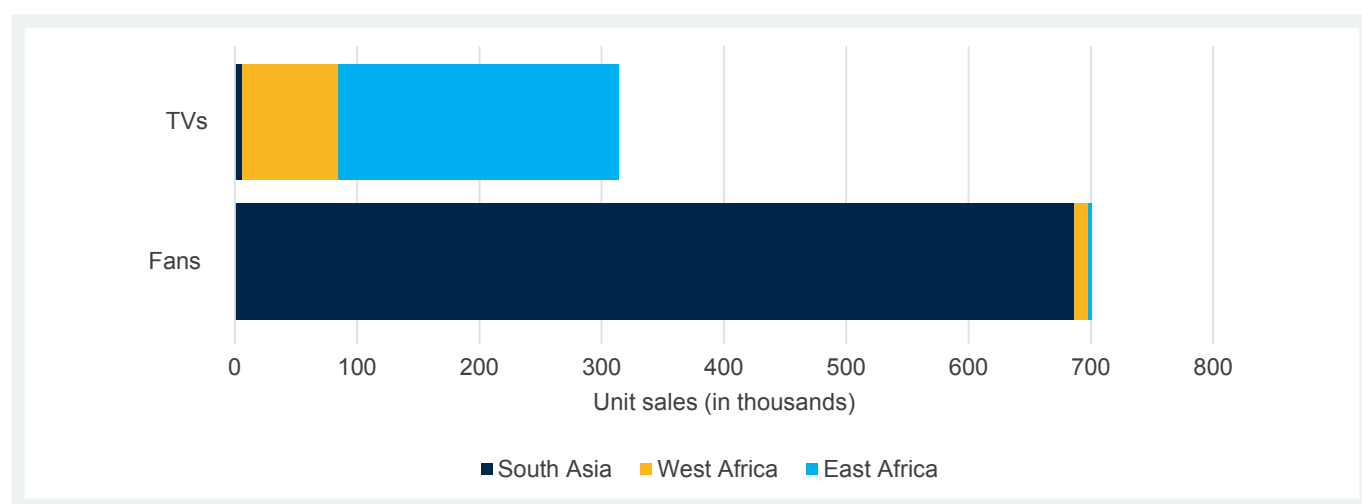
⁷ These figures apply only to the affiliate portion of the market.

in PAYGo unit sales in the last year, reaching 47 percent of all unit sales and 92 percent of market value in that market in H1 2019. Within the affiliate market, PAYGo comprises 76 percent of SHS unit sales and 14 percent of pico unit sales.⁸

Nonetheless, cash-based sales of pico products will remain the backbone of the industry in terms of unit sales over the next few years. More than 75 percent of affiliate products and the vast majority of non-affiliate products are sold on a cash basis.⁹ Given the low incomes of target customers for off-grid products, which are generally not sold on a PAYGo basis.

The household appliance category is becoming a major driver for the sector; affiliate companies sold more than a million appliances in H2 2018 and H1 2019. High-efficiency DC appliances are contributing to the increase in PnP SHS sales. Between H2 2018 and H1 2019, appliance sales increased by 111 percent, with televisions and fans accounting for 99 percent of recorded sales.¹⁰ Most fans are sold in South Asia, while most televisions—typically more expensive than fans—are sold in East Africa, where PAYGo financing is very prevalent (Figure RS 4). The current global addressable market for off-grid household appliances is an estimated US\$ 12.6 billion and could grow to US\$ 25.3 billion by 2030.¹¹

Figure RS 4: PAYGo Regional Unit Sales of Televisions and Fans (Cumulative 2018 H2 and 2019 H1)



Source: Vivid Economics and Open Capital Advisors analysis of GOGLA sales data.

Productive use leveraging solar energy (PULSE) products represent an emerging opportunity for the OGS sector, although the market is still in its infancy and will continue to learn and evolve. PULSE covers a wide range of products including solar water pumps (SWPs) and cold storage for agricultural applications, as well as refrigeration and appliances for microenterprises.¹² The market for SWPs has been heavily driven by government subsidies; in India, for example, over 150,000 SWP units have been sold to date, bolstered by government subsidies.¹³ The commercial opportunity for the broader PULSE market is growing due to falling costs of PULSE technology, increases in appliance efficiency, and innovations in business models. Affiliate companies sold fewer than 10,000 SWPs (all less than 3kW) between H2 2018 and H1 2019, the only periods for which sales were collected.¹⁴ However, given the high number of non-affiliate manufacturers of solar water pumps in the market, anecdotal evidence suggests the number of units sold globally is much higher.

8 Vivid Economics and Open Capital Advisors analysis of GOGLA sales data.

9 Vivid Economics and Open Capital Advisors analysis of GOGLA sales data.

10 GOGLA and Lighting Global, Off-Grid Solar Market H2 2018; and GOGLA and Lighting Global, Off-Grid Solar Market H1 2019.

11 Dalberg, The State of the Off-Grid Appliance Market (London and Washington, DC: Efficiency for Access Coalition, October 2019), <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>, 10.

12 Lighting Global, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa (Washington, DC: Lighting Global, September 2019), <https://www.lightingglobal.org/resource/pulse-market-opportunity/>, 12.

13 Dalberg, Solar Water Pump Outlook 2019: Global Trends and Market Opportunities (London and Washington, DC: Efficiency for Access Coalition, September 2019), <https://clasp.ngo/publications/solar-water-pump-outlook-2019-global-trends-and-market-opportunities>, 6.

14 GOGLA data.

Companies are still testing business models and a wide variety of technologies to meet large potential PULSE markets for cold storage, refrigeration, and agri-processing. Affiliate companies sold less than 10,000 off-grid refrigerators in H2 2018 and H1 2019, and only a portion of these are for productive use. Meanwhile, in addition to refrigeration, many solar milling business models and technologies are in the pilot phase and not yet commercially deployed. Beyond agri-processing, even more specialized productive use applications have emerged in specific value chains such as poultry, dairy, and coffee.¹⁵ Though the PULSE segment remains in its infancy, the rapid expansion in market participants indicates strong potential growth, with a total addressable market of US\$ 11.3 billion in 2018 for Sub-Saharan Africa alone.¹⁶



AS THE SECTOR MATURES, COMPANIES ARE FOCUSING ON FINANCIAL SUSTAINABILITY AND UNIT ECONOMICS BY EXPANDING TO NEW MARKETS AND SELLING LARGER SYSTEMS THAT PROVIDE HIGHER LEVELS OF SERVICE TO CUSTOMERS.

Companies are moving into new geographies and underserved markets in pursuit of scale. Several providers in East Africa have expanded into new markets, especially in West Africa, as established markets become more saturated. In Nigeria, companies are introducing new products; for example, Zola launched its Infinity backup product to serve the large unreliable grid market in that country, and Beebeejump offers an SHS product with an AC inverter, a category in which several other companies are currently testing products. Other international companies, such as RZB Lighting, are looking at Vietnam, Indonesia, and the Philippines as new core markets of interest in Asia, after achieving mixed success in more developed off-grid markets, such as India.¹⁷ With the goal of accelerating energy access, an increasing number of government incentives are encouraging expansion to underserved regions. In Togo, both BBOXX and Soleva have entered to take advantage of the Togolese government's incentive scheme for SHS.¹⁸

PAYGo technology, declining manufacturing costs, and increasing appliance efficiency have fueled the shift towards larger systems. SHS manufacturing costs have declined by approximately 5–15 percent over the last two years. There are now also highly efficient DC appliances on the market, representing an increasingly cost-effective option for users. The combination of continued efficiency gains for appliances, declining manufacturing costs, and use of the PAYGo business model to increase affordability will continue to drive the SHS and appliance markets. These systems provide higher revenues and improved cashflow, important for companies that began to face investor pressure to generate profits two or three years ago.¹⁹

These larger PAYGo-enabled systems are providing customers with energy access levels of Tier 1 and greater, crucial for achieving energy access targets. More than half of people currently using an OGS product have at least Tier 1 access, the minimum that counts as electricity access against globally agreed targets (Figure RS 5). The remaining 45 percent use an OGS product below Tier 1—pico products, such as solar lanterns. Achieving the Sustainable Development Goal (SDG) 7 objective of universal access to “affordable, reliable, sustainable, and modern

¹⁵ GOGLA data.

¹⁶ Lighting Global, Market Opportunity for PULSE, 20.

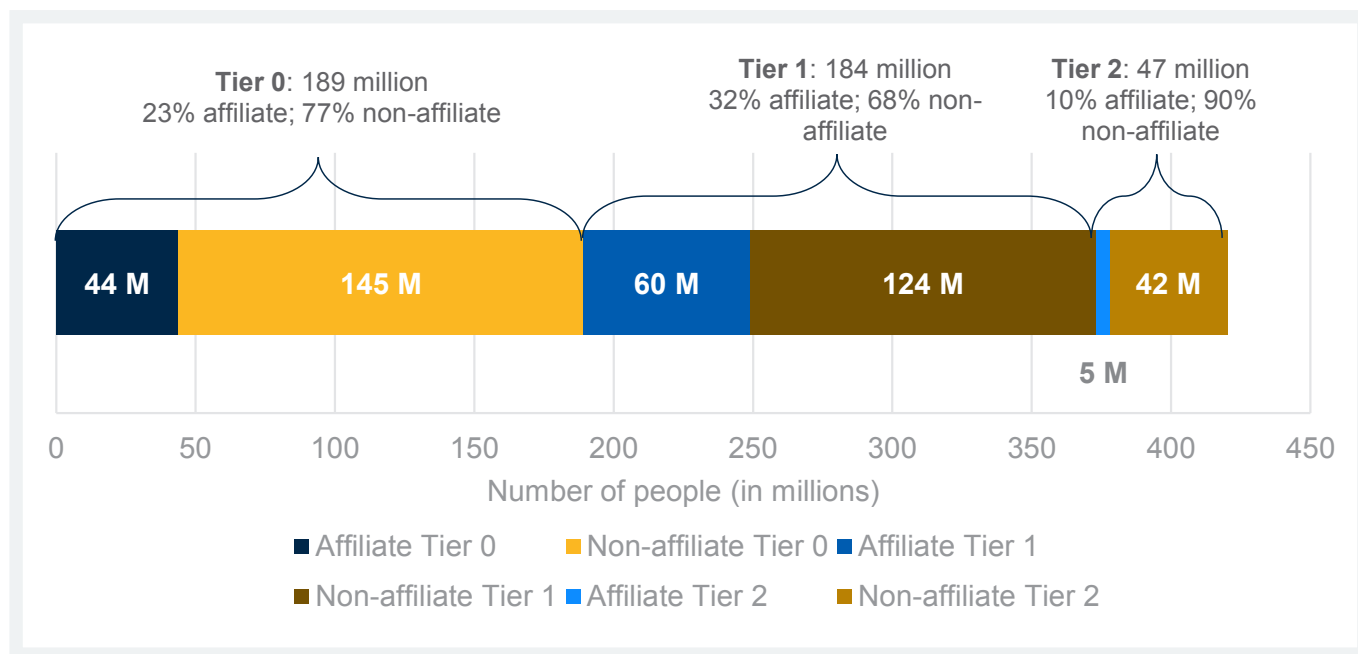
¹⁷ RZB Group, “RZB Founded New Subsidiary RZB Lighting Asia & Pacific Sdn. Bhd.,” news release, June 5, 2014, <https://www.rzb.de/en/media-centre/press-releases/article/1183-rzb-founded-new-subsiary-rzb-lighting-asia-pacific-sdn-bhd-kuala-lumpur-malaysia/>.

¹⁸ BBOXX, “BBOXX Receives Invitation to Meet President of Togo to Roll Out 300,000 Solar Home Systems,” news release, July 17, 2017, <https://www.bboxx.co.uk/bboxx-receives-invitation-meet-president-togo-roll-300000-solar-home-systems/>; and Ayi Renaud Dossavi, “CIZO Project: SOLEVA Starts Operations as Planned,” Togo First, June 3, 2019, <https://www.togofirst.com/en/energy/0306-3298-cizo-project-soleva-starts-operations-as-planned>.

¹⁹ Vivid Economics and OCA consultations.

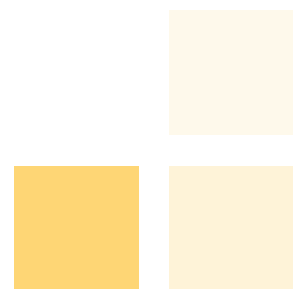
energy” will require not only reaching currently unserved populations, but also helping those using below Tier 1 products move up to Tier 1 systems. Growing sales of larger systems that can provide at least Tier 1 service indicates progress towards that goal.

Figure RS 5: People Benefiting from Access to Electricity through OGS Devices (Millions)



Source: Vivid Economics and Open Capital Advisors.

THE FOCUS ON FINANCIAL SUSTAINABILITY HAS ACCELERATED INNOVATION IN BUSINESS MODELS, AND NEW MODELS CONTINUE TO EMERGE. VALUE CHAIN SPECIALIZATION IS INCREASING AS COMPANIES FOCUS ON CORE CAPABILITIES.

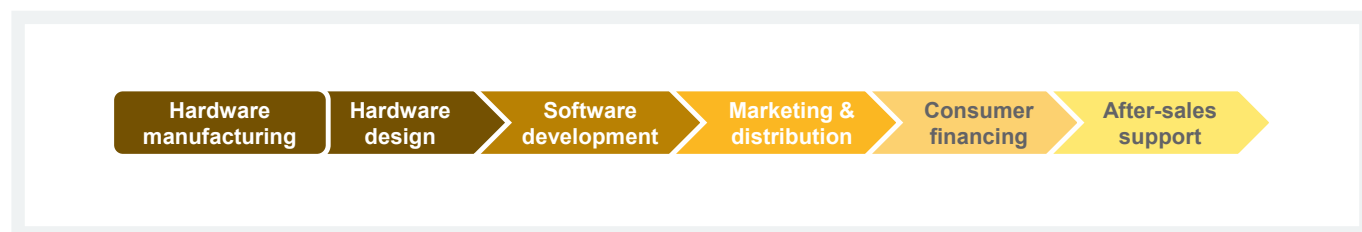


Two new shifts have emerged in business models: (1) companies moving “beyond energy” and (2) the rise of next-generation off-grid utilities. Moving beyond energy, OGS companies are using data from PAYGo platforms to understand customer creditworthiness and upselling additional products to customers, including small loans for education, cash loans, micro-loans for small businesses, micro-insurance products, and partnerships to distribute fast-moving consumer goods. Meanwhile, the next-generation off-grid utility offers an integrated suite of energy products and services to off-grid or unreliable grid customers. These companies leverage their platforms to provide a wide range of off- and on-grid energy products to customers, including PnP OGS lighting products, liquefied natural gas solutions, small mini-grids, and on-grid solar battery backup installations.

We are also continuing to see the disintegration of vertically integrated business models in off-grid energy, as companies solidify their niches and increase efficiency along the value chain. New partnerships and adaptations

are emerging at each link of the value chain (Figure RS 6) that allow companies to focus on their core businesses to bolster profitability.

Figure RS 6: Overview of OGS Supplier Value Chain



Source: Vivid Economics and Open Capital Advisors.

Examples of key trends include the following:

- **Hardware manufacturing and design.** Manufacturers are increasingly seeking quality verification and developing their own brands to potentially compete with well-established brands; these manufacturers could provide lower-cost products for customers at consistently higher levels of quality.
- **Software development.** Software specialists are providing more customizability and open architectures that lower the barriers to entry for PAYGo models while increasing the usability of PAYGo platforms to drive effective business decisions.
- **Marketing and distribution.** Large international companies are better leveraging data to optimize their sales and distribution models, while more hardware companies are partnering with local distributors to reach previously unserved markets.
- **Consumer financing.** PAYGo uptake is increasing, with continued innovation on payment terms, credit processes, and enabling technology. Also, companies are finding new ways to partner directly with financial institutions to decouple consumer finance from their business models.
- **After-sales support.** Remote monitoring is enabling companies to improve both customer service and asset management, and companies are beginning to incorporate e-waste disposal considerations into their business models or through partnerships with third-party providers.

COMPETITION REMAINS STRONG ACROSS THE SECTOR IN TERMS OF BOTH PRICE AND QUALITY, WITH HUNDREDS OF PRODUCT CHOICES AVAILABLE IN THE MARKET.

While competition has historically been based on price, increased familiarity with OGS products among users means quality is an increasingly important competitive attribute. The pico product segment has been largely characterized by a “race to the bottom” on price, with solar lantern prices as low as US\$ 3. As prices have begun to stabilize, however, users are placing more weight on quality; with quality-verified products starting to replace previous sales of cheaper, low-quality products. Among SHS products, price still drives competition in markets where PnP SHS cash sales are common, with non-affiliate PnP systems competing with more expensive affiliate brands. PnP SHS also often struggle to compete against component-based systems on price, a particularly acute challenge in

Asia due to the higher influx of cheap OGS components from China in this region. With the continued growth in sales of PAYGo PnP systems, especially in East Africa, total product price is becoming less important as many consumers focus primarily on down payment costs and companies increasingly differentiate themselves based on their PAYGo terms and product bundles.

Affiliate manufacturers face increasing pressure from a large number of non-affiliate manufacturers, including those seeking to enter the affiliate market through quality verification. While affiliate distributors rank quality as the most important criterion when sourcing products from manufacturers, they are becoming more price-sensitive. Some are considering moving to lower-priced, high-quality non-affiliate manufacturers, even if these manufacturers do not become Lighting Global quality-verified. Yet some non-affiliate manufacturers are already planning to seek Lighting Global quality verification, which could put downward pricing pressure on existing affiliate manufacturers, unless they can demonstrate their products are worth a higher price.


SECTOR CONSOLIDATION COULD
FUNDAMENTALLY ALTER MARKET DYNAMICS
BUT WILL LIKELY REMAIN OPPORTUNISTIC IN
THE NEAR FUTURE.



The past two years marked the first signs of sector consolidation through ENGIE's acquisitions of Simpa Networks, Mobisol, and Fenix. Other strategic investors, particularly other energy conglomerates and multi-sectoral Japanese conglomerates, have recently shown increased interest in the off-grid sector. Strategic acquisitions could massively alter market dynamics, leading to consolidation and investment exits for early-stage investors. However, mergers and acquisitions in the sector remain nascent; consolidation to date has been rare and opportunistic. For consolidation to accelerate from opportunistic transactions into a broader trend, OGS companies would need to demonstrate the increased maturity-in terms of profitability and scale-required to attract strategic investors.

Increased consolidation or competition could both provide significant benefits to the sector, but it is too early to tell which market dynamic will predominate moving forward. Increased competition could drive down costs and foster innovation in a sector where both are crucial to providing reliable energy to the un- and underserved, but the high cost of launching OGS companies could limit new entrants to the market, particularly if early-stage equity remains difficult to access. Conversely, if companies can demonstrate the scale and profitability required to attract strategic investors, consolidation could create OGS companies with huge scale, supported by large amounts of capital, able to aggregate sector expertise, and achieve significant economies of scale – which would drive down system costs and accelerate energy access.





THE GLOBAL POTENTIAL MARKET REMAINS SUBSTANTIAL, WITH 840 MILLION PEOPLE WITHOUT ELECTRICITY ACCESS GLOBALLY IN 2017 AND MORE THAN ONE BILLION USING AN UNRELIABLE GRID CONNECTION.²⁰

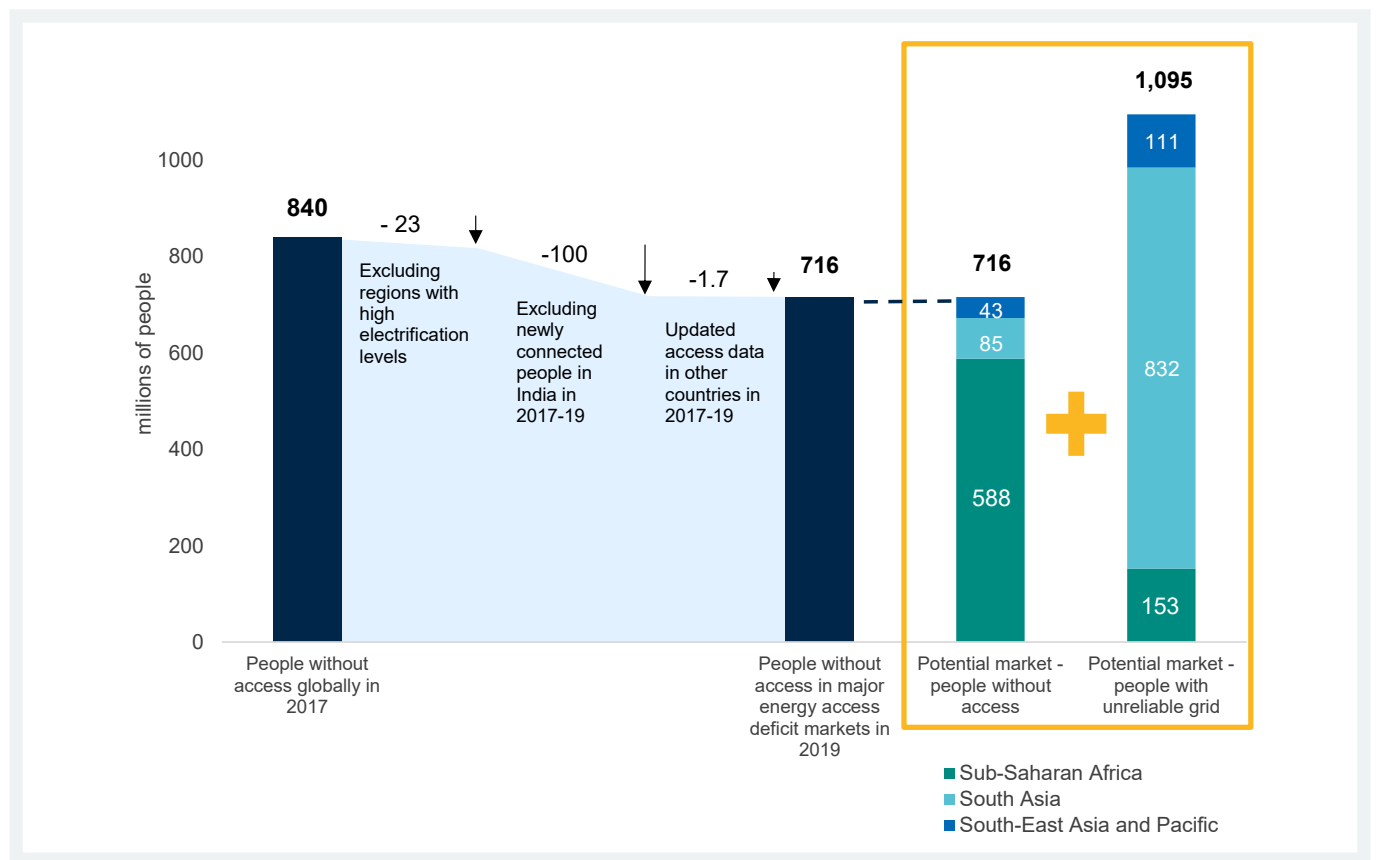
Electrification - both through grid connections and off-grid solutions offering Tier 1 or higher access - has improved rapidly from 83 percent of the global population in 2010 to 89 percent in 2017, with the most significant progress in Central and South Asia.²¹ Since 2010, many countries have adopted electrification plans to reach universal access by 2030, and these increasingly include off-grid aspects alongside grid and mini-grid solutions. However, in most of the 20 countries with the largest energy-access deficits, the rate of electrification has not kept pace with population growth, increasing the number of people in these countries without access to electricity. In countries with unserved populations of more than 50 million people, such as the Democratic Republic of Congo, Nigeria, and Pakistan, electricity access in terms of the percentage of the population with access expanded by less than one percentage point each year between 2010 and 2017.

The potential market for OGS products across Sub-Saharan Africa and Asia-Pacific—the regions with the largest energy deficits as well as the focus of this report—consists of 716 million people without electricity access and more than 1 billion people with an unreliable grid. Over the last two years, some countries in these regions have continued to make strides towards universal electrification, most notably India, where almost 100 million people gained new access between 2017 and 2019 (Figure RS 7). Despite this progress, global demand for OGS remains high across households and microenterprises that currently do not have electricity access, and among people using an unreliable grid connection, although the entire market cannot be addressed and reached through commercial business models. While markets with major energy-access deficits in Sub-Saharan Africa and the Asia-Pacific region account for the majority of OGS sales to date, low-access countries such as Yemen in the Middle East, or Haiti in Latin America and the Caribbean, provide additional market opportunities.

²⁰ While the figure of 1.095 billion people with unreliable grid connections was estimated for this report, 840 million people without access was estimated by the International Energy Agency et al. Tracking SDG 7, 1–2.

²¹ International Energy Agency et al., Tracking SDG 7.

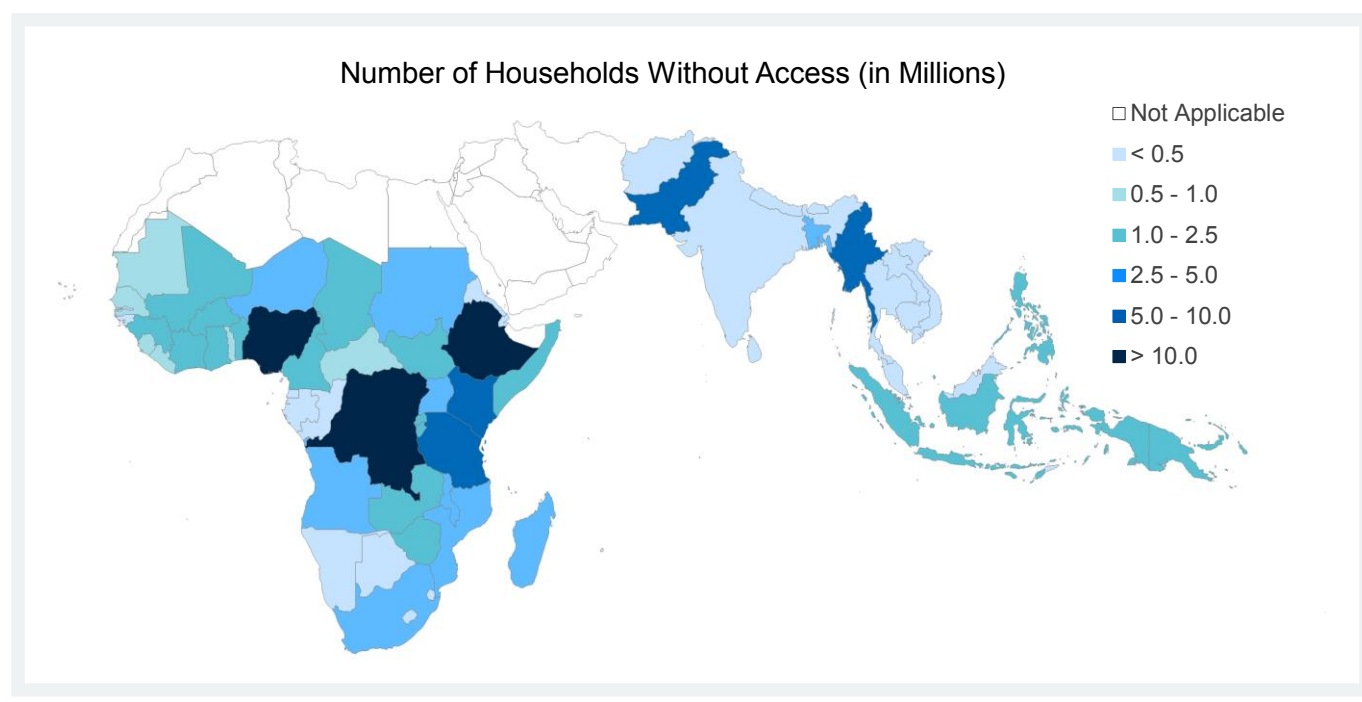
Figure RS 7: The Potential Market in Sub-Saharan Africa and Asia-Pacific Consists of 716 Million People Without Electricity Access and More than 1 Billion with an Unreliable Grid



Source: Vivid Economics and Open Capital Advisors analysis.

The vast majority (over 80 percent) of people without electricity access live in Sub-Saharan Africa (Figure RS 8). Within this region, the countries with the largest populations without access in terms of absolute numbers are Nigeria (89 million), the Democratic Republic of Congo (68 million), and Ethiopia (61 million). Smaller countries also represent substantial opportunities, especially where populations without access are highly concentrated; in Burundi, for example, the total population is just 11 million, but more than 90 percent of Burundians do not have access to electricity. In South and South East Asia, even though grid electrification rates are high, sizeable populations still lack access to electricity, and many in remote, hard-to-reach regions use OGS products as their primary source of electricity.

Figure RS 8: Across Key Energy-Deficit Countries in Africa and Asia-Pacific, 716 Million People Do Not Have Access to Electricity (Absolute Numbers)



Source: Vivid Economics and Open Capital Advisors analysis of International Energy Agency et al., Tracking SDG 7.

Note: This report focuses on countries with access deficits in Sub-Saharan Africa and Asia-Pacific. Countries not shaded in this figure have high access rates and high grid reliability and therefore offer less of a focus market for OGS suppliers.

Around 70 percent of the population without access in Sub-Saharan Africa and Asia-Pacific could afford to pay the monthly installments for a Tier 1 multi-light product, so the current addressable market for this product is 476 million people.²² The remaining 240 million people who cannot afford a Tier 1 OGS product are mostly concentrated in Sub-Saharan Africa, which reflects the region’s lower ability to pay compared to Asia-Pacific. The addressable market for a basic SHS (21–50 Wp) is smaller at 43 percent (310 million people) of the global target population. While this affordability gap persists for quality-verified, Tier 1-enabling products and above, almost all people in these markets can now afford an entry-level, single-light pico product.²³

PAYGo and other business models offering consumer finance are bringing OGS products within reach to a larger share of the population. While only 476 million people could afford a Tier 1 multi-light system if they were to pay equal monthly installments of product cost throughout its lifetime, 670 million could afford the system by saving the PAYGo deposit over three months and subsequently paying a lower amount per month. This leads to a 40 percent increase in the addressable market for this product.²⁴ As ability to cover the deposit is often considered the main barrier to affordability in practice, this demonstrates how PAYGo brings higher-capacity systems within reach to a much higher share of the population.

Even when OGS products are affordable, they must compete against a range of alternatives. Competing alternatives include connecting a grid connection (where available), mini-grids, battery-operated torches, (sometimes-

²² “Affordable” in this context means the OGS product costs less than 5 percent of total monthly expenditures. We compare this to the average cost of a high-end pico product (multi-light and mobile charger system) of 3–11 Wp, which provides Tier 1 access to at least one person and offers Tier 1 access to a household at the high end of the power range. We use the annualized cost of the system over its lifetime.

²³ With non-affiliate products on the market costing as little as US\$ 5 or less.

²⁴ In this calculation, we assume that a PAYGo deposit is affordable when it is less than three months of savings at 5 percent of total monthly expenditure.

subsidized) kerosene for basic lighting, and petrol- or diesel-powered generators.²⁵Willingness to pay for OGS depends on the availability, reliability, convenience, and pricing of alternatives, but can also be influenced by marketing and consumer-awareness campaigns. As a result, consumers may be willing to allocate larger amounts to products that they see as highly desirable, especially if they offer services “beyond energy,” such as insurance, cash loans, and other durable goods.

In addition to the ‘without-access’ market, the unreliable grid market is increasingly being tapped into by OGS products, thereby providing a more reliable energy supply to households and microenterprises. Particularly in rural areas, many people connected to the main electric grid receive less than 12 hours of supply per day, experience voltage surges and low-voltage days that damage or limit their use of appliances, or both.²⁶ A substantial part of this unreliable grid market comprises small businesses, which often require larger-capacity OGS products.

The largest concentrations of people with unreliable grid connections are in South Asia and West Africa.²⁷ In South Asia, while grid access rates have expanded rapidly, some 832 million people have an unreliable grid connection (Figure RS 9). This translates to about 46 percent of all grid-connected people. In West Africa, the majority of all grid-connected households in Guinea and Nigeria report not having electricity “half of the time.”²⁸

While the total potential market as a result of unreliable grid exceeds one billion people, only a subset of these people are realistic customers for OGS backup energy products. Although unreliable grid populations are increasingly important markets for OGS products, market penetration remains relatively low against the large number of people with unreliable grid connections. Countries for which data are available, supported by consultations with industry stakeholders, suggest that OGS devices currently reach only 5 percent or less of unreliable-grid users, even in markets where the grid is very weak.²⁹ Nonetheless, anecdotal evidence and interviews with companies show that unreliable grid populations are increasingly viewed as an important growth market for OGS companies, particularly in South Asia. As a realistic benchmark of what could be reached in the coming five to 10 years, we estimate one in four people with an unreliable grid connection may also buy an OGS product, which would bring the market down from more than one billion to around 250 million people.³⁰

25 In some countries, especially in South Asia, where kerosene subsidies are still in place, many people also continue to use kerosene lamps during outages or because they cannot afford electricity. Tara Laan et al., Policy Approaches for a Kerosene to Solar Subsidy Swap in India (Geneva: International Institute for Sustainable Development Global Subsidies Initiative, April 2019), <https://www.iisd.org/library/india-kerosene-solar-swap>. For a more geographically general discussion of competition for off-grid solar from dirty fuels, see: Nicholas L. Lam et al., The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries (Washington, DC: International Finance Corporation, September 2019), https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/financial+institutions/resources/dirty-footprint-of-broken-grid; and Prabhakar Yadav, Anthony P. Heynen, and Debajit Palit, “Pay-As-You-Go Financing: A Model for Viable and Widespread Deployment of Solar Home Systems in Rural India,” *Energy for Sustainable Development* 48 (February 2019): 139–53, <https://doi.org/10.1016/j.esd.2018.12.005>.

26 Abhishek Jain et al., Access to Clean Cooking Energy and Electricity: Survey of States 2018 (New Delhi: Council on Energy, Environment & Water, November 2018), <https://www.ceew.in/publications/access-clean-cooking-energy-and-electricity>; Vivek Sen and Saloni Sachdeva, “Post Saubhagya: Moving Beyond Connections to Quality of Supply,” Shakti Sustainable Energy Foundation (blog), March 12, 2019, <https://shaktifoundation.in/post-saubhagya-moving-beyond-connections-to-quality-of-supply/>; Sreekumar Nhalur, Ann Josey, and Manabika Mandal, “Rural Electrification in India: Looking Beyond ‘Connections for All’ to ‘Power for All,’” *Economic and Political Weekly* 53, no. 45 (November 17, 2018), <http://www.prayasgroup.org/peg/publications/item/399-rural-electrification-in-india-from-connections-for-all-to-power-for-all.html>; and Prayas (Energy Group), “Electricity Supply Monitoring Initiative (ESMI),” published March 2015, <https://www.prayasgroup.org/peg/resources/electricity-supply-monitoring-initiative-esmi.html>.

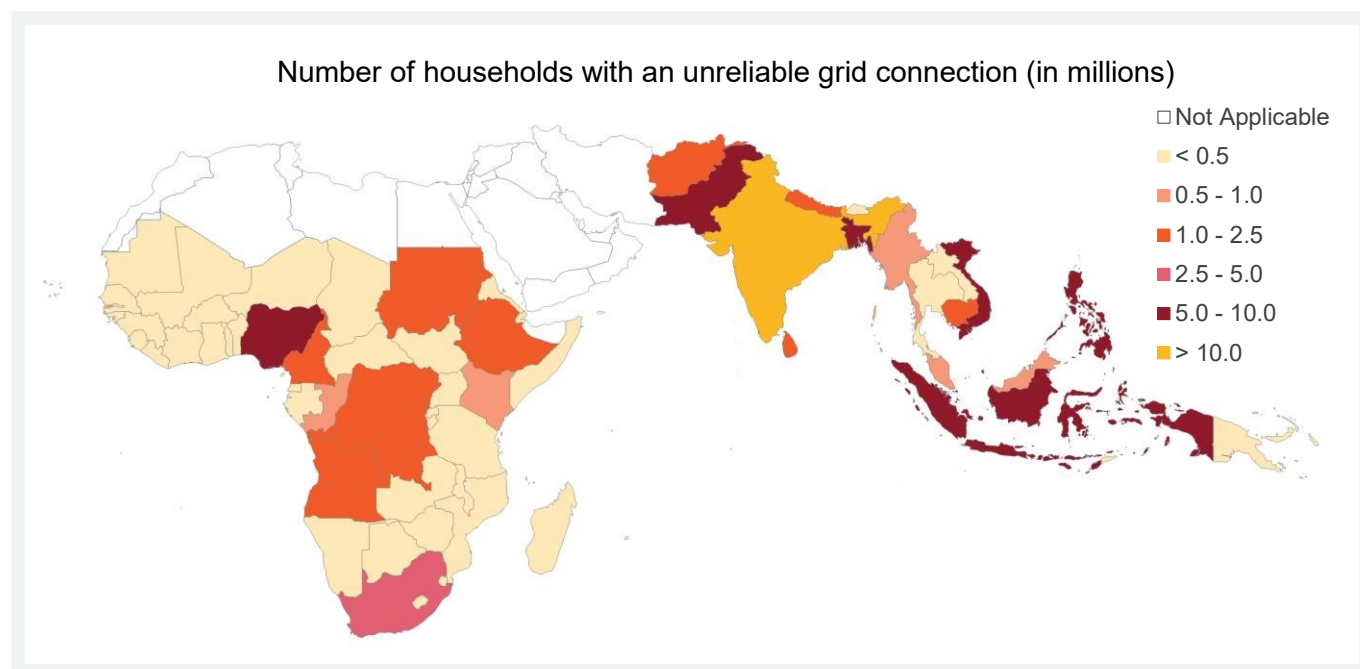
27 The share of unreliable grid connections is based on three sources, in order of robustness: (1) the data underlying ESMAP’s Beyond Connections reports, available for seven countries; (2) the Afrobarometer Round 7 survey results; (3) and the World Bank Enterprise Surveys. The answer buckets for these surveys were slightly different, but we only include the share of people who responded their grid was “unreliable” or “very unreliable,” which means we do not include slightly unreliable connections in the potential unreliable grid market. ESMAP, Energy Access Diagnostic Reports Based on the Multi-Tier Framework (MTF): Beyond Connections, <https://www.esmap.org/node/56715>; Afrobarometer, Merged Round 7 Data (34 Countries) (2019), <https://www.afrobarometer.org/data/merged-round-7-data-34-countries-2019>; The World Bank, Enterprise Surveys: What Businesses Experience, <https://www.enterprisesurveys.org/en/data>.

28 Afrobarometer, Round 7 Data.

29 Based in part on data, available for seven countries, underlying ESMAP, Diagnostic Reports Based on the MTF.

30 Estimate based on the current reach of OGS products to grid connected customers from MTF survey data, and stakeholder consultations

Figure RS 9: More than One Billion People Suffer From an Unreliable Grid Connection, Many of Whom Are in South Asia and West Africa



Source: Vivid Economics and Open Capital Advisors analysis of ESMAP, Diagnostic Reports Based on the MTF; Afrobarometer, Round 7 Data; and The World Bank, Enterprise Surveys.

Notes: This report focuses on countries with access deficits in Sub-Saharan Africa and Asia–Pacific. Countries not shaded in this figure have high access rates and high grid reliability and therefore offer less of a focus market for OGS suppliers.

The OGS market has evolved rapidly beyond lighting and consumptive energy services for households and microenterprises, offering a range of PULSE applications. Demand for dual-use appliances (providing both residential and productive use services), as well as demand for SWPs, cold storage solutions, and solar milling solutions for smallholder farmers, is substantial and expected to grow.

- **The potential SWP market exceeds 67 million smallholder farmers worldwide, and SWPs can help relieve the strain on overstretched main grids.**³¹ Sub-Saharan Africa is the largest potential market for SWPs, with more than 43 million smallholder farmers currently without access to the main grid. In South Asia at least 22 million smallholders are not currently connected to the grid, with a further two million smallholders in South East Asia without grid connections. In addition, governments are increasingly incentivizing uptake of SWPs by grid-connected farmers, opening a large potential market. For example, the governments of India and Bangladesh are supporting the deployment of SWPs to reduce the strain on over-stretched electricity distribution grids.
- **Solar-powered cold storage solutions also have large market potential, with 6.5 million smallholder farmers in Sub-Saharan Africa alone active in sectors that would benefit from refrigeration.**³² Six-and-a-half million smallholder farmers working in the dairy and horticulture sectors in SSA have no access to the grid and require cooling technologies, ranging from small cooling units for low volumes of dairy or horticultural produce to large walk-in storage facilities serving multiple smallholders.³³

31 This assumes that all smallholder farmers without electricity access are potential SWP customers. In reality, the demand for irrigation to improve productivity varies by crop type, access to market, quality of seed, and other non-energy-related aspects. In addition, demand is influenced by farmers' ability to pay and SWPs' affordability.

32 Lighting Global, Market Opportunity for PULSE, 22

33 Lighting Global, Market Opportunity for PULSE.

- **The potential demand for solar mills and threshers in Sub-Saharan Africa is around 940,000 units.** In Sub-Saharan Africa, 38 percent of a total 120 million metric tons of produce is processed by smallholder farmers, of whom approximately 75 percent are off-grid. Assuming a capacity of 55 metric tons per processing unit, this market could be serviced by 940,000 processing units.³⁴
- **Dual-use PULSE appliances—used for both residential and productive use which include fans, televisions, and refrigerators—represent a market of 38 million users. Fans enable small and microenterprises to work longer and more productively in very hot climates—and have been a major driver of OGS sales in countries like Pakistan.** Televisions provide a potential income stream, with 12 percent of off-grid television owners in East Africa showing television for a fee.³⁵ Refrigerators are primarily used by small businesses to sell cold goods and avoid food spoilage.³⁶ Finally, solar-power electric cookstoves and hand tools such as drills, saws, and hair clippers also show promise, as they could save their relevant micro-enterprises significant time and labor.

Unlocking the PULSE market potential requires tackling specific affordability challenges. Affordability presents especially specific challenges in the agricultural PULSE market, with repayments heavily dependent on crop yields and timing of revenue. Business models and payment schemes must be adapted to income levels and the seasonality of agricultural income to allow farmers to reap the benefits of increased earnings.

Public institutions such as education and health facilities represent an important potential for OGS technologies. In 78 low- and middle-income countries, 59 percent of health care facilities lack access to reliable electricity, and in the Democratic Republic of Congo just 9 percent of health care facilities have access to reliable electricity.³⁷ Similarly, for education facilities, just 34 percent of primary schools in Sub-Saharan Africa and 52 percent in South Asia have access to electricity.³⁸

Serving these public institutions will require continued refinement of sustainable OGS technologies and business models. Two of the major challenges that supply models need to address are (1) tailoring OGS technology to the specific and varied needs of public institutions and (2) adapting business models to a business-to-public (B2P) sector approach, in particular taking into account affordability for the public purse and incentivizing long-term sustainability. The upfront cost of systems poses a major constraint for governments, which have limited public budgets, as does the cost of ensuring the systems are well-maintained and operational. Institutional OGS systems often break down due to a lack of dedicated financing for operations and maintenance, as well as due to a lack of awareness of the need, or a lack of technical capacity, to maintain these systems.³⁹ To address these challenges, innovative financing structures are emerging, including public–private partnerships and fee-for-service arrangements with local service providers.

³⁴ Lighting Global, Market Opportunity for PULSE, 23.

³⁵ Emmanuel de Dinechin, Guillaume de Chorivit, and Oliver Reynolds, Powering Opportunity: The Economic Impact of Off-Grid Solar (Utrecht: GOGLA, July 2018), <https://www.gogla.org/resources/powering-opportunity-the-economic-impact-of-off-grid-solar>, 56.

³⁶ Dalberg, Off-Grid Appliance Market.

³⁷ Ryan Cronk and Jamie Bartram, “Environmental Conditions in Health Care Facilities in Low- and Middle-Income Countries: Coverage and Inequalities,” *International Journal of Hygiene and Environmental Health* 221, no. 3 (April 2018): 409–22, <https://doi.org/10.1016/j.ijheh.2018.01.004>; and Jem Porcaro et al., *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education* (Washington, DC: United Nations Foundation; Vienna: Sustainable Energy for All, April 2019), <https://www.seforall.org/publications/lasting-impact-sustainable-off-grid-solar-delivery-models>, 24.

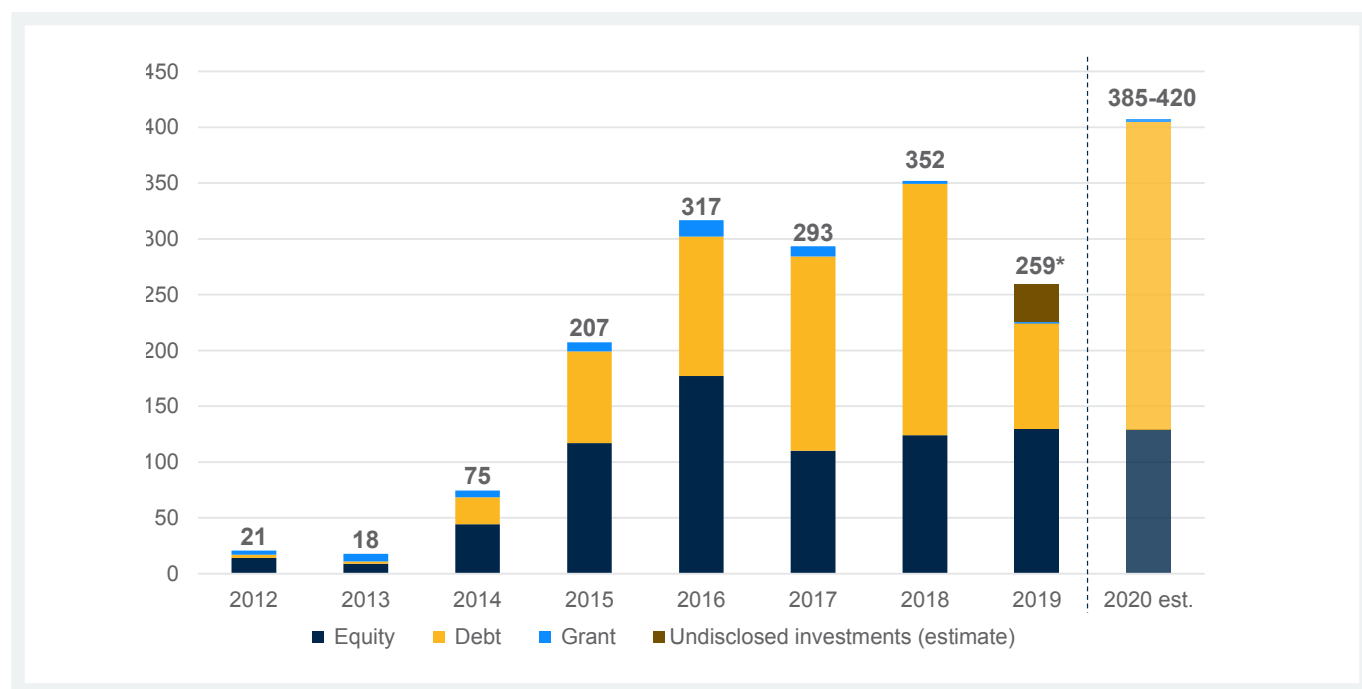
³⁸ According to data for 2015–2018. UNESCO, UIS.Stat, <http://data.uis.unesco.org/>.

³⁹ Consultations.

SEVERAL SIGNS INDICATE THE INDUSTRY'S GROWING FINANCIAL MATURITY, SUCH AS AN INCREASE IN DEBT INVESTMENTS AND LARGER INVESTMENT SIZES.

As of the end of 2019, the OGS sector had attracted more than US\$ 1.5 billion in investment, with growth in the early years primarily driven by equity, and debt becoming more common recently.⁴⁰ From 2012 to 2018, capital investment in the OGS sector grew at a 50 percent compound annual growth rate (CAGR), with investments in 2018 reaching an all-time high at US\$ 352 million (Figure RS 10). The decline in 2019 should not be cause for concern but is rather symptomatic of (1) the concentration of investments in First-Generation companies, which raise debt funds cyclically, and (2) the long time horizons on debt deals. A number of First-Generation companies raised significant debt in 2017/18, so the decline in 2019 is unsurprising; several First-Generation companies are expected to close large debt financing rounds again in 2020. In addition, increasingly large and complex debt deals are taking longer to close, with the anticipated announcement of around US\$ 100 million in debt delayed from 2019 to early 2020. This puts 2020 on course to be a bumper year for debt investments, potentially driving total annual investment to an estimated all-time high of US\$ 385–420 million.

Figure RS 10: Capital Invested by Type (2012–2019, 2020 Est.)



Source: Vivid Economics and Open Capital Advisors analysis of GOGLA, Deal Database.

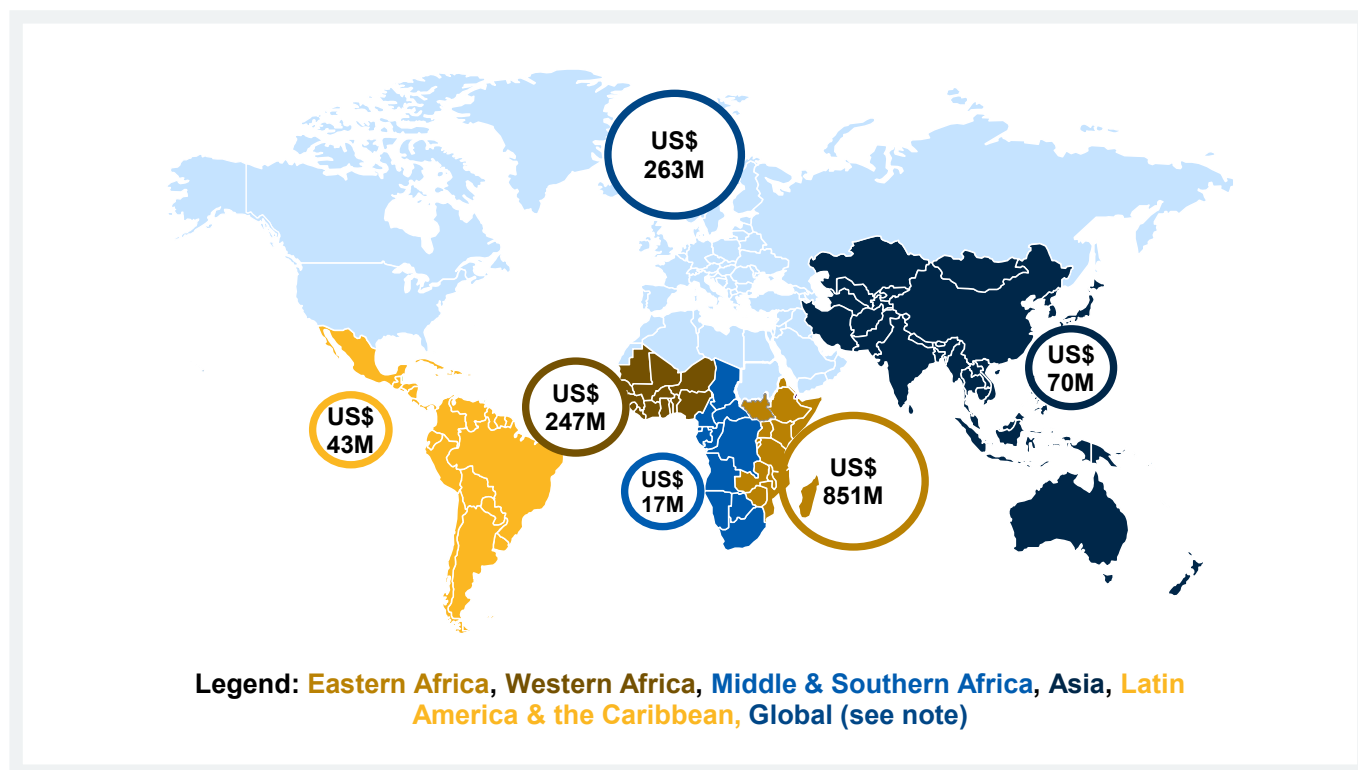
Note: The GOGLA database does not include 2019 investments. As such, deals have been sourced from secondary research and publicly available information. Undisclosed investments for 2019 are included based on investment trends from 2016 to 2018; 2020 estimates are based on current investment trends and deals that are expected to be announced in the first quarter of 2020 after failing to close in 2019.

40 2019 investments have not yet been collected by GOGLA and have been sourced from secondary research and publicly available information. As such, 2019 data may not be fully representative of all investments made in the year due to undisclosed deals, for which estimates have been made. GOGLA, Deal Database (Investment Data 2012–2018), <https://www.gogla.org/access-to-finance/investment-data>.

As the sector matures, debt will continue to drive the total value of investments into the sector, though equity demand remains strong. Equity investments dominated transaction value in the sector’s early stages, as companies raised funds to test their business models. In recent years, debt has become the most frequently utilized financing instrument in terms of both value and number of transactions. This is especially true for First-Generation companies that have greater working capital requirements and whose cashflows can support larger amounts of debt. Meanwhile, equity investment has remained relatively constant in recent years, as few new investors enter the sector and others have already chosen players to back and have not yet seen a return on this capital through exit. Grants remain an important but small percentage of the total capital deployed to the sector.


There is a growing gap between the ability of First- and Second-Generation companies to raise capital. Investments have been highly concentrated, with the top 10 recipients of financing receiving 80 percent of the total value of investment to date. Second-Generation companies have struggled to raise equity, as existing early-stage investors in the sector have already made equity plays, and these companies are still too small to interest later-stage investors. Investments are also geographically concentrated (Figure RS 11), with East Africa dominating in terms of both value and number of investments, having received 60 percent of total capital to date due to the presence of several large First-Generation companies that can absorb large amounts of debt. While investments in West Africa appear to be increasing, this is driven by just two First-Generation companies in the region, with very limited capital flowing to the dozens of other, smaller companies present. Similarly, investments into Asian markets are limited to major investments in two First-Generation companies that launched in Asia.

Figure RS 11: Total Cumulative Investments by Region (2012–2019)



Source: Vivid Economics and Open Capital Advisors analysis of GOGLA, Deal Database.

Note: Regions are based on GOGLA definitions. Global refers to investments raised by companies that operate across multiple regions, such as Angaza, d.light, and Greenlight Planet, and that generally do not raise capital on a region-by-region basis.



INVESTOR TYPES ARE SHIFTING, WITH AN INCREASED PRESENCE OF LARGER STRATEGIC INVESTORS, SPECIALIZED DEBT PROVIDERS, AND CROWDFUNDING; WHILE LOCAL BANK INVOLVEMENT REMAINS NASCENT, LOCAL CURRENCY DEBT IS ANTICIPATED TO INCREASE.

- **Strategic investors**, such as ENGIE, Mitsubishi, Shell New Energies, and Sumitomo have invested in large First-Generation companies, with deals spiking in 2018 and 2019. These investors have deep pockets and long-term interests, making them ideal investors to help exit other equity positions and bring capital, expertise, and global networks to support the sector. But this trend is nascent; most strategic investors are waiting to see signs of further scale and maturity before committing further capital.
- **Impact investors and venture capital (VC) funds**, instrumental in catalyzing the sector, are unable to recycle their capital as a lack of exits prevents them from liquidating their early investments. Hence, these investors have not been able to continue investing as they had in the sector's early days.
- **Crowdfunding platforms** have gained prominence in the sector after the first investments in 2015/16. Crowdfunding leverages popular interest in the sector and has gained traction, particularly for companies between Series A and B rounds that struggle to access more commercial debt capital. In some cases, larger companies have also benefited from crowdfunding due to the often-concessional rates and speed at which funds can be deployed, though ticket sizes tend to be small.
- **Specialized debt providers** are gaining prominence, filling an important niche for smaller, harder deals due to their deep sector knowledge, which allows them to evaluate credit profiles more efficiently. Their role is anticipated to increase as their successes attract additional funding from their own investors.
- **Development finance institutions (DFIs)** are making more direct investments as companies reach the scale to absorb larger ticket sizes; DFIs also continue to support the sector through indirect investments. DFIs invest large amounts of capital, often at concessional rates, in impact investors, specialized debt providers, VC firms, and local banks, which then invest in the OGS sector. They plan to continue catalyzing the sector in this way, as well as driving an increase in the value of local currency financing in the sector, either directly or through credit facilities administered by local banks.
- **Private equity (PE) and traditional asset managers** have made initial investments in the sector, though this trend is unlikely to accelerate soon due to limited profitability and some high-profile losses, such as Investec's investment in Mobisol. Private equity investors write the larger ticket sizes the sector now requires but are more commercial, expecting higher returns over shorter periods. This does not fit the current profile of the OGS sector, which requires higher risk tolerance and more-patient investments.
- **Local banks** have been involved in few OGS transactions to date, though there are signs that this may be changing as stakeholders continue to support their engagement. Key hurdles for further involvement will be increasing banks' understanding of OGS-specific credit risks, demonstrating increased profitability in the sector, and continuing to de-risk local banks' investments through syndication. Increasing local banks' involvement can yield huge benefits for the sector because they are able to supply local-currency financing and act as a new source of capital for OGS companies.

The currently increasing availability of local currency financing and hedging instruments will enable companies to better manage their foreign exchange risk. In the past, OGS companies have struggled to manage foreign-exchange risk due to the lack of available local currency financing. Most investment in the sector has been in hard currency, while companies often have local currency revenues and long revenue cycles for PAYGo sales. This exposes them to potential local currency depreciation risks as they convert local currency revenues to repay hard currency financing over time. Since the last Market Trends Report, this trend has begun to change, driven by several DFIs, funds that offer direct local currency financing, and hedging providers that offer to assume this currency risk. There also appears to be an opportunity to involve local banks and institutional investors, which have expressed greater interest in the sector and, in some cases, have already been involved in local currency financing rounds.

ACCELERATING FUNDING FOR THE SECTOR WILL REQUIRE INNOVATIVE FINANCING MECHANISMS, AND COMPANIES NEED TO DEMONSTRATE PROFITABILITY AND INCREASE TRANSPARENCY AROUND OPERATIONAL EFFICIENCIES.



While the US\$ 1.5 billion capital inflow to date has fueled the sector's growth, it is not yet anywhere near sufficient to serve the available market opportunity. The vast majority of companies report a lack of available finance, and Second- and Third-Generation companies particularly report a shortage of equity capital. The reasons for this lack of capital can be summarized by four key themes: (1) very few new equity investors are entering the sector; (2) the lack of exits prevents investors from liquidating to reinvest equity and discourages potential new investors; (3) commercial investors require large ticket sizes to invest, requiring companies to reach sufficient scale; and (4) investors are increasingly requiring near-term signals of profitability and positive cash flows, which they are not yet finding.

A range of financing mechanisms, such as off-balance-sheet financing, will enable additional capital to flow into the OGS sector. Off-balance-sheet financing has increased in the past few years, although uptake has been slower than anticipated due to the high complexity, costs, and risks of this mechanism. However, significant progress has been made in sensitizing the sector to off-balance-sheet financing, with some companies expected to announce large deals within the next 24 months. This could pave the way for securitization to further accelerate capital availability by de-risking investments. Some companies are looking at bond structures, including green, climate, and social bonds, as ways to attract new sources of capital.

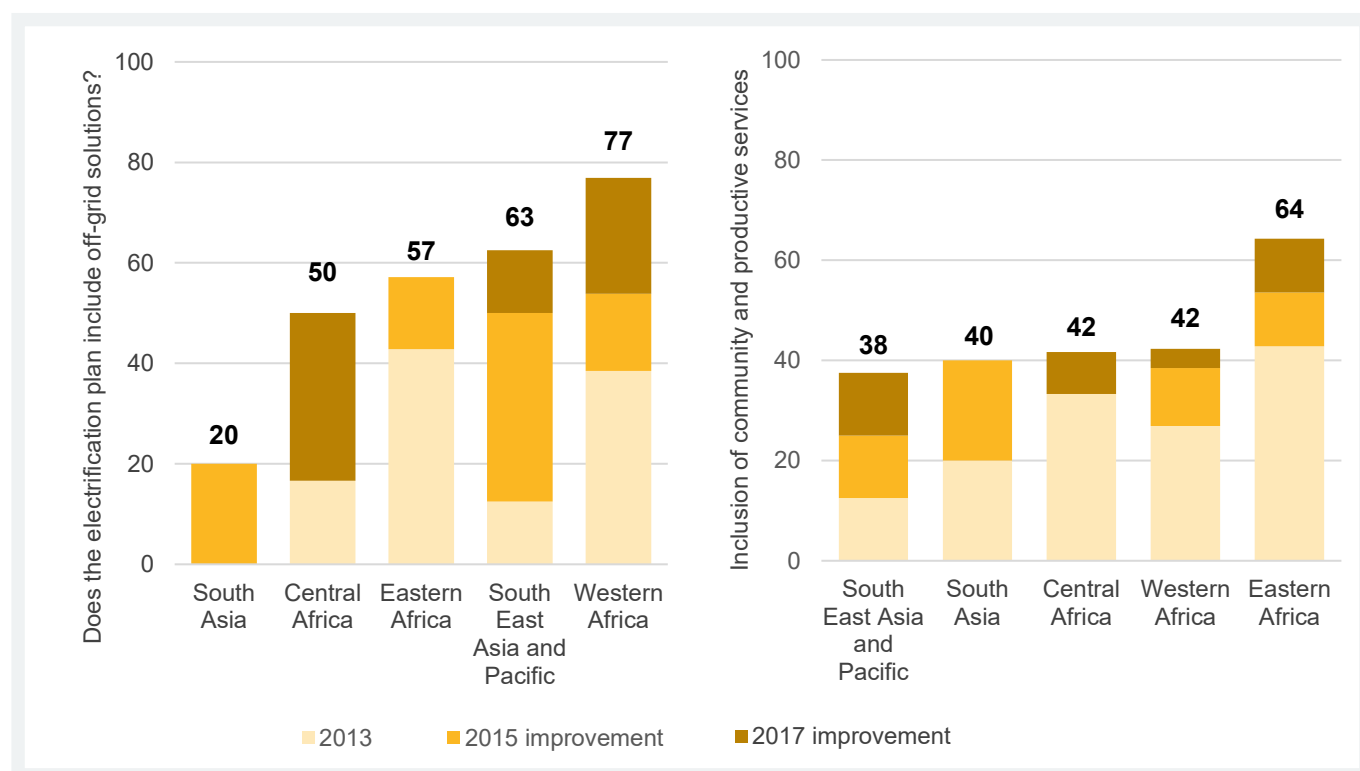
Some companies are now well on their paths to profitability, which will attract new sources of capital. Companies have begun to achieve EBITDA profitability, at least within key country markets. However, the complexity of OGS business models means that EBITDA profitability might not tell the whole story. Companies are now increasingly focusing on understanding their fundamental unit economics and cashflows, as well as on more transparent Key Performance Indicators (KPIs) such as customer acquisition costs, average revenue per customer, contribution margin, cost of capital, utilization, and collection efficiency.⁴¹ Projects such as the PAYGo PERFORM, a joint initiative by IFC, CGAP, and GOGLA, underpin moves to standardize financial reporting metrics for the PAYGo sector to increase investor confidence.

41 Acumen and Open Capital Advisors., Lighting the Way: Roadmap to Exits in Off-Grid Energy (New York: Acumen; Nairobi: Open Capital Advisors, 2019), <https://acumen.org/energy-exits-report/>, 29–32.

GOVERNMENTS INCREASINGLY RECOGNIZE OGS AS A KEY DRIVER FOR REACHING UNIVERSAL ENERGY ACCESS (SDG 7) BY 2030, INCREASING PUBLIC FUNDING FOR THE MARKET.

The policy landscape continues to improve, with almost all governments in countries with energy-access deficits now including a role for off-grid electricity solutions in their electrification plans. Alongside growing OGS contributions to national electrification rates, governments are increasingly cognizant of the sector’s potential and are stepping up their support for OGS.⁴² As captured in the World Bank’s Regulatory Indicators for Sustainable Energy (RISE) index, the majority of governments in all regions except South Asia include a defined role for stand-alone off-grid solutions (Figure RS 12), a drastic improvement since 2013. There has also been continued improvement in fiscal incentives to support standalone solar systems, with 65 percent of governments implementing duty exemptions or subsidy programs in 2017, compared to just 43 percent in 2013.⁴³ Progress is, however, uneven across countries, and implementation of plans sometimes lags behind policy changes.

Figure RS 12: Scores on Key RISE Indicators Have Improved Substantially since 2013



Source: Vivid Economics and Open Capital Advisors from World Bank data underlying its 2018 RISE index.

Geospatial least-cost electrification planning tools are now more and more available and increasingly inform national electrification plans. These emerging geospatial planning tools are transforming electrification planning by allowing for accelerated, relatively low-cost, and visually powerful modelling of least-cost electrification pathways that

42 Juliette Besnard et al., “Chapter 1: Access to Electricity,” in *Tracking SDG 7*, by the International Energy Agency et al. (Washington, DC: The World Bank, May 2019), 32–33.

43 Of the 65 percent of governments with duty exemptions, subsidies, or both in place in 2017, 80% had duty exemptions and 63% provided subsidies.



clearly define the role of main grids, mini-grids, and OGS technologies. Open-source tools are emerging to make geospatial planning tools widely available, in particular with the launch of the Global Electrification Platform (GEP) in November 2019.⁴⁴ The World Bank and ESMAP have supported or are in the process of supporting geospatial least-cost electrification plans in 20 countries. Other development partners, such as GIZ and Power Africa, are providing additional support.

Best practices for OGS integration into national electrification programs are now emerging. Togo and Ethiopia are among the successful examples of how OGS has been incorporated into national electrification plans to catalyze demand and facilitate suppliers' routes to market. In Togo, a clearly defined role for OGS technologies, transparent licensing requirements, and government support to relieve key market barriers has attracted private-sector operators. Similarly, Ethiopia has set a clear national policy framework for the country's pathway to universal access, using OGS as both a transition and a long-term solution. Meanwhile, Kenya is leading the way in demonstrating how government support can unlock hard-to-reach and low-affordability customers by providing targeted local currency financing and results-based incentives. All three countries have also adopted favorable tax regimes for OGS products.

Governments are increasingly adopting quality standards, promoting consumer awareness, and implementing consumer-protection measures. Building consumer confidence in OGS products is essential—especially in younger markets—and governments play a key role in protecting consumers from exposure to low-quality products or excessive financial risks. Raising awareness of the benefits of (high-quality) OGS products is critical to catalyzing demand among new potential customers. Lack of awareness among consumers is the most common reason for their lack of uptake, ranking even above affordability.⁴⁵ Governments increasingly are adopting and implementing internationally recognized quality standards, often tying tax and import exemptions to qualifying products. For example, Ethiopia recently adopted international standards, which lowered importation costs for OGS companies and helped reduce the inflow of low-quality products.

PAYGo solutions are the fastest-growing business model—and require an enabling environment that expands traditional energy sector policies and regulations to reach their full potential. Creating a positive enabling environment for PAYGo requires consideration of the interlinkages among energy sector policies, financial inclusion, and digital finance, as well as, more broadly, regulations around the provision of consumer credit and the banking sector. This means that energy authorities must closely coordinate with their counterparts in the digital and financial sectors; furthermore, regulatory changes in these sectors can inadvertently affect OGS.

Governments play a critical role in creating an enabling environment to put PAYGo on a sustainable growth path, with customer protection a key consideration. Unbanked customers buying solar home systems through microfinance or the PAYGo business model may have limited prior exposure to consumer finance. Working with consumers is key to ensure they can meet repayment profiles and that the OGS product is affordable without placing poor households under unanticipated financial strain. Government policy and regulation can help protect consumers against risks related to consumer finance, but these cross-sector policies must be developed in close consultation with the industry to ensure that they enable and do not restrict financial inclusion. The industry recently adopted the GOGLA code of conduct which recognizes companies' duty to consider consumer protection against these risks. Governments can draw on this code in setting policy.

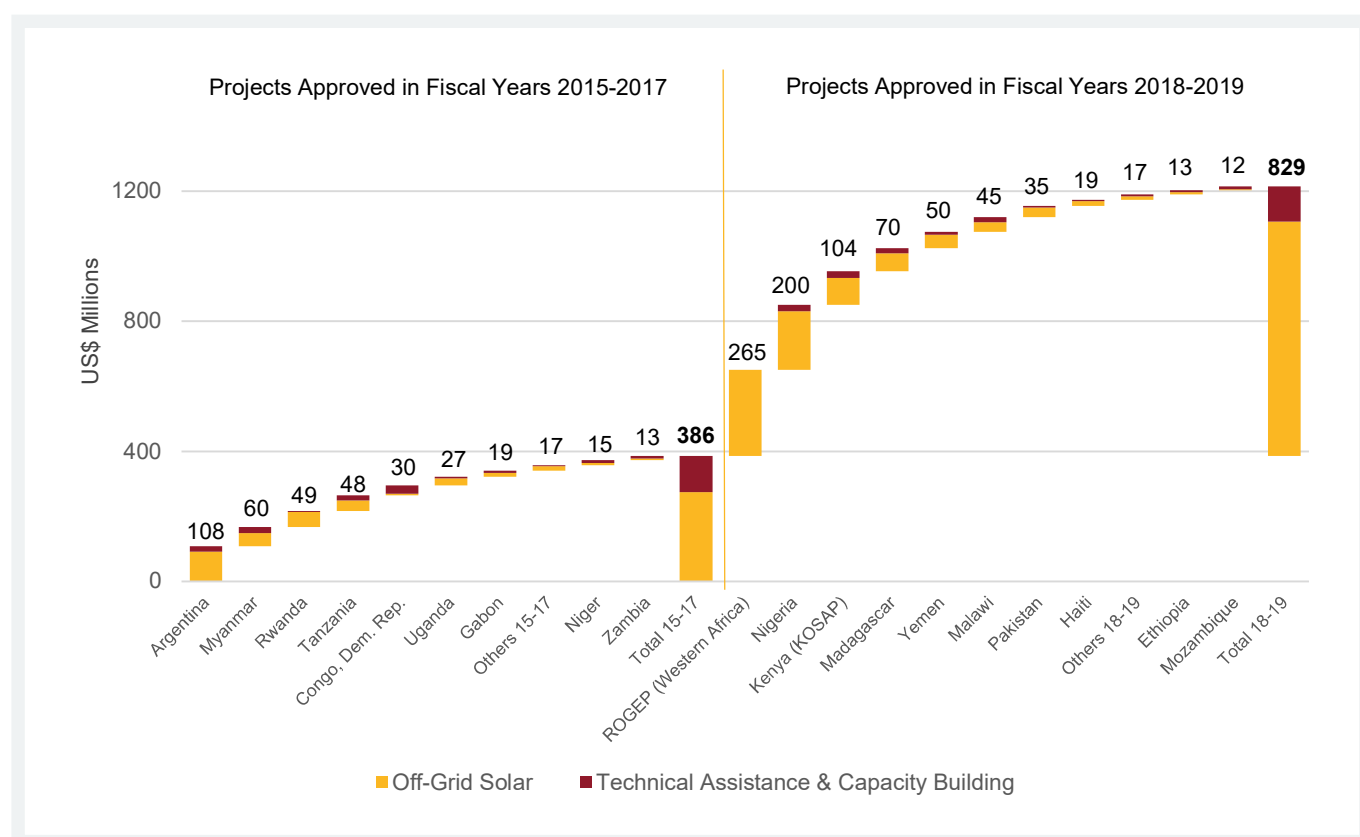
The new policy and regulatory frameworks supporting OGS need to be flexible to keep pace with a fast-evolving sector. These frameworks will need to evolve to address new opportunities and challenges, such as PAYGo, PULSE applications, and the electrification of public institutions. In addition, the impact of policy measures will depend on whether governments have the capacity and political will to adequately support their implementation. It is too early to evaluate the success of the most recent wave of national policies, but it is clear that policy goals must be met by strong and quickly implemented plans. In this spirit, development partners must support governments to ensure that they have the financial and technical resources they need to implement ambitious policies and strategies and that the support for off-grid electrification does not fade as a result of political or capacity constraints.

44 The GEP analyzes different pathways to national electrification for more than 50 countries based on an open source, geospatial, least-cost electrification model. ESMAP, "Global Electrification Platform," <https://electrifynow.energydata.info/>.

45 Kat Harrison and Tom Adams, An Evidence Review: How Affordable is Off-Grid Energy Access in Africa? (New York: Acumen, March 2017), https://energypedia.info/wiki/Publication_-_An_Evidence_Review:_How_Affordable_is_Off-grid_Energy_Access_in_Africa%3F.

Public funding for the OGS sector has grown rapidly, with over US\$ 800 million for OGS and energy access-related technical assistance approved by the World Bank from 2018 to 2019 alone.⁴⁶ This represents a significant increase in the availability of finance compared to the US\$ 386 million approved by the World Bank between 2015 and 2017 (Figure RS 13). The World Bank has a forward-looking commitment to continue the levels of funding seen in the last few years, with approximately US\$ 400 million for OGS and technical assistance already in the pipeline for 2020 and 2021. The vast majority of this funding is provided in the form of loans to governments, with governments' willingness to borrow funds to support the sector underlining their growing commitment to the role of OGS in achieving universal electricity access.

Figure RS 13: World Bank Funding for Off-Grid Solar Has Increased Substantially over the Last Four Years



Source: Vivid Economics and Open Capital Advisors analysis of funding for the OGS sector by the World Bank's energy access projects, based on the World Bank's "Project Appraisal Documents," 2015–2019.

Note: The figure shows only the committed amount for off-grid funding and technical assistance for projects with an off-grid component, although the technical assistance component itself is not exclusive to off-grid but is instead allocated for energy access in general. Energy access projects often include grid-based and mini-grid components.

In addition to this World Bank funding, a wide range of bi- and multilateral funds are available for OGS. For example, the Off-Grid Energy Fund launched by the AfDB, Nordic Development Fund, and the Global Environment Facility has committed capital of almost US\$ 60 million, and this is just one of a large number of funds offering finance to the OGS sector.

Supply- and demand-side subsidies will continue to play a key role in scaling up commercial opportunities, unlocking further market potential, and reaching the poorest and hardest-to-reach consumers (including in fragile and conflict-affected states).

- **In markets with commercial potential, supply-side subsidies channeled through companies and investors are best placed to support market development.** These include a range of initiatives, such as concessional debt facilities, grant funding, and risk-sharing instruments. Results-Based Financing (RBF) instruments, for

⁴⁶ Based on the World Bank's "Project Appraisal Documents," 2015–2019. n.b. World Bank fiscal years.

example, are proving an effective means to support market expansion. Examples include RBF schemes targeted at companies seeking to accelerate market growth (in, for example, Nigeria and Myanmar), targeted at hard-to-reach populations (such as the Kenya Off-Grid Solar Access Project), or to incentivize entry and expansion in yet unexplored markets, such as Burundi.

- **To address affordability and attract OGS companies in markets where ability to pay is low, direct consumer subsidies are being explored to complement supply-side subsidies.** Demand-side subsidies remain in the pilot stage, and more evidence is needed to demonstrate working subsidy models before they can be scaled.

Both supply- and demand-side subsidies must be carefully designed to ensure that they are well targeted, sustainable, and minimize the risks of market distortions. Distortions ultimately impede market development. Despite their risks, subsidies will be needed to achieve universal access to electricity, especially to connect the 30 percent of households globally that cannot yet afford a Tier 1 system.

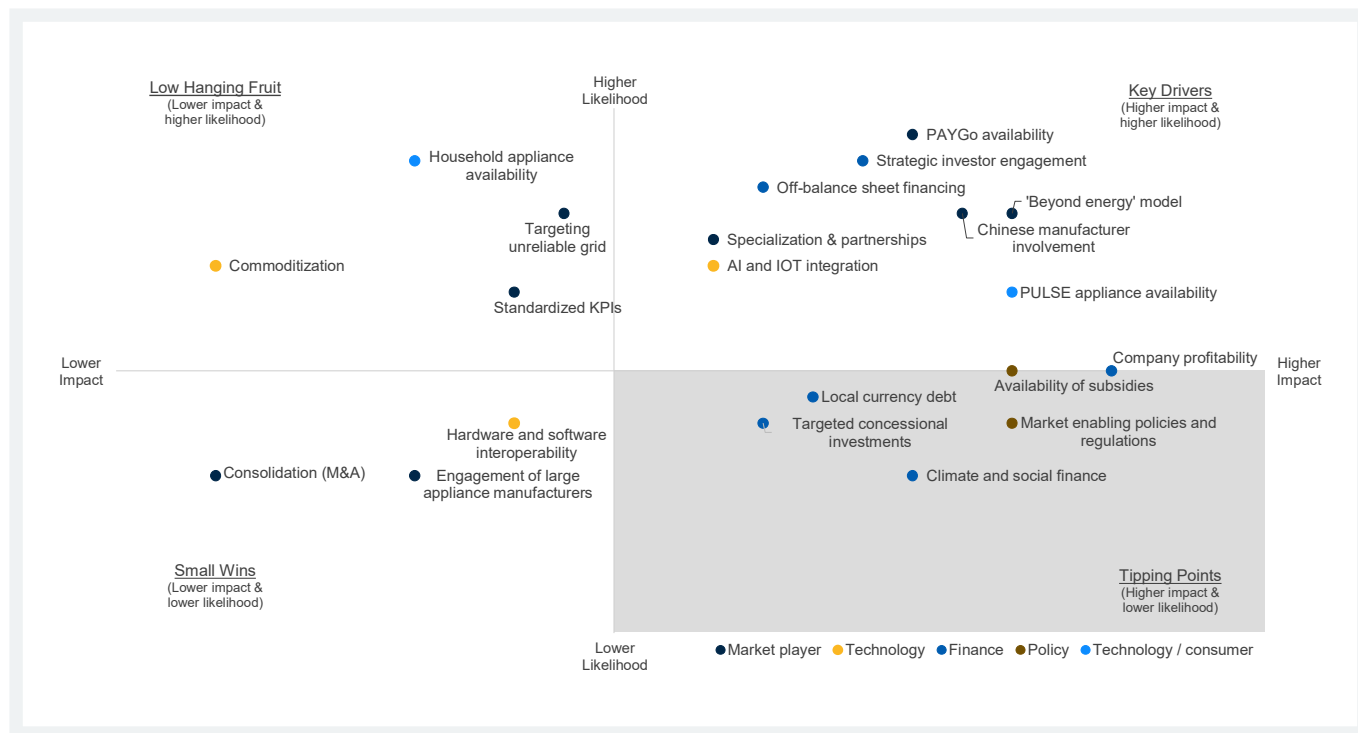
For continued success, the sector must find ways to leverage public funds to create sustainable and economically viable markets that attract increasing levels of commercial capital. It is crucial that public funding be used to relieve market barriers and crowd-in commercial investment, catalyzing fully (or at least increasingly) commercial markets. Design of any facility should be judged by its ability to crowd-in commercial funds. Growing competition between concessionary and commercial capital for transactions risks decreasing interest rates on debt and crowding out or delaying market entry by commercial lenders.⁴⁷ Blended finance is likely to emerge as a stronger trend in the future, with public funds structured to address early-stage sector risk and, thus, crowd-in commercial investors. Similarly, crowdfunding platforms are increasingly blending investment from their customer base with public money (in the form of guarantees and matching funds), which allows crowdfunders to offer much-needed smaller ticket sizes alongside more flexible conditions.

THE OGS MARKET REMAINS ON A STRONG GROWTH TRAJECTORY, BUT NEEDS AN ADDITIONAL BOOST TO REACH UNIVERSAL ACCESS (SDG 7) IN THE NEXT DECADE.

Potential Game Changers for the sector influence both a projected growth scenario (what is likely to happen) and a universal access scenario (what needs to happen to achieve SDG 7). We identified a long list of potential Game Changers for the OGS sector and ranked them based on likelihood as well as relative impact (Figure RS 14).

⁴⁷ Johanna Galan, Juliana Martinez, and Dieter Poortman, "The Top 5 Investment Trends in the Off-Grid Solar Energy Sector," GOGLA (blog), May 9, 2019, <https://www.gogla.org/about-us/blogs/the-top-5-investment-trends-in-the-off-grid-solar-energy-sector>.

Figure RS 14: Relative Ranking of Game Changers for the OGS Sector



Source: Vivid Economics and Open Capital Advisors.

The **“Key Drivers”** are current high-impact market trends that we think are likely to accelerate going forward, enabling our projected growth scenario. The **“Low Hanging Fruit”** are also high likelihood but lower impact, and will influence our projected growth scenario to a lesser extent. To achieve SDG7, the **“Tipping Points”** have the potential to propel the OGS sector towards faster growth to close the universal access gap by 2030, but are lower likelihood and will require support across a range of sector stakeholders. Along the way, sector stakeholders may also help support the lower priority **“Small Wins”** that will have incremental impact on sector growth.

IN THE PROJECTED GROWTH SCENARIO, THE MARKET IS ON TRACK TO REACH 823 MILLION USERS BY 2030.

The OGS sector will have CAGR in sales of 6 percent over the next decade and reach 823 million users by 2030.⁴⁸ Of these 823 million users, 389 million are expected to have an OGS product that will provide them with Tier 1 service or above. In this projected growth scenario, 6 percent CAGR in sales implies a reduced annual growth rate in unit sales from 10 percent today to 4 percent in 2030.

OGS sector growth will be driven by business model adaptations, sales of larger systems and appliances, and new capital sources and structures. Pico sales will continue to represent a large share of the OGS market in

⁴⁸ Today’s annual growth rate of 10 percent in sales is not expected to continue over the next decade. Annual growth rates have historically declined; however, given volatility in the historic data, the rate of decline in annual sales growth rate is difficult to estimate. The current growth trajectory CAGR of total sales was therefore estimated in our model as the growth rate that would be needed to reach the full addressable market of 827 people (177 million households) in 2030. This was translated into an annual growth rate that declines by 8 percent every year, starting from an annual rate of growth of 10 percent in 2019. Assuming that the ratio of Below Tier 1 and Tier 1 products remains the same in 2030 as in 2019, we estimated the number of people with Tier 1 products in 2030 at 389 million.

unit sales and will be dominated by Chinese manufacturers who are expected to become LG verified and engage more directly with end-consumers. Current affiliate players will focus on higher value products, such as large SHS, appliances and PULSE products, which are expected to drive faster revenue growth and help companies make strides toward profitability.

Below, we explore the potential impact of these and additional “Key Drivers,” as well as what could happen to sector growth if these likely “Key Drivers” lose momentum or do not materialize.

- **Increased specialization across the value chain will drive efficiencies.** Previously vertically integrated firms will continue to shed value chain operations to increase focus on their core business by partnering more effectively with other players in the value chain. Meanwhile, new companies entering the sector will specialize in individual components of the value chain. This will allow companies to achieve profitability more quickly. In contrast, if the market reverts towards vertically integrated players, we expect to see more failures that have a chilling effect on investor engagement as companies struggle to achieve profitability.
- **Chinese manufacturers will engage directly with end markets.** Chinese manufacturers will continue to sell higher-quality, self-branded products through local distribution partners and increasingly through their own distribution networks, including on PAYGo. This will increase competition at the product level and increase the amount of high-quality but lower-cost products reaching the market. If Chinese manufacturers are deterred by the market barriers that have limited their direct involvement to date, including poor knowledge of end markets, fewer lower-cost products may be available in the market, resulting in less consumer choice and decreased consumer affordability.
- **PAYGo will become more widely available, driving market growth.** As enabling conditions such as mobile-money availability improve in new markets, an increasing number of companies will adopt the PAYGo model beyond East Africa. This will increase the affordability of larger products and the level of service for consumers, potentially also improving profitability for companies that can market additional products and services through their PAYGo platforms. However, if growth in mobile-money availability stalls, certain markets will remain underserved as a result of persistent gaps in affordability coupled with challenges in providing consumer financing through other channels.
- **Increased appliance efficiency and income-generation potential will drive growth in the PULSE market.** Continued improvements in appliance efficiency and lower manufacturing costs will help companies tap into the large potential demand for PULSE appliances. PULSE appliances will also see fast growth as a result of the income-generating opportunities they provide, making them attractive for consumer financing. However, if PULSE technology does not improve and manufacturing costs don't decrease even while increasing efficiency, PULSE products will not be able to compete with current alternatives, and businesses founded on these PULSE products will not reach scale.
- **More companies will implement and expand their offerings “beyond energy.”** Effective use of consumer PAYGo data will allow companies to offer consumer financing services that go beyond basic energy access, including financing for other consumer electronics, educational loans, and insurance. This will support company sustainability while also unlocking additional benefits for consumers, but the sector must be wary of over-leveraging consumers with debt. If the “beyond energy” model fails to flourish, however, companies seeking profitability will need to continue moving away from pico products towards higher-margin, larger products. This could negatively impact the sector's ultimate goal of achieving SDG 7 as companies shift away from serving generally poorer customers without electricity access.
- **Off-balance-sheet financing will accelerate.** As the risk level of receivables portfolios become better understood in a maturing sector, ever-larger amounts of off-balance-sheet financing will be used to better manage receivables and continue to help operations reach scale. This could be further accelerated through securitization to de-risk investments and attract more commercial investors to the sector. If the promise of off-balance-sheet financing continues to fall short in reality, scale in the PAYGo model will be limited by high working capital needs for ever-expanding receivables portfolios.

- **Strategic investors will play an increasingly large role.** Strategic investors will continue to take equity stakes in companies, leading to additional exits that can help free impact investor capital for investment in Second- and Third-Generation companies. Their involvement will also gradually change companies' trajectory away from fast-paced innovation and towards more sustainable growth. If strategic investors back away from the sector, the shortage of equity capital for Second- and Third-Generation companies will persist. Early-stage equity capital will remain tied up in large First-Generation companies, which may also struggle to attract later-stage equity investment.
- **Artificial Intelligence (AI) and the Internet of Things (IoT) will improve customer service and increase operational efficiency.** More companies will incorporate IoT and AI into their product offerings, allowing tailored performance management of devices to improve customer service and reduce costs.

In addition to the continued momentum of the “Key Drivers,” US\$ 1.7–2.2 billion in total external investment will be required from 2020 to 2024 to maintain the current growth trajectory.⁴⁹ This financing need is driven primarily by funding consumer receivables of PAYGo businesses and increased inventory financing. Therefore, debt is expected to continue being the major source of capital, representing 65 percent of this external investment need. Companies will also require equity and grant financing to test out new products and expand to new markets. Equity is expected to represent 30 percent of this financing need while grants would represent 5 percent.

DESPITE THE STRONG MARKET GROWTH TRAJECTORY, THE SECTOR WILL LIKELY MISS SDG7 BY AT LEAST 228 MILLION PEOPLE.



Achieving universal access to electricity by 2030 would require that as many as 617 million people be served through OGS products as their main source of electricity, providing Tier 1 access or above. Based on geospatial least-cost electrification projections for the 2030 population, OGS products could be the primary source of electricity for 16 percent (617 million people) of the population in Sub-Saharan Africa and Asia.⁵⁰

Consequently, if the sector continues on its current growth trajectory, it will likely be 228 million people short of its potential to contribute to universal access. The OGS share of universal access in 2030 will of course depend on a range of factors, including how quickly and cost-effectively national utilities are able to expand the grid and whether mini-grids are able to scale towards 2030 at the pace required to reach their electrification potential.⁵¹ In all scenarios, because of relatively low costs, modularity, proven business models, and continued innovations, the OGS sector nevertheless offers a key part of the technology mix needed to close the gap towards universal electricity access for all.

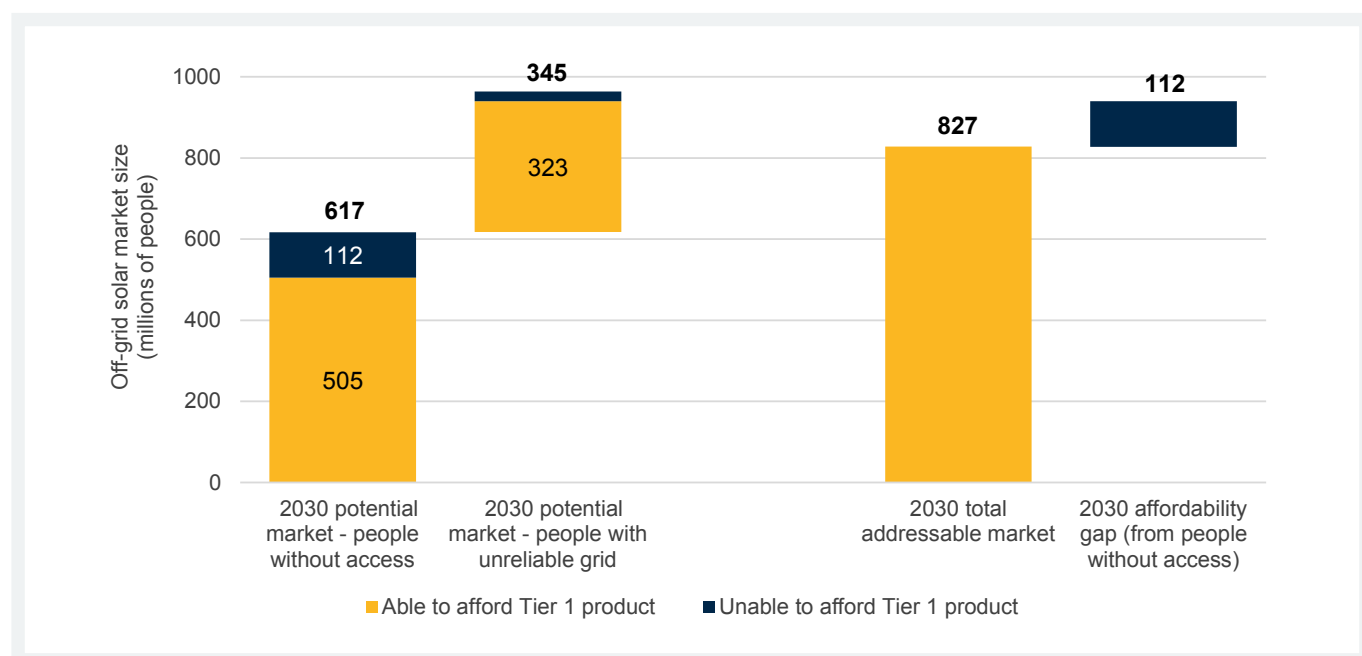
⁴⁹ The lower figure for investment need is based on scaling up total investment to date to arrive at the investment needed from 2020 to 2024. The higher figure extrapolates inventory and receivables need per unit to cumulative forecast Tier 1 sales volumes.

⁵⁰ Based on the recently launched World Bank/ESMAP Global Electrification Platform (GEP) projections under the “universal access” scenario, given medium population growth, GEP estimations of cost for on-grid and PV costs, and a low top-down demand target. The choice of a low demand target reflects the least-cost plan, consistent with the ambition to ensure that every household has at a minimum Tier 1 electricity access by 2030. ESMAP, “Global Electrification Platform,” <https://electrifynow.energydata.info/>.

⁵¹ ESMAP, Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, Technical Report 014/19 (Washington, DC: The World Bank, June 2019), <https://openknowledge.worldbank.org/handle/10986/31926>.

Of the potential market of 617 million people with OGS as their main source of access, 505 to 603 million will be able to afford a product that will bring them Tier 1 access or higher.⁵² This affordability range is driven by two factors: (1) people’s rising incomes up to 2030 and (2) different methods of determining affordability. The lower 505 million figure reflects the most conservative combination of these two factors, using present-day incomes and evaluating people’s ability to afford monthly payments across the entire product lifetime (Figure RS 15). By contrast, the upper 603 million figure combines 2030 incomes (which will be higher) with an evaluation of people’s ability to afford only the PAYGo deposit with three months’ savings, assuming people will be able to make the monthly payments after that.⁵³ The affordability gap is only relevant for people without access, as only these people must be served to reach universal access goals. In addition, a further 345 million people are expected to use an OGS device as a backup for an unreliable grid.

Figure RS 15: By 2030, the Potential Market Consists of 617 Million People Without Electricity Access and 345 Million People With an Unreliable Grid, About 85 Percent (827 Million People) of which is Addressable




Source: Vivid Economics and Open Capital Advisors.

Note: Conservative scenario, assuming present-day income and evaluating households’ ability to afford monthly payments across the entire product lifetime.

⁵² To estimate the addressable market, we consider the total potential market in 2030 (people without access and “realistic” number of people with an unreliable grid), determining their ability to pay the average price of a Tier 1 product. We then segment this addressable market by comparing the total system costs of pico and SHS products and assuming people will purchase the highest-capacity product they can afford. The unreliable grid market is based on current estimates of grid unreliability per country, assuming the 2018 share of unreliability will remain constant to 2030. It further assumes 25 percent of unreliable grid people could also purchase an OGS product as a backup device for residential use, to power their SME or microbusiness, or both.

⁵³ To determine affordability, we compared monthly PAYGo payments to 5 percent of monthly household expenditures (today and in 2030). Ability to pay the PAYGo deposit is compared to three-month savings at 5 percent of monthly expenditure (today and in 2030).



REACHING SDG7 BY 2030 WILL REQUIRE THE OGS SECTOR TO GROW AT AN ACCELERATED ANNUAL RATE OF 13 PERCENT, AS WELL AS US\$ 6.1 TO 7.7 BILLION IN EXTERNAL INVESTMENT FOR OGS COMPANIES AND US\$ 0.5–3.4 BILLION OF PUBLIC FUNDING TO BRIDGE THE AFFORDABILITY GAP.

Closing the gap towards universal access requires the sector to grow at an average annual growth rate of 13 percent, over double current projections. This growth rate would allow the sector to provide the addressable market of people without access and those currently below Tier 1 with a Tier 1 product—taking continued efforts of grid and mini-grid electrification into account. To additionally provide people with an unreliable grid with a Tier 1 product would require even faster growth at 18 percent CAGR in sales.

Achieving this growth rate will require concentrated efforts across stakeholders. Companies need to prove profitability to expand sustainably and drive investor confidence. Investors need to double down and drive new flows of capital into the sector. Policymakers need to create favorable enabling environments for OGS. And donors need to close the affordability gap for consumers and incentivize companies to move into new markets.

Below, we explore the “Tipping Points” that could supercharge sector growth, but these will require increased investment and focus across different sector stakeholders.

- **Companies need to achieve profitability and become cashflow positive.** Profitability underpins long-term sector growth and sustainability and would drive a new wave of investment into the sector – including from a new, currently untapped, later-stage commercial investor base.
- **Market-enabling policies, regulations, and enforcement need to improve.** Governments can drive policy and regulatory changes to support the sector more quickly than ever before. Accompanied by robust implementation plans, they can thereby crowd-in public and private capital to finance ambitious off-grid electrification plans. However, now that governments have realized the importance of the OGS sector and begun to incorporate OGS in national electrification plans as well as their tax and customs regimes, over-regulation may be a risk that could impede sector growth. For example, the growth of the PAYGo sales model (a Key Driver supporting the sector’s current growth trajectory) could be severely curtailed if policymakers decide to regulate PAYGo companies like financial institutions.
- **Supply-side incentives and demand-side subsidies are needed to address the affordability gap and catalyze markets.** The right supply-side incentives can encourage OGS companies to develop new markets and serve more users. The right demand-side incentives can help achieve SDG 7 by closing the affordability gap for the poorest consumers. However, these public finance initiatives must be well-targeted to accelerate market development and increase market inclusion for the poorest consumers without distorting commercial markets.
- **Concessional finance needs to be targeted at early-stage companies and nascent markets, creating a new wave of innovation.** As some market segments move to profitability, concessional finance can be targeted to catalyze nascent markets, support continuing innovation in PULSE products for early-stage companies, electrify public institutions, and serve the hardest-to-reach residential markets.
- **A stronger link between climate change or social finance and the OGS sector is needed to enable a new wave of funding.** As the OGS sector expands, it is well-placed to take advantage of climate and social impact bonds, which would unlock massive amounts of new concessional capital.

- **Increased access to local currency loans is needed to de-risk investments and drive growth.** In the short term, larger amounts of local currency financing could be available from specialized debt providers, currency hedging providers, and DFIs to help companies manage their foreign-exchange risk. Within the next decade leading up to 2030, OGS companies will need to access local currency financing directly from local banks.

To realize the OGS sector “Tipping Points,” investors, governments, and donors will need to inject an additional US\$ 6.6–11 billion in financing (Figure RS 16).⁵⁴ The majority of this financing, US\$ 6.1 to 7.7 billion, will be external investments into OGS companies in the form of debt, equity and grants. Debt will be critical for companies to finance receivables at such an accelerated pace of growth while equity and grants will enable companies to rapidly expand to unserved markets. But investment into OGS companies will not be enough. Up to US\$ 3.4 billion of public funding from governments and development partners will be required to bridge the affordability gap for people without electricity access that are unable to afford a Tier 1 OGS product.⁵⁵

Figure RS 16: Total Funding Needed to Reach SDG7



Source: Vivid Economics and Open Capital Advisors.

Achieving universal access by 2030 therefore requires the sector to grow much faster, with significantly more external investment and public funding to bridge the affordability gap. Given the sector’s track record, its proven ability to innovate, expansion in terms of geography and products, falling costs and rising quality, even in the nonaffiliate market, together with the enhanced focus by governments and development partners on the SDG7 goal, the OGS sector certainly could surpass the current growth trajectory forecast, particularly if public funds can be used to catalyze markets and crowd-in private sector finance.

⁵⁴ Taking into account repeat purchases from now to 2030 as asset life of the products expires. Overall asset life is the weighted average of pico and SHS products. The lower investment figure is based on scaling up total investment to date to arrive at the investment needed from 2020 to 2030 to achieve the cumulative sales targets, while the higher figure extrapolates the inventory and receivables need per unit to reach cumulative Tier 1 sales volumes from 2020 to 2030.

⁵⁵ The US\$ 3.4 billion reflects the more conservative combination of present-day (lower) incomes and people’s ability to afford the monthly payments over the product lifetime. As incomes rise between now and 2030, the number of people that require financial support to afford OGS products will decrease, expanding the addressable market and shrinking the affordability gap to US\$ 1.4 billion in 2030. If we consider the least conservative combination of people’s 2030 income and their ability to afford the PAYGo deposit, the affordability gap would be US\$ 0.5 billion.

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