



Off-Grid Solar Market Trends Report 2018

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and

LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy



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The Voice of the Off-Grid Solar Energy Industry

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ABOUT

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GOGLA is the voice of the off-grid solar lighting and electrification sector. Established in 2012, GOGLA now represents over 100 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



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Lighting Global is the World Bank Group's platform to support sustainable growth of the international off-grid solar market as a means of rapidly increasing energy access to the 1.2 billion people without grid electricity. Through Lighting Global, the International Finance Corporation (IFC) and the World Bank work with the Global Off-Grid Lighting Association (GOGLA), manufacturers, distributors, governments, and other development partners to develop the modern off-grid energy market. The Lighting Global program supports market development by working with private companies to lower first-mover risk and mobilize private sector investment through market intelligence, quality assurance, business support services and consumer education. To find out more, go to www.lightingglobal.org



ESMAP

ESMAP is a global knowledge and technical assistance program administered by the World Bank. It assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. Through continuous support to Lighting Global, ESMAP aims at expanding the World Bank off-grid energy portfolio in other regions. ESMAP support focuses on (i) promoting sustainable markets with potential for scale-up; (ii) mobilizing private sector financing; (iii) leveraging synergies with other regions, the International Finance Corporation (IFC), development partners and other key stakeholders; (iv) promoting innovation and knowledge-sharing.



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Dalberg Advisors

Dalberg Advisors is a strategic advisory firm combining the best of private sector strategy skills and rigorous analytical capabilities with deep knowledge and networks across emerging and frontier markets. It has a dedicated Energy practice to help clients – from governments to multinationals and financial institutions – increase the supply of economically viable, environmentally sustainable, socially equitable energy. Its expertise spans designing evidence-based strategies for entering emerging markets, developing business models for doing business with low-income consumers, policy analysis, and innovative financing to find energy delivery models.

ACKNOWLEDGEMENTS

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The 2018 MTR was prepared by an independent advisory team from Dalberg Advisors. The team was led by Gaurav Gupta (Project Director) and Kanishka Bhattacharya (Sr. Project Manager), with support from Michael Tsan (Expert Advisor) and a dedicated team of writers, interviewers, and researchers including Kabir Nanda, Anne Johnson, Kendrick Hung and Mallika Kirti.

We welcome your feedback on this effort and encourage you to reach out to the Lighting Global team with your questions and comments through www.lightingglobal.org or by emailing info@lightingglobal.org.

ABBREVIATIONS

Segment	Definition
A2F	Access to finance
B2C	Business to consumer
BNEF	Bloomberg New Energy Finance
BoP	Base of the pyramid
C-Si	Crystalline silicon
CAGR	Compound annual growth rate
CGAP	Consultative Group to Assist the Poor
COO	Chief Operating Officer
CRM	Customer relationship management
CSR	Corporate social responsibility
DC	Direct current
DESCO	Distributed energy services company
DFI	Development finance institution
EAP	East Asia and Pacific
FMCG	Fast moving consumer goods
FOB	Free on board
FOREX	Foreign exchange
GDP	Gross domestic product
GOGLA	Global Off-grid Lighting Association
GSM	Global System for Mobile Communications
GSMA	GSM Association
GW	Gigawatt
H1	First half of calendar year
H2	Second half of calendar year
HHI	Herfindahl-Hirschman Index
IEA	International Energy Agency
IDA	International Development Association
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
KES	Kenyan shilling
kV	Kilovolts
kWh	Kilowatt hour
LAC	Latin America and Caribbean
LED	Light emitting diode

LG	Lighting Global
Li-ion	Lithium ion
lm-hr	Lumen-hour
M&A	Mergers and acquisitions
MENA	Middle East and North Africa
MFI	Microfinance institution
MIV	Microfinance investment vehicle
MTF	Multi-Tier Framework
NGO	Non-governmental organization
OEM	Original equipment manufacturer
OGS	Off grid solar
PAYGO	Pay-As-You-Go
PM _{2.5}	Particulate matter, 2.5 micrometers
PnP	Plug and play
PPP	Purchase power parity
PV	Photovoltaics
QV	Quality verified
R&D	Research and development
RCT	Randomized control trial
ROGEP	Regional Off-Grid Electrification Project
RISE	Regulatory Indicators for Sustainable Energy
SA	South Asia
SACCO	Savings and credit cooperative
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SHS	Solar home system
SIV	Specialized investment vehicle
SME	Small and medium enterprises
SPV	Special purpose vehicle
SSA	Sub-Saharan Africa
TELCO	Telecommunications company
TV	Television
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States dollar
VAT	Value added tax
VC	Venture capitalist
Wp	Watt (Peak)

CONTEXT AND KEY DEFINITIONS

In 2010, the World Bank Group published the first Lighting Africa report which quantified the significant business potential of delivering lighting to over 600 million people in Africa through portable solar lights. Seven years later, that market has borne out the initial excitement and has evolved and expanded substantially.

The market is more complex and fluid than in 2010, when it was marked by low levels of awareness, a single, lighting-oriented product, and a limited geographical presence primarily in Sub-Saharan Africa. Since then, the sector's growth has been impressive:

- Sales of over 130 million devices since 2010, penetrating approximately 17% of the global potential market, and generating 3.9 billion in cumulative revenue.¹
- Emergence of multiple product categories sold via cash and Pay-As-You-Go (PAYGO) business models, and expanding beyond lighting to increasingly include off-grid appliances.
- Significant market entry and private sector engagement from an increasingly diverse, global pool of manufacturers and distributors.
- Increasing interest and commitments from investors, including more than USD 500 million raised in the past two years.
- Growing acknowledgement from governments and development institutions who are committing significant resources to the sector.

Given this complexity and dynamism, the informational needs for the sector are also considerably different today than they were seven years ago, or even two years ago, when the last report was written. There is a need to go beyond a monolithic framing of the market, and delve into trends and dynamics of different segments and geographies. To do so in a clear and structured manner, it will be important to define and contextualize important terms related to the market that will be used heavily over the course of the report (Table 1). To aid in navigation throughout the report, several product-related terms are also matched with icons, as shown below.

¹Note: Cumulative sales refers to all devices sold to date, including those that have lapsed their warranties or have been discarded. Estimate includes affiliate and non-affiliate pico and PnP SHS, as well as component-based systems via institutional/government distribution and open-market sales. See definitions in Table 7 of full report. Source: Lighting Global/GOGLA sales data; Dalberg market model and analysis

Table 1: Key definitions

Term	Definition
Access to electricity	Traditionally, access to electricity has been measured on the basis of household connections to the national electric grid of their respective country. A recent shift, driven by SEforALL's Multi-Tier Framework (MTF) for electricity access, seeks to understand electricity access not in binary on or off terms, but as a continuum of service levels that may be satisfied by a range of technologies. ² Using global baseline surveys that are currently underway, the MTF captures more robust granularity of electricity access including capacity, duration of supply, reliability, quality, affordability, legality and safety. ³
Off-grid population	Households (or people) that lack access to an electricity connection to the national grid. These households lack Tier 1 access to electricity according to the MTF, barring the minority that have access to alternative sources of electricity such as off-grid or mini-grid technologies.
Unreliable-grid population	Households (or people) that have a poor-quality or inconsistent connection to the national electric grid. For the purpose of this report, "unreliable-grid" households are assumed to receive electricity for less than 12 hours a day. It should be noted that there is no universally accepted definition of unreliable-grid areas. Nor is there reliable data on the size of the population that lives in these areas globally. The estimates underlying this study are detailed in Section 1A.1 of the full report (see Figure 19).
Potential market	The overall market of households (or people) 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 continue to be a 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 the devices by the potential market to arrive at an estimate for the addressable market, and provides directional estimates of the market's reachability. The methodology for these estimates is in Section 1A.1 of the full report (see Table 6).


²Source: (World Bank ESMAP/SEforALL, 2015b)


³Note: While most major methodologies tracking electricity access have focused on grid electrification to date (including those by IEA in 2016 and prior), many are shifting to include all forms of electricity access, including OGS. For example, the IEA Energy Access Outlook Special Report released in October 2017 provides data that also incorporates renewable off- or mini-grid connections with sufficient capacity to provide a minimum bundle of energy services, including several lights, phone charging and a radio. For full definition, see World Energy Outlook Methodology for Energy Access Analysis (International Energy Agency, 2017b)


Off-grid solar devices (OGS)	Pico solar devices, plug-and-play solar home systems (PnP SHS), and component-based systems. ⁴
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Affiliate	Companies that are Lighting Global Program Associates, companies with products that meet Lighting Global Quality Standards, or companies that are GOGLA members. These companies report sales data to GOGLA on a quarterly basis. As a result, much more is known about this universe of players/products. The report will aim to broadly use affiliate data as a proxy for trends and developments in the wider sector. The report will also articulate and comment wherever trends diverge by affiliate versus non-affiliates.
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Non-affiliate	Companies that are not affiliated to Lighting Global or GOGLA in any way, and whose products are either branded or generic (comprising no-names, copycats and counterfeits). ⁵ These companies do not report their sales to GOGLA.
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 Pico	Lanterns and simple multi-light systems (which may enable mobile charging) of 0-10.999 Wp. These enable partial or full Tier 1 electricity access to a person or household.
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 Plug-and-play SHS	All-in-one packaged SHS kits of 11+ Wp, typically powering several lights as well as energy-efficient appliances, and enabling full Tier 1 or higher electricity access for a household.
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 Component-based systems	Devices in which components (i.e. PV module, battery, lights, inverter, wiring, etc.) are compiled independently. These devices are typically SHS (11+ Wp), but can be smaller.
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 Pay-as-you-go (PAYGO)	PAYGO refers to a business model that allows users to pay for their product via 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 there are alternative methods that include scratch cards, mobile airtime and cash.
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PAYGO is typically used on large pico devices (multi-light plus mobile charger <10.999Wp, per the Lighting Global/GOGLA product categories⁶) as well as PnP SHS (>11Wp). This report also refers to PAYGO SHS as shorthand for multi-light systems enabled with PAYGO technology; most of these are PnP SHS, but some may be multi-light pico.

⁴Note: See Table 7 of full report for definitions of off-grid solar device categories

⁵Note: Generic terminology adopted from Bloomberg New Energy Finance, 2016

⁶Source: (GOGLA, 2017)

Off-grid appliances

As defined by Global LEAP, off-grid appliances are electricity-consuming products that plug into and can operate on an off-grid energy system. They are typically highly energy efficient and use DC power to be compatible with and make the most effective use of OGS device wattage.



The Lighting Global/GOGLA Off-Grid Solar Market Trends Report has been established over the past 8 years as the report of record for the off-grid solar industry. It is the biennial anchor of the Lighting Global/GOGLA franchise of market data and trends reports, which is the go-to source of sector information for investors, industry members, policymakers, and other stakeholders in the sector. The biennial flagship publication provides an opportunity to step back for reflection on trends in the sector to deepen understanding among market players and illuminate the pathway forward for the sector.

This iteration of the Market Trends Report reviews the OGS industry's evolution in the preceding years around six topic areas: market fundamentals, sales, the competitive landscape, finance, the enabling environment, and impact. It then provides projections on likely trends in the market for the coming five years, and provides a blueprint for how actors in this market can be competitive. Given this wide-ranging scope and multiple audiences, it is important to note that this report is not exhaustive in its coverage of each topic area. Numerous targeted publications are available on specific topical areas and to meet the information requirements of specific stakeholder groups. For example, the enabling environment section of this report comprises a summary of largely external research sources rather than fresh analysis and evidence; these sources can be referenced as deeper dive resources. Relevant publications are detailed in the references at the end of the report, and further resources are available on the GOGLA, Lighting Global, and ESMAP websites.

High-growth, high-impact market to-date

In 2017, the global off-grid solar (OGS) sector is providing improved electricity access to an estimated 73 million households, or over 360 million people, thus transforming lives that were previously reliant on kerosene and solid fuels for most of their lighting needs.⁷ This market has evolved and expanded substantially since 2010, when IFC released its first off-grid lighting report.⁸ At that stage this was a market marked by low awareness, a single category of lighting-oriented products, and a limited geographical presence (mainly in Sub-Saharan Africa and India).

The sector's growth since 2010 has been impressive. It has seen:

- Substantial cumulative sales (over 130 million devices since 2010), growth (~60% CAGR), and significantly increased penetration (~17%) of the global potential market of off- and unreliable-grid households. The total sales value generated by the OGS sector has exceeded USD 3.9 billion.⁹
- Emergence of three product categories (pico, plug-and-play SHS, and component-based systems), catering to lighting and beyond (e.g. communication, cooling, entertainment, refrigeration), and two distinct business models (cash-based versus Pay-As-You-Go).
- Significant market entry and private sector engagement from an increasingly diverse, global pool of manufacturers and distributors. These include "affiliates," who are engaged with Lighting Global and/or GOGLA, and "non-affiliates," who belong to a broader universe. Less is known about these non-affiliates, who comprise an estimated 71% of pico sales today.¹⁰
- Increasing interest and commitments from investors, including commercial debt and equity players, since 2014. More than USD 500 million has been raised in the past two years alone.
- Growing acknowledgement from development institutions who are committing significant resources to the sector. For example, more than 25 countries are now engaged in partnerships with the World Bank Group (mostly in SSA) to build capacity and deploy funding to the sector.

The estimated *impact* of this growth has been far-reaching.¹¹

⁷Note: Current improved access estimate incorporates sales of all actively in-use OGS devices, including both affiliate and non-affiliate products (see Table 4 in full report for definitions). This analysis relies on the methodology developed by GOGLA for affiliate products (with known performance) and extrapolates it to the broader industry. Given the unknown performance of non-affiliates, however, this number should be treated as a range. Penetration figures are discounted to assume 10% sales to repeat customers and 3% loss of devices sold, and assume a 3-4 year product lifetime. See GOGLA Impact Metrics for calculation methodology (GOGLA, 2016a). Source: (Dalberg, 2010)

⁸Source: (Dalberg, 2010)

⁹Note: Cumulative sales refers to all devices sold to date, including those that have lapsed their warranties or have been discarded. Estimate includes affiliate and non-affiliate pico and PnP SHS, as well as component-based systems via institutional/government distribution and open-market sales. See definitions in Table 7 of full report. Source: Lighting Global/GOGLA sales data; Dalberg market model and analysis

¹⁰Note: See Section 1B.2 of the full report for details regarding this estimate

¹¹Note: GOGLA metrics utilize company output data (sales, product cost etc.). They project or estimate impact, they do not showcase impact being created on-the-ground. It should be noted that these numbers include the estimated impact for affiliates, non-affiliates and component-based systems. These analyses rely on the methodology developed by GOGLA for affiliate products (with known performance) and extrapolate it to the broader industry. Given the unknown performance of non-affiliates, however, these numbers should be treated as purely directional

- Approximately USD 5.2 billion in economic savings¹² to households as they switch from kerosene and/or other conventional fuels to affiliate OGS devices. When considering the entire universe of OGS devices, which includes non-affiliate products and component-based systems, total savings could be more than double.¹³
- 28.6 million tons of greenhouse gas emissions have been avoided through the reduced use of traditional lighting sources due to the uptake of affiliate devices.¹⁴ When considering the entire universe of OGS devices, emissions avoided are likely to be substantially higher.
- Across geographies, an estimated 1.9 million people have used OGS devices to support income-generating activities.¹⁵
- Improved health reported by 45% of OGS users who previously used kerosene, especially regarding respiratory and eye issues, and reductions in burns and accidents.¹⁶

In parallel to OGS sector growth, grid expansion is finally outpacing population growth in many countries. The grid serves nearly 140 million more households today than in 2010, although the progress has been uneven. South Asia leads the way (11 percentage-point increase in coverage since 2010, reaching over 80% coverage in 2017), while Sub-Saharan Africa lags significantly (7 percentage-point increase, leading to less than 40% coverage in 2017).¹⁷

Despite these strong advances in energy access, the size of the potential market, in terms of people to be served, has remained largely unchanged. This is by virtue of a complex set of dynamics that will maintain a substantial potential market for at least a decade. These include:

- A large portion of off-grid populations that were connected to the grid since 2010 are receiving inadequate power. They have effectively transitioned from off- to unreliable-grid, and continue to represent a potent market for OGS devices.
- High population growth in some of the most poorly electrified regions (especially Sub-Saharan Africa) keeps the market size large in absolute numbers.
- Customers that the OGS market has already served require replacement devices every 2-4 years, and therefore remain part of the potential market. Energy products also display the characteristics of an “experience good,” i.e. as customers gain access to electricity for the first time, they desire more (and in some cases, are willing to pay more for each unit of electricity) and therefore may be targeted for upgrades to systems that offer higher levels of service.

These trends are summarized in Figure 1.

¹²Source: (GOGLA, 2017)

¹³Note: Refer to Footnote 11

¹⁴Source: (GOGLA, 2017)

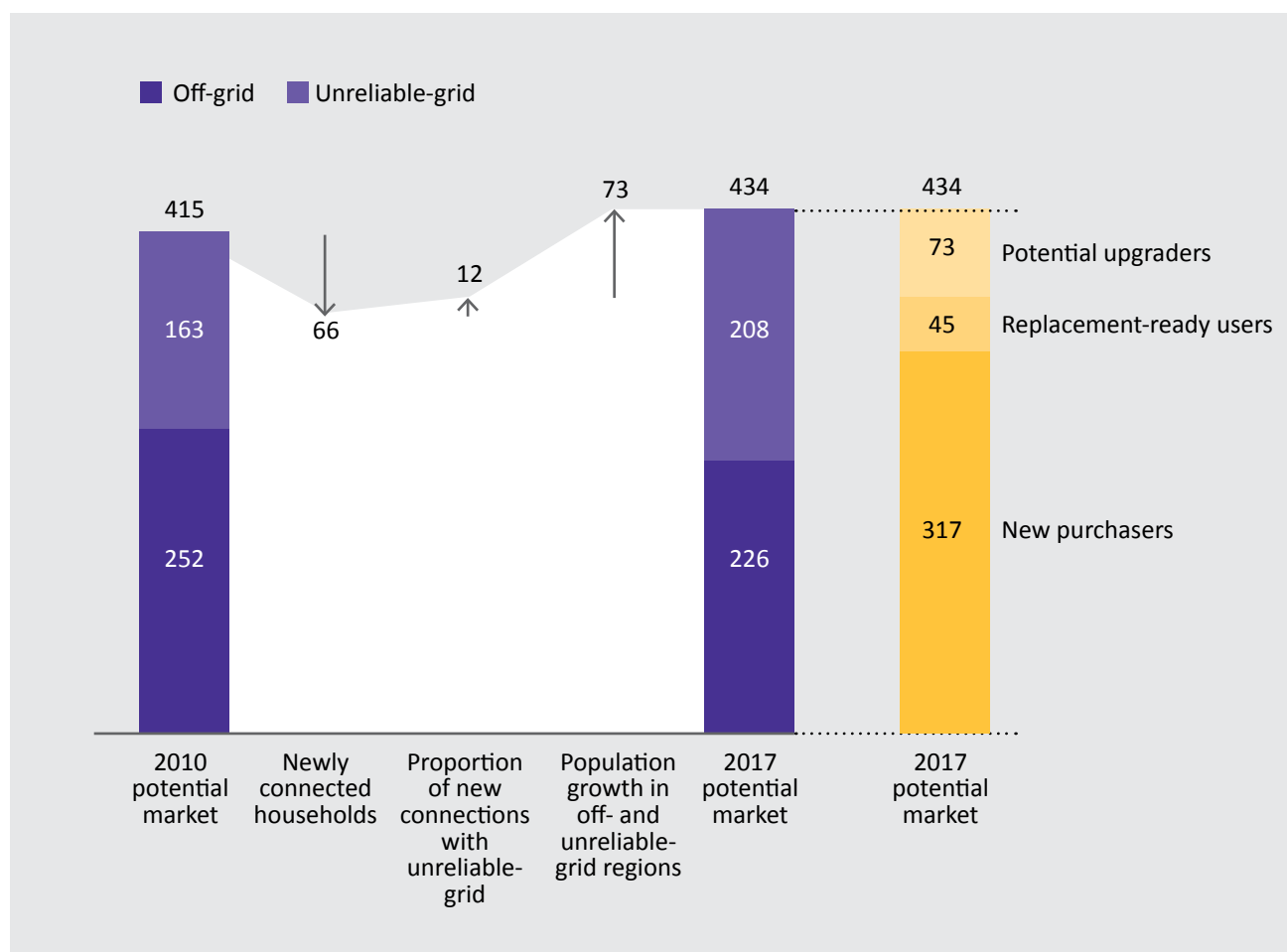
¹⁵Note: This reflects only the universe of affiliate products. Given the opacity around the value chains of non-affiliates, this number has not been calculated for the entire OGS universe. Source: (GOGLA, 2017)

¹⁶Source: (Acumen, 2017a)

¹⁷Source: (International Energy Agency, 2016); (International Energy Agency, 2017a); Dalberg analysis

Figure 1: Change in potential market¹⁸

Million households (2010-17 est.)



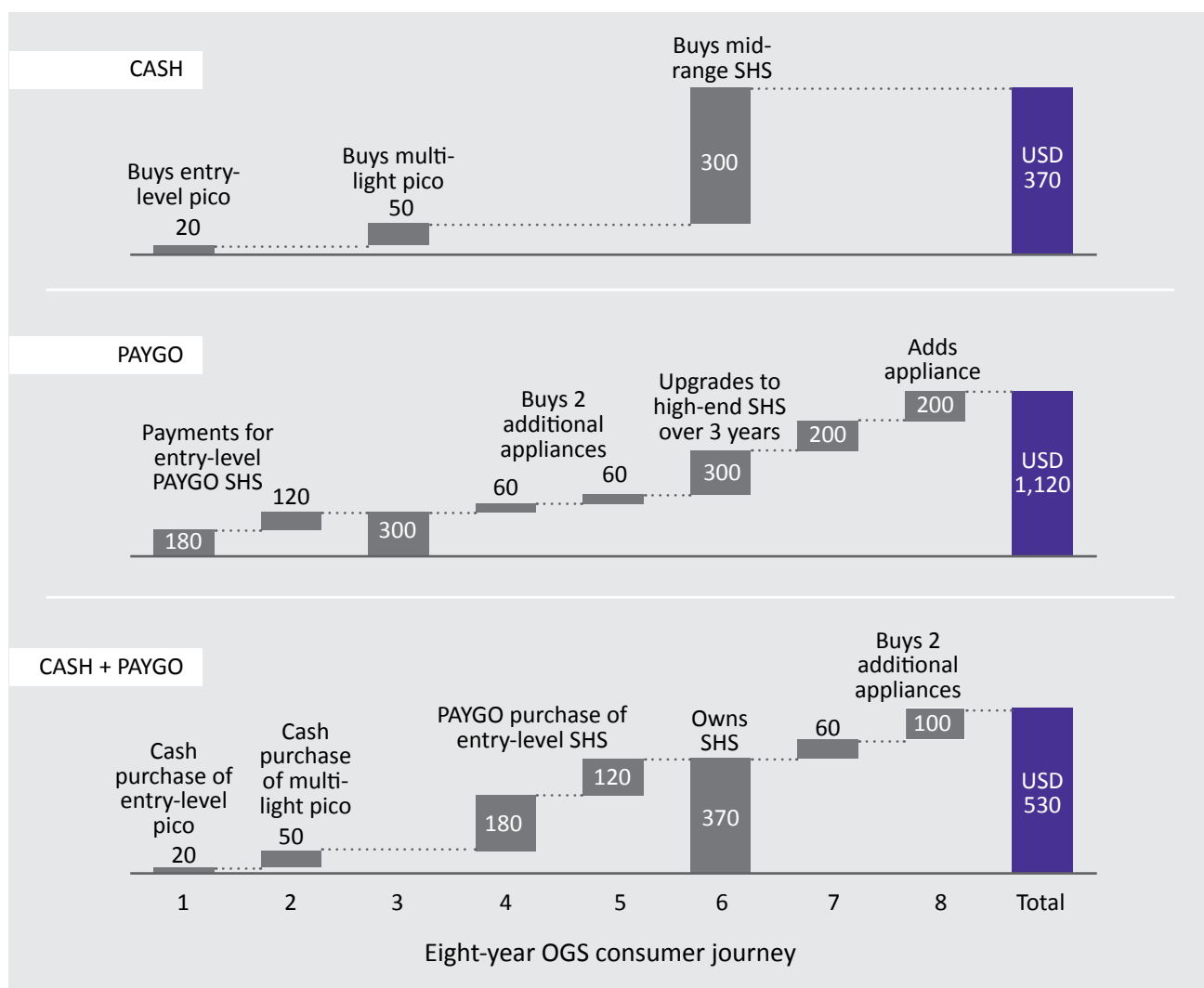
This figure illustrates that despite significant electrification gains since 2010, the potential market remains vast, at 434 million households. It accounts for some of the competing drivers in this dynamic market, which include the following: (1) grid improvements provided new electricity connections to 66 million households since 2010, (2) at least 12 million of those 66 million households received unreliable-grid access and so continue to represent a potential market, (3) population growth in off-grid and unreliable-grid regions added an estimated 73 million new households to the potential market. Together, these global trends resulted in an addition of nearly 20 million households to the total potential market, which grew from 415 million in 2010 to 434 million in 2017. Based on this report's estimates of the total market (see Section 1B of full report) about 73 million of these are current OGS users who have made purchases within the last three years and could be targeted for upgrades and up-selling. Another 45 million households purchased devices more than three years ago (2010-2014), and may be ready for a replacement device. Finally, there remain about 317 million untapped households who represent potential new users.

Importantly, potential revenues for the sector have risen as companies come to recognize customers' lifetime value, rather than just as one-off transaction points. This has entailed a shift among players toward viewing

¹⁸Note: Estimates may not add up to totals due to rounding. Sales are discounted to assume 10% sales to repeat customers and 3% loss of devices sold (GOGLA, 2016a). For unreliable-grid estimation methodology, see Footnote 82 in full report. For total sales estimation methodology, see Section 1B in full report. Source: (International Energy Agency, 2016); (International Energy Agency, 2017); (United Nations, 2014); Lighting Global/GOGLA sales data; Dalberg market model and analysis

Figure 2: Lifetime value potential of off-grid solar consumer (Illustrative)

USD; 8-year horizon



energy as having a long consumption ladder with initial product sales being the start of a long-term relationship. The main drivers behind this shift have been:

- Innovations in financing that are allowing higher overall spend on energy (e.g. PAYGO is relaxing the norm that customers will only spend up to 2-3 months of saved disposable income on a given product).
- Access to a wider product set including household appliances and services, allowing the sector to provide services for a wider array of consumer needs.
- Rising real incomes (7% annual increase in South Asia and 3% increase in Sub-Saharan Africa since 2009), although the distribution of this rise is uneven across geographies and income groups.

As shown in Figure 2, an average customer who in 2010 was estimated to spend USD 30-80 on an OGS product, is now estimated to have a lifetime value of USD 370-1,120, depending on the mode of purchase (i.e. cash versus PAYGO or both). Sophisticated, branded players have created an internal energy product ladder that not only caters to customers' differing willingness to pay, but also induces customers to migrate from basic to more feature-rich products over time. As explored in detail in the full report that follows, this bodes well for the outlook of the industry overall, and pushes companies to either evolve or perish by managing newer sets of competitive dynamics.

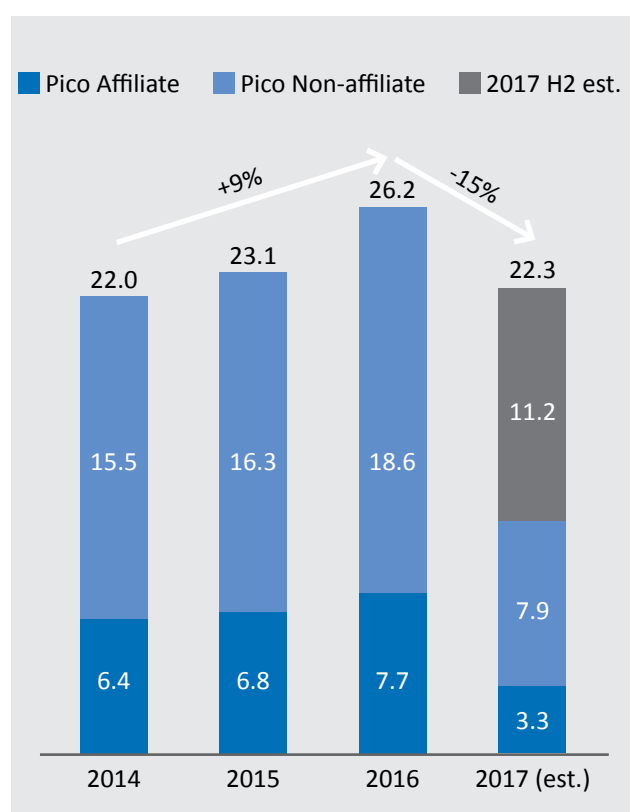


Slowing pico sales. Potential to return to solid growth.

Long the engine of growth, the pico segment's estimated overall market growth in terms of units sold has recently slowed. While slowing growth rates are natural for a sector that, as of 2016, had a base of over 90 million cumulative devices sold (including close to 30 million affiliate devices), the sharp decline was still surprising. In particular, there has been a recent slowdown in the pico sales of many Lighting Global and GOGLA affiliates (with 2017 H1 sales 20% lower than 2016 H1 sales).¹⁹

Figure 3: Estimated annual pico sales²⁰

Million units (2014-17 est.)



Why the slowdown in the pico segment? Localized shocks in several key markets, as well as structural trends in the OGS market globally are responsible:

Localized shocks in several key markets.

Disruptions in key national markets have impacted this sector adversely. Demonetization in India (the sudden removal of INR 500 and 1,000 bills from circulation) caused a rural cash crunch in the world's largest pico market. A major drought in Kenya and Tanzania constrained consumer incomes in the region. And Nigeria's economic crisis devalued the naira, which inhibited customers purchasing power and led to lower access to foreign exchange for OGS suppliers. These four countries represented over two-thirds of global affiliate pico sales in 2016, and each experienced pico sales drops of 35-60% between 2016 H1 and 2017 H1. These localized shocks affected sales of many fast-moving consumer goods (FMCGs), although many sectors have revived since.

In some cases, localized shocks were specific to OGS devices. For example, in Ethiopia, mandated local testing of every product (including systems passing Lighting Global quality verification standards) in an environment with low testing capacity led to already quality-verified products being held up in customs, while multiple non-affiliate products bypassed authorities and went directly to customers. This led to an immediate, rapid decline in affiliate sales in 2016, though this has since been resolved.

Structural trends across the OGS market globally.

- *Exhaustion of the low-hanging fruit in major markets.* Due to the difficulty of large scale distribution to remote markets, most companies have focused on relatively easier commercial options. These include targeting customers that are closer to cities, have higher spending power, and are often already connected to some level of electricity. While by no means saturated, the industry cannot maintain previous growth rates if it continues to focus on easy-to-reach markets. Innovations and investment will be required in order to expand to untapped last-mile areas.

¹⁹Source: Lighting Global/GOGLA sales data; Dalberg analysis

²⁰Note: See Table 8 and Footnote 149 of full report for details on non-affiliate estimation. 2017 H2 estimate assumes H2 sales are equivalent to H1 sales and comprises both affiliate sales and non-affiliate estimates. Source: Lighting Global/GOGLA sales data; Dalberg market model and analysis



- *Uneven real income growth.* Past forecasts relied partly on strong real income growth, however, while average incomes have risen, many of the gains have not gone to those that typically consume OGS products (for example, in India, the share of the country's wealth held by the top 1% grew from 40% in 2010 to 58% in 2016).²¹
- *Cannibalization* at the upper end of the pico market by plug-and-play (PnP) SHS products. PnP SHS products (especially lower-wattage devices) now have product economics that resemble those of pico products due to the emergence of PAYGO financing models. Yet these products deliver a much higher value proposition—a boon for consumers. At the same time as sales in pico have slowed and recently dipped, affiliate PAYGO sales grew at a CAGR of ~140% in the last three years.
- *Increasingly commoditized pico market,* where differentiation among players is substantially based on price. In the early days, companies affiliated with Lighting Global and GOGLA represented cutting edge design and quality. Yet as the industry matures, that product advantage has diminished. This has led to increasing market share for non-affiliate sales (estimated at 71% globally, based on a weighted average of 16 countries for which estimates were developed²²), who typically have greater flexibility on pricing and margins. Due to increased competition in some countries, a few markets have started to see exits, whereas previously the industry only saw the entrance of new players.

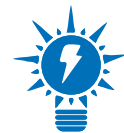
Globally, it is clear a sizeable potential market continues to exist. To capture it, pico players must adopt a more aggressive stance on geographic expansion and further financial innovation to support consumer ability to pay. This report's projections (see Section 2 of the full report) estimate business-as-usual annual sales growth in the pico sector of 15-20% over the next five years, reaching approximately USD 1-1.5 billion in annual revenue. However, a higher growth rate is expected if the following hurdles are addressed:

- **Innovative financing mechanisms**, such as the application of PAYGO with PnP SHS, are effectively deployed further in the pico segment (early experiments have shown some success, but examples of scaled players are rare). The cost of consumer financing—estimated to amount to 20-40% of the final price—will need to fall. This price drop is to be expected if PAYGO platforms and players achieve economies of scale in operating countries and once investors gain confidence in assessing and investing in PAYGO models (e.g. through local currency funding, growth of receivables-based financing, etc.).
- **Expansion into nascent markets** continues, buffered by patient capital that offsets the risk of entry. For example, PEG Africa leveraged a grant from GSMA Mobile for Development Utilities in 2014 to build its business in West Africa, an emergent market, and subsequently raised more than USD 21 million for growth. The vast scope for expansion can be seen in that penetration of OGS products has reached 10% in just eight countries to date; by contrast, over 40 countries continue to have at least one million off-grid households.
- **Gap-funding for last-mile households** is made available without distorting the market. While few market watchers would advocate a return to the indiscriminate giveaways that plagued the industry in its infancy,²³ most recognize that a substantial portion of potential pico customers are both highly remote and significantly cash constrained. Support mechanisms such as vouchers, targeted tax incentives, or rebates can help unlock a large part of this market, such as EnDev's results-based financing program in Tanzania, which provides private-sector suppliers a cash incentive based on the performance (mainly lumen-hours) of each high-quality product they sell in rural areas.

²¹Source: (Jha, 2017)

²²Note: See Section 1B.2 and Table 8 of the full report for non-affiliate estimation methodology details

²³Note: These can distort commercial market product pricing and contaminate the market for businesses that sell a product that consumers believe should be free



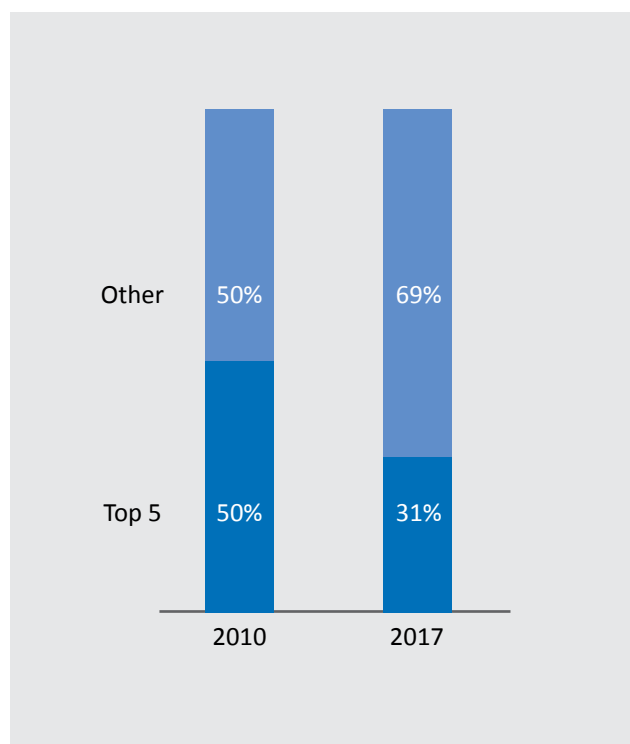
- **Policymakers continue to recognize and buy into the energy access and impact potential** of pico products (and OGS as a whole) and provide a favorable business and trade enabling environment. In particular, as noted by GOGLA in a guidance note to governments, “temporary or permanent removal of VAT and tariffs – covering the entire product, including any appliances – is one of the most effective ways for governments to support the growth of the standalone solar market, improving affordability, boosting uptake and accelerating energy access.” To illustrate the potential impact: a study in Kenya found that reducing the price of a solar lamp from USD 7 to USD 4 increased household uptake from 37% to 69%.²⁴

But even with significant growth, profitability has eluded most players in the market. At the same time there has been significant market entry to date: the known universe today comprises more than 300 players, where there were only 60 in 2010. Companies must rise to meet the demands of increased competition and commoditization through specialization or by delivering an integrated energy ladder offering. Currently, many operators are stuck in between those two positions, with leading first-mover firms relying on their local monopoly positions, which will prove to be fragile in the long run.

Even with high levels of entry and low net profitability, there is no expectation of consolidation. The significant under-penetration of the sector and the wide geographic spread of the customer base have kept the market open. Across the pico and PnP SHS industries, the top-5 players today command only ~30% of annual sales, down from 50% in 2010. Several leading players, such as Greenlight Planet and d.light, have put investor and management focus into fast-growing PAYGO SHS portfolios, further adding to this report’s expectation that the market (as-a-whole) will remain competitive in the near future.

Figure 4: Market concentration of pico affiliates and non-affiliates²⁵

% of total annual unit sales (2016)



Customer sensitization to quality has also risen. As a result, the market will continue to see returns for strong investments in quality, both in terms of revenue and margin. The industry’s top sellers continue to put out objectively higher-quality products (see Figure 5).

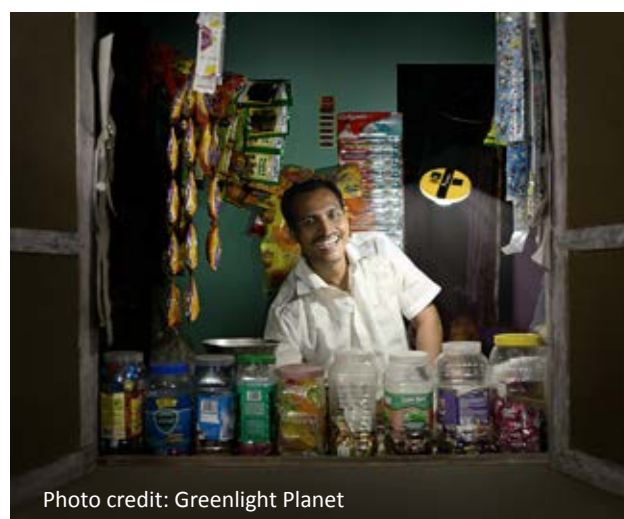


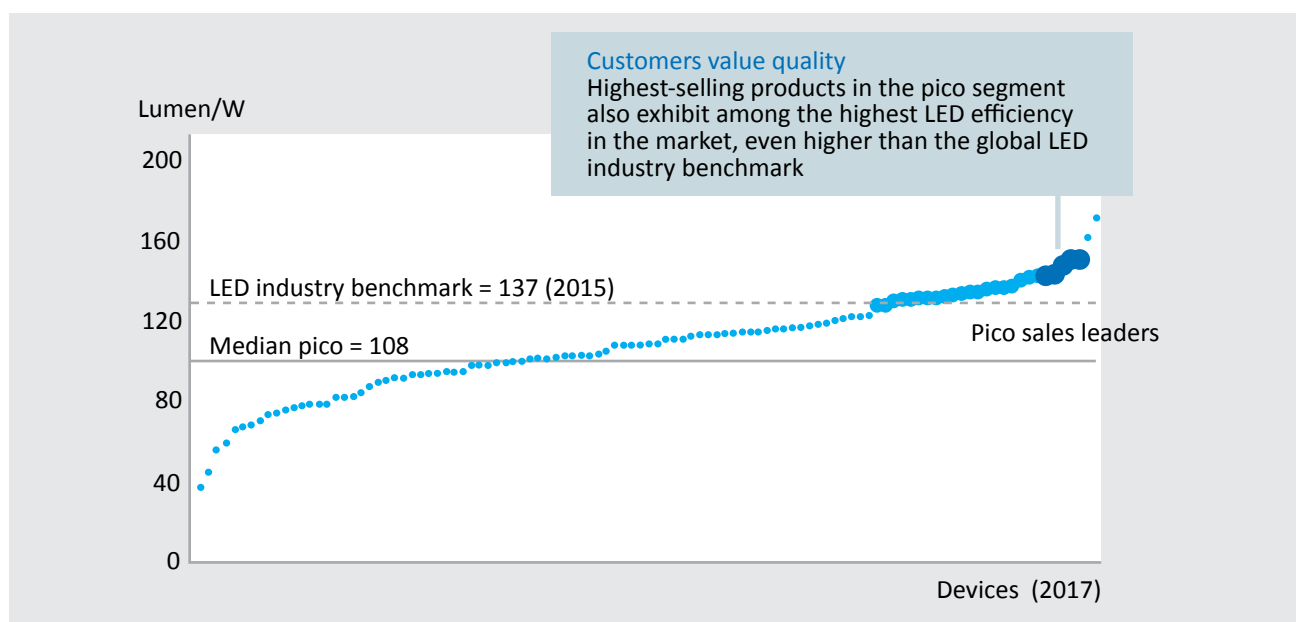
Photo credit: Greenlight Planet

²⁴Source: (GOGLA, 2017); (Rom, Gunther, & Harrison, 2017)

²⁵Note: Individual market shares have not been shown to protect confidentiality. Number of suppliers in 2016 collated using the GOGLA and Lighting Global websites, Alibaba and desk research. Source: Industry interviews; Dalberg research and analysis

Figure 5: Lighting efficacy industry performance²⁶

Lumen/Watt; n=107; select affiliates and non-affiliates (2017)



It is important for the industry to have pico sales return to a strong trajectory. Not only is it the fastest and often most cost-effective means to deliver partial or full Tier 1 electricity to the most under-served (see Table 1 for discussion of energy access tiers), it also acts as the main engine for the OGS market by bringing customers onto the energy ladder and in time moving them onto higher feature (and potentially higher margin) products. Some options for pico companies to gain competitive advantage in an increasingly crowded field are covered in Section 3 of the full report.



A rapidly-growing plug-and-play SHS market, driven by PAYGO. Some risks ahead.

Plug-and-play SHS sales have grown rapidly from a small base since 2013-14. The segment accounts for less than 5% of total annual OGS distribution, yet makes up 20-30% of annual revenues. The standout OGS growth story of the last three years has been PAYGO-based PnP systems (most of which are SHS, but some are pico), with an average annual growth rate of ~140% (2013-2016). While still small in overall numbers, the PnP SHS segment's revenues are expected to overtake total pico revenues in the next three to five years. This is due to strong growth, a much higher average unit price compared to pico prices, as well as the opportunity to up-sell.

Thus far, growth has been limited to countries with strong mobile money ecosystems, with particular crowding-in in East Africa. This signals both high growth potential in the future, but also the challenges of operating successfully in different regulatory environments (see Figure 6). Several countries in West and Central Africa (especially Nigeria and the Democratic Republic of the Congo) are already showing healthy mobile money growth.²⁷ India, the largest OGS market in the world, currently has very low PAYGO penetration corresponding largely to its minimal mobile money market and relatively low uptake of PnP SHS to date. It is, however, poised for significant growth in mobile and digital transactions over the next five years. Mobile money has proved the most streamlined mechanism of payment for PAYGO operators, but as PAYGO technology and business models mature and diversify, digital money may be less of a constraint.

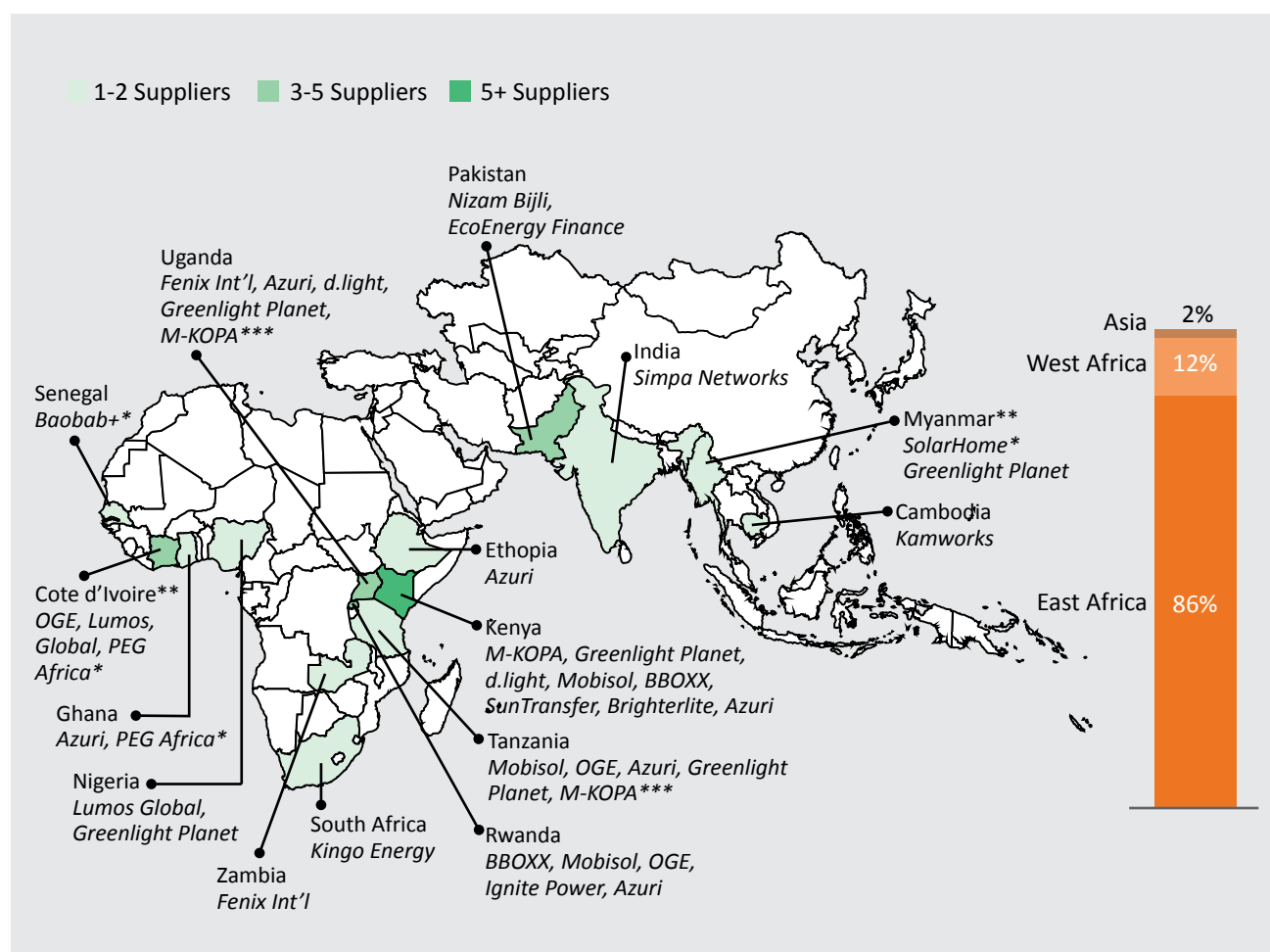
²⁶Note: Industry benchmark based on stated average efficacy of commercial A-type LED bulbs as per U.S. Dept. of Energy. Source: Lighting Global data; U.S. DoE; Dalberg research and analysis

²⁷Source: (Patterson, 2016)



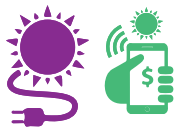
Figure 6: Presence of PAYGO players by country, and geographic share of the PAYGO market²⁸

Left: number of players; Right: % cumulative unit sales; n=11 players (2013-17)



A flood of investments in the PAYGO segment have enabled aggressive customer acquisition. The PAYGO segment has been the main magnet of investments into the OGS sector. **From 2012 to 2017 PAYGO businesses raised USD 773 million, equal to ~85% of all funds raised. These investments are highly concentrated, with just four companies accounting for 67% of total PAYGO investments.** This suggests that investors have aggressive expectations on how fast PAYGO companies can grow.

²⁸Note: Figure does not consider pilots, only companies with an established sales presence in a country. The data are not exhaustive, but are representative. Key: (*) Distributor (**) New entrants (2015-2017) with low overall in-country sales; (***) M-KOPA has presence but bulk of their sales come from Kenya. Source: Dalberg research and analysis



This initial investor optimism (which latest numbers show dampening somewhat) was built, in part, on the recognition that PAYGO is not just an energy product, but a broader debt offering. **For many customers, it constitutes their first meaningful banking relationship.** In this respect, it has helped drive financial inclusion (CGAP estimates that 30-50% of PAYGO customers outside of Kenya opened mobile money accounts to pay for electricity).²⁹ This opens a world of opportunity for energy companies, including:

- **A wider product offering thanks to integrated debt financing.** The majority of these have been efficient household appliances that integrate with a core solar home system product. Among household applications, fans, radios and televisions dominate.
- **Acquiring an explosion of data.** Billing, credit scoring and asset monitoring require amassing a significant amount of product usage data. Aggregated, this can be a powerful management tool (PAYGO players spoke of the ability to tell if a wedding was coming up in a village based on electricity usage patterns alone). It also allows tailored on-sell/up-sell opportunities. Monetizing this data is key to the industry's valuation.
- **A lifelong customer.** The nature of the PAYGO product is such that it lends itself to local monopolies and customer stickiness.³⁰ Data collection over time means that an incumbent player understands a current customer (and importantly, the customer's credit worthiness) better than a new entrant. Technology barriers, though on the decline, have also limited entrants.

While the segment is growing strongly, there are several challenges that existing players will need to address:

- **Four businesses in one.** Most PAYGO businesses make or assemble their own product, distribute their own product, create the technology platform for running PAYGO operations and run an effective lending bank. It is hard to be a leading performer across all four of these.
- **Deteriorating asset quality.** In search of new customers, many PAYGO companies have expanded into customer segments that have increased their bad-debt ratios significantly (i.e. higher number of customers default on payments). Across the top-10 PAYGO players, rates vary widely, suggesting that portfolio quality will be a key competitive advantage going forward.
- **Increasing competition, including from entry of pico companies and specialists.** Companies such as Greenlight Planet and d.light have entered PAYGO markets and have shown strong growth. They come from strong product heritage giving them an edge in the fundamental product design while also leveraging a wide set of existing distribution relationships, given the scale of their pico business. Specialized technology providers such as Renewit (hardware) and Angaza (PAYGO platform) are also allowing new entrants to leapfrog technology development requirements. While increasing competition is not inherently negative for the sector, existing players will need to respond effectively to justify investor enthusiasm.
- **Limited economic engine.** Perhaps the biggest challenge for PAYGO companies to achieving exponential growth is that they are currently competing for a very limited share of wallet. While debt financing solves the challenge of saving for otherwise large upfront costs, it does not translate into more money in consumers' pockets. Beyond affording lighting, the ability to pay for other devices rapidly diminishes. As such, most PAYGO companies have been serving the apex of pyramids in each community. This lack of intensification within the geographies in which they operate is raising service costs and limiting any scale economies.

²⁹Source: (Winiecki, 2015)

³⁰Note: Emerging research from UNCDF's Energy Ladder research in Uganda suggests that consumers purchasing PAYGO products are most likely to purchase future products and modular upgrades from the same company, while consumers buying products on a cash basis purchased from their original supplier and new suppliers in equal measure. Source: (UNCDF, 2017); industry interviews



- **Data and privacy issues.** There exists a potential risk around the all-important data assets that PAYGO companies are building. The level of data collected can reduce a customer's bargaining power and lead to predatory behavior. If data can predict that a wedding is coming up in a village, as noted above, bombarding people with advertisements for a wedding loan (to make the wedding grander) could be the next step. Some investors would see that as a measure of progress, and potentially replacing loan sharks, while others would consider it irresponsible.

There are several ways in which PAYGO players can respond to these emerging challenges. Chief among them are:

- **Find the core and outsource or spin off the rest.** PAYGO companies, as they stand today, are too complex. This is because the culture and capabilities for successfully running a lending business versus a consumer electronic product business are fundamentally different. Reducing vertical integration is part of the maturation of the industry.
- **Link sales incentives to long-term customer value.** Many companies have a mismatch between what the sales team wants to achieve in sales growth versus what the finance team wants to achieve through a healthy balance-sheet. Persuading sales agents to maximize long term value from customers can help align incentives.
- **More aggressively explore productive use applications.** For PAYGO to thrive, incomes need to rise. While many will argue that using energy devices such as lights, fans, fridges, and TVs enhance productivity, there is limited evidence to suggest that they have significant impact on household income beyond delivering savings relative to alternatives. Therefore, exploring specialized income generating opportunities (such as through efficient sewing machines, PAYGO water pumps, etc.) is in the interests of both sector players (some like Mobisol have already ventured in) and customers.
- **Utilize off-balance sheet financing.** The long term financial health of PAYGO companies will require an influx of financial specialists that can effectively manage both the credit risk of the portfolio of consumer receivables and a company's treasury function, including external fundraising to meet working capital needs. The expected increased use of off-balance-sheet financing can leverage cash flows from the portfolio of receivables in order to enable debt fundraising, thus resulting in a more rapid turnover of capital.
- **Establish customer protection mechanisms and principles:** As the segment expands, consumers will require protection in two important respects: First, from misleading marketing and low-quality PnP SHS devices, especially given that their exposure (in terms of money spent and share of income) is much higher than in the pico segment.³¹ Second, PAYGO companies need to get ahead of the data and privacy issue by either individually, or preferably as an industry, signing up to transparency and outlining guidelines for the handling of customer data. The World Bank's focus group study with retailers and distributor networks showed universal concern over private consumer data being shared externally by the providers, while recognizing the potential for benefits to consumers from prudent and confidential uses of their data.³²

PAYGO is poised to continue being a significant growth driver of the PnP SHS segment in particular, and the overall OGS sector. This report's business-as-usual projection sees the PnP SHS segment (overwhelmingly driven by PAYGO companies as far as low-income consumers are concerned) set to achieve growth of 80-90% over the next five years. This would enable it to reach over 20 million in annual sales units and USD 6-7 billion in annual revenues in 2022.

³¹Source: (Diecker, Wheeldon, & Scott, 2016)

³²Source: (Alstone, Gershenson, Turman-Bryant, Kammen, & Jacobsen, 2015)



Component-based systems: No longer an industry focus in most regions, and quality remains highly variable.

For over two decades, large institutional programs such as Bangladesh's Infrastructure Development Company Limited (IDCOL) and India's National Solar Mission have distributed approximately seven million "institutional component-based"³³ SHS for free or at variously subsidized rates. In parallel, consumers in these and other markets are independently assembling "open-market component-based" systems using PV modules, batteries and other components. Given the decentralized and often informal nature of component sales, conclusive data on these open-market component-based systems remains unavailable.

New estimates suggest that the open-market segment may represent as much as 9% of all OGS system sales globally to date.³⁴ Little is known about the changing share of open-market component-based systems over time. It is clear, however, that market share varies significantly by country, from as much as 60% of all OGS devices in Myanmar, where such systems are the norm, to less than 5% in most of East Africa (where plug-and-play devices dominate) and other markets where institutional distribution programs have not primed the market.

Outside of Bangladesh and India - which have had continuous institutional distribution programs for more than a decade - the spread of component-based systems has largely been driven by direct consumer demand. Open-market component-based systems present several advantages, namely that they are often less expensive on a per watt basis than PnP SHS. They can also be tailor-made to a household's changing needs, and they can be serviced locally, consequently supporting jobs for local technicians. However, open-market component-based systems do not enjoy the protections often provided by major institutional program distribution like Bangladesh's IDCOL and India's National Solar Mission, which vet suppliers and provide financing or subsidies. As such, they tend to have high failure rates as well as quality and safety issues related to using components with mismatched power or lacking a control box.

The question for those approaching off-grid solar in all its forms from an impact lens is whether opportunities exist to increase quality, safety, and financing within the open-market segment while maintaining the above advantages.

While little data is available about the outlook for component-based systems, Kenya provides a useful case study: component-based systems comprised an estimated 70-80% of all OGS in the country in 2010. Yet today, following intensive investment to build the market for quality-verified and easy-to-use pre-packaged pico and PnP SHS, open-market component-based systems are believed to represent just 1-4% of annual OGS sales.³⁵ Kenya's shift, from a component-centric market to one in which pre-packaged devices are nearly ubiquitous, suggests that component-based systems will have an uphill challenge in an increasingly sophisticated product market that values quality.

³³Note: See Table 7 of full report for segment definitions

³⁴Note: Figure is calculated on a base of all affiliate and non-affiliate pico and PnP SHS, as well as institutional and open-market component-based systems. It is calculated as a weighted average of 16 markets for which directional estimates exist. Estimates are included in this report as a constant over time due to limited information on annual sales in the past five years, however findings from the MTR IVR and field surveys suggest that sales remain significant. Source: (Hansen, Pedersen, & Nygaard, Review of Solar PV Market Development in East Africa, 2014); (Hansen, Pedersen, & Nygaard, Review of solar PV policies, interventions and diffusion in East Africa, 2015); (Ipsos, 2016a); (Ipsos, 2017); (Lighting Global/Dalberg, 2017) (Galpay, 2016); (Government of Myanmar, 2014); (Government of India, 2011); (Jain, 2017); (IRENA, 2016b); industry interviews; Dalberg analysis

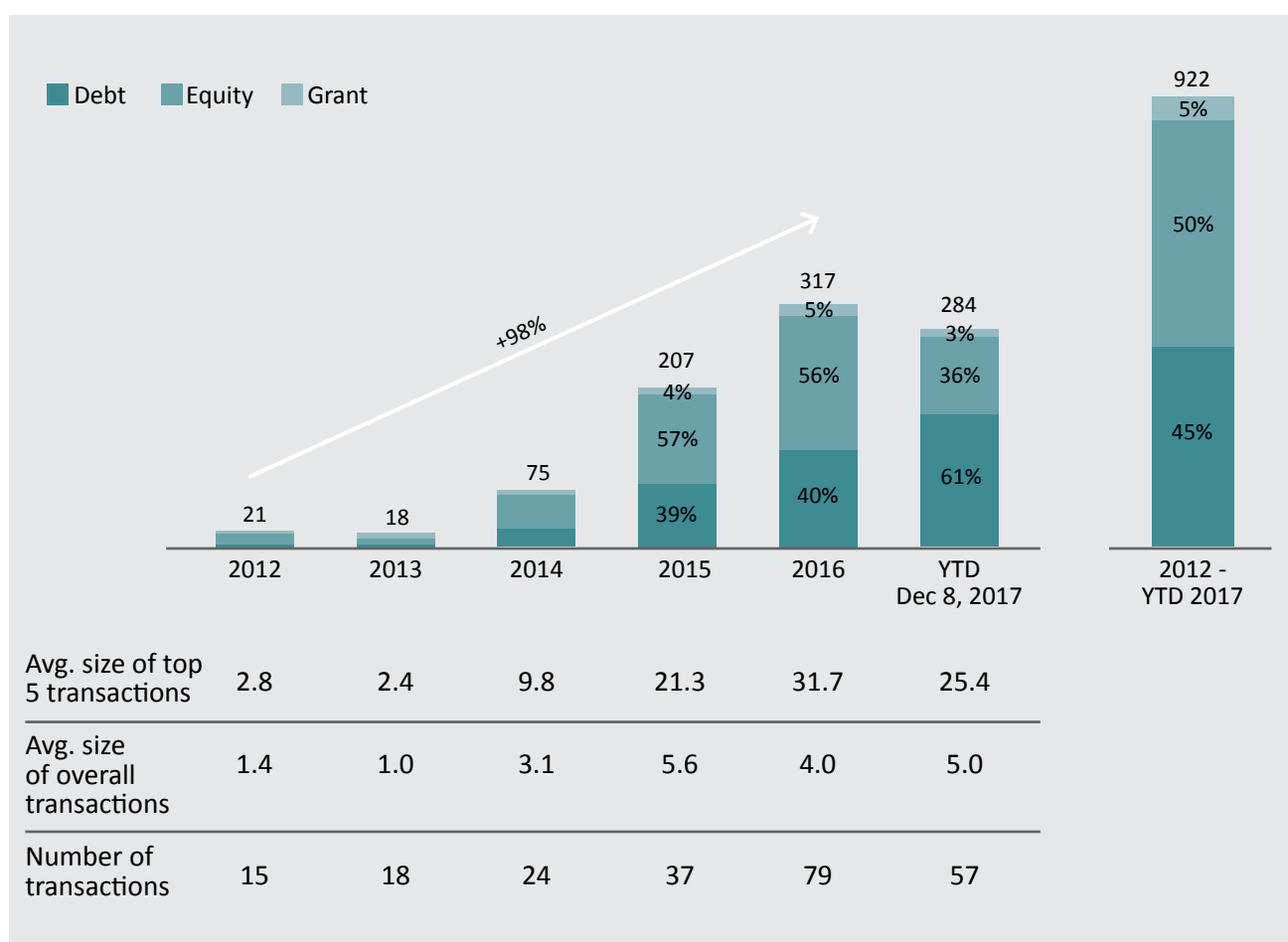
³⁵Source: (Hansen, Pedersen, & Nygaard, Review of Solar PV Market Development in East Africa, 2014); (Hansen, Pedersen, & Nygaard, Review of solar PV policies, interventions and diffusion in East Africa, 2015); (KERA, 2014); (Ipsos, 2016a); Dalberg analysis

Investment into the OGS sector has grown significantly, but expectations are not being met on the impact and commercial fronts.

The UN Sustainable Development Goal 7 has helped refocus investor attention toward electrification. Sustainable Energy for All reported that during 2014, at least USD 20.1 billion dollars were invested to improve electricity access and that national governments, drawing on their own budgets, accounted for roughly half of those investments. Support for electrification projects notwithstanding, finance for decentralized energy (which included the financing discussed in this report) received only 1% of total financial commitments.

Despite the fact that investment into decentralized energy is small compared to total investment into electrification, OGS investments have experienced strong growth, doubling annually from 2012 to 2016. In 2017, annual investments touched USD 284 million with USD 922 million raised since 2012.

Figure 7: Annual investment in the OGS sector over time, by financing instrument³⁶
Millions; USD equiv. (2012-17)

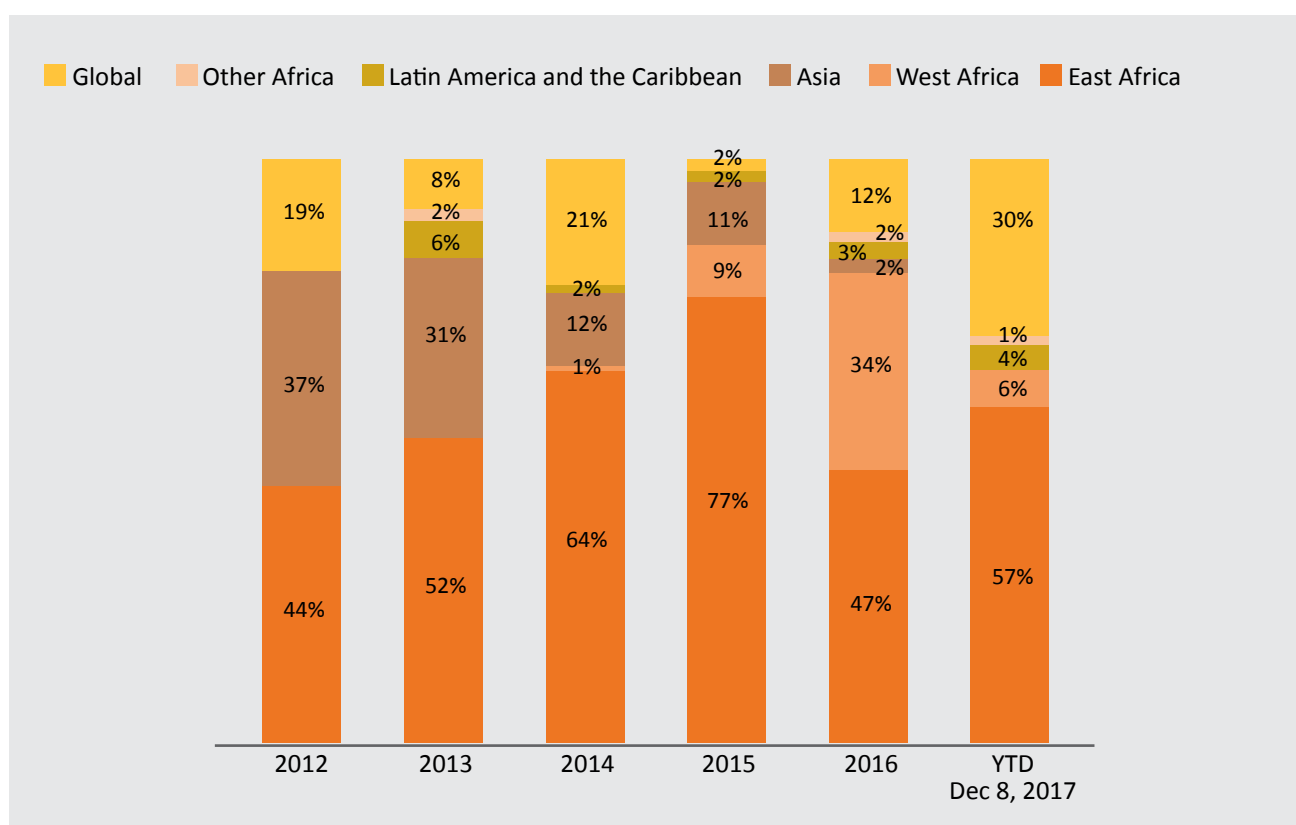


³⁶Note: Figures may not add to 100% due to rounding. As details of these two transactions were not publicly disclosed, YTD 2017 figures include Dalberg's best estimates (which in total fall in the range of USD 30 – 45 million) on the value of the Engie acquisition and the follow-on investment by Investec into Mobisol. Details on all other financial transactions in the database are from publicly disclosed sources or confirmed in interviews. Source: GOGLA 2018 Deals Database

Deal sizes have grown considerably in the past five years, reflecting the shift toward using PAYGO SHS business models. The largest transactions are now in the range of USD 50–80 million and are generally funded by a group of co-investors or a syndicate of lenders. Nevertheless, large individual investments of up to USD 40 million are still made by large lenders and commercial equity investors. Investment that was primarily focused in East Africa is now diffusing outwards, as competition enters the market and incumbents seek virgin markets. Several large investments are also helping fund the transition of traditionally pico players into the PAYGO PnP SHS space.

Total investment in 2017 is likely to be slightly less than in 2016. While not a positive trend, this dip in funding should be understood in the context of a very lumpy funding environment, where a few transactions could materially change year-over-year investment trends. Ultimately, 2017 marked a year of reflection for the industry, as several interviewees mentioned that slowing industry sales may have led to some firms missing their projected sales targets. This in turn has resulted in some investors taking a pause to reassess corporate valuation and investment strategies. Investors to-date were riding a wave of optimism. This pause is not a sign of investor souring on the industry, as nearly all investors interviewed were positive on the long-term trajectory of the market. However, concerns of a possible short-term overvaluation in some companies may have dampened equity investments.

Figure 8: Geographic split of funding³⁷
% of total funds raised (2012-17)



³⁷Note: Figures may not add to 100% due to rounding. The geography assigned to each specific investment was based on the primary geography where the investment would be channeled. For example, an investment to expand a company's operation into West Africa would be classified as West African. In circumstances where specific project details were unavailable, the geographical focus of the investee's operations was assigned to the investors. In instances where a company's operations spanned multiple geographies, a global geography was applied. 2017 figures included two transactions related to the acquisition of Fenix International by Engie and a follow-on investment from a consortium of investors led by Investec Asset Management into Mobisol. This study was not able to verify the sizes of these transactions prior to publication, and has thus included estimates, which in total fall in the range of USD 30 – 45 million. 2017 YTD total also includes investment in Asia representing less than 1% of the global total and thus does not appear on the graph. Source: GOGLA 2018 Deals Database

Development finance institutions (DFIs) and impact investors who have historically seen the OGS market as something of a silver bullet—able to serve the BoP while being financially sustainable—are reassessing their positions. In the words of one DFI, “the honeymoon is over.” The impact investment community is increasingly aware that for these companies to be financially sustainable, they cannot strictly serve the lowest-income populations. Majority of efforts today are focused on the higher-income segments within villages and peri-urban segments. There has also been a shift among impact investors who had previously offered very concessionary terms on their financing toward demanding commercial terms.

With overall OGS sales slowing and some companies missing projections, investors have broadly favored debt over equity investments, as some investors looked to cover against (in their opinion) overstated company valuations. This may give the market a chance to cool down. However, the view that OGS firms are overvalued is not shared by all investors. Some are more bullish on the potential of the OGS industry driven by a large potential market and an ability to leverage PAYGO technology in new and profitable ways. A shift to debt also better reflects current industry needs which center on funding working capital requirements.

Table 2: Sources and uses of capital - Forecasted total financing needs by top OGS affiliate companies

USD millions (2017-22)

Uses of capital		Sources of capital	
Funding receivables	3,350 – 3,725	Operating cash	900 – 1,000
Funding inventories	1,275 – 1,425	Change in payables	225 – 250
Capex	475 – 550	External (Debt)	2,600 – 2,850
		External (Equity)	1,175 – 1,325
		External (Grants)	200 – 275
Total	5,100 – 5,700	Total	5,100 – 5,700

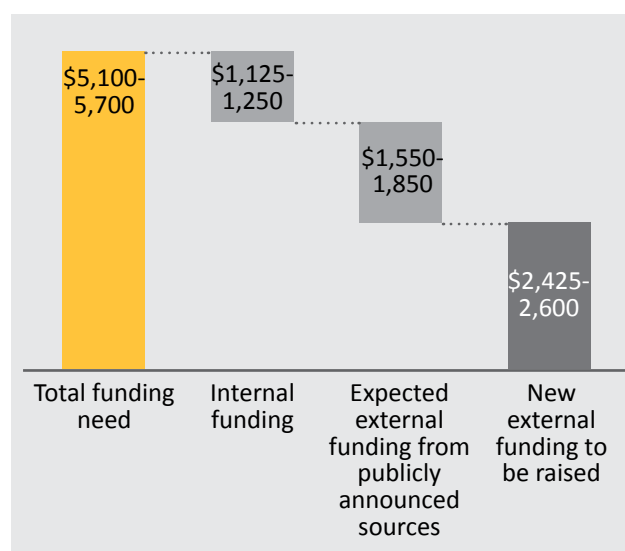
For OGS to hit its potential, this report estimates that about USD 5.1 – 5.7 billion of investment will be needed by the sector from 2017-22 (as outlined in Table 2). It is important to note that this range does not comprise an aggressive or pessimistic scenario, but reflects the uncertainty of individual variables within the underlying forecast model (as detailed in Section 1D of the full report).

While most of the need for investment has evolved toward debt for working capital, targeted equity and grant capital is still required to spur innovation and finance business development. This will help the sector reach hard-to-serve consumers and open new markets.

With an estimated USD 2.7 - 3.1 billion of funding already in place, a further USD 2.4 – 2.6 billion must be raised from the market over the next five years, largely for PAYGO working capital needs.

Figure 9: New external funding to be raised

Projected funding sources; Millions USD (2017-22)



How will these funds be raised? Current patterns provide some clues. Leveraging the value of consumer receivables on a company balance sheet to support commercial loans is an important fundraising tool. Some companies have chosen to borrow from local banks (supported by DFIs & impact investors), using the consumer receivables to form the foundation for a borrowing base. Other companies have used off-balance-sheet structures where the receivables are sold to a special purposes vehicle ('SPV'). Cash flows from the repayment of those consumer receivables, which are diverted into the SPV, service the commercial loan repayment. In either case, leveraging these consumer receivables allows companies to raise working capital before net profitability is achieved. Companies also benefit as these types of lending transactions can help to limit foreign exchange risk.

What's next for the OGS sector?

Overall, the OGS sector is expected to provide improved current energy access to 740 million people in 2022, compared to 360 million today.³⁸ Annual revenues will grow to around USD 8 billion. This report projects a CAGR of 25% in terms of units sold with revenues expected to rise faster. While meteoric growth rates are expected to be a thing of the past, especially for the pico segment, the downward swing of 2016-17 is likely to be temporary.

Table 3: Estimated sales and revenues across OGS segments³⁹

% annual growth; units; USD (2010-2022)

	2016			2022 Est.		
	Sales units CAGR (2010-2016)	Annual unit sales	Annual revenue (USD)	Sales units CAGR (2017-2022)	Annual unit sales	Annual revenue (USD)
Pico	~99%	26 Mn	\$600-650 Mn	~16%	47 Mn	\$1-1.5 Bn
PnP SHS	~125% ⁴⁰	<1 Mn	\$150-200 Mn	~87%	24 Mn	\$6-7 Bn
Open-market component ⁴¹	n/a	2-2.5 Mn	\$200-250 Mn	n/a	2-2.5 Mn	\$200-250 Mn
TOTAL	~100%	~30 Mn	~\$1 Bn	~25%	~72 Mn	~\$8 Bn

While sector level growth potential is attractive, individual countries are at very diverse starting positions. Figure 10 identifies the current status of several key markets based on their market penetration and sales growth over the past several years. This data provides directional insight into the future robustness of each market, and four possible strategies to follow based on their starting points:

1. **Harvest:** Markets where sales continue to rise despite relatively high penetration, suggesting that suppliers can continue to harvest revenues.
2. **Upgrade:** Highly penetrated maturing markets, where suppliers may consider upgrading existing customers to higher quality technologies and service levels, and should seek innovative distribution

³⁸Note: Based on Dalberg calculations using the "improved energy access, current" metric of the GOGLA impact metrics. Source: (GOGLA, 2016a)

³⁹Note: Revenue estimates include all product categories except institutional distribution of component-based systems, as these are typically not fully market-based. Estimates for non-affiliates are based on affiliate product category mix, and assume 30% lower prices among non-affiliates. Affiliate revenues based on GOGLA data (cash only) and on price estimates based on supplier interviews and the Lighting Global and Sendea/Mangoo databases; Estimates uses cash prices to estimate all sales due to limited reliable data on PAYGO revenues. See Section 1B of full report for further details and sources. 2022 projections assume prices and product mix at 2017 levels. Source: Lighting Global/GOGLA sales data; (Lighting Global); (GOGLA, 2016b); (Sendea, n.d.); Dalberg market model and analysis

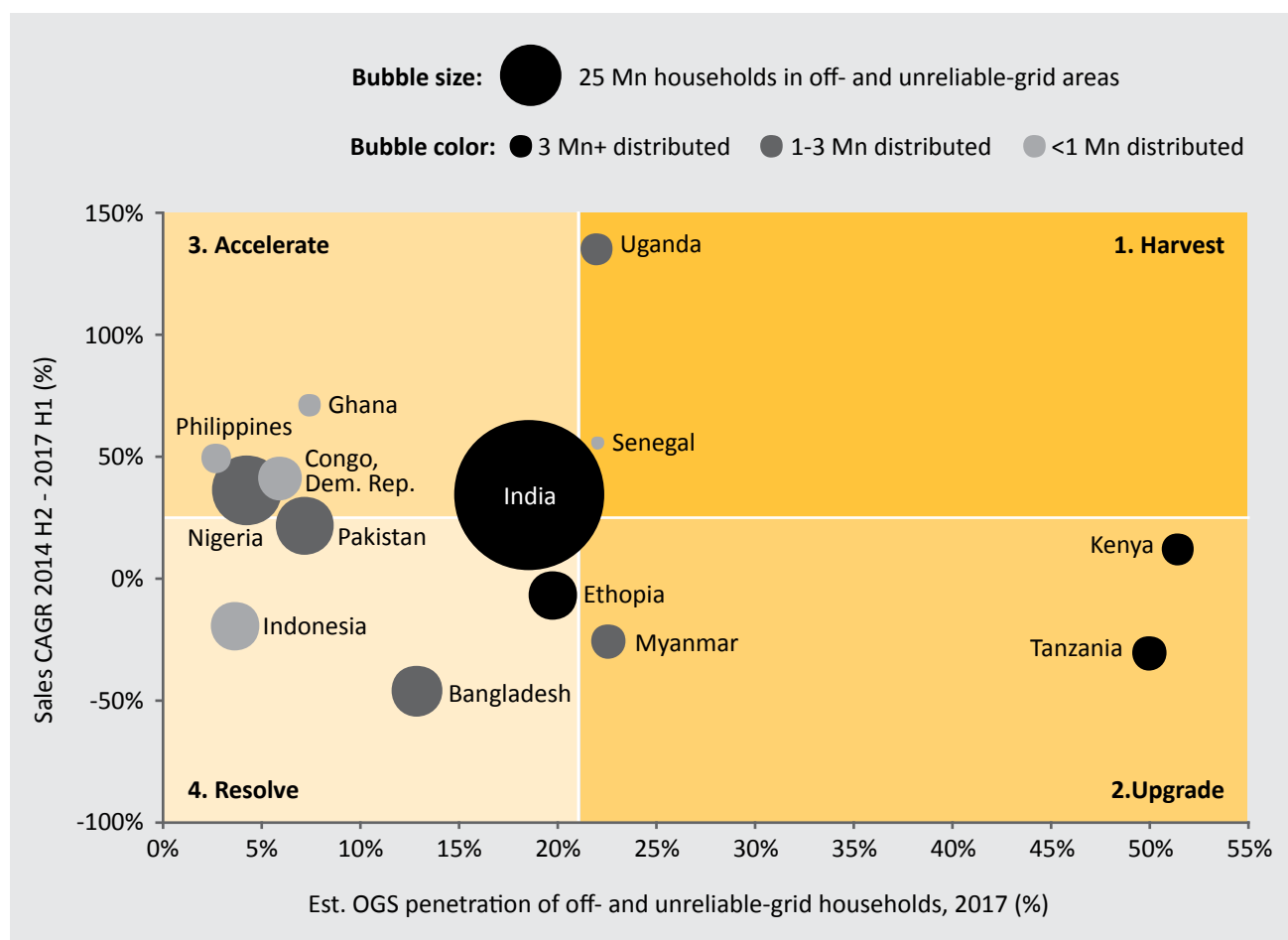
⁴⁰Note: PnP SHS growth is provided for 2014-2016 only, due to lack of sales data prior to 2014

⁴¹Note: Due to limited data and research scope, this report has not provided an estimate of the rate of change for open-market component-based sales, and the figures here are based on the assumption that open-market component-based sales will remain constant in absolute numbers to 2022. Revenue calculations are based on price assumption of USD 90-100 per open-market component-based device. Source: (Lighting Global/Dalberg, 2017)

partnerships to penetrate the harder-to-reach customers.

3. *Accelerate*: Up-and-coming markets which show promising growth and where suppliers can continue to scale operations to take advantage of large unpenetrated populations.
4. *Resolve*: Under-penetrated markets which have seen sales fall, and which would need concentrated supplier investment to resolve context-specific issues.

Figure 10: Estimated sales and penetration of OGS devices in select markets⁴²
% (2014 H2 - 2017 H1)



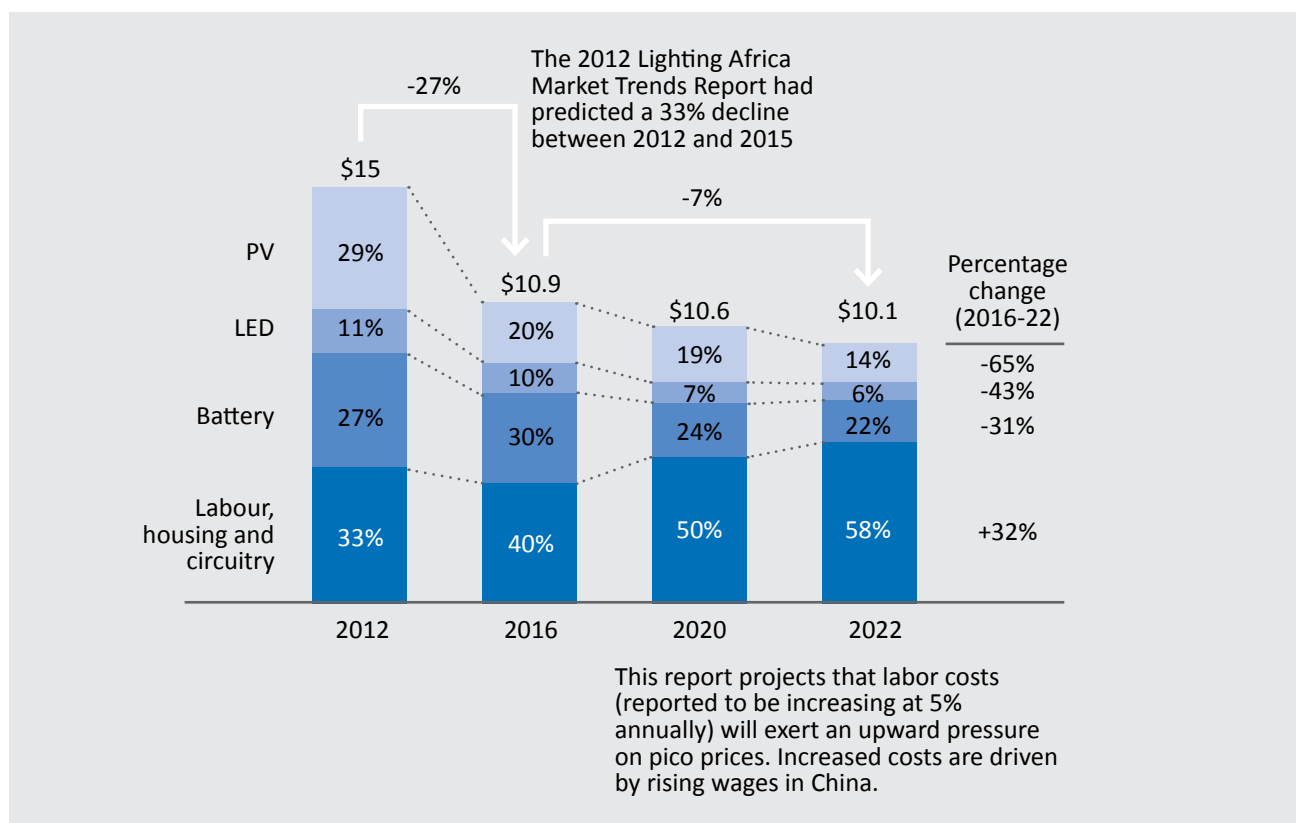
Looking ahead, this report projects a strong overall OGS market based on the following expectations:

- *The market fundamentals will remain buoyant*, with a stable and underpenetrated potential market (including a growing market for replacements and upgrades for current OGS consumers), ongoing real income growth, improvements in distribution infrastructure and ease-of-doing business within countries, an increasingly enabling policy environment, and a maturing private sector that continues to be hungry to expand. Ongoing technological improvements, efficiency gains and price drops for OGS components and appliances (albeit slower than in the past) will continue to fundamentally expand the value proposition for customers.

⁴²Note: Estimate includes both affiliate sales and non-affiliate sales estimates of pico and PnP SHS, as well as institutional component-based (India, Myanmar and Bangladesh) and open-market component-based devices. Sales are discounted to assume 10% sales to repeat customers and 3% loss of devices sold, and assume a 3-4 year product lifetime (GOGLA, 2016a). Source: Lighting Global/GOGLA sales data; industry interviews; Dalberg market model and analysis

Figure 11: Decomposition and forecast of the median pico component cost⁴³

USD (2012-20)



- *Expansion of PAYGO, including cheaper systems as well as wider appliance availability, will continue to drive growth.* Improvements in appliance performance and affordability, especially fans and TVs, will boost SHS sales, and vice versa. Industry experts have noted that these two technologies are farthest ahead in their development cycles for efficient off-grid use. Three PAYGO companies have already launched self-branded televisions in 2016-17, with one player, M-KOPA, having sold up to 70,000 units by July 2017.⁴⁴ Based on inputs from interviews and desk research it is conservatively estimated that up to 60% of SHS sold in the market over 2017-2022 could have bundled DC fans, and about half would likely include DC-powered TVs. This means the OGS sector will command a higher share of customers' wallets.
- *Virgin and under-penetrated markets will offer incremental growth opportunities,* including those with large off-grid populations like the Democratic Republic of Congo. As depicted in Figure 10, few countries have achieved penetration in excess of 20% of their potential markets, implying large scope for expansion into harder-to-reach areas, including in maturing markets. Moreover, there are at least 40 countries that together account for around 200 million off- and unreliable-grid households that remain largely unaddressed by OGS.
- *Growth or expansion of second-generation companies is expected,* particularly non-vertically integrated players in the PAYGO space. The growth of these companies (and new ones, including local players) will be essential to support the projected growth of the OGS sector. It is likely that that these second-generation companies will continue to be increasingly focused on relatively untapped markets, enabling them to capture first-mover advantage. They can also leverage the innovations developed by the first-

⁴³Note: Holding performance constant for a PV of 3W, light output of 75 lumens and battery size of 14 Wh. Source: Dalberg research and analysis

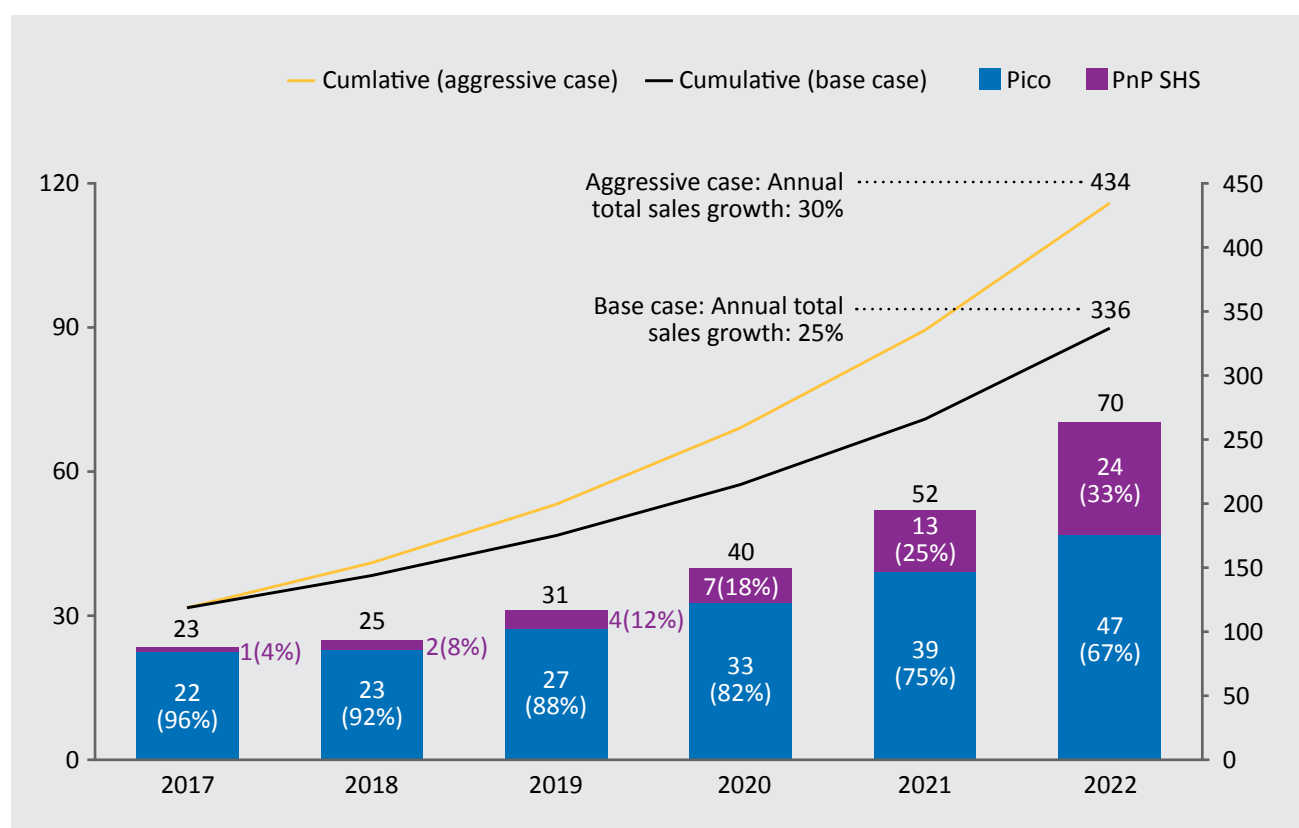
⁴⁴Source: (M-KOPA, 2017a)

generation of companies in order to focus their efforts on operational excellence, building out their internal finance capacity and external fundraising methods, and understanding the nuances of their local target markets.

- *Well-targeted gap funding from development and public-sector partners is available.* There is a rising focus on achievement of universal sustainable electrification, as enshrined in the SDGs and the SEforALL agenda. This has led to significant DFI, government, and foundation funding that could help plug the gap between investor hurdle rates and where the market is today.⁴⁵ The impetus to achieve this target counters the decline in initial investor exuberance, however any such investments must be carefully designed to avoid undermining the commercial market.
- *Consumer awareness of the category is largely established.* By now, even in many virgin markets there is basic awareness of OGS devices. This report expects consumer loyalty toward individual brands to become the next battleground although price will remain the overwhelming driver for pico products.
- *Policymakers will continue to recognize and buy into the energy access and impact potential of OGS as a whole, and work toward providing a favorable business and trade enabling environment.* High-level government endorsement and incorporation of off-grid technologies into national electrification plans, are an important signal to other players regarding the stability of the off-grid sector. It is also important to coordinate with the private sector on regulation, particularly when dealing with issues such as OGS quality standards, taxation, and e-waste.

Figure 12: OGS market forecast for pico and PnP SHS⁴⁶

Million units; left axis: annual sales; right axis: cumulative sales (2017-22)



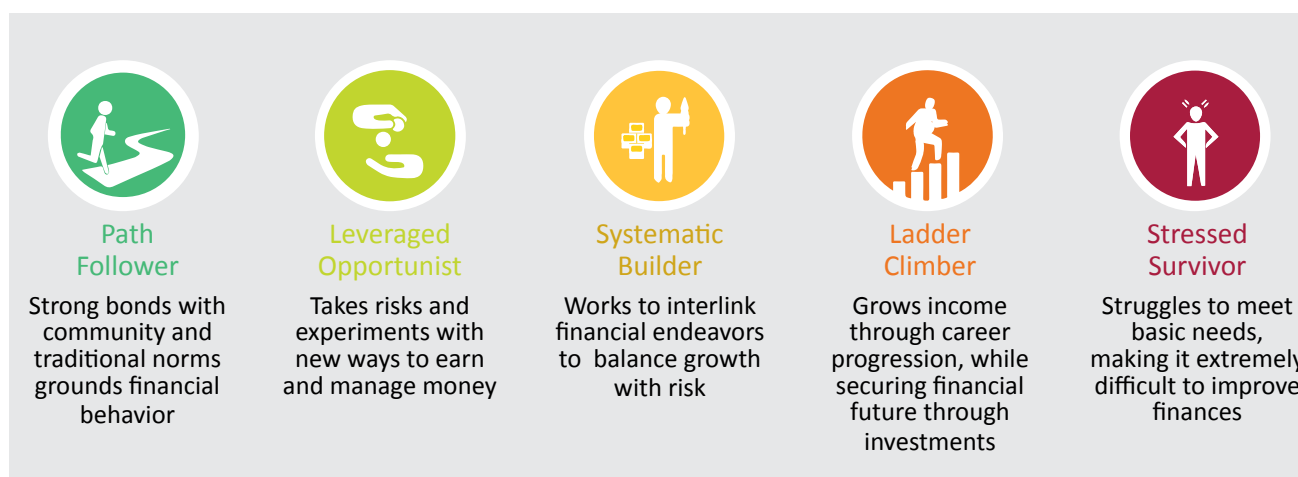
⁴⁵Note: Key examples include EnDev's results based financing program in Tanzania, which incentivizes distribution in rural areas, and the World Bank's ROGEP partnership with 15 ECOWAS member states, which aims to foster the enabling environment in West Africa

⁴⁶Source: Dalberg market model and analysis (see Table 12 of full report for methodology and sources)

Several cross-cutting initiatives/scenarios can help supercharge the OGS sector. This report's business-as-usual scenario, as described above, would still leave approximately 300 million households without improved access to electricity.⁴⁷ There are several high potential opportunities to drive the mandate for stronger growth. Most impactful among these are:

- *Defining the next level of customer segmentation.* A common refrain among OGS companies interviewed for this report is the difficulty of penetrating beyond an initial core set of users in a village, even though macro indicators of income would suggest an ability to pay. The experience of other electronic goods and FMCG companies suggests that segmentation needs to move beyond economic indicators and dig deeper into customer behavior. Greater investment in human centered design-based segmentation can help all players better target product design, communications and offerings to the various behavioral segments present in a village.

Figure 13: Example of behavior segmentation: Personas of digital finance users in India, Kenya



- *Major corporations enter the segment in a substantial way.* The OGS industry has attracted interest from large multinational corporations for some time. However, this has not materialized into sustained market entry or long-term presence. Players such as Schneider, Panasonic and Phillips that explored OGS in the past 5-8 years have limited their scope and are marginal players to the sector. Recently, two other international conglomerates, Total and Engie, formalized their interest by acquiring stakes in OGS companies: Total acquired a stake in Off Grid Electric in 2016 and Engie completed its acquisition of Fenix International in 2017. Salesforce also took part in Angaza's Series B round in late 2017.

These types of transactions are likely to build steam over the next few years as several large global utilities and/or oil and gas companies seek to build their renewable assets substantially in the face of falling oil prices and long-term decline of that industry. In addition, distribution partnerships have shown success, such as Total's Awango initiative which is among the largest sole distributors of OGS with a footprint in over 30 countries globally. The entry of additional corporate players could help existing OGS companies address key challenges by: (1) increasing access to capital (both debt and equity), (2) leveraging supply chains and economies of scale in procurement and distribution, (3) increasing access to technical skills and expertise, (4) promoting access to global and local networks including strong government contacts, and (5) helping develop a higher brand equity. At the same time, it should be noted that competition from companies with

⁴⁷Note: Current improved access estimate incorporates sales of all actively-in use OGS devices. See GOGLA Impact Metrics for calculation methodology (GOGLA, 2016a). Source: (International Energy Agency, 2016); (International Energy Agency, 2017a); Dalberg market model and analysis

far superior access to finance via their parent corporations could crowd out prospective small and medium entrants.

- *Mobile money penetration increases in key OGS markets such as India, Nigeria, and Ethiopia.* The growth and scale up of digital finance and payments (including mobile money penetration) is expected across many developing markets. This would most notably include India and Nigeria, which also have the largest potential markets for OGS in the world with a total of nearly 200 million potential household customers in off-grid and unreliable-grid locations as of 2017.⁴⁸ This, in turn, is expected to translate into an increase in end-user affordability on the demand side, and to significantly ease and facilitate the growth of PAYGO business models at an accelerated pace for operators. Bolstering symbiotic relationships between PAYGO companies and mobile money operators could accelerate this trend. In fact, market watchers observed that first time mobile money usage is often driven by the need to make energy payments. PAYGO providers will therefore need to ensure careful communication and support to such customers to avoid some of the risks that new users of mobile money often face, such as fraud and low awareness of transaction fees.⁴⁹
- *Growth of off-balance-sheet, structured asset financing.* One way to address the emerging funding gap described above is to deploy off-balance-sheet asset financing models. Investors and companies alike have pointed to the prospects of unlocking financing for PAYGO companies based on their underlying receivable assets. Until recently, off-balance-sheet structures were funded by DFIs and impact investors with a higher risk tolerance than typical commercial investors. However, as companies improve their credit risk assessment capabilities, commercial uptake could increase quickly. Segmenting customers into different risk pools and raising funding accordingly is one option that could become feasible once off-balance-sheet structures prove effective in fundraising. Better data on these transactions and standardization of performance metrics will help to bring in new investors. However, the OGS industry offers a complex environment for this kind of financing. As a result, several legal and administrative hurdles will need to be resolved before these off-balance-sheet financing models can deliver their potential.
- *Local-currency financing materializes and is deployed effectively.* The last two years have seen greater prevalence of local currency financing, which will only go up courtesy of a large set of bilateral and multilateral funding agreements for energy access (inclusive of OGS, mini-grid, and grid). These agreements, primarily between the World Bank and Sub-Saharan African countries, involve investments of close to USD 600 million of which over 60% will be available to the OGS sector. Much of this funding will target the local currency needs of OGS companies and could be catalytic due to the reduced currency risk and resultant increase in local bank involvement in the space. It could improve on-the-ground understanding as well as offer a nuanced view on risk management. At the same time, it will be important for local banks to build the requisite expertise to assess the risk in the OGS sector in order to effectively lend to it.
- *Emergence of specialized investment vehicles (SIVs).* In the early days of the microfinance industry, finding appropriate debt providers was a challenge. Over time, specialized investment funds called microfinance investment vehicles (MIVs) emerged. They developed specific expertise in the industry and provided wholesale debt to MFIs. The dynamics of PAYGO business models lend themselves to similar funding opportunities. In fact, there are likely to be direct opportunities for MIVs to also invest in PAYGO solar companies as they look for new growth opportunities. Currently, MIVs collectively manage over USD 10 billion of capital and could be a significant source of future funding, as has been noted by several impact funds interviewed for this report.⁵⁰

⁴⁸Note: See Section 1A of full report for estimation methodology. Source: (International Energy Agency, 2016); (International Energy Agency, 2017a); Dalberg market model and analysis

⁴⁹Source: (Kiiti, 2012)

⁵⁰Source: (Sotiriou, CGAP, 2017)

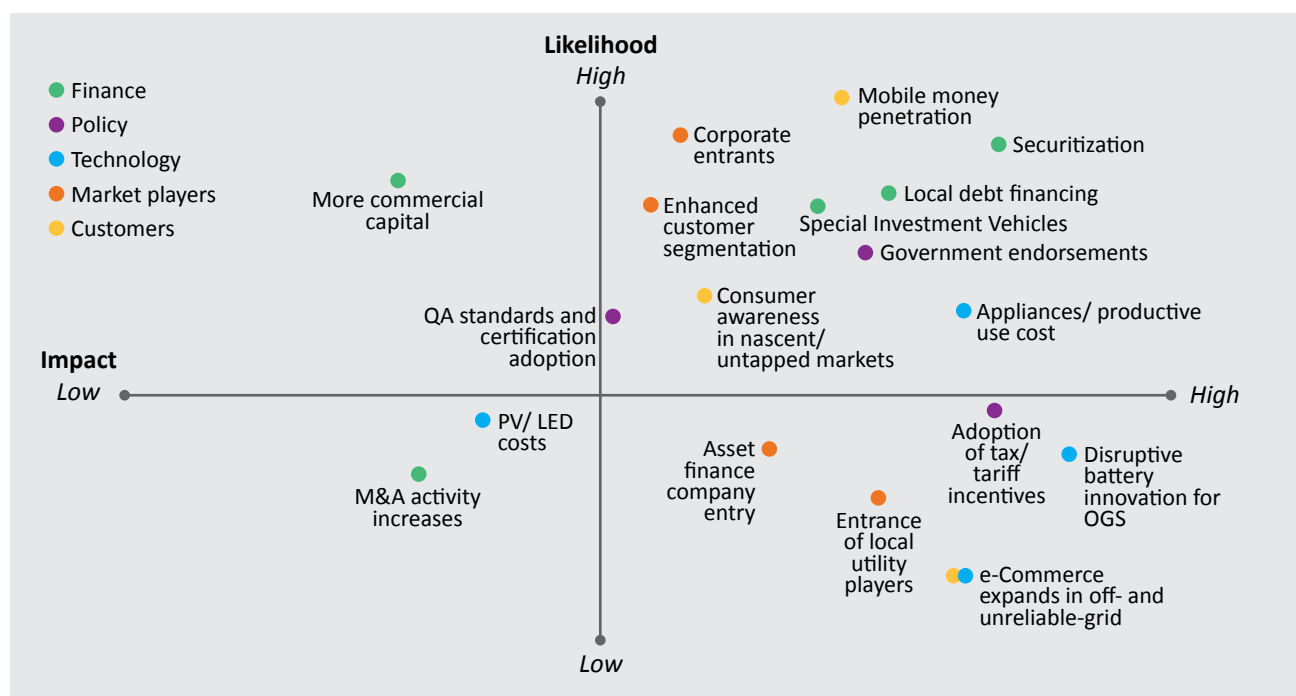
- *Increased integration of productive-use appliances with SHS.* It is clear that the industry needs to help put money back in the pockets of consumers if it wants to help move customers up the energy ladder. Several industry players have noted in interviews that they are likely to increase their R&D budget to develop and pilot productive use solutions such as agricultural implements and refrigerators. An increase in investment levels above existing plans could help catalyze the integration of productive-use appliances. Importantly, significant potential exists for convergence between larger capacity solar players (mini-grids, captive plants) that are already experimenting with productive use applications, and the capabilities of PAYGO OGS players with know-how of product level financing and remote asset management.
- *Increased government endorsements and regulatory support for OGS.* Policymakers are increasingly incorporating OGS into their energy access strategies to complement grid and mini-grid approaches. It is expected that this trend will intensify in the next three to five years, as more governments become convinced of the positive impact of OGS markets as seen on millions of households in energy-poor countries. In addition, as noted above, stronger government coordination with the private sector and the adoption of tax and tariff exemptions and incentives for OGS systems, components, and energy-efficient appliances could transform the industry as occurred in early winner markets in East Africa. These instruments are non-distortionary, increase end-user affordability (by directly reducing prices by up to 30% in certain countries), and level the playing field for enterprises. In addition, recent studies have shown that VAT and import tariff exemptions may deliver a boost to government finances in the long-run, while offering broader household and macroeconomic benefits. One model in Mozambique found that standalone solar market growth would increase business taxes by offering multiple benefits. It would enable businesses to stay open longer, increase time spent working (by improving health), and encourage job creation in the standalone solar supply chain.⁵¹ However, governments will need to be careful to ensure that support provided does not distort commercial markets (e.g. through end-user subsidies).
- *Accelerated adoption of universal quality standards among countries.* Wide adoption of internationally agreed-upon quality assurance standards can provide a significant boost to country markets, ensuring that consumers experience with OGS is based on quality products and increasing the likelihood that they will be repeat purchasers. However, as evidenced in the experience of Ethiopia, implementation and enforcement are key to ensuring that quality standards have the desired effect. Without coordination with established international standards and testing schemes, customs regulations can do more harm than good by creating unnecessary costs, unproductive barriers to entry and enable poor quality goods provided by actors who simply avoid customs to flood the market.

These and other potential game-changers are mapped according to their potential industry impact and likelihood in Figure 14.

⁵¹Source: (GOGLA, 2017)

Figure 14: Relative ranking of game-changers for the OGS industry

Subjective ranking (5-year time horizon)



Winning in the OGS market: The profitable growth challenge

Few OGS companies are declaring profits today, and price competitiveness is only going to escalate. While the long-term prize, a market worth USD 8 billion by 2022, is large, there is a question mark over the ability of companies to serve it profitably in each market. For those players seeking to be the leaders in the sector and deliver outsized returns, the authors expect the following common traits:

- A reach across multiple countries, as opposed to a narrow geographic focus
- A broad product portfolio that lowers the per-unit customer acquisition cost
- Products sourced from low-cost manufacturing bases
- Access to low-cost capital that enables companies to move faster and further than competitors

However, no one model will dominate. Below, four distinct models that will have a competitive advantage in the long-run are characterized. While many hybrids emerge, the characterizations below serve as a guide and reflect elements already witnessed in leading companies today.

Model 1: The Energy Ladder Companion

This model provides a full suite of energy products, ranging from entry-level pico, to large SHS, to associated appliances. Such companies focus on a lifelong association with the customer, helping them transition up the energy ladder irrespective of their starting point. This enables them to both reduce their per-unit customer acquisition costs (which are substantial, and more than the cost of upgrading a customer), as well as spend more (in absolute terms) on marketing. Key ingredients to the success of this model include a strong entry product (which helps set the foundation for future interactions with the customer), consistency in branding (demonstrated by quality, after sales service and longevity of the product), a flexible business model by geography (different forms of payment and delivery), and effective customer relationship management.

Model 2: The Banker

This model is followed by PAYGO SHS players focused on deepening a loan product relationship with customers using OGS as an entry point. While the firm may use PAYGO to finance OGS compatible appliances, PAYGO services can extend to meet other consumer needs such as loans or to purchase other consumer goods as well. This ability to upsell is important, given the heavy costs of establishing the initial loan relationship. Key success factors for this model include the ability to mine customer data (which can reduce portfolio risks and support product and service sales), effective banking capabilities (such as credit scoring, portfolio management and loan collection), a technology advantage (resulting in differentiated design and efficiency of large appliances), and access to cheaper capital.

Model 3: The Fast Follower

This model is used by OEM or non-affiliate manufacturers that focus on replicating tried and tested models and markets. Such players take advantage of a low-cost manufacturing base and limited investment in design, marketing and proprietary distribution to focus on providing good, established design at highly competitive prices. For some players, this can also be a starting point to becoming a brand. This strategy is well-established in consumer electronics, and comes into its own as a high-volume, low-margin approach once initial trust in the product category is established. Key success factors include scale economies across multiple products (such as emergency lights, torches and broader electronics), flexible manufacturing to follow market trends, and the ability to leverage distributor relationships (both formal and informal).

Model 4: The Value Chain Specialist

This model pertains to companies that opt to achieve excellence on a specific part of the OGS value chain, and outsource or partner on the other parts. Examples of this are emerging on all parts of the value chain, be it technology, distribution, manufacturing or even financing. The increase in specialization has been driven by a maturing market that allows for it, in comparison to the early days of the market which necessitated vertical integration (to account for lack of suppliers in various parts of the value chain). Specialization allows parts of the sector to scale faster; companies such as Renewit (design and manufacturing), and Angaza (PAYGO platform technology) are testimony to this. At the same time, one potential exit for such players is to be bought out by a market leader (such as the acquisition of Lumeter by Mobisol). Success in this model is driven by scale economies (which help make specialists the de-facto market standard), and effective client servicing abilities.

The authors' view of a potential future: From OGS to a consumer electronics company

As avid followers, researchers, and advisors in the OGS space, the authors of this report have consistently felt that the sector has defined itself around a critical challenge, but in addressing that challenge, leading sector players have developed impressive and broadly applicable capabilities. The future of the sector lies in going beyond the initial clean, safe, and affordable lighting challenge.

Leading OGS players have the ability to transform themselves into broader consumer electronics companies that have a DNA for making products work in tough conditions and in frontier markets. This applies not only to the integrated B2C players, but also the specialists in the value chain (e.g. PAYGO technology specialists) who can serve additional product segments.

This study, by definition, focuses on the OGS sector, but the players within it don't need to. Energy provision itself promises to be lucrative, and all signs point toward significant growth in energy demand as the more than 430 million off- and un-reliable grid households globally experience the transformative shift to dependable energy access. But in the long-run, leading companies will leverage their brand and customer relationships to serve broader electronics needs. Investors, should take note as that is potentially an even bigger prize.

Download the full report at www.lightingglobal.org