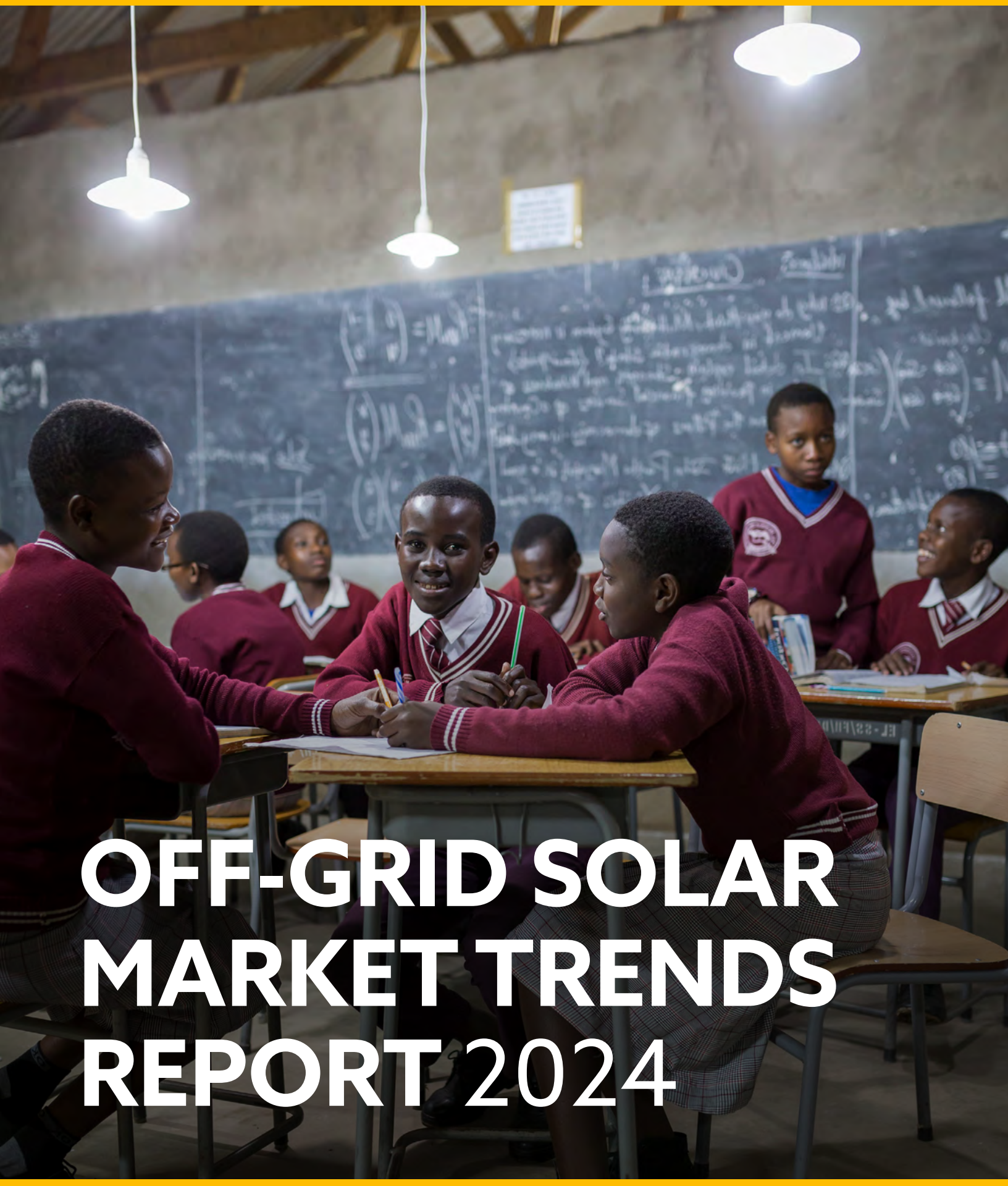

OFF-GRID SOLAR MARKET TRENDS REPORT 2024

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THE WORLD BANK
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Energy Sector Management Assistance Program

GOGLA

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Foreword

The world reversed course on electricity access for the first time in two decades. Analysis by the custodians of SDG 7 released this year found that in 2022, population growth outstripped progress on access, leaving 685 million people in energy poverty. Without immediate action to change the current trajectory, 660 million people will still live without electricity in 2030.

This is unacceptable. It is also solvable. Off-grid solar technologies are a significant part of that solution. They provide the least-cost route to reach 40% of the people who still need to be connected to electricity by 2030 — the majority of whom are living on the lowest incomes and in fragile, disaster-prone, or conflict-affected regions. Off-grid solar technologies also offer an alternative electricity source for 1.6 billion others subject to frequent power outages, helping keep the lights on and businesses open.

The off-grid industry has already reached 560 million people globally. Of these, 253 million have gained basic electricity access at tier 1 level, as defined by the ESMAP Multi-Tier Framework, and 132 million are benefitting from enhanced access at tier 2 and above. This report shows that the last two years have seen an increase in the sale of income-generating solar appliances for businesses and farms and the use of off-grid solar to electrify schools and health centres. This modest growth in sales and impact was achieved despite high inflation levels, currency devaluation, extreme weather conditions, and conflict in many countries, negatively impacting affordability and profitability. Off-grid companies have demonstrated their resilience by adapting rapidly to these challenging conditions.

The industry is also receiving more recognition internationally. More governments are making off-grid solar part of their electrification plans, commercial investment in the sector continues to slowly increase, and hundreds of millions of US dollars have been committed as part of results-based financing. The announcement of the "Mission 300" initiative by the World Bank and African Development Bank - which aims to electrify 300 million people by 2030 - alongside other programs and efforts to accelerate access to off-grid solutions, has created further momentum.

Yet, affordability constraints place the hardest-to-reach communities at a high risk of being left behind. Even with pay-as-you-go consumer finance, only 22% of the households that currently lack access to electricity can afford the cost of a solar energy kit providing tier 1 level access. This percentage drops even further in the most remote areas, where affordability is the lowest, and off-grid solar companies face the highest operating costs.

Achieving universal energy access requires a sustainable, adequately funded off-grid sector. This report estimates that USD 3.6 billion annually is needed to provide electricity access by 2030 to the 398 million people for whom off-grid solar is the most cost-effective solution. About 60% of this funding could come from a combination of private sector equity, debt, and grants from several sources, while the remaining 40% would need to be provided through subsidies to address the affordability gap of the people who are hardest to reach. This additional investment represents a sixfold increase from the overall USD 3.5 billion invested in the sector. Even more investment is needed to enable the powering of businesses, farms, and public services.

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ESMAP
Energy Sector Management Assistance Program

The Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and over 20 partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the WB, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7), which ensures access to affordable, reliable, sustainable, and modern energy for all. It helps shape WB strategies and programs to achieve the WB Climate Change Action Plan targets. Learn more at: www.esmap.org.

ESMAP Support to Off-Grid Solar
ESMAP has been a leader of off-grid solar electrification efforts for more than 15 years, previously through the now-closed Lighting Africa and Lighting Global Programs, which positively impacted over 320 million people. Today, as part of its Energy Access Program, ESMAP continues to catalyze off-grid solar activities with the new business plan (FY25-FY30) focusing on enabling access to three primary groups of beneficiaries - households, businesses, and public institutions.

IFC International Finance Corporation WORLD BANK GROUP

IFC—a member of the World Bank Group—is the largest global development institution focused on the private sector in emerging markets. We work in more than 100 countries, using our capital, expertise, and influence to create markets and opportunities in developing countries. In fiscal year 2021, IFC committed a record USD 43.7 billion to private companies and financial institutions in developing countries, leveraging the power of the private sector to end extreme poverty and boost shared prosperity as economies grapple with the impacts of the COVID-19 pandemic. For more information, visit www.ifc.org.

GOGLA

GOGLA is the global association for the off-grid solar energy industry, representing over 200 members working to transform lives through clean, affordable, and high-quality solar products and services. More than 560 million climate-vulnerable people already benefit from off-grid solar to power their homes, farms, enterprises and public infrastructure. With the right support, our industry is poised to scale rapidly, aiming to improve the lives of 1 billion people by 2030. GOGLA drives this progress by serving as a central hub for the sector, offering vital market data, advocating for supportive policies and increased investment, and providing value-added services to our members.
Learn more at www.gogla.org.

Dalberg

Dalberg 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. To find out more, visit www.dalberg.com

Abbreviations

AC	Alternating current
AI	Artificial intelligence
BDS	Business development support
CAGR	Compound annual growth rate
CCF	Concessional consumer financing
C&I	Commercial and industrial
DC	Direct current
DFI	Development finance institution
EaaS	Energy-as-a-service
EPR	Extended producer responsibility
FaaS	Farming-as-a-service
FCV	Fragile, conflict-affected, and vulnerable
FDP	Forcibly displaced people
GEAPP	Global Energy Alliance for People and Planet
IoT	Internet of Things
MDB	Multilateral development bank
MFI	Microfinance institution
MSME	Micro, small, and medium-sized enterprise
MTCO2e	Million metric tons of carbon dioxide equivalent
MTF	Multi-Tier Framework
MTR	Market Trends Report
OGS	Off-grid solar
O&M	Operations and maintenance
PAYG	Pay-as-you-go
PUE	Productive use of energy
QV	Quality-verified
RAR	Receivables at risk
RBF	Results-based financing
ROI	Return on investment
R&D	Research and development
SDG 7	Sustainable Development Goal 7
SHF	Smallholder farmer
SHS	Solar home system(s)
SME	Small and medium-sized enterprise
SSA	Sub-Saharan Africa
SWP	Solar water pump
USD	United States dollar
VAT	Value added tax
W	Watt
Wp	Watt-peak
YoY	Year-on-year

Key definitions

Affiliate	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 VeraSol quality standards, and appliance companies that participated in the Global LEAP Awards or are engaging with the Low Energy Inclusive Appliances (LEIA) program. It is important to note that not all products produced by affiliate companies meet VeraSol quality standards, but stakeholders assume that all products affiliate companies produce are of reasonably decent quality.
Appliances	OGS Appliances are solar-powered devices that are energy-efficient and powered by direct current (DC). In this report, OGS appliances are categorized in the following way: • Household and small business OGS appliances, which provide essential services to homes and small business. In this report, they include fans, radios, and TVs. • Productive use OGS appliances, which are utilized for income-generating activities. In this report, they include solar water pumps, refrigerators, milling machines, and similar products.
Compound annual growth rate (CAGR)	A measure used to describe the average annual growth rate over a specific period, thereby eliminating the effects of volatility.
End-user Subsidies	Commonly interchangeable with "consumer" or "demand-side" subsidies; a tool used to overcome affordability challenges by directly reducing the consumer price—either channeled through companies or paid directly to customers in the form of cash transfers or vouchers.
Fragile, Conflict and Violent settings.	Fragile, conflict-affected, and vulnerable (FCV) settings include a variety of challenging situations, such as humanitarian crises, prolonged emergencies, and armed conflicts. The term applies to countries experiencing significant institutional and social fragility, and those impacted by violent conflict.
Global Electrification Platform (GEP)	Open-source, data-driven tool designed to support decision-making in planning and scaling electrification efforts. It was developed by the World Bank's Energy Sector Management Assistance Program (ESMAP). The platform uses geospatial data to help governments, development agencies, and energy planners determine the most cost-effective and efficient ways to provide electricity to underserved populations, particularly in remote and rural areas, and is used throughout this report to identify the proportion of the unelectrified population that should be addressed by off-grid solutions.
Hard-to-reach	Segment of population that resides in remote locations and is are difficult to serve due to poor infrastructure and relatively low incomes. The term can also encompass populations living in fragile, conflict-affected, and vulnerable areas; displacement settings; and surrounding communities.
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 electricity access their products provide.
Off-grid solar products	Off-grid solar (OGS) products are self-contained energy systems that generate and store electricity for individual use, typically in homes or businesses, without relying on the central power grid or connection to mini-grids. For the purposes of this report, OGS products are categorized as either solar energy kits or OGS appliances, which, in turn, are divided into either household and small business OGS appliances or productive uses OGS appliances. *Refer to Annex 1* – OGS Use case and product typology for more detail on the breadth of technologies included.

OGS market turnover	Market value of sales in USD of the OGS market globally, estimated based on the number of units sold by both GOGLA affiliate and non-affiliate OGS companies.
PAYG	PAYG business models allow users to pay for their products via technology-enabled, embedded consumer financing. A PAYG company will typically offer a solar product (typically SHS) 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.
Productive use of energy	The World Bank defines productive use of electricity as activities that use energy to improve income and welfare. Note: The definition is linked to the impact and not the technology.
Rural	Refers to remote areas, with low population density and limited built infrastructure. Commonly also referred to as "hard-to-reach."
Results-based financing	Results-based financing is an umbrella term referring to any program or intervention that provides rewards to companies after agreed-upon results are achieved and verified.
SDG 7	Sustainable Development Goal 7 is one of 17 Sustainable Development Goals established by the United Nations General Assembly in 2015. It aims to "ensure access to affordable, reliable, sustainable, and modern energy for all."
Securitization	Future cash flows generated by PAYG solar energy systems are bundled and sold to investors—typically "secured" against the SHS themselves. This allows companies providing solar products to raise capital faster and reinvest in scaling up. As PAYG receivables are in local currencies and currency volatility is high, there is a big advantage to companies in local currency securitization, but this is less commonly available.
Solar energy kits	Solar energy kits (SEKs) are bundled, pre-packaged systems designed to provide basic electricity access to households and small businesses in areas without grid electricity. The SEK category includes solar lanterns and solar home systems (SHS). For this report's purpose, solar lanterns are systems below 3 Wp and that provide below Tier 1 electricity. A majority (83%[1]) of smaller and larger solar home systems typically provide access to Tier 1 electricity or above.
Solar home systems	Solar home systems (SHS) are standalone photovoltaic systems designed to provide electricity to households, small businesses, and community facilities that are not connected to the central grid. Typically consisting of solar panels, a battery for energy storage, and an inverter, SHS can power basic appliances such as lights, mobile phones, radios, fans, and sometimes larger appliances like televisions or refrigerators, depending on system size. The power capacity rating of a SHS typically ranges from 3 Watt-peak (Wp) to 100 Wp, although larger systems exist. For the purposes of this report, SHS are divided in the following categories: • **Smaller SHS** (capacity rating: 3 to 49.9 Wp) are solar-powered setups typically designed to provide electricity for multiple lights and small appliances such as fans • **Larger SHS** (capacity rating: 50 Wp and above) are more comprehensive solar-powered set ups to power multiple rooms of lighting and multiple or larger devices such as TVs or refrigerators in homes and small businesses

1. Source: ESMAP, Off-Grid Solar Market Trends Report, 2022

Social infrastructure	Social infrastructure refers to public and private facilities and services that support the quality of life and well-being of a community. It encompasses educational facilities such as schools, healthcare facilities, and other community services. As they represent the vast majority of the addressable market, this report focuses mostly on public facilities.
Solar lanterns	Solar lanterns are compact, portable lighting devices powered by solar panels, primarily designed for single-point lighting and often capable of charging phones in off-grid areas. In this report, they are defined as having a power capacity below 3 watts peak (Wp) and providing electricity access below Tier 1.
The Multi-Tier Framework (MTF)	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 counting the number of access points to any source of electricity equally. The MTF gives electricity access a multi-dimensional redefinition as "the ability to access 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 considers additional aspects, such as reliability and affordability. Electricity access is measured on a tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access).
Tier 1 electricity access	Tier 1 electricity access refers to the initial level of access to electricity as defined by the Multi-Tier Framework (MTF). In this tier, households have access to basic electricity services, such as the ability to power a few small devices (e.g., lights, phone chargers, radios) for a limited amount of time each day. To qualify as Tier 1 under the MTF, the household must have access to : • At least 4 hours of electricity per day, including at least 1 hour in the evening. • A system with a power capacity rating of at least 3 Wp, able to generate daily at least 12 Wh.
Tier 2 electricity access	Tier 2 electricity access represents an enhanced level of energy access within the MTF. Tier 2 provides more substantial and reliable electricity services compared to Tier 1, enabling additional appliances and greater daily usage. To qualify as Tier 2 under the MTF, the household must have access to: • At least 4 hours of electricity per day, including at least 2 hours in the evening. • The A system with a power capacity rating of at least 50 Wp, able to generate at least 200 Wh daily.
Unelectrified households	Households that either have no electricity access or have access to electricity that falls below Tier 1 according to the MTF.
Urban	Encompasses areas with a high density of population and built infrastructure, including housing and public services.
Weak grid	Grid distribution networks that suffer from poor reliability, or inadequate service quality, such as frequent load shedding, service interruption, instable voltage that can damage electrical appliances, and more.

Exhibits

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Headline trends

Off-grid solar (OGS) is the most cost-effective solution to reach 41% of people that need to be electrified by 2030.

In 2022, the number of people lacking access increased for the first time in 20 years, to 685 million people. A further 1.6 billion people live in weak-grid areas without reliable access to electricity. If current trends continue, 660 million people will still be living without Tier 1 electricity access in 2030.

The OGS sector served 561 million people in 2023, of which 385 million people at Tier 1 level access or above, and accounted for 55% of new connections in Sub-Saharan Africa from 2020 to 2022.

OGS is the least-cost solution for 398 million people that will lack electricity access between now and 2030, accounting for population growth – 41% of the households that will need to be electrified. It also offers an alternative electricity source for the 1.6 billion that today suffer intermittent grid access.

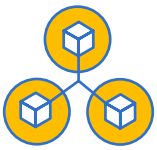
Sales and market turnover have shown resilience in challenging macroeconomic conditions, but PAYG collection rates point to ongoing affordability constraints.

More than 50 million OGS products were sold in 2022 and 2023—above the pre-COVID all-time high of 47 million in 2019. Market turnover reached an estimated 3.9 billion USD in 2022 and 3.8 billion USD in 2023, surpassing the previous record of 3.3 billion USD in 2019.

In 2023, 1.76 million fans and TVs were sold, alongside 30,000 solar water pumps and refrigerators. While TV and refrigerator sales are fairly stable, fans and solar water pumps are seeing strong growth.

An increasing proportion of OGS products are sold on PAYG. 39% of affiliate OGS products were sold through PAYG in 2023, up from 24% in 2018.

In many countries, currency devaluations have triggered local currency price increases and made OGS products less affordable. Non-performing PAYG loans peaked in 2022 before improving in 2023. The sector has responded by improving credit management practices—but collection rates remain low, pointing to ongoing customer affordability constraints (62% in 2023, in line with 2021).



Three core trends have emerged in the past two years: consolidation, diversification of business models, and skills shortages.

Mergers and acquisitions have gathered pace, as companies leverage addition to enhance their market positions and extend their reach into new regions.

OGS companies that have diversified their businesses, or focused on an innovative business model, have seen improved commercial performance. Some are offering higher-value products to higher-income customers, while others are exploring alternatives to PAYG to reach lower-income households, such as rental or service models.

The sector is facing a shortage of skilled labor required for the sale, installation, operation, and maintenance of OGS systems, especially in remote areas. 78% percent of respondents in the OGS sector view the "limited skills" challenge as an impediment to their expansion efforts.

Affordability is a critical challenge globally for households lacking access.

Only 22% of households lacking electricity globally can afford the monthly payment required for a Tier 1 solar energy kit on PAYG, while 49% would be able to afford it at a stretch. Tier 2 OGS products on PAYG are affordable for only 1%, and affordable at a stretch for 2%, of those lacking access. Productive use appliances sold on PAYG remain unaffordable for most.

The cost of extending services to remote or conflict-affected areas increases prices locally by an estimated 57%, with Tier 1 PAYG system prices increasing from USD 127 to USD 199. 82% of people lacking access to electricity live in these settings.

Public and private investment in OGS is growing, with USD 1.2 billion in debt and equity invested from 2022–23. Access to finance is still a challenge for small and mid-sized firms.

Investment in the OGS sector reached USD 1.2 billion during the 2022–23 period, up from USD 773 million in 2020–2021. About 20% of this investment was in local currency, which is crucial for mitigating the currency risks that OGS business models face. Since 2017, funding has grown at an average annual rate of 6%, largely driven by an increase in debt financing.

Public funding for OGS is growing; the World Bank lent a record USD 660 million to governments to scale up proven solutions in fiscal year 2024, with a range of development partners also active in the sector. Results-based financing (RBF) is being scaled up, with USD 733 million committed and 350 million disbursed since 2018. While the use of credit lines is being scaled back, the use of guarantees to unlock debt investments appears to be growing. Climate finance and carbon credits are underutilized.

Access to finance remains a significant challenge for the OGS industry, particularly for small and mid-sized companies.

OGS is rising up the international agenda, and increasingly incorporated into national electrification and energy transition plans.

OGS is rising up the international agenda. The World Bank and AfDB have jointly committed to Mission 300 (M300), a pledge to provide first-time access to electricity to 300 million people in Africa, enabling governments to access financing for new OGS programs from multilateral development banks.

At the national level, governments continue to integrate OGS into national electrification plans and are starting to integrate OGS into energy transition plans. While there has been progress on adoption of harmonized quality standards, some implementation challenges remain. Progress on other issues such as taxation, gender-inclusivity, e-waste management, and local manufacturing has been mixed.

Government investment in the OGS sector has a profound social impact and generates a positive return.

Achieving universal Tier 1 access for households could save USD 15.5 to USD 16.7 billion per year—equivalent to USD 142 per household—by reducing inefficient lighting expenditure and increasing incomes.

Replacing diesel generators used by businesses with OGS could save an estimated USD 6.3–12.5 billion in fuel costs, while avoiding a significant 8.3–16.6 million metric tons of carbon dioxide equivalent (MTCO2e) of greenhouse gas emissions per year.

Electrifying social infrastructure can reduce the average annual expense of USD 10,000 per school and USD 30,000 per health center for fuel generators, while also avoiding 0.9 MTCO2e globally each year.

Growing the OGS sector generates tax revenue and reduces fossil fuel subsidy expenditure, in some cases enabling governments to make a net profit on their OGS programs.

A significant increase in public and private investment is required if OGS is to meet its potential.

In a universal access to electricity scenario, USD 21 billion is needed to electrify all the 398 million people who would be most efficiently connected via OGS. Only USD 2.4 billion is needed to electrify more than one million schools and healthcare facilities that require electricity. A further USD 74 billion is needed to cover the total addressable markets for solar water pumps, cold storage solutions, and Tier 2+ OGS solutions for micro, small, and medium-sized enterprises (MSMEs).

The cost of electrifying households, farmers, businesses, and social infrastructure with OGS is affordable and attractive compared to alternative development pathways. Governments would need to cover only around 30–40% of the cost to unlock a further 60–70% in public and private co-investment.

Several emerging game changers can help unlock and scale the market.

A set of "game changing" business models, approaches, and support mechanisms is needed to 1) improve the commercial viability of the industry, 2) enable OGS companies to scale up provision of first-time access, 3) help the industry move beyond traditional PAYG models when serving hard-to-reach groups, and 4) accelerate the uptake of OGS for productive use and social infrastructure.

Many such game changers were already identified in the previous edition of this report; this report shares a few new additions, such as impact-linked concessional finance and tailored financing instruments for smaller companies, as well as some positive developments on existing game changers, such as local currency and off-balance sheet financing.

Achieving SDG 7 by 2030 requires a collective effort from governments, donors, and the private sector.

Achieving universal electrification by 2030 is not yet out of reach, but it is at risk. A significant increase in public funding for OGS is needed to unlock private investment and accelerate progress toward universal electrification.

The need to accelerate electricity access through OGS has never been more urgent. With just five years to 2030, the sector is at a critical juncture. The time is right for companies, investors, governments, and development partners to unite in a new effort to ensure the OGS fulfills its potential—enabling the achievement of SDG 7, while having a transformative impact on households, businesses, farmers and social infrastructure.

Introduction

For more than a decade, the biennial Off-Grid Solar Market Trends Report (MTR) has been the sector's flagship publication, produced by the World Bank / ESMAP and GOGLA with support from key partners. It serves as the primary source of information on the off-grid solar (OGS) sector for investors, industry professionals, policymakers, and other stakeholders.

Building on previous editions, Part One of the 2024 MTR focuses on the state of the OGS market and explores key trends in supply, demand, finance, and policy over the last two years. Part Two focuses on the market outlook and explores the factors that will shape the OGS sector's contribution to Sustainable Development Goal (SDG) 7.1 – to ensure universal access to affordable, reliable, sustainable, and modern energy for all by 2030.[2]

The MTR has traditionally covered off-grid solar energy kits (SEKs)—including solar lanterns and home systems. In 2022, the scope of the report expanded to include the most mature productive use of energy (PUE) product categories—solar water pumps and refrigerators—used for income-generating activities. This time, the MTR also includes a focus on using OGS to electrify social infrastructure such as schools and health facilities. Annex 1 gives an overview of the products considered in this report, including their primary characteristics and uses. Mini grids and clean cooking systems are out of scope. The report covers all countries with an electricity access deficit, as well as humanitarian settings. The structure of the report is outlined below.

Part 1 - State of the Off-Grid Solar Market

- **Chapter 1 – Off-Grid Solar and the Path to Universal Electrification** – Sets out the global electrification challenge and the critical role of OGS in delivering access to households, businesses, farmers, and public institutions.
- **Chapter 2 – Off-Grid Solar Market Trends** – Analyzes trends in the supply of off-grid solar products, including sales volumes, turnover, pricing, market landscape, and dynamics.
- **Chapter 3 – Affordability of OGS** – Explores the affordability of OGS, with a particular focus on the additional costs companies face when serving remote or fragile, conflict-affected, and vulnerable (FCV) areas and the impact of these costs on pricing.
- **Chapter 4 – Investment and Funding Trends** – Explores the types, volumes, and sources of financing flowing into the OGS sector, as well as key trends and access to finance challenges related to both private investment and public funding.
- **Chapter 5 – Enabling Environment** – Reviews the national and international enabling environment agendas involving OGS, including key commitments, policies, and regulatory trends affecting the sector.

Part 2 – Market Outlook

- **Chapter 6 – The Case for Off-Grid Solar** – Makes the case for government investment in the off-grid solar sector, highlighting its social, economic, environmental and political benefits
- **Chapter 7 – Funding Needed to Achieve Universal Access for Households, Businesses, and Social Infrastructure** – Projects the investment needed for the contribution of OGS to universal access for households, businesses, and social infrastructure, compared with current investment trends.
- **Chapter 8 – Enabling OGS to Meet its Full Potential** – Discusses 'game changers' to overcome challenges in the sector
- **Conclusion** – Provides recommendations to the key stakeholders as to how to unlock the sector and achieve universal access

2. Source: United Nations Department of Economic and Social Affairs, Ensure access to affordable, reliable, sustainable and modern energy for all. Note: SDG 7.1. will be referred to, for simplicity, as SDG 7.

Introducing the Market Trends Report Microsite and AI Chatbot

For the first time, the MTR is also complemented by an interactive, interactive, AI-supported microsite - coming soon. The microsite enriches the findings presented in the written report with more in-depth content on key topics of interest, such as an in-depth exploration of the global electrification gap; deep dives on specific fragile, conflict and violent countries, in-depth affordability analysis, and much more. 'Dynamic' content enables users to use the models built for the MTR themselves, adjusting assumptions and inputs to see what impact this has on results.

Throughout the report, the icon to the left will indicate an additional resource available on the microsite.

In addition to containing further resources, the microsite also hosts the AI chatbot, named the "MTR Assistant." The AI chatbot can help answer questions and provide additional insights coming not only from the MTR and the deep dives present on the microsite, but also from additional core resources such as previous MTRs, GOGLA Sales and Impact data, ESMAP Reports, and other relevant knowledge products.

photo credit: SOLARKIOSK

PART 1

State of the Off-Grid Solar Market

photo credit: Lagazel

CHAPTER 1

Off-Grid Solar and the Path to Universal Electrification

photo credit: d.light

KEY MESSAGES

According to current trends, 660 million people will still be living without Tier 1 electricity access in 2030.

In 2022, the number of people lacking access increased for the first time in 20 years, to 685 million people, 64% of whom live in fragile, conflict-affected or vulnerable (FCV) settings.

A further 1.6 billion people live in weak-grid areas without reliable access to electricity.

Off-grid solar (OGS) is already playing a critical role in delivering electricity access to households, businesses, and public institutions in off- and weak-grid areas. The OGS sector served 561 million people in 2023 and accounted for 55% of new connections in Sub-Saharan Africa from 2020 to 2022.

OGS is the least-cost solution for 398 million people - 41% of the 969 million people that will need to be electrified by 2030, accounting for population growth. It offers an alternative electricity source for the 1.6 billion with weak grid access, replacing generators and leading to savings for households and governments on subsidized fuels.

OGS enables households, businesses, and farmers to use electricity productively and generate income, while enhancing health and education outcomes in unelectrified communities through powering essential social infrastructure such as schools, healthcare facilities, and community centers.

Progress towards Universal Access to Electricity

Progress toward universal electrification reversed for the first time in 20 years in 2022, a year in which 685 million people lacked access to electricity. According to current trends, 660 million people will still lack access in 2030, 85% of them in Sub-Saharan Africa.

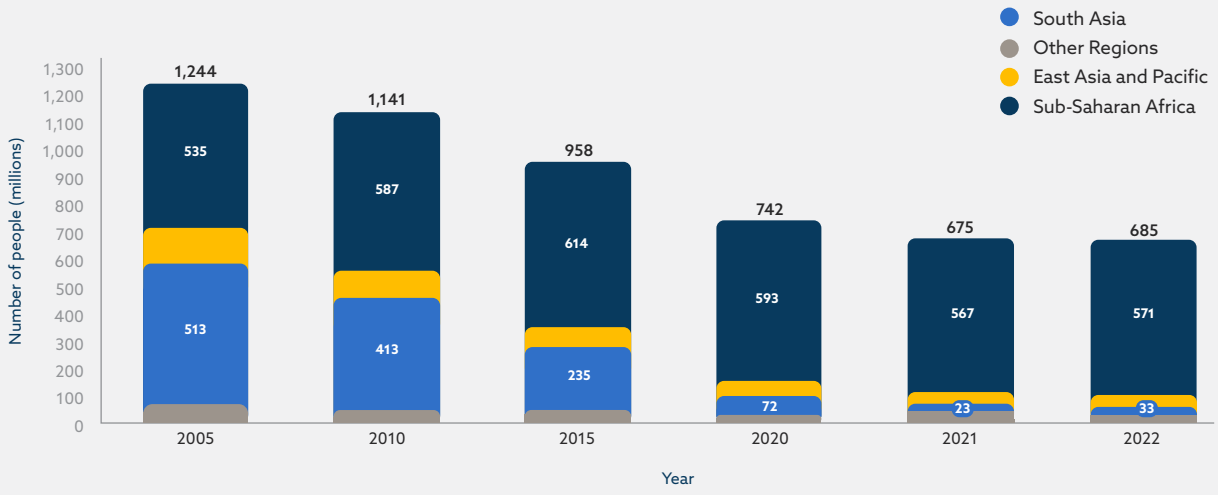
Despite significant progress in narrowing the access gap over the past two decades, 685 million people worldwide still lived without access to electricity in 2022—the last year for which data are available.[3] The population lacking access dropped from over 1.2 billion people in 2005 to 675 million in 2021, but this trend reversed when population growth surpassed the expansion of electricity access between 2021 and 2022 (see *Figure 1*). The reversal of progress can be attributed in part to global shocks, notably COVID-19 and the disruption in energy markets caused by the war in Ukraine, as well as regional shocks such as the increasing frequency and severity of droughts and floods in Sub-Saharan Africa due to climate change.[4]

Key Concept: Measuring Access to Electricity using the Multi-Tier Framework

Access to electricity refers to "the ability to access energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy, and safe for all required energy services."[5] The Multi-Tier Framework (MTF) measures access on a tiered spectrum, from Tier 0 (no access) to Tier 5 (highest level of access).

Solar lanterns, which provide lighting and sometimes mobile charging, provide partial Tier 1 access. **Smaller solar home systems**, which provide multiple lighting points, phone charging, and some appliance use (e.g., radio or fan), provide Tier 1 access. **Larger solar home systems** provide Tier 2 access, which includes lighting, phone charging, and the ability to power multiple appliances, such as radios, fans, and televisions.

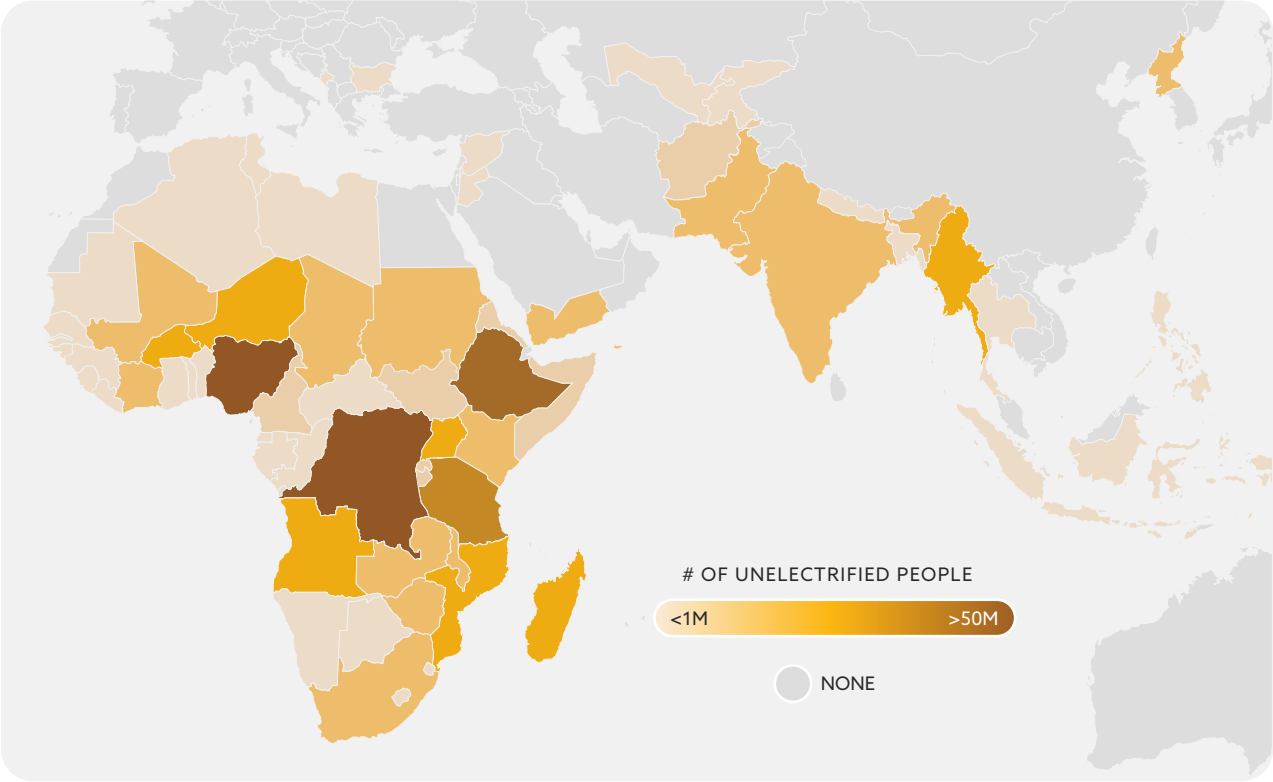
Figure 1: Total number of people lacking electricity access by region, 2005 - 2022 (millions)[6]



3. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
4. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
5. Source: ESMAP, Multi-Tier Framework for Energy Access (MTF)
6. Source: ESMAP, Tracking SDG 7data; Dalberg analysis, 2024

Since 2005, progress in electrification has been uneven across regions; while South Asia has made rapid progress, Sub-Saharan Africa has fallen behind. South Asia has seen a rapid increase in access to electricity, accounting for 75% of the decline in the population lacking access since 2005. In contrast, Sub-Saharan Africa, home to 85% of the world's population lacking access (around 571 million people), has struggled with high population growth, affordability issues, and conflicts, and is increasingly impacted by climate shocks (Figure 2). These challenges have primarily affected rural areas and countries with unstable governments, leading to slower progress in electrification. Advances in Sub-Saharan Africa have occurred mainly in urban settings and more stable regions, underscoring the need for targeted interventions to address those areas at risk of being left behind.[7, 8]

Figure 2: Heatmap of access deficit countries with the number of people without electricity access by country[9]



Coming soon: Explore the number of people without electricity access by country.

Nearly half of the population lacking access to electricity in Sub-Saharan Africa continues to be concentrated in Nigeria, the Democratic Republic of Congo (DRC), Ethiopia, Tanzania, and Uganda. Progress in Nigeria—where a continent-most 86 million people still lack electricity—is critical to achieving SDG 7. Despite its position as West Africa's economic powerhouse, Nigeria struggles with an unreliable grid, even in urban areas. The DRC follows closely, with 76 million people lacking access as of 2022. Grid coverage is limited to the capital, Kinshasa—emphasizing the need for off-grid solutions.

Globally, 64% of those without electricity access currently reside in fragile, conflict-affected, and vulnerable (FCV) countries, up from 57% in 2018.

This increase highlights the growing challenge faced by these regions, where weak governance and limited fiscal capacity have led to significant underinvestment in the energy sector. Current power sector development strategies—including plans for off-grid solar market development—are often inadequate for addressing the complex issues unique to FCV contexts, such as instability and insecurity.

7. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
8. Source: NASA, Plugging-in Sub-Saharan Africa, 2018
9. Source: ESMAP, Tracking SDG 7data; Dalberg analysis, 2024

Key Concept: Fragile, conflict-affected, and vulnerable settings

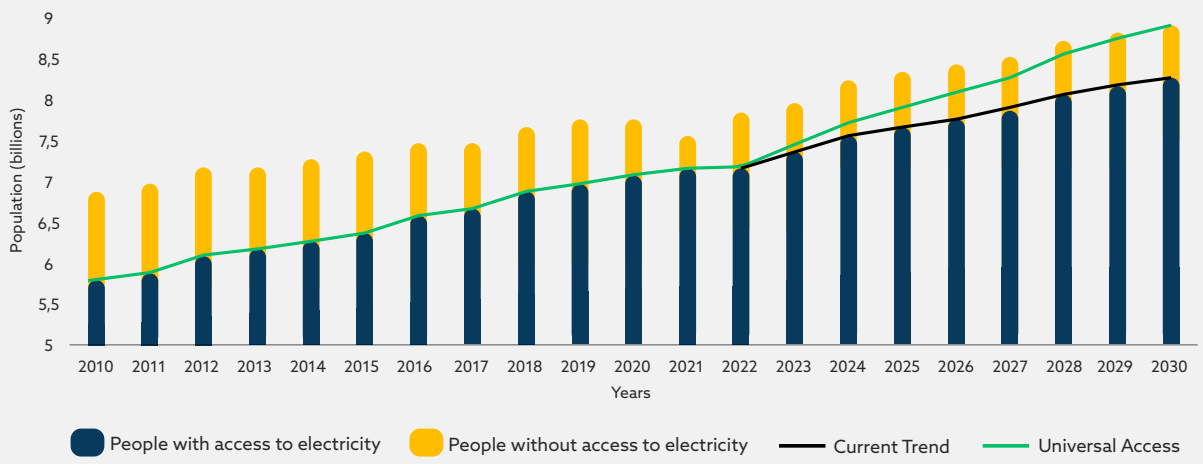
Fragile, conflict-affected, and vulnerable (FCV) settings encompass a range of situations including humanitarian crises, protracted emergencies, and armed conflicts. The term refers to (i) countries with high levels of institutional and social fragility and (ii) countries affected by violent conflict. These are identified based on (i) indicators that measure the quality of policy and institutions, and manifestations of fragility and (ii) a threshold number of conflict-related deaths relative to the population.[10]

In FCV contexts, development efforts, including electrification, are more complex due to the risk of disruptions, lack of infrastructure, and heightened humanitarian needs. Off-grid solar solutions are often critical in these areas because they can be rapidly deployed and offer resilient, decentralized energy where traditional infrastructure is either damaged or nonexistent.

If current trends continue, the world will fall short of achieving SDG 7, leaving 660 million people lacking access to electricity in 2030 (Figure 3).[11] (*Refer to Chapter 7 for further details on current and universal trends*).

Those still lacking access are harder to reach, because of remoteness and low incomes, as well as fragility and conflict, compared to those that have gained access in recent years.[12]

Figure 3: Global electrification gap, 2010–2030 (estimated)[13]



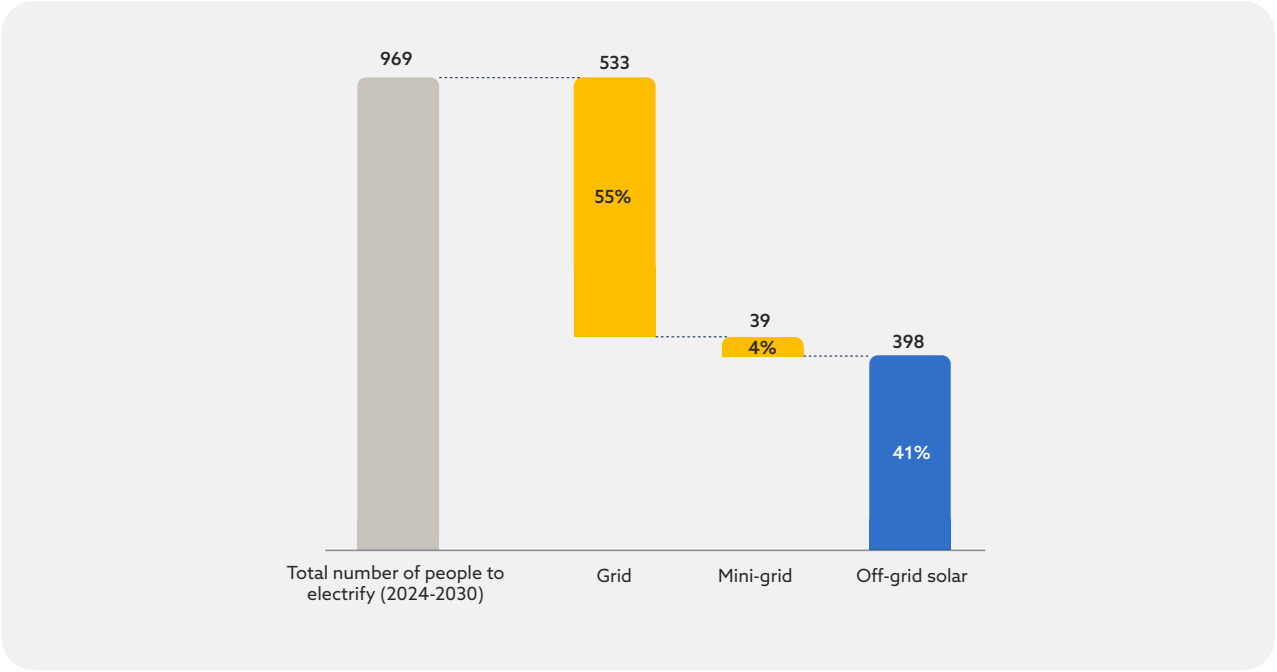
Coming soon: To explore the change in the electrification gap by region and country over different years, and the expected trends in electrification through 2030.

10. Source: World Bank, Classification of Fragile and Conflict-Affected Situations, 2024
11. Source: ESMAP, Tracking SDG 7 data; Dalberg analysis, 2024
12. Source: ESMAP, Tracking SDG 7 data; Dalberg analysis, 2024
13. Source: ESMAP, Tracking SDG 7 data; Dalberg analysis, 2024

The Role of Off-Grid Solar

Off-Grid Solar (OGS) represents the least-cost solution for 398 million people (41%) out of a total of 969 million people that will need to be electrified by 2030, accounting for population growth, according to World Bank Electrification Platform (*Figure 4*).[14, 15] For countries with relatively low per capita incomes, low population density, and challenges relating to fragility and conflict—such as South Sudan, Somalia, and Niger—OGS can represent the least-cost solution for a significant proportion of the population (61%, 70% and 70%, respectively).[16]

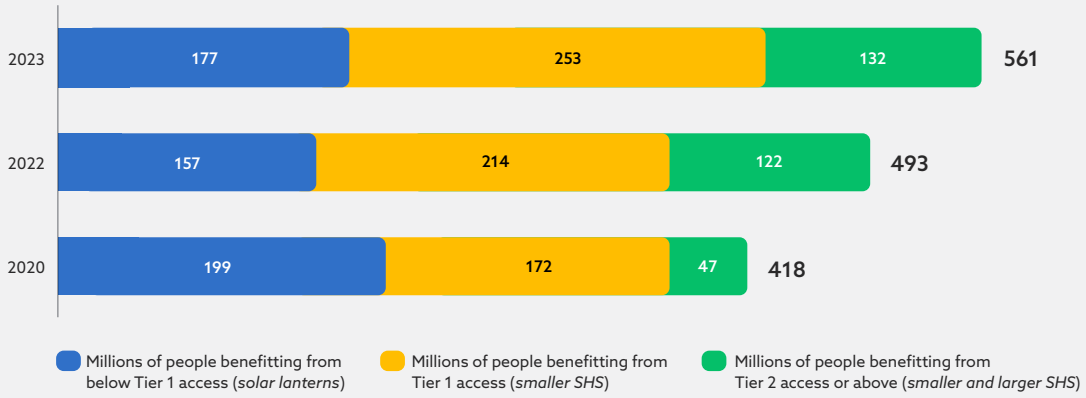
Figure 4: Number of people that need to be electrified between 2024 and 2030 to achieve universal access accounting for population growth (millions)[17]



Compared to grid or mini grid connection, OGS is a lower-cost solution that can be implemented more quickly to meet current levels of demand. It is particularly suited to more remote areas where the cost of providing grid or mini grid power is higher, to lower income households that can afford to consume only small amounts of electricity, and to FCV settings where affordability and infrastructure challenges are even more pronounced. For these reasons, the OGS sector served 561 million people in 2023 and accounted for 55% of new connections in Sub-Saharan Africa from 2020 to 2022.[18,19] Additionally, between 2020 and 2022, OGS solutions provided first-time electricity access to 42.4 million people, nearly 34% of whom were living in FCV countries.[20] Figure 5 provides an overview of the number of people served by the OGS sector, and the level of service provided to them, between 2020 and 2024.

14. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation is based on the bottom-up scenario from the platform. OGS represents the least-cost solution for 41% of about 1 billion people that will require access to electricity between today and 2030, including population growth. GEP estimates considered OGS to be the least-cost solution for 423 million people in 2022; to project the figures for 2024, a 6.15% growth in electrification is applied over two years of anticipated growth.
15. Note: Currently benefit here means that as of 2023, there were over 561 million people with an OGS product within 1.5 years of their stated product warranty. For more details, refer to definitions by GOGLA here.
16. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation corresponds to the low-demand scenario on the platform.
17. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024
18. Source: GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales & Impact Data, 2023; Dalberg analysis
19. Note: "Served" here means that as of 2023, there were over 561 million people with an OGS product within 1.5 years of their stated product warranty. For more details, refer to definitions by GOGLA here.
20. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation corresponds to the bottom-up scenario on the platform.

Figure 5: Total number of people benefitting from off-grid solar energy kits by tier of electricity access (millions)[21]



OGS can serve as an interim solution for households, businesses, and public institutions that will eventually benefit from grid or mini grid connections. With OGS, governments can meet current levels of demand as quickly as possible, delivering immediate household savings and improvements in quality of life, while continuing to invest in long-term grid or mini grid expansion plans. This also gives governments more time to stimulate demand, so that when households are eventually connected to grids or mini grids they consume enough electricity, and can be sustainably served without incurring losses requiring excessive subsidies.

OGS offers an alternative electricity source for the 1.6 billion people with intermittent access to grid electricity,[22] replacing the use of generators and enabling both households and governments to save money on subsidized fuel. Unreliable electricity forces households to go without electricity when it is not available, or to turn to expensive, polluting alternatives such as generators (and often to keep them running for much of the day).[23] Generators are estimated to provide nearly 9% of Sub-Saharan Africa's electricity,[24] costing households a significant sum of USD 28–50 billion annually on fuel, plus an additional 10–20% in maintenance costs. OGS would also reduce government spending on fossil fuel subsidies, which cost USD 50 billion in Sub-Saharan Africa in 2022.[25] Switching to OGS solutions would generate significant savings by eliminating the need for recurring fuel costs.[26]

OGS enables households, businesses, and farmers to use electricity productively and generate income. In a survey of over 79,000 off-grid customers across 31 countries, 86% of solar water pump (SWP) users experienced increased productivity, and 60% expanded their cultivated areas, leading to an income increase for 88% of these users. Similarly, 88% of refrigerators were used for productive uses, with 81% of users reporting improvements in quality of life.[27] In 2023, over 3 million people were using their SHS to run an enterprise.[28, 29]

Similarly, OGS can enhance health and education outcomes in unelectrified communities by powering essential social infrastructure such as schools, healthcare facilities, and community centers. Without reliable electricity, schools struggle to deliver quality education, while healthcare facilities face challenges in providing effective medical care and serving more patients. By providing consistent power, OGS can improve learning conditions and outcomes in schools, as well as ensure reliable operation of medical equipment, adequate lighting, and proper refrigeration of vaccines in healthcare settings. Additionally, OGS supports local economies by powering street lighting, communication services, entertainment options, and community activities.

21. Source: Dalberg analysis
22. Source: GEAPP, Powering People and Planet, 2022
23. Source: GEAPP, Powering People and Planet, 2022; A power system is considered unreliable if it experiences more than 12 hours of outage per month.
24. Source: IFC, The Dirty Footprint of the Broken Grid, 2019
25. Source: IMF, Fossil Fuel Subsidies Data, 2023
26. Source: IFC, The Dirty Footprint of the Broken Grid, 2019
27. Source: 60 Decibels, Why Off-Grid Energy Matters, 2024
28. Source: GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, 2023
29. Note: This is only based on affiliate sales data and the number including non-affiliate sales is likely much higher.

CHAPTER 2

Off-Grid Solar Market Trends

photo credit: SolarAid

KEY MESSAGES

More than 50 million OGS products were sold in 2022 and 2023 – above the pre-COVID all-time high of 47 million in 2019. Likewise, market turnover reached an estimated 3.9 billion USD in 2022 and 3.8 billion USD in 2023, surpassing the previous record of 3.3 billion USD estimated for 2019.

The sale of affiliate solar lanterns with mobile charging dropped in 2023 (-23%), whereas more affordable single-light portable lanterns increased by 11%, reflecting reduced consumer spending power linked to macroeconomic challenges.

1.76 million fans and TVs were sold in 2023, alongside 30,000 solar water pumps and refrigerators. While TV and refrigerator sales are fairly stable, fans and solar water pumps are seeing strong growth.

New evidence suggests many OGS products—from solar lanterns to solar water pumps and refrigerators—are **being used for both residential and income-generating purposes.**

OGS has the potential to electrify social infrastructure, such as schools and health facilities, but growth in this area has been limited due to high upfront costs and the lack of public funding to pay for ongoing operation and maintenance costs.

An increasing proportion of OGS products is sold on PAYG. 39% of affiliate OGS products were sold through PAYG in 2023, up from 24% in 2018. 67% of smaller SHS and 96% of larger SHS are sold via PAYG.

In many developing countries, currency devaluations have triggered price increases in local currency and made OGS products less affordable. Non-performing PAYG loans peaked in 2022 before improving slightly in 2023. The sector has responded by improving credit management practices—but collection rates remain low, pointing to ongoing customer affordability constraints (62% in 2023, in line with 2021).

Mergers and acquisitions have gathered pace, as companies leverage acquisitions to enhance their market positions and extend their reach into new regions.

OGS companies that have diversified their businesses, or focused on an innovative business model, have seen **improved commercial performance.**

The sector is facing an acute shortage of skilled labor required for the sale, installation, operation, and maintenance of OGS systems, especially in remote areas.

Global Sales Volumes and Market Turnover

After a 36% rebound in 2022 from the impact of COVID-19, total OGS sales volumes stabilized in 2023, showing only a marginal decline in challenging macroeconomic conditions (-3%).

Key Concept: OGS product categorization

This report divides the total OGS market into three broad OGS product categories: solar energy kits, household and small business OGS appliances, and productive use OGS appliances.

Solar energy kits (SEK) are bundled, pre-packaged systems that typically consist of a solar panel, battery, and charge controller, alongside LED lights, phone charging ports, radios, fans, or televisions. The SEK category includes solar lanterns and solar home systems (SHS).

- **Solar lanterns** (capacity rating: <3 Watt-peak [Wp]) are portable, small-scale lighting devices powered by solar panels, primarily used for single-point illumination and often phone charging in off-grid areas.
- **Smaller SHS** (capacity rating: 3 to 49.99 Wp) are solar-powered setups typically designed to provide electricity for multiple lights and small appliances such as fans
- **Larger SHS** (capacity rating: 50 Wp and above) are more comprehensive solar-powered setups to power multiple rooms of lighting and multiple or larger devices such as TVs or refrigerators in homes and small businesses

Household and small business OGS appliances are energy-efficient devices specifically designed to operate with off-grid solar systems, such as fans, radios, and televisions and other small devices powered by solar electricity. For this report, we focus on the sale of TVs and fans, as they represent by far the largest share of household and small business appliances sold by volume.

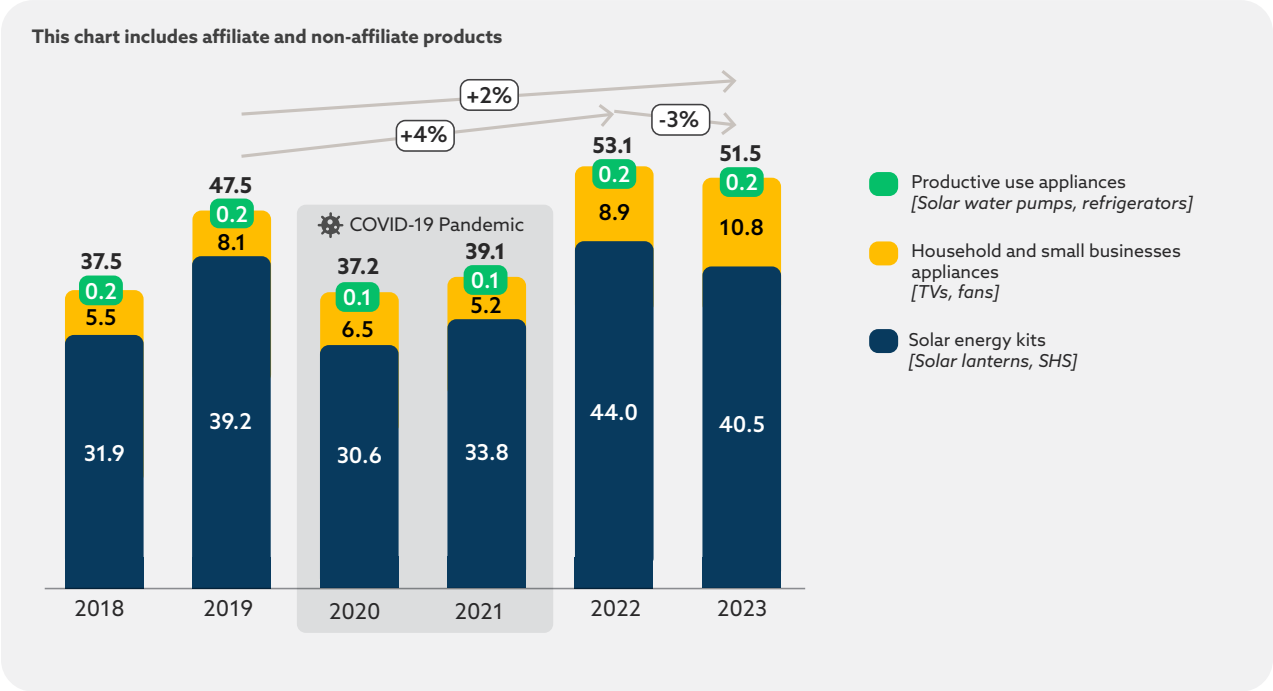
Productive use of electricity (PUE) OGS appliances are solar-powered devices that drive income-generating activities, boosting productivity and fostering economic growth in off-grid regions. For this report, we focus on solar water pumps (SWPs) and refrigerators, since these are the most mature PUE appliance categories.

The total OGS market grew 36% from 2021 to 2022, surpassing pre-COVID-19 levels, and then stabilized in 2023, showing only a modest 3% decline and demonstrating the market's resilience (*Figure 6*).[30] The remarkable growth experienced in 2022 was driven by a surge in demand following the end of the COVID-19 emergency that particularly affected solar lanterns, smaller solar home systems (SHS), and fans. Growth plateaued in 2023, despite inflation, currency depreciation, and increases in the cost of living, which exacerbated affordability challenges.

In 2023, 40.5 million SEKs were sold, accounting for 79% of total OGS sales. The proportion of household and Small business appliances—fans and TVs— has risen from 13% in 2021 to 21% of total OGS sales in 2023. The increase in household and small business appliances sales is linked to increased sales of SHS, which are sold bundled with these appliances. Demand for SHS sold bundled with appliances grew particularly in areas with intermittent grid access. There was also a significant increase in fan sales, driven partly by companies reporting increased sales and partly by companies that previously did not report sales data newly choosing to do so.

30. Note: For the purposes of this report, the total OGS Market includes Solar Energy Kits (SEKs), household and small business OGS appliances and then "productive use of electricity OGS appliances, referring to sales from both affiliate and non-affiliate companies.
31. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024

Figure 6: Global annual number of off-grid solar products sold, including affiliate and non-affiliate sales, 2018–2023 (millions)[31, 32]



In 2023, OGS sales volumes decreased by 2 million to 51 million units due to a decline in sales of SEKs. The growth momentum experienced during the previous year plateaued in 2023, largely due to higher local prices for SEKs. This price increase, driven by inflation and currency depreciation, made products less affordable and reduced demand across many markets.[33] Despite this downturn, the market remained robust, with sales volumes still 8% higher than pre-COVID levels in 2019 (47 million units) and a remarkable 38% higher than in 2018. This underscores the sector's resilience in the face of the adverse macroeconomic situation—the overall market maintained relative stability following the post-COVID surge.

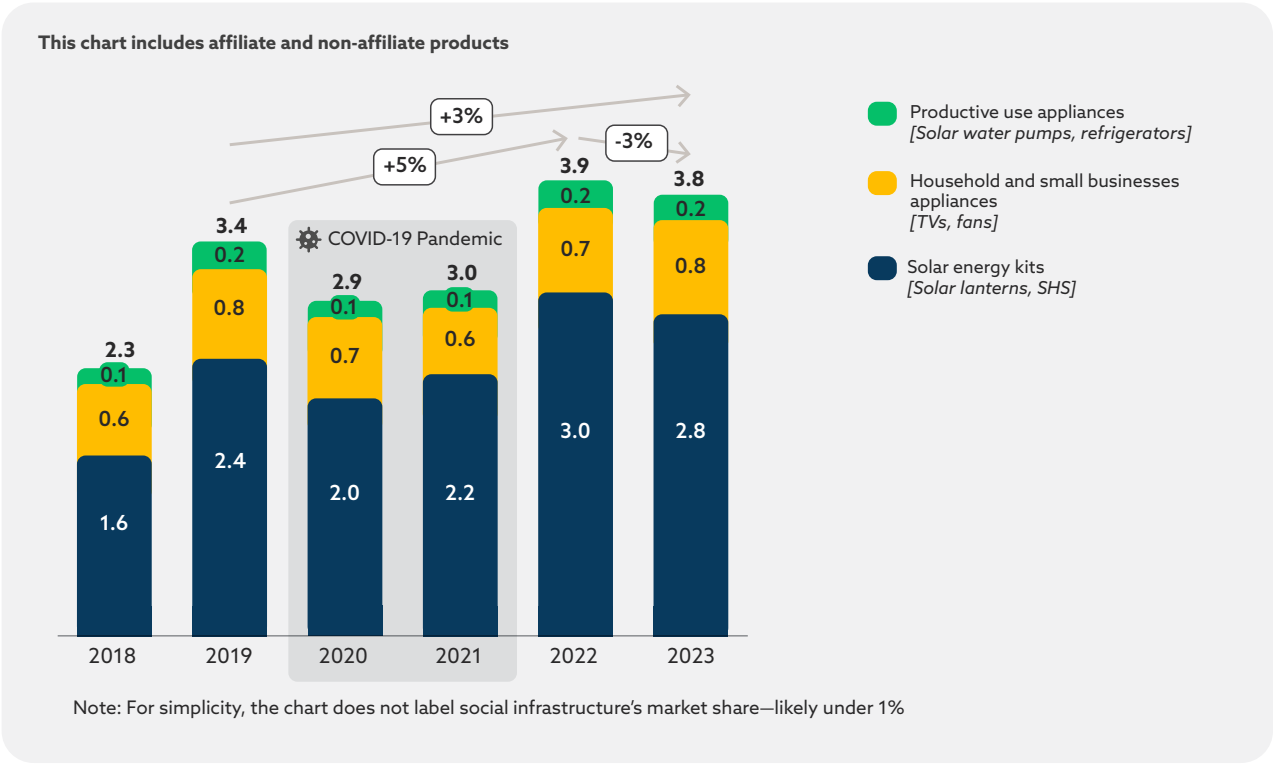
The slight decline in sales in 2023 can be attributed to global macroeconomic challenges and a deteriorating economic outlook, which have intensified affordability issues. In 2023, inflation rates across Sub-Saharan Africa averaged 16%, exacerbated by geopolitical events and climate change. Food price inflation in the region continues to outpace overall inflation, straining household budgets and limiting spending on electricity access.[34] Inflation has driven up the cost of goods and services, increasing business costs and further constraining consumer spending on OGS (*refer to OGS Product Pricing and Chapter 3 – Affordability of OGS*). The continued instability of grid connections and rising fuel prices may be driving a shift toward OGS in weak-grid areas, particularly in markets heavily dependent on generators. In 2023, kerosene prices rose by over 200% in Nigeria,[35] by 15% in Senegal,[36] and 50% in Central African Republic.[37] As noted, the current addressable market for OGS in weak-grid settings amounts to 1.6 billion people.[38]

Coming soon: to further explore the global annual number of off-grid solar products sold.

32. Note: The products in each market segment of this chart are categorized based on their predominant use. SEKs includes solar lanterns, smaller SHS and larger SHS; Households and small business appliances includes TVs and fans; productive use appliances includes refrigerators and solar water pumps. Non-affiliate sales are estimated as a proportion of affiliate sales for solar lanterns, SHS and appliances separately – more detail in Annex 4.
33. Source: Stakeholder consultations
34. Source: Business Insider Africa, African countries hit hardest by food inflation in 2023, 2024.
35. Source: Reuters, Nigeria petrol prices soar to record high after subsidy removal, 2023.
36. Source: Bloomberg UK, Senegal Lifts Fuel Prices as Subsidies Strain Government Budget, 2023.
37. Source: MarketScreener, Central African Republic Increases Fuel Prices by 50%, 2023.
38. Source: GEAPP, Powering People and Planet, 2022.
39. Source: GOGLA, Affiliate sales data; MTR 2022 market model; Dalberg analysis, 2024.

Turnover reached an estimated USD 3.9 billion (+32%) in 2022, but stabilized in 2023 at USD 3.8 billion (-3%).

Figure 7: Global off-grid solar market size, including affiliate and non-affiliate (USD billions)[39, 40]



Note: For simplicity, the chart does not label social infrastructure's market share—likely under 1%

In 2022, the total OGS market size reached an all-time total high of USD 3.9 billion in turnover, a remarkable 32% growth from the previous year and surpassing pre-COVID levels by 15% (*Figure 7*). This surge was primarily driven by a 10–13% increase in sales volumes across a range of solar products, including solar lanterns and smaller SHS, alongside a slight uptick in consumer pricing.[41]

However, in 2023, the market saw a slight contraction, with turnover dipping to USD 3.8 billion—a modest 3% decline compared to 2022. Despite this drop, the market still stood 15% above pre-pandemic figures, underscoring its resilience in the face of global economic challenges. Revenue trends were driven largely by the same factors that influenced sales: rising local prices stretched affordability and slightly dampened demand. A small reduction in prices in USD terms (-3%) also contributed to the overall decline in revenue.[42]

40. Note: The products in each market segment of this chart are categorized based on their predominant use. SEKs includes solar lanterns, smaller SHS and larger SHS; Households and small business appliances includes TVs and fans; productive use appliances includes refrigerators and solar water pumps. Non-affiliate sales are estimated as a proportion of affiliate sales for solar lanterns, SHS and appliances separately – more detail in Annex 4.
41. Source: Mangoo Marketplace; MTR 2022 pricing model; MTR 2020. Based on MTR 2020 and MTR 2022 data for pico products (0-10Wp), the average cash price increased by 1%, and the average PAYG price increased by 13%. For SHS products (11-100+Wp), the average cash price increased by 19% and the average PAYG price increased by 8%.
42. Source: GOGLA member survey conducted in Spring 2024; stakeholder consultations; Dalberg analysis, 2024.

Affiliate Market Insights

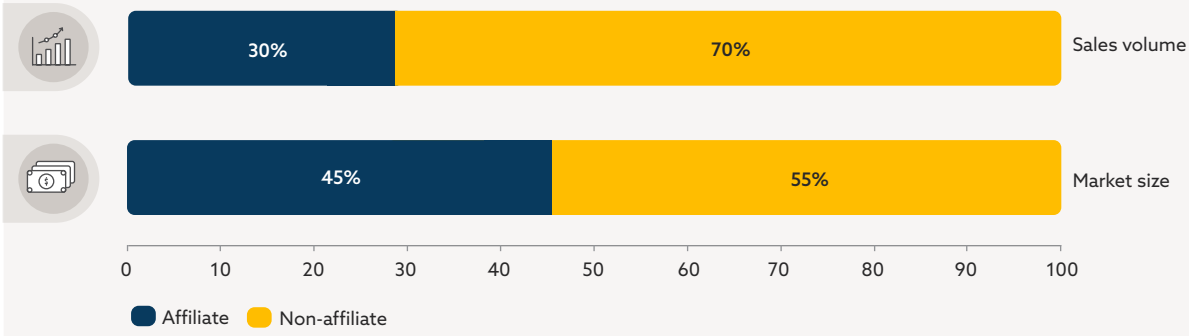
Key Concept: 'Affiliate' vs. 'non-affiliate' OGS companies

This report distinguishes between 'affiliate' and 'non-affiliate' off-grid solar products and companies.

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 VeraSol quality standards, and appliance companies that participated in the Global LEAP Awards or are engaging with the Low Energy Inclusive Appliances (LEIA) program. 89% of SEKs made by affiliate companies meet VeraSol quality standards, and stakeholders assume that all products produced by these companies—referred to as 'affiliate products' throughout the report—are of reasonable quality. As of 2023, roughly 40% of affiliate sales were PAYG; the remainder were cash sales.

Non-affiliate companies are those that fall outside the matrix of affiliate companies. These companies do not report their sales to GOGLA, and much less is known about the quality and level of energy access that their products provide as measured on the Multi-Tier Framework (MTF).[43] Throughout the report, such products are referred to as 'non-affiliate products. Non-affiliate companies consist of manufacturers that sell directly to smaller distributors and retailers, often bypassing formal importation channels. They primarily sell solar lanterns and smaller SHS, on a cash basis without a warranty. Based on 2024 estimates, non-affiliate products account for 70% of the annual OGS market, compared to 72.1% in 2022 and 71.5% in 2020 (Figure 8).[44] This large market share is likely due to non-affiliate products having a lower price because they are of lower quality. The use of informal importation channels that avoid taxes and failure to provide warranties also reduces costs that can be passed on through lower prices—while having a negative impact on consumer protection and government revenues. Despite the large market share, due to lower prices, the non-affiliate market accounts only for 55% of the turnover (*refer to Annex 4 for the methodology*).

Figure 8: Affiliate versus non-affiliate share of volume of off-grid solar products sold and market size, 2023[45]



The overall share of quality-verified products in the total OGS market remains concerningly low, at around 27% of total OGS market share. The proliferation of low-quality OGS products poses significant risks, including financial losses for end-users, as unreliable systems may fail prematurely or underperform, and reduced consumer trust in the OGS market. As such, low-quality OGS products can undermine the long-term benefits of OGS by discouraging users from investing in better, certified systems, ultimately slowing progress toward sustainable electrification.

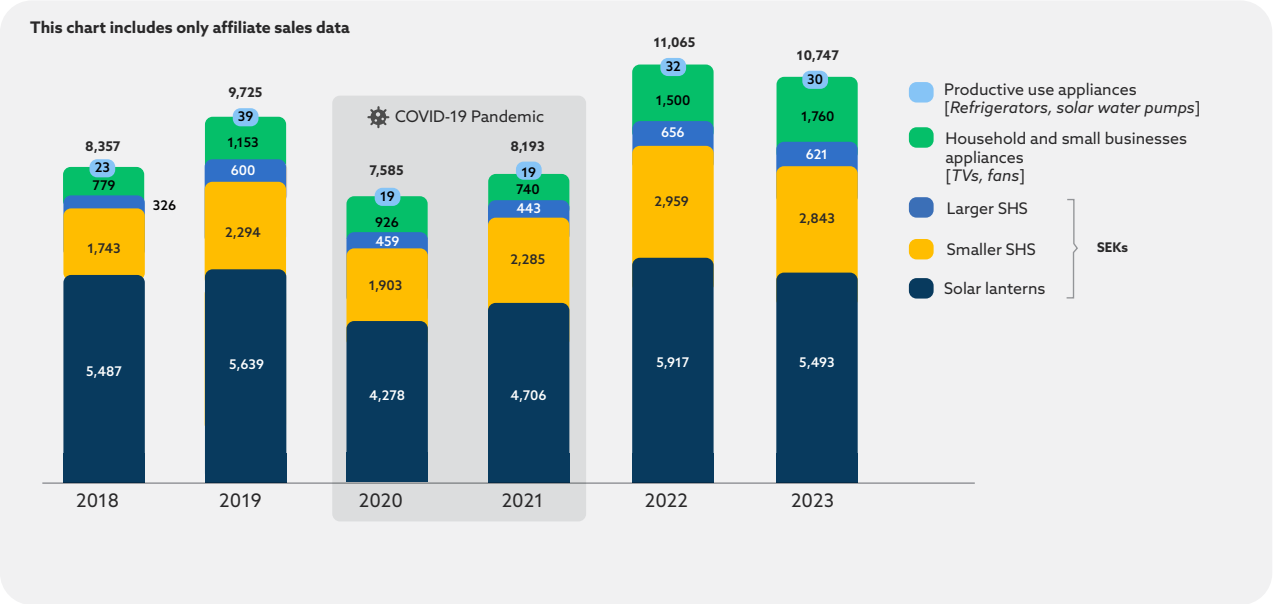
Given the limited data on non-affiliates, this report's estimations are built on a set of assumptions, and should be thus used with caution. We explored three methods to estimate non-affiliate sales: MTF data, import data, and survey results. *Refer to Annex 4 for further details on the methodology.*

43. Note: The Multi-Tier Framework (MTF) defines access to electricity according to a spectrum that ranges from Tier 0 (no access) to Tier 5 (full electricity access 24 hours a day).
44. Source: Multi-Tier Framework Survey data; stakeholder consultation, GOGLA member survey conducted in Spring 2024; Dalberg analysis.
45. Source: Multi-Tier Framework Survey data; stakeholder consultation, GOGLA member survey conducted in Spring 2024; Dalberg analysis.

This section provides insights into OGS products sold by affiliate companies and collected in GOGLA's semi-annual sales data. Although these data do not represent the entire industry, they enable the identification of specific trends at a granular level and provide a more detailed view of the sector's performance over the past years.

SEKs have made up over 80% of total affiliate sales on a yearly basis (Figure 9). This ratio peaked at 91% of total sales in 2021 likely due to the purchases by humanitarian organizations during COVID-19. Smaller OGS systems represent most of these sales. Solar lanterns accounted for 53% of sales in 2022 and 51% in 2023; in the same years, small SHS sales constituted 27% and 26% of the market share, respectively. Finally, in recent years, households and small business appliances sales appear to have grown, with a CAGR of 53.5% between 2021 and 2023—although this is in part due to additional companies choosing to provide fan sales data. PUE appliances continue to account for a marginal portion of the market, chiefly due to ongoing affordability challenges.

Figure 9: Global annual number of affiliate off-grid solar products sold, 2018-2023 (thousands)[46, 47]

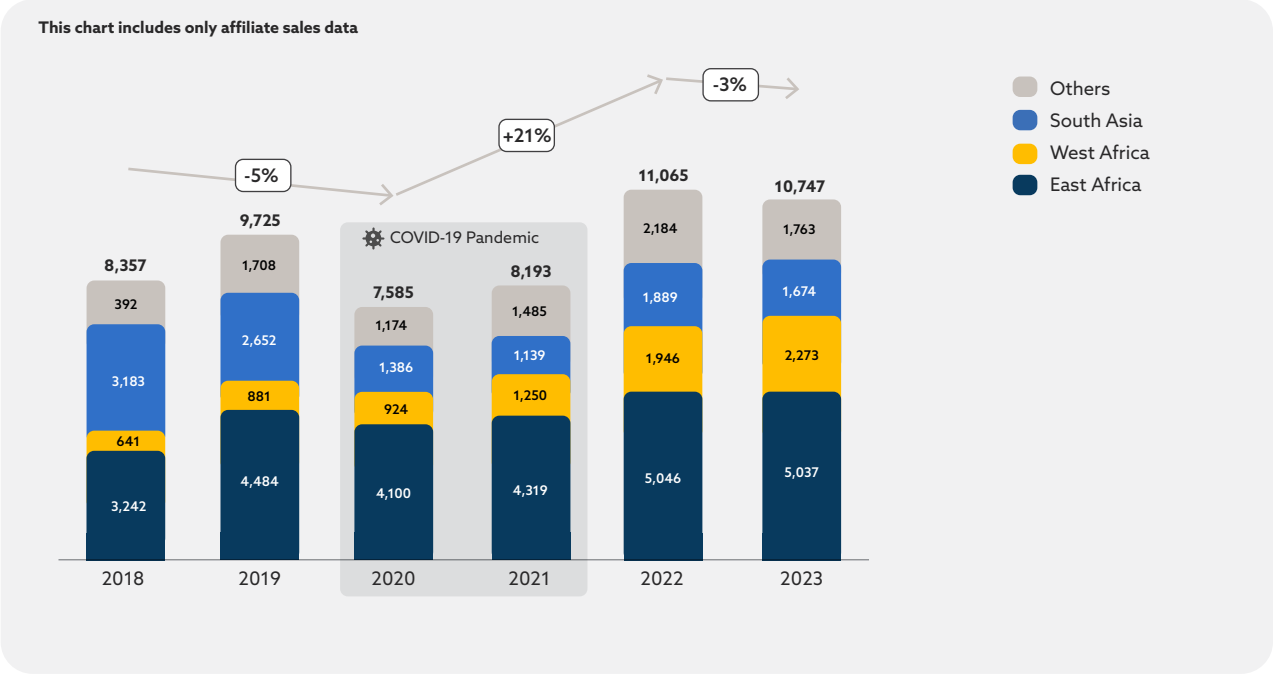


East Africa remained the largest market for affiliate sales, accounting for approximately 46% of the total volume (Figure 10). Sales in East Africa grew from about 4 million units in 2021 to roughly 5 million in 2022, reflecting an 18% increase, and then stabilized with flat growth in 2023. Kenya saw continued growth in OGS sales, likely due to the reinstatement in 2021 of a tax exemption which had been removed in 2020, as well as targeted programmatic initiatives. Similarly, Zambia, though a relatively less more mature market, experienced increased demand driven by (i) load-shedding, which led to greater reliance on backup solutions, and (ii) more consistent implementation of duty and VAT waivers.

Coming soon: Explore the annual number of off-grid solar products sold by affiliate companies.

46. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024.
47. Note: [1] Approach for estimating 2018 affiliate sales: In 2018, only H2 affiliate data was available. To project full-year estimates for 2018, H1 sales data was interpolated using the 'average ratio between H1 and H2' from historical data. [2] The sum of disaggregated sales may slightly differ from the total number of affiliate OGS products sold in Figure 6 as a result of data reporting differences due to data privacy. [3] The data presented is the 'number of OGS products sold', not 'number of OGS sales'. For example, a company selling a bundled package of a SHS and TV would report it as one sale, but it is presented in this analysis as two products sold. [4] The products in each market segment of this chart are categorized based on their predominant use. SEKs includes solar lanterns, smaller SHS and larger SHS; Households and SME Appliances includes TVs and fans; Productive Use Appliances includes refrigerators and solar water pumps.

Figure 10: Global annual number of affiliate off-grid solar products sold by region, 2018–2023 (thousands)[48, 49, 50]



West Africa demonstrated significant momentum and was the only region among those with established markets to continue growing in 2023. Sales nearly doubled from 2021 to 2022, during which period the region represented 21% of global affiliate sales. This growth was largely driven by the expansion of SHS sales in Nigeria. In Nigeria, rising fuel costs,[51] along with supportive initiatives like the Nigeria Electrification Program (featuring a USD 75 million results-based financing (RBF) facility and the Solar Power Naija Program, spurred robust growth. While sales in Nigeria continued to increase in 2023, the growth rate slowed to 14% from 89% in 2022, primarily due to rising OGS product costs caused by the depreciation of the naira and the exhaustion of funds in the RBF scheme.[52] Despite these challenges, sales of larger OGS products grew significantly, reflecting ongoing demand in light of unreliable grid electricity and escalating fuel prices.[53, 54] However, this growth was partially offset by a 7% decline in solar lantern sales.

The contrasting growth patterns between East and West Africa may reflect the relative maturity of the OGS markets in these regions. In East Africa, where OGS companies have a longer established presence, the market is experiencing slower growth as it becomes saturated, with new customers being more price-sensitive and typically lower-income. Conversely, in West Africa, where OGS is a newer entrant, the market is still expanding rapidly, with a potentially less price-sensitive customer base.

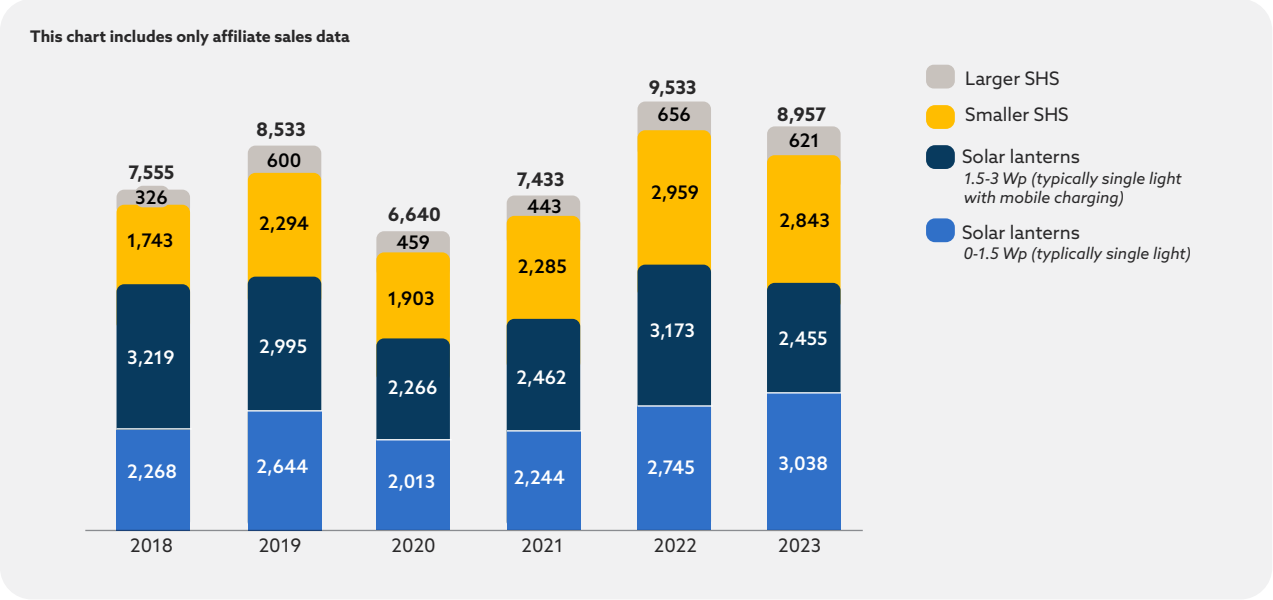
In South Asia, sales are on the decline, primarily due to advancements in grid electrification. The region saw a 66% increase in sales in 2022, largely driven by substantial humanitarian purchases in Pakistan and Afghanistan.[55, 56] However, sales have since dropped by 37% compared to 2019, due to a significant decrease in sales of solar lanterns and SHS in India.[57, 58] This decline is attributed to improvements in grid expansion and increases in microfinance interest rates, making systems bought on credit with MFI loans more expensive.[59]

48. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024.
49. Note: Approach for estimating 2018 affiliate sales: In 2018, only H2 affiliate data were available. To project full-year estimates for 2018, H1 sales data were interpolated using the 'average ratio between H1 and H2' from historical data.
50. Note: "Others" includes Central Africa, Southern Africa, East Asia and the Pacific, Latin America and the Caribbean, Europe and Central Asia, the Middle East and North Africa, and North America.
51. Source: Stakeholder consultations
52. Source: GOGLA, Insights from the January-June 2023 sales and impact data, 2023
53. Source: PR Newswire, d.light revenues surge by 41 percent in first six months of 2023, driven by 143 percent growth in Nigeria, 2023
54. Source: World Economic Forum, Here's how Nigeria is tackling the barriers to its green energy transition, 2023
55. Source: GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, 2022
56. Note: A change in the set of companies reporting sales data in Pakistan also accounts for part of the growth
57. Source: GOGLA, Insights from the January-June 2023 sales and impact data, 2023
58. Source: GOGLA, Indian Market Outlook: Solar Lantern and Solar Home System, 2023
59. Source: GOGLA, Indian Market Outlook: Solar Lanterns and Solar Home System, 2023

Affiliate Market Trends for Solar Energy Kits

Sales of solar lanterns with mobile charging dropped by 23% due to local currency price increases and worsening affordability constraints. Customers instead opted for more affordable single-light portable lanterns, which saw an 11% increase in sales.

Figure 11: Global annual number of affiliate solar energy kits sold by product type (thousands)[60]



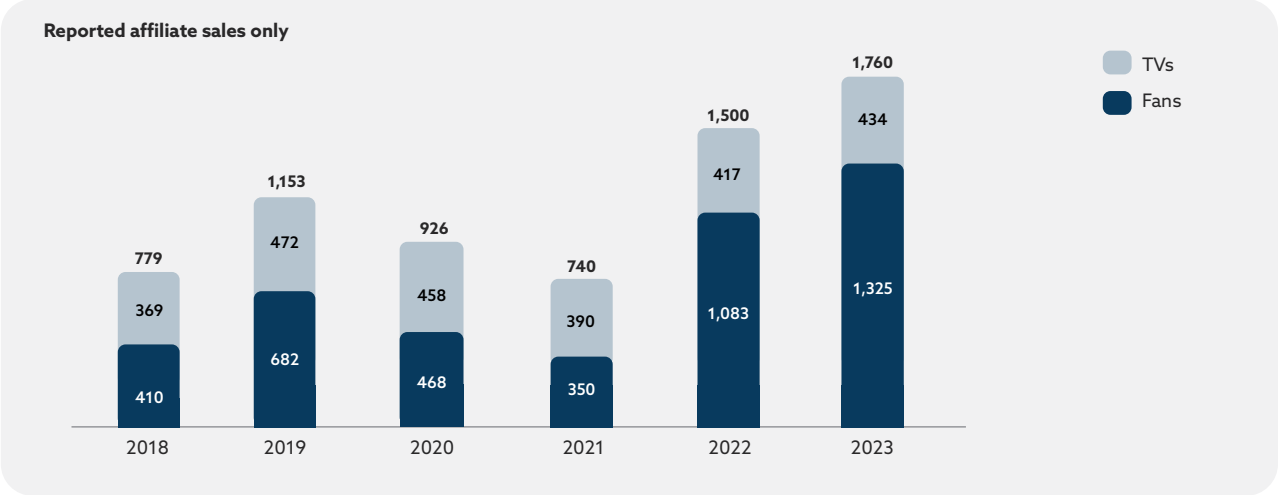
From 2021 to 2022, all SEK product categories experienced exceptional growth in the rebound from COVID-19; solar lantern sales increased 26%, those of smaller SHS increased 29%, and those of larger SHS increased a robust 48% (Figure 11). In 2023, the 3% decline in SEK sales was mainly driven by a 7% decline in solar lantern sales—in particular, sales of solar lanterns with mobile phone charging (typically 1.5–3Wp) dropping 23%. This decline was offset by an 11% increase in sales of single-light solar lanterns, as higher local currency prices encouraged many customers to choose more affordable products instead.[61]

Coming soon: to further explore the number of affiliate SEKs sold by OGS product type

60. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024
61. Source: Stakeholder consultations

Affiliate Market Trends for Household and Small Business OGS Appliances

Figure 12: Global annual number of affiliate household and small business OGS appliances sold by product type, 2018–2023 (thousands)[62]



Fans remain the leading OGS household and small business appliance with 1.3 million units sold in 2023 (Figure 12). Sales are driven by the affordability of such products, their limited energy needs, and their ease of distribution. Most of these sales occur in South Asia (61% in 2023), where demand is driven by high temperatures, humidity, and the risk of heat stress. The growth in sales from 2021 onwards reflects a combination of companies reporting higher sales as well as additional companies choosing to provide sales data.

TV sales are gradually returning to pre-COVID levels. After a 17% decline between 2019 and 2021, TV sales are now 8% below 2019 levels.[63] TVs are typically bundled with SHS, especially in the Sub-Saharan Africa market, and are typically being sold to higher-income households in more densely populated areas and more mature markets.[64]

Affiliate Market Trends for Productive Use OGS Appliances

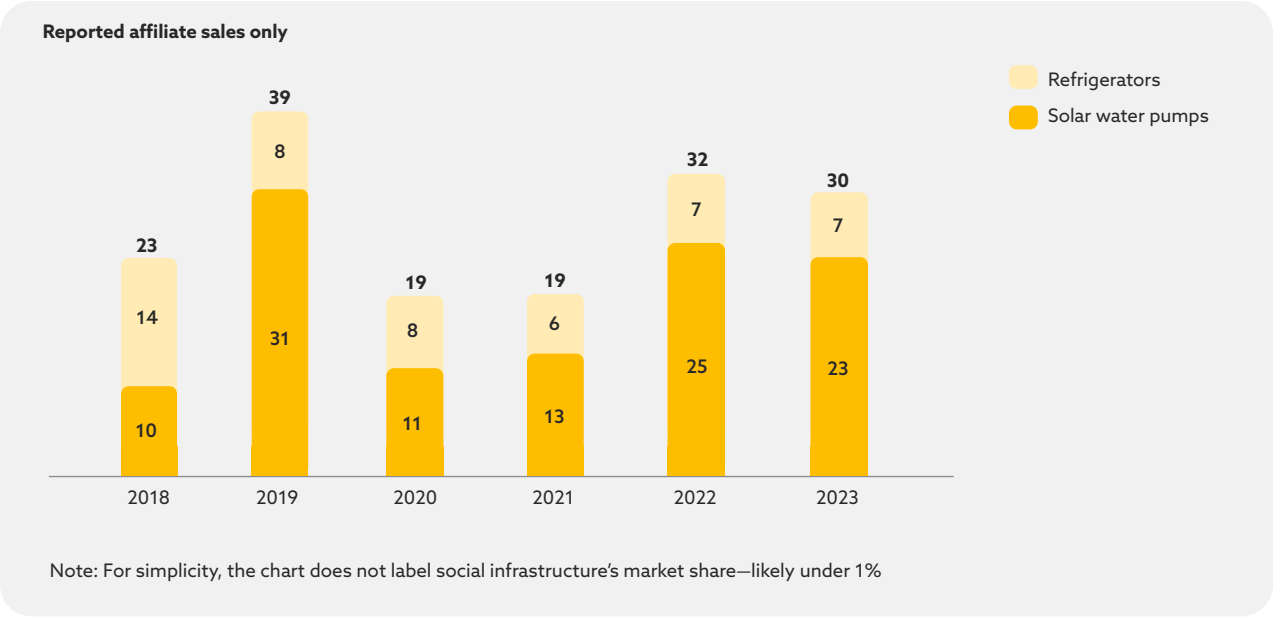
In this report, productive use of electricity (PUE) OGS market analyses focuses on the most mature productive use product categories: small-scale refrigeration and SWPs for irrigation. For both product categories, customers are typically wealthier households, businesses, and farmers, which tend to reside in more densely populated areas of more developed countries.[65]

Key Concept: Productive uses of electricity

The World Bank defines productive use of electricity (PUE) as activities that use energy to improve income and welfare.[66] PUE is thus enabled by off-grid solar appliances that directly enhance income, productivity, or economic development. For this report's purpose, OGS PUE appliances are limited to solar water pumps and small refrigerators, representing the most mature technologies on the market. However, in addition to this, OGS can be used to power milling machines, walk-in cold rooms, ice-making, drying, egg incubation, and a range of other agricultural and light commercial activities such as sewing or hair clipping. By enabling these activities, productive use of electricity helps improve livelihoods and supports local economies, making OGS a catalyst for economic growth in off-grid areas.

62. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024;
63. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024.
64. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024
65. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024.
66. Source: World Bank, Accelerating the Productive Use of Electricity, 2022

Figure 13: Global annual number of affiliate productive use OGS appliances sold by product type, 2018–2023 (thousands)[67]



Note: For simplicity, the chart does not label social infrastructure's market share—likely under 1%

SWPs have experienced high sales growth since 2021, with a 34% compound annual growth rate (CAGR) (Figure 13).[68] This is likely due to relative technological maturity and programmatic interventions promoting their use. SWP sales have been driven by improvements in consumer awareness and development programs specifically targeting SWPs; with support from development programs, approximately 120,000 SWPs have been since 2019.[69] Despite a substantial uptick in SWP sales, this growth may slow if not supported by cost subsidies. Factors such as diverse terrain and the seasonal nature of harvests affect customers' ability and willingness to pay through current PAYG models, especially for those reliant on successful income generation to afford SWPs.[70] However, given rising fuel prices, SWPs are projected to be an increasingly cost-effective alternative to diesel pumps over time, potentially achieving approximately 23% savings over a decade of usage.[71]

In contrast, refrigerators have seen a slower growth rate of 4% CAGR, likely due to slower technological advancement, higher average cost, and lower perceived returns on investment. Affordability remains the main barrier to market growth. Concerns around durability and ability to repair, as well as uncertainty around whether asset acquisition will lead to increased incomes, limit sales.[72] Low consumer awareness, limited access to consumer financing, and underdeveloped business models for sales and distribution—as well as after-sales service and repair—also hinder adoption.[73] National-level policies and regulations focus largely on on-grid contexts, while quality standards in the off-grid sector have not yet been developed for cooling technologies. That said, there remains an urgent and growing need for high-performing, affordable cooling solutions. Technology and business model R&D is needed to scale up access to cooling solutions for health, safety, food preservation, and economic growth (*see Box 1*).

67. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024.
68. Source: GOGLA, Insights from the January-June 2023 sales and impact data, 2023.
69. Note: These programs include the Beyond the Grid Fund for Africa (BGFA), Sustainable Energy for Smallholder Farmers, the CIZO Cheque program in Togo, the Energy Access Scale-up Project in Uganda, and the GEAPP Productive Use Financing Facility.
70. Source: Stakeholder consultations.
71. Source: Hystra, Scaling Irrigation for Small-scale Producers: the Role of Private Sector Solutions, 2024.
72. Source: CLASP, Leave no one behind, 2024 [upcoming]
73. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024

Box 1: The case for off-grid solar cooling[74]

Rural communities have diverse needs for sustainable cooling that can be served through off-grid solar solutions, including cooling units for food preservation (e.g., refrigerators, freezers, walk-in cold-storage), improved health and well-being (e.g., fans), and healthcare applications (e.g., vaccine refrigerators).

An estimated 1.12 billion people, living in both rural and urban areas, are at high risk of the effects of extreme heat due to lack of access to cooling—resulting in negative impacts on living conditions and safety, food preservation, health, and the economy. An estimated 356,000 deaths in 2019 were a result of extreme heat; 620 million metric tons of food is lost annually due to poor cold chain infrastructure; 15% of healthcare facilities in Sub-Saharan Africa have no access to electricity; and the impact of extreme heat stress has led to an estimated global productivity loss of USD 2.1 trillion per year (1.7% of global GDP)—a trend that is likely to increase with climate change.[75, 76, 77]

Although sales of refrigerators and SWP represent only about 2% of the estimated potential market (approximately 232 million units), scaling up productive use sales faces significant challenges.[78] These include: (i) limited availability of productive use products from relatively few companies with small inventories and minimal access to concessional finance; (ii) data gaps in many Sub-Saharan African countries that hinder market entry; (iii) for SWPs, the continued competitiveness of traditional irrigation solutions due to lower initial costs, consumer familiarity, and versatility; and (iv) insufficient concessional financing and consumer subsidies relative to market needs, leaving low-income individuals unable to afford appliances at current price points.[79]

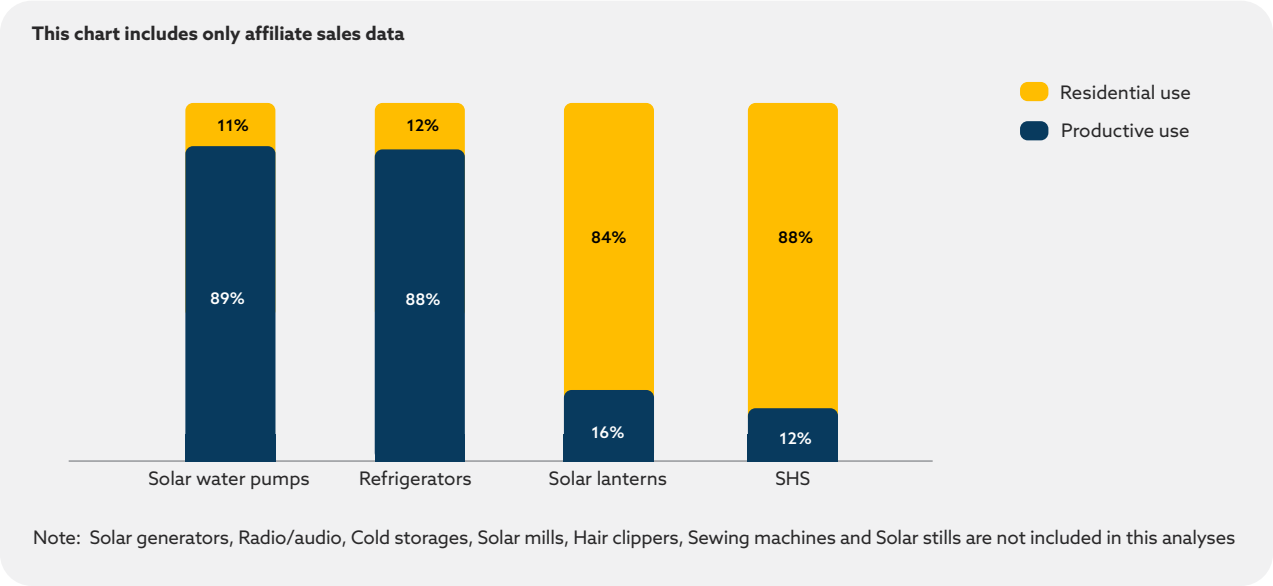
The design of productive use appliances has also historically overlooked the needs and preferences of women. The limited involvement of women in the design and feedback processes for these products has created a disconnect between what is available in the market and what is needed by female consumers. This gap hinders the effective use of these products and reduces their potential impact on women's lives. To address this, it is essential to design products that are tailored specifically to women's needs and preferences. Actively considering and involving women in the product design process, from conception to feedback, ensures that the end products are both practical and empowering. This approach would not only enhance product usability but also foster greater adoption and impact. This includes financial products attached to productive use, with flexible financing tailored to women, such as those offered by the Self Employed Women's Association (SEWA). Another example is the Sosai Renewable Energy's initiative, Women of the North for Excellence, where women become entrepreneurs through commission-based projects associated with off-grid energy for productive use, such as solar dryers for drying pepper and other crops. The incomes of the members of this initiative have increased by as much as 30%.[80]

> **An average of 16% of solar lanterns and 12% of SHS are used for both residential and income-generating purposes.**

Finally, new data highlight that solar lanterns and home systems play a significant role in income generation. Similarly, solar water pumps and refrigerators bought primarily for productive use are also used in the home (Figure 14). Affordability, portability, and ease of setup make solar lanterns and home systems highly adaptable for business purposes, with almost 16% of solar lanterns and 12% of SHS being used for income-generating activities. Solar lanterns are commonly used by street vendors, small shops, and market stalls to extend business hours after sunset. The mobility of these lanterns allows users to carry them between home and workspaces, increasing productivity and reducing reliance on more expensive or unreliable energy sources, such as kerosene lamps or diesel generators. Smaller SHS units provide reliable power to operate small appliances, such as mobile phone charging stations, which are often a source of additional income in rural or underserved areas. The versatility of OGS products makes them a crucial tool in promoting financial inclusion and economic resilience, especially in remote or low-income areas where traditional electricity infrastructure is lacking.

74. Source: ESMAP, Sustainable Cooling in Off-grid Rural Areas: Nexus between Access to Energy and Clean Cooling, 2024 [upcoming]
75. Source: Friedman-Heiman, A. and Miller, S, A., The impact of refrigeration on food losses and associated greenhouse gas emissions throughout the supply chain, 2024
76. Source: The Lancet, Health in a world of extreme heat, 2021
77. Source: SEforALL, Powering Healthcare Hub
78. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024.
79. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024.
80. Source: ESMAP, Gender Equality in the Off-Grid Solar Sector, 2022.

Figure 14: Affiliate off-grid solar users reporting usage of products for income-generating activities, 2023 (percentage)[81, 82]



Note: Solar generators, Radio/audio, Cold storages, Solar mills, Hair clippers, Sewing machines and Solar stills are not included in this analyses

Market Trends for Social Infrastructure

> **Only 75,000 OGS products have been sold for social infrastructure use since 2018 despite an estimated 1.87 million schools and 146,000 healthcare facilities lacking reliable electricity, and significant donor commitments.**

Very little data are available on the size of the OGS market for social infrastructure. OGS can provide health facilities with lighting and power for appliances such as vaccine refrigerators, while providing schools with computers and internet access. This often saves facilities money on fuel for generators. Since 2018, at least 75,000 OGS products have been sold for social infrastructure purposes, though this represents less than 1% of total OGS sales (Box 2).[83] However, this represents only a fraction of the total market for social infrastructure. It is estimated that over 1.87 million schools and over 146,000 healthcare facilities lack proper and reliable access to electricity.[84]

Growth in the use of OGS for public social infrastructure has been hampered by affordability and customization challenges.[85, 86] Scaling up these solutions requires substantial capital investment due to the need for tailored infrastructure; public schools and health facilities typically are unable to cover these costs on their own, and governments also face fiscal constraints. When systems are installed, funding for operations and maintenance is scarce, and systems often fail prematurely due to lack of upkeep and component replacement. Private sector actors, donors, governments, and other stakeholders must cooperate to address financial and logistical barriers through private sector-based models that focus on ensuring availability of service over time, rather than just installations.

Development organizations have committed to electrify over 135,000 school and healthcare facilities currently in the dark, the majority of which are in remote areas and would be best electrified via OGS products. These commitments include the World Bank's DARES program to electrify 100,000 schools and health facilities by 2026;[132] USAID's Global Health Bureau and Power Africa's Health Electrification and Telecommunications Alliance (HETA) initiative to electrify and digitally connect 10,000 health facilities by 2027;[133] and IKEA Foundation's goal to provide energy to 25,000 health facilities across 12 countries by 2026.

81. Source: GOGLA, Affiliate sales data; Dalberg analysis, 2024.
82. Source: 60 Decibels, Why Off-Grid Energy Matters, 2024
83. Note: Due to data limitations, this is a minimum estimation based on the sum of the number of vaccine fridges deployed by two large manufacturers and a large global program
84. Source: Dalberg Analysis, 2024
85. Note: Data limitations on OGS for public institutions; no available data globally
86. Source: Stakeholder consultations

Box 2: Examples of off-grid solar-powered social infrastructure

Gavi, through its Cold Chain Equipment Optimization Platform, has installed approximately 40,000 solar-powered fridges in health facilities worldwide since 2017. Evaluations in three countries found that increased cold-chain equipment capacity led to the expanded reach of vaccination services, reduced the occurrences of vaccine shortages, and enabled more frequent vaccinations.[87]

Signify Foundation, with local NGO Bright Dada, provided lighting to seven remote healthcare centers in Homa Bay County, West Kenya; a further 20 healthcare centers were slated to receive OGS lighting in 2023. Reported impacts include increased survival rates in medical emergencies and for women in labor.[88]

The Malawian government's Building Education Foundations through Innovation and Technology (BEFIT) aims to leverage solar-powered ed-tech to boost educational outcomes for Malawian children. Through a solar electrification partnership with Sun King, BEFIT plans to electrify 6,000 schools in Malawi by 2029 to power ed-tech solutions and benefit 3.8 million children.[89]

Affiliate PAYG and Portfolio Performance Trends

Sales of OGS affiliate products via PAYG are steadily increasing and are showing resilience to adverse macroeconomic challenges. Inflation, currency depreciation, and macroeconomic shocks stretched affordability, resulting in lower rates of PAYG repayment in 2022; a nascent recovery began to emerge in 2023.

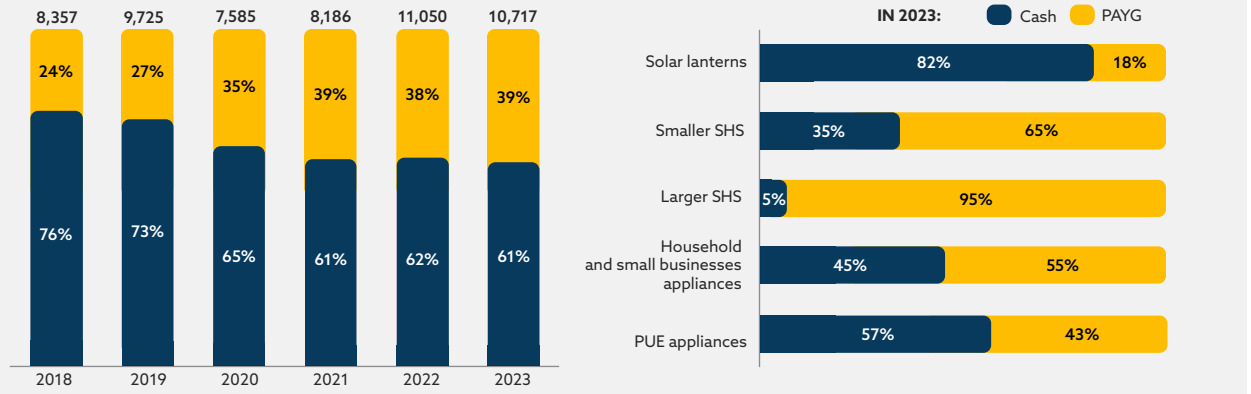
Key Concept: Pay-as-you-go

PAYG (pay-as-you-go) is a financing model that allows customers to access OGS systems via technology-enabled, embedded consumer financing. A PAYG company will typically offer a solar product (usually an SHS) for which a customer makes a down payment, followed by regular payments over a period typically ranging from six months to three years. Payments are usually made via mobile money, though alternative methods include scratch cards, mobile airtime, and cash. This model makes solar energy more affordable by reducing the upfront costs, enabling customers to pay over time while using the product.

PAYG is particularly effective in regions where financial constraints prevent consumers from purchasing solar systems outright. By allowing payments based on usage or fixed installments, PAYG not only improves accessibility but also offers flexibility to low-income households that may not have regular income streams. Likewise, PAYG offers OGS companies a sustainable business model by expanding their customer base and increasing sales. It also helps build long-term relationships with customers, as companies can provide maintenance and support over the repayment period. The model has been instrumental in scaling the OGS market, particularly in Sub-Saharan Africa, where mobile money infrastructure is widely available. However, it requires robust credit management, as companies must manage risks associated with defaults and operational costs while ensuring product affordability for customers.

87. Source: GAVI, How solar power is revolutionising immunisation in the most remote parts of the world, 2023
88. Source: Signify Foundation, Annual Report, 2022
89. Source: Sun King, BEFIT Set To Roll Out Solar-Powered EdTech to All Primary Schools in Malawi by 2029, 2024

Figure 15: Global annual number of affiliate off-grid solar products sold through PAYG and cash, 2018–2023 (thousands), and proportion of affiliate off-grid solar products sold through PAYG and cash in 2023 by product type (%)[90]



Sales of OGS affiliate products through PAYG are increasingly prevalent, demonstrating greater resilience to macroeconomic downturns compared to cash sales (Figure 15). The share of affiliate OGS products sold via PAYG grew from approximately 24% in 2018 to 39% in 2023, representing 94% of the affiliate sales growth during this period. PAYG sales maintained a modest growth rate of 0.5% from 2022 to 2023 while cash sales declined by 5.2% in the same timeframe, driven by a drop in solar lantern sales, most of which are sold for cash.

This trend is particularly notable given the significant drop in solar lantern sales in 2023. As disposable incomes decreased, consumers may have shifted toward PAYG models due to their lower upfront costs and extended repayment terms. Despite this, the growth in PAYG sales has not been without challenges, as it has implications for write-off rates and receivables at risk, which are important considerations for assessing portfolio quality and performance.

Key Concept: Collection, write-off, receivables at risk

Write-off ratio refers to the percentage of payments expected from customers that companies have written-off due to customer non-payment during a given period.

Receivables at risk (RAR 30) are receivables that have not been paid more than 30 days after they were expected to be paid. Receivables are the funds PAYG companies expect to receive from end-users over the duration of their loans. RAR 30 is added to the write-off ratio (referred to as "Write-off ratio + RAR 30") to offer more standardized results, since write-off ratios vary depending on when companies choose to write off payments.

Collection rate refers to the percentage of customer payments received compared to payments expected for a given period.

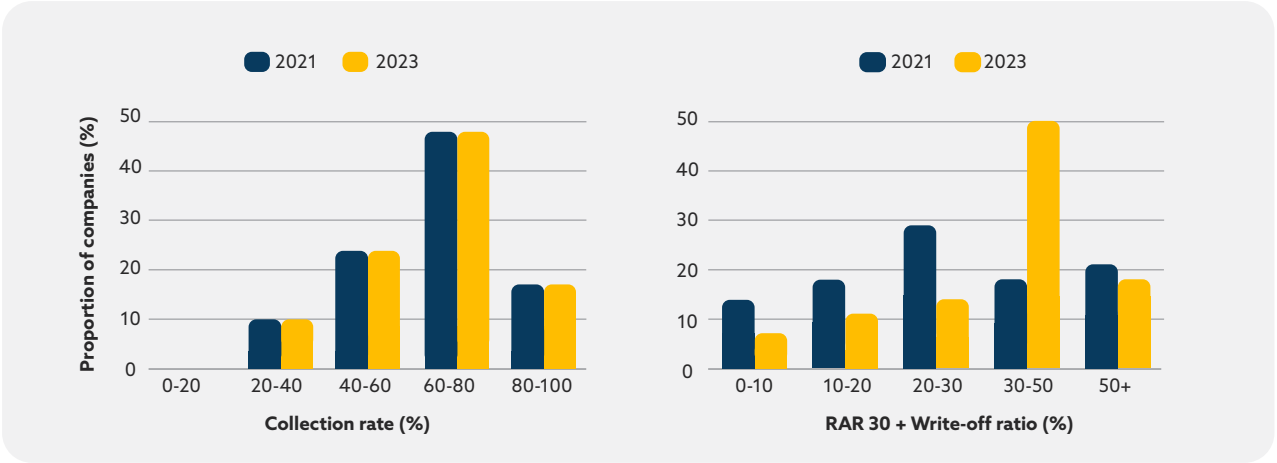
Collection rates remained steady from 2021 to 2023, with significant variation between companies, and between companies' individual country operations. The performance of PAYG portfolios varies based on factors such as the portfolio's age, whether a company is entering a new market, or the macroeconomic conditions affecting specific regions. Since the 2022 edition of this report, data on portfolio quality has been collected from companies through the PAYG Perform project, using a standardized and transparent set of key performance

90. Note: The sum of disaggregated sales may slightly differ from the total number of affiliate OGS products sold in Figure 6 as a result of data reporting differences due to data privacy

indicators.[91] From 2021 to 2023, the average collection rate stayed the same at 62%, with top quartile companies achieving rates of 75–80% and bottom quartile companies achieving rates below 50%.

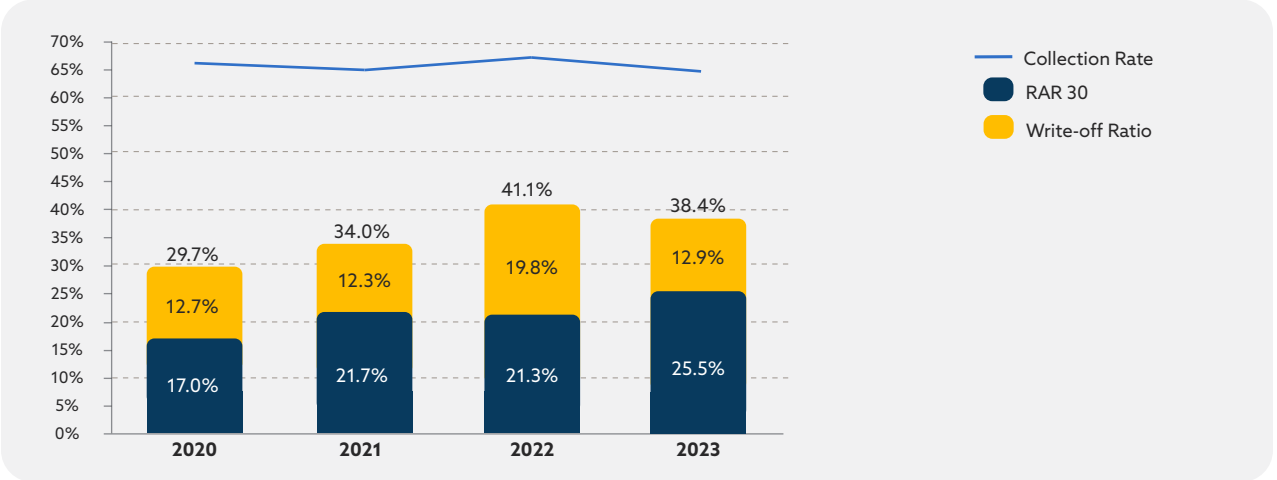
The write-off ratio + RAR 30 surged from 2021 to 2023, as customers came under intense financial pressure because of inflation, currency depreciations, and macroeconomic shock. Half of OGS companies faced a write-off ratio + RAR of 30–50% in 2023, compared to just 18% in this range in 2021. This suggests a significant increase in the number of customers who are struggling to meet their PAYG payment obligations, as well as an increase in those that have lost access to their OGS products because of payment default. Financial stress among OGS consumers intensified from 2020 through 2022. Many two-year PAYG contracts, particularly those signed just before the pandemic, ended before they were fully repaid, leading to a substantial increase in write-offs in 2022.

Figure 16: Distribution of PAYG portfolio performance of OGS companies participating in the PAYG Perform Program, 2021 and 2023[92, 93]



The write-off ratio improved from 2022 to 2023, but RAR 30 has continued to rise. Currently, 1 in 4 PAYG customers faces payment difficulties, compared to fewer than 1 in 5 just four years ago (Figure 16). This increase is directly related to the deteriorating macroeconomic conditions that affect customers' ability to meet their PAYG payment obligations. Additionally, some companies may still be prioritizing sales volume over the creditworthiness of potential customers, resulting in a higher proportion of less reliable payers.[94]

Figure 17: PAYG portfolio quality trends (non-weighted mean collection rate, RAR 30, write-off ratio), 2020–2023[95, 96]



91. Source: GOGLA, PAYG PERFORM KPIs
92. Source: GOGLA, PAYG Perform Monitor (PFM) data.
93. Note: Data is collected on OGS companies as country firms.
94. Source: Catalyst Energy Advisors, PAYG Lab.
95. Source: GOGLA, PAYG Perform Monitor (PFM) data.
96. Note: [1] Write-offs are removed from the collection rate calculation (since they are no longer active customers with expected payments), thus an increase in write-offs can improve the collection rate; [2] these results are not weighted by portfolio size but represent the average performance of "country firms" (i.e., if a company has operations in several countries each would be recorded as its own "country firm").

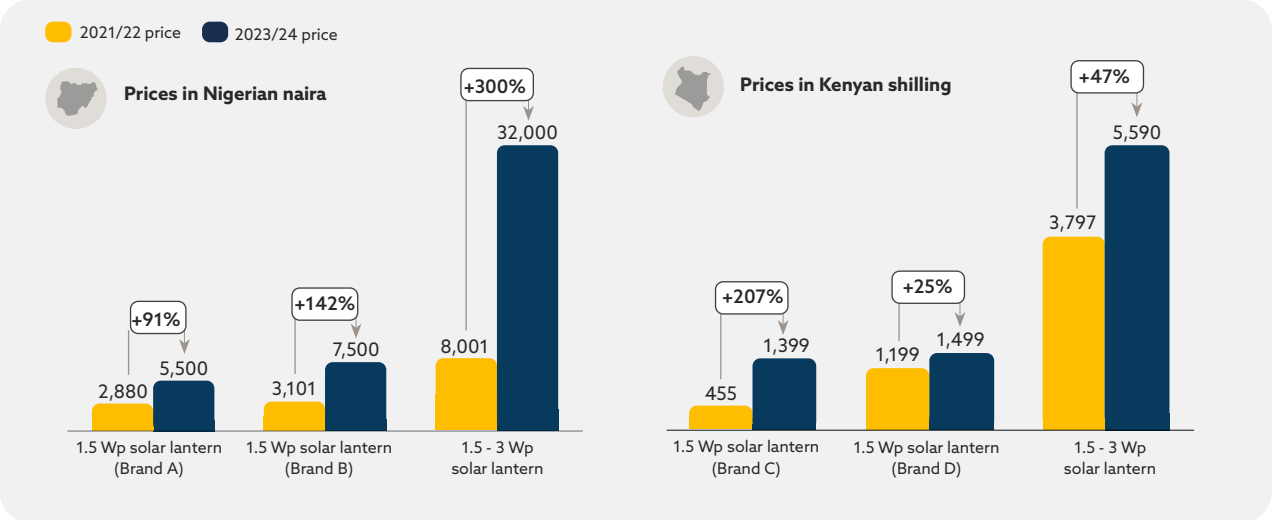
The overall reduction in non-performing PAYG loans from 2022 to 2023 suggests the worst of the macroeconomic shock is over and a gradual recovery is underway, although improvement in the RAR 30 has yet to be seen (Figure 17). The overall decline indicates that companies have been able to improve portfolio quality through enhanced credit risk management—using stronger credit screening processes, closely monitoring their portfolios, and introducing collection incentives for distributor agents.[97, 98] Companies must ensure that their customers fully understand the terms of their contracts and are capable of making payments comfortably.

Fair business practices, including responsible sales strategies, equitable pricing, and respectful customer treatment, are essential to maintaining high levels of customer satisfaction. These principles are embodied in GOGLA's Consumer Protection Code, which provides a framework for companies that can help to improve credit risk management and consumer protection in tandem.[99] Additionally, OGS companies have secured alternative financing sources, such as off-balance-sheet financing and increased access to local currency financing, to bolster their financial stability and operational flexibility.

OGS Product Pricing

> **Despite some price declines in USD terms for smaller systems, currency devaluations triggered price increases in local currency and made OGS products less affordable.**

Figure 18 : Solar lantern prices in Nigeria and Kenya in 2021/22 and 2023/24 (selected products for anonymized companies)[100]



Local currency prices surged in 2023, driven by high inflation, and the sector passed on a portion of these costs to consumers (Figure 18). Retail prices show substantial variation among distributors and countries, influenced by factors such as currency depreciation and devaluation, and inflation. For instance, in Nigeria, local currency prices for some VeraSol-certified solar lanterns have increased from 91% to as much as 300%. Similarly, in Kenya, price increases for solar lanterns have ranged between 15% and 207%, reflecting the broader volatility in pricing across the sector.[101]

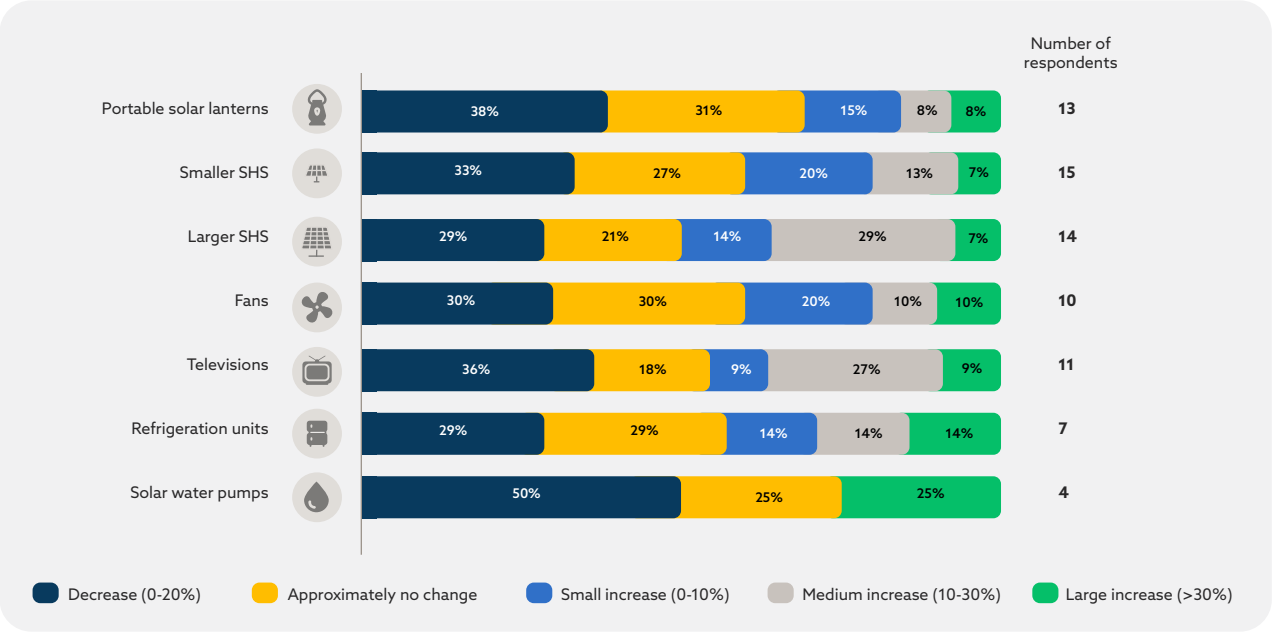
USD prices however, indicate an estimated 3% decrease for OGS products compared to 2022, due to declining costs of solar panels and batteries.[102] This price decline reflects broader trends in the solar industry, where technological advancements and shifts in manufacturing capacity have led to cost savings. The cost of Chinese-made solar panels, which dominate the global market, dropped by a remarkable 42% in 2022.[103] Similarly, battery prices have also seen a significant reduction, decreasing by 14% from 2022 to 2023.[104] However, reductions in hardware costs

97. Source: Catalyst Energy Advisors, PAYG Lab; Stakeholder consultations.
98. USAID, Helping Off-grid Companies Enhance Credit-risk Management Practices, 2023
99. GOGLA, Consumer protection code.
100. Source: 2023/24 prices from public e-commerce platforms (Jumia and Dolkon), as of April 2024; 2021 prices from MTR 2022 analyses, and prices captured in early 2022.
101. Source: Stakeholder consultations; Pricing data from public e-commerce platforms (e.g., Jumia)
102. Source: Stakeholder consultations; GOGLA member survey conducted in Spring 2024
103. Reuters, China solar industry faces shakeout, but rock-bottom prices to persist, 2024; Shifting Sands of Technology, Massive Solar Power Price Drops in China Solar Modules and Global Solar Panels in 2023: An Impactful Solar Revolution, 2023
104. BloombergNEF, Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh, 2023; Pacific Green, Good news for storage as lithium-ion prices fall, 2024

have been partially offset by increases in distribution costs due to several factors, including the difficulty of ensuring commercial viability and lack of skilled labor.

With the exception of solar water pumps, simpler systems have seen USD price reductions while larger and more complex systems have seen price increases (Figure 19). Prices for solar water pumps, portable solar lanterns, and smaller SHS decreased in USD prices. Conversely, larger solar home systems and televisions saw respondents reporting medium to large increases in prices. Refrigeration units and fans had varied results, with no clear trend dominating the responses, while prices for solar water pumps decreased. The significant variability in the responses suggests differing regional market conditions and supply chain dynamics affecting companies unevenly.

Figure 19: Global survey on changes in retail cash prices in USD terms, 2022–2023 (%)[105]



OGS Market Landscape and Dynamics

> **The OGS market relies on both large companies and smaller domestic firms; the latter playing a crucial role in reaching remote areas.**

In Sub-Saharan Africa, the OGS market is characterized by a diverse landscape, where both large companies and small domestic firms coexist. While large OGS companies have a broad reach, their products are often distributed through local partners. This means that in many countries with active OGS markets, large company products are present, either directly or through local distributors. Among the 34 countries where products from large OGS companies are available, these companies have a direct, vertically integrated presence in only 15. This indicates that a significant portion of products are channeled through local distributors.

The reach of these vertically integrated large companies is generally confined to more densely populated urban areas, especially in countries with relatively nascent markets. Consequently, small domestic companies often fill the gap by providing last-mile distribution in rural and remote areas. In some countries, only one or two large companies operate, and their sales volumes are relatively low—often below 10,000 units annually.

The availability of OGS is particularly notable in markets with large unelectrified populations and in FCV contexts. For instance, OGS products have established a solid presence in countries like Ethiopia, Nigeria, and the

105. Source: GOGLA member survey conducted in Spring 2024. Survey question: How have the global average retail purchase prices (in USD) changed for your off-grid solar products from 2022 to 2023? Rate each option where applicable.

Democratic Republic of Congo (DRC), where each market hosts at least eight last-mile distributors. In 2023, large affiliate companies sold over 100,000 OGS products in both Ethiopia and Nigeria. While data limitations prevent us from confirming whether these distributors operate in conflict zones, their presence suggests that OGS products are relatively accessible.

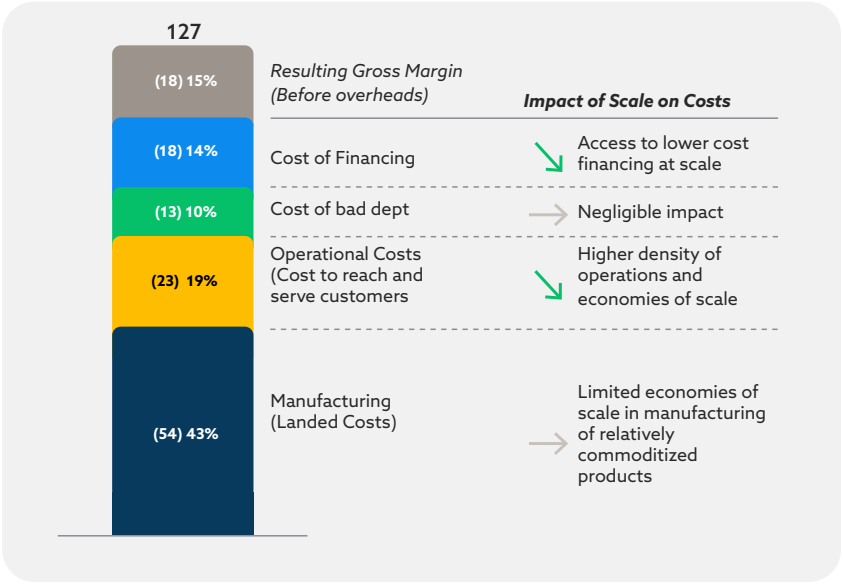
Despite the dominant market share of large global companies, the role of smaller domestic OGS companies is crucial for achieving universal Tier 1 electricity access. These smaller firms are instrumental in providing first-time electricity access, particularly in remote areas where large global companies may not operate. Their ability to maintain low operational costs and leverage their local presence allows them to keep product prices affordable. Additionally, their streamlined business models often enable them to use their funding more effectively, achieving a higher sales volume per dollar of capital raised compared to their larger counterparts.[106] These dynamics underscore the importance of both large and small players in driving progress towards universal electrification.

Three core trends have emerged in the OGS market over the past two years: growing market consolidation, a wide diversification of business models, and a generalized lack of skilled labor.

First, mergers and acquisitions have increased in the market (Box 3). These strategic mergers and acquisitions indicate a trend toward consolidation within the OGS sector, where companies are leveraging acquisitions to enhance their market positions and extend their reach into new regions. It also reflects the severe challenges smaller companies face when seeking to access finance, sometimes leaving them with no choice but to allow themselves to be acquired by companies with larger or more robust balance sheets. Through consolidation, larger companies can strengthen their competitive edge, streamline operations, cut operating costs, and ultimately increase profitability.

OGS company costs can be divided into four categories—manufacturing, operational, bad debt, and financing costs—each of which is affected differently by the scale of operations (Figure 20). While manufacturing costs do not decrease significantly with scale, financing and operational costs are more closely linked to the size of the operations. The scale of large, global OGS companies allows them to negotiate better terms with financial institutions and secure larger funding amounts at lower interest rates, which significantly reduces their overall cost of capital. On the operational side, costs are influenced by population density and proximity of customers to distribution centers. Companies operating in densely populated areas benefit from lower operational costs since they are able to serve a larger customer base with fewer distribution points. Customer density reduces the per-unit cost of logistics, maintenance, and customer service. Bad debt costs do not vary with scale but are impacted by the quality of assessment and repayment approaches. Customers are also adversely affected by high financing costs, as a 2–3% increase in the cost of capital can translate into a 5% rise in prices for end-users.[107]

Figure 20: Typical cost breakdown of a Tier 1 SHS with PAYG and implications of scale to each cost line[108]



106. Global Distributors Collective, The Growth and Fundraising Journeys of Last Mile Distributors, 2021
107. Source: Dalberg analysis
108. Source: Dalberg analysis based on stakeholder consultations with OGS providers; Hystra, Reaching Scale in Access to Energy, 2017

Box 3: Recent mergers and acquisitions in the off-grid solar sector

- **EDF acquired upOwa,** strengthening its position in Cameroon (2024)[109]
- **Ignite Power acquired Oolu,** expanding its footprint to Nigeria, Senegal, Burkina Faso, and Cameroon (2024)[110]
- **Ignite Power acquired Pawame,** expanding its footprint to Kenya (2023)[111]
- **Ignite Power acquired Mwezi,** further expanding its presence in Kenya (2023)[112]
- **Bboxx acquired PEG Africa,** expanding its footprint to Senegal, Ivory Coast, Ghana, and Mali (2022)[113]
- **Sun King acquired Soleva,** expanding its activities to Togo (2022)[114]

Data confirm that a small number of large, vertically integrated companies, offering a range of products and operating in more mature markets, have continued to attract relatively large amounts of investment and maintained profitability.[115, 116] These large, integrated players benefit from economies of scale and robust operational efficiencies, which make them more appealing to investors. They dominate the financing landscape and are able to leverage their extensive market reach to secure and sustain significant funding (*Refer to Chapter 4 – Investment and Funding Trends*).

Second, OGS companies that have diversified their businesses—or focused on an innovative business model—have seen improved commercial performance. By offering higher-value products, targeting higher-income customer segments, and potentially catering to commercial and industrial (C&I) customers, companies have positioned themselves to better withstand market fluctuations and achieve long-term profitability. Several companies have also been exploring alternatives to PAYG to reach more consumers. Examples include energy-as-a-service (EaaS), in which users pay a monthly fee to use a solar product but do not own that product, and rental models where in customers rent batteries or charged solar products for short periods of time from solar kiosks or hubs.

> **The OGS landscape is showing signs of both market consolidation and increased specialization.**

Some companies are choosing to specialize in particular segments of the value chain, while others are expanding into new areas. For example, companies like M-KOPA have shifted to focus exclusively on white-label manufacturing. This trend is driven by rising in-house and local manufacturing costs, exacerbated by global inflation. To streamline operations and reduce costs, many OGS companies are transitioning to white-label manufacturing partnerships, often with suppliers from China, while keeping assembly and maintenance operations local.[117]

Some OGS companies are adapting by selling unbundled SHS or developing ultra-low-cost products to reach customers who cannot afford current prices. For instance, d.light has explored this approach to enhance affordability and expand its market reach. These shifts signify the growing maturity of the OGS industry and highlight the increasing variety of strategies available for achieving profitability and growth in a dynamic market environment.[118]

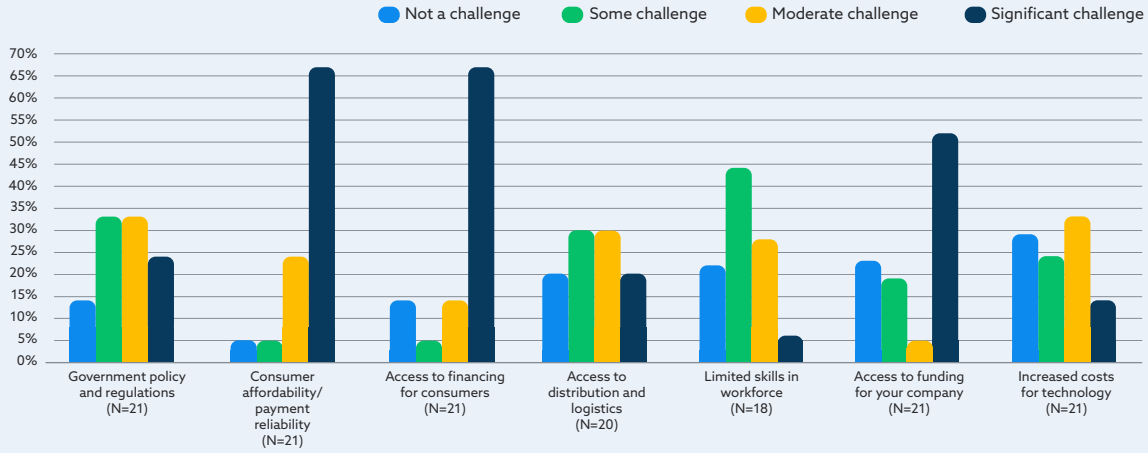
Third, the renewable energy sector in Sub-Saharan Africa, including OGS, is facing a significant shortage of skilled labor required for the sale, installation, operation, and maintenance of these systems.[119] Recent surveys indicate that 78% of respondents in the OGS sector view the "limited skills" challenge as a notable impediment to their expansion efforts. The problem is particularly severe in remote areas, which often have the largest populations living without electricity access. The lack of local expertise in these regions complicates system installation and maintenance.[120] Addressing this skill gap is essential for enhancing service delivery and advancing efforts toward universal electrification in the region.

109. Source: HSFG Africa, EDF takes control of upOwa in Cameroon, 2024
110. Source: HSFG Africa, Ignite Power acquires DRE provider Oolu, 2024
111. Source: EIN Presswire, Ignite Power Acquires Pawame, Expanding its Presence to the Kenyan Solar Market, 2023
112. Source: Abdas, Ignite Power Expands Presence in Kenya with Acquisition of Mwezi's Solar Solutions Portfolio, 2023
113. Source: Reuters, UK-based power Bboxx buys solar energy provider PEG Africa, 2022
114. Source: TogoFirst, CIZO: Sun King Group buys Soleva, 2022
115. Source: GOGLA, Investments database
116. Note: Examples include [Sun King – USD 134 million (2023)] [D.light – USD 30 million (2023)]; [Sun King – USD 335 million (2022)]; [D.light – USD 57 million (2022)]; [BBOX – USD 35 million (2022)]
117. Source: Stakeholder consultations
118. Source: Stakeholder consultations.
119. Source: World Economic Forum, Renewable energy jobs are at risk from a skills gap, 2018.
120. Source: GOGLA member survey conducted in Spring 2024.

Women are significantly underrepresented in the OGS value chain, particularly in technical and leadership roles. This underrepresentation is largely due to a lack of access to the education and skills needed to participate meaningfully in the sector. Barriers such as limited access to education, technical training, and skill development opportunities prevent women from entering and advancing within the OGS sector. This exclusion not only limits their potential but also deprives the sector of diverse perspectives that could drive innovation and growth.

Box 4: OGS sector self-assessment

Figure 21: Survey question – To what extent do the following factors represent challenges to your company's expansion in your target markets?[121]



A survey performed among OGS companies—both large and small—reveals the perceived key barriers to expansion. Most small and mid-sized companies reported that access to funding was a significant challenge. This issue is far less prevalent among large global companies, which have better access to both local and international financing sources. This imbalance in access to funding creates a significant growth bottleneck for smaller players in the sector.

Consumer affordability and payment reliability also emerge as critical challenges across the board, particularly in smaller markets. The survey shows that more than half of respondents view these factors as either a significant or moderate challenge, suggesting that while there is demand for OGS products, consumers' ability to make consistent payments remains a barrier. These affordability issues are exacerbated by broader macroeconomic trends, such as inflation and currency fluctuations, making it even harder for companies to expand.

Finally, factors like limited workforce skills and rising technology costs further constrain the sector. About half of the respondents cited limited workforce skills as a significant challenge, highlighting the need for greater technical and operational expertise at the local level. Increased technology costs, driven by global supply chain disruptions, also emerged as a growing concern, affecting companies' ability to offer affordable products while maintaining profitability.

Coming soon: Explore the factors that represent challenges to OGS company's expansion

121. Source: GOGLA member survey conducted in Spring 2024

CHAPTER 3

Affordability of OGS

photo credit: Biolite

KEY MESSAGES

Affordability of SEKs is a critical challenge for households lacking access globally. Only 22% of households lacking electricity globally can afford the monthly payment required for a Tier 1 solar energy kit with PAYG, while 49% would be able to afford it at a stretch. Tier 2 OGS products with PAYG are affordable for only 1%, and affordable at a stretch for 2%, of those lacking access.

In Sub-Saharan Africa, monthly PAYG payments for Tier 1 OGS products are **affordable for only 16% of the population** lacking access and affordable at a stretch for 46%.

82% of people lacking access to electricity live in low-density rural, remote, or conflict-affected contexts. The cost of extending services to these areas can increase prices locally by an estimated 57%, with Tier 1 PAYG system prices increasing from USD 127 to USD 199.

Household and small business appliances are affordable to those that can afford a medium to large SHS. Being able to buy these appliances bundled with SHS on PAYG has helped to overcome affordability constraints.

Productive use appliances sold on PAYG remain unaffordable for most despite their clear economic benefits—reaching only 2% of the addressable market. PUE companies can overcome these challenges through using PUE-as-a-service models, rent-to-own, demand aggregation, and seasonal pricing.

Development organizations have set ambitious targets to electrify social infrastructure. However, affordability and budgeting concerns on the public sector side prevent sustainable operations and maintenance, which in turn leads to premature system failures.

Key Concept: Affordability

Affordability refers to the ability of households to pay for off-grid solar products without straining their financial resources.

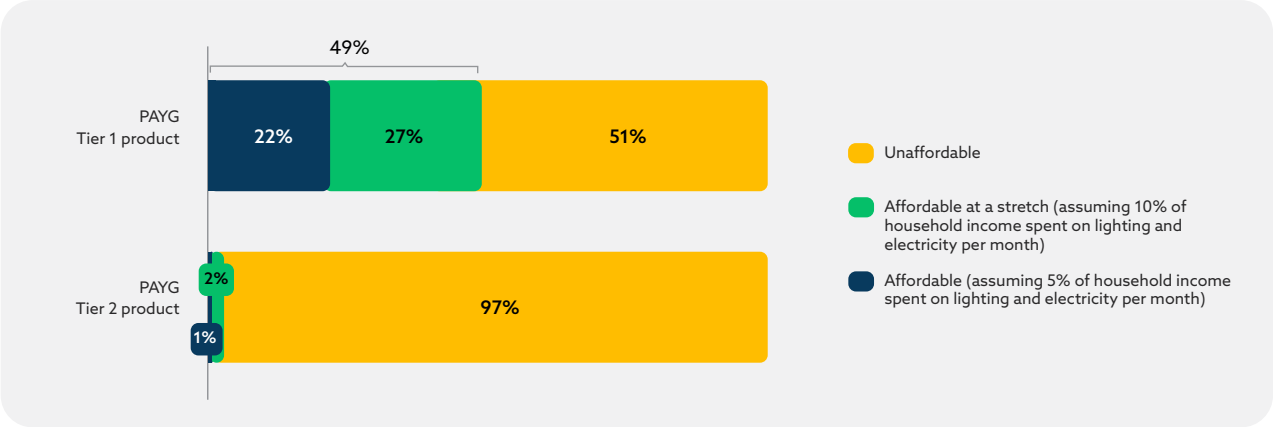
In this report, a product is considered affordable when it costs less than 5% of a household's income on a monthly basis, in line with the Multi-Tier Framework definition of affordability. A product is considered affordable at a stretch when it requires a household to allocate 10% of monthly income.

Affordability of Solar Energy Kits

Globally, only 22% of households lacking access can afford a Tier 1 solar energy kit with PAYG, while an additional 27% can afford it at a stretch.

Affordability is a critical challenge for households lacking access, especially where OGS products are most needed. Many households, particularly in rural and underserved areas, face financial constraints that limit their ability to purchase OGS systems outright or make regular payments under financing schemes like PAYG. Economic factors such as inflation, currency depreciation, and rising costs of living further strain household budgets. Furthermore, lack of electricity hinders business opportunities, thereby creating a vicious circle of energy poverty and income poverty, which is exacerbated in fragile, conflict-affected, and vulnerable (FCV) settings. These financial barriers hamper the widespread adoption of OGS solutions.

Figure 22: Affordability of monthly PAYG payments for Tier 1 and Tier 2 OGS products for households without access globally[122]



The ongoing payment for a Tier 1 OGS product with PAYG is considered affordable—that is, it would cost 5% or less of their monthly budget—for only 22% of households lacking access globally (Figure 22). In contrast, an additional 27% of households without access would be able to afford the product "at a stretch," which would require spending 10% of their income on energy, potentially leading to significant financial strain.[123, 124] Affordability is even lower for Tier 2 OGS products with PAYG: only 1% of the households would consider this "affordable"; for 2% it would be "affordable at a stretch."[125] (*For a description of electricity access tiers according to the Multi-Tier Framework, please refer to Chapter 1 – Off-Grid Solar and the Path to Universal Electrification*).

Coming soon: Explore the impact of different inputs on the affordability of Tier 1 OGS access, specifically (i) the factors that increase the prices of Tier 1 OGS access for hard-to-reach populations, (ii) the corresponding affordability gap to Tier 1 OGS access by country, and (iii) the sensitivity of affordability to changes in pricing inputs.

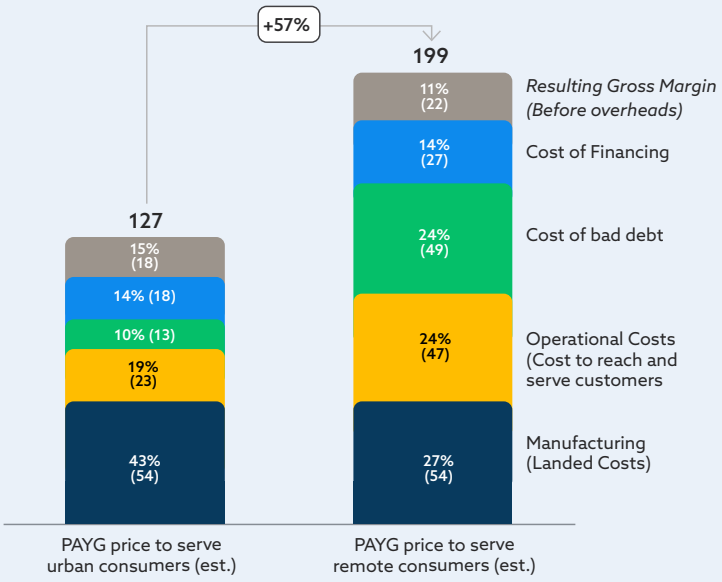
122. Note: [1] Affordability gap estimations differ from MTR 2022, as a result of methodological differences. The MTR 2024 methodology assumes a higher cost to serving hard-to-reach populations (from both higher OPEX and bad debt costs). Refer to Annex 5 for further detail. [2] The model assumes affiliate product prices are too expensive for consumers to purchase with cash, so affordability estimates are calculated using PAYG prices.
123. Note: At USD 71.61 cash price for urban households/ USD 198.75 for rural households (2017 dollars at PPP), with a PAYG downpayment of 20% of the product cost, to be repaid at a 40% annual interest rate in two years, considering 5% of income spent on energy for 'affordable' and 10% for 'affordable at a stretch'
124. Note: The change in affordability from MTR 2022 is partly due to the different methodology used to calculate the affordability gap and should not be read as affordability becoming much worse since 2022. Refer to Annex 5 for details on how the affordability gap is calculated.
125. Note: At USD 465 for both urban and rural householders (2017 $ at PPP), with a PAYG downpayment of 20% of the product cost, to be repaid at a 40% annual interest rate in 2 years, considering 5% of income spent on energy for 'affordable' and 10% for 'affordable at a stretch'.

Affordability constraints are amplified for those who live in remote locations and in conflict-affected settings, where Tier 1 access comes at a much higher price owing to higher operational costs. About 82% of the population lacking access—roughly 562 million people—reside in hard-to-reach areas, where off-grid solar companies face higher expenses for delivery, maintenance, and payment collection. Around 31% of people lacking access (~211 million people) live in active conflict zones, where the cost of doing business is high and potential revenues are limited. Nearly three-quarters of this population (~158 million people) is concentrated in conflict-affected areas of Nigeria, Ethiopia, and the Democratic Republic of Congo. Distributing OGS products to remote or FCV areas tends to be significantly more expensive, which exacerbates affordability challenges (*See Box 5*).

Active conflicts in many regions have led to significant electrification challenges for forcibly displaced and refugee populations, which typically do not have the income or savings to afford off-grid solar products. Currently, there are 51 million forcibly displaced people in FCV contexts, living either in resettlement camps or informal settlements where access to electricity is extremely limited. Nearly 94% of these individuals lack reliable electricity.[126] Although, on average, people spend about 17 years in resettlement camps, accommodations for displaced individuals are intended to be temporary, with insufficient focus on developing long-term infrastructure.[127]

Box 5: What are the cost implications of serving remote and FCV populations?

Figure 23: Cost increase for a Tier 1 PAYG OGS product to serve remote populations (USD)[128]



Distributing and selling OGS products in remote or FCV areas is significantly more costly than in densely populated regions near major infrastructure. As a result, OGS companies often have to implement differentiated pricing within the same country, leading to price increases of up to 57% in harder-to-reach areas. This can raise the total costs of Tier 1 OGS system financed via PAYG to approximately USD 199—versus an average price of USD 127. This higher cost is incorporated into the affordability calculations in this report. Several factors contribute to these higher costs:

- **Higher operating expenses:** In remote areas, economies of scale for sales, distribution, and collection are often unachievable due to low population densities. Consequently, these higher operating costs are reflected in increased product prices for customers in less accessible areas.

126. Source: Global Platform for Action, The State of the Humanitarian Energy Sector: Challenges, Progress and Issues in 2022, 2022
127. Source: Pyper, J., Solar Power to Light Up Syrian Refugee Camps in Jordan, 2015
128. Source: Hystra, Reaching Scale in Access to Energy, 2017; Dalberg analysis, 2024

- **Challenges with local distribution:** The lack of strong local distributors and the high costs associated with maintaining a direct sales force in low-density areas further drive up prices. These additional costs are ultimately passed on to consumers.
- **Higher financing costs:** For OGS companies operating in remote areas, particularly those that are conflict-affected, the cost of capital is typically higher. This is largely due to the uncertainty stemming from heightened security and political risks, which reduces investor confidence and, in turn, raises interest rates. As a result, customers are adversely affected, as a 2–3% increase in the cost of capital can translate into a 5% price hike for end-users.[129]

Even when consumers are reached, they often have limited savings, unstable incomes, and poor creditworthiness. This increases the credit risk associated with PAYG OGS products, leading to potential payment delays and defaults. Income variability and sensitivity to economic fluctuations can affect affordability, even for customers who might otherwise be able to pay. These factors also contribute to higher bad debt costs for OGS suppliers.

Local currency OGS prices, which rose faster than wages from 2021 to 2023, have exacerbated affordability issues. Suppliers who purchase products in USD face increased costs, which are then passed on to consumers through higher prices. While PAYG remains a viable model with the right public funding support, there is a threshold beyond which it becomes less effective. Due to the high operational and bad debt costs associated with serving the lowest-income customers in remote and conflict-affected areas, PAYG may not always be the most commercially viable solution for these populations (*refer to Chapter 4 – Investment and Funding Trends*)

The role of OGS in FCV contexts
Coming soon: Explore the potential of OGS to play an important role in providing electricity access to conflict-affected areas where the traditional electricity supply infrastructure is often disrupted or severely damaged.

Affordability of Households and Small Business and Productive Uses OGS Appliances

Sales of affordable household and small business appliances are increasing, driven by low prices, limited energy needs, ease of distribution, and the ability to pay through PAYG when they are bundled with SHS.

In Sub-Saharan Africa, household and small business appliances are typically sold bundled with SHS kits, with PAYG financing to help address affordability constraints. While smaller Tier 1 SHS bundled with appliances such as fans or radios are affordable to a small proportion of people lacking access, larger Tier 2 SHS bundled with appliances such as TVs are primarily sold to wealthier households in weak-grid areas, and remain unaffordable to the vast majority lacking access (*refer to Affordability of Solar Energy Kits*).

Fans continue to be the most popular OGS appliance for households and small businesses with 1.3 million units sold in 2023. Fans require minimal energy and can be connected to either the grid or off-grid solutions. They are therefore often sold unbundled through existing distribution networks for off-grid solar kits, as they do not require additional skilled distributors capable of installation and maintenance. This is particularly true in Pakistan, which accounted for 70% of global fan sales in 2023.

129. Source: Dalberg analysis.

Productive use appliances reach only 2% of the estimated addressable market. Innovative business models, demand aggregation and seasonal pricing can allow more people to benefit from these appliances.

OGS productive use appliances remain out of reach for many despite their clear economic benefits. The productive use of energy (PUE) sector is still in its early days, as only 2% of the estimated addressable market is currently being served, and stakeholders are still learning about and exploring the sector.[130, 131] However, evidence on the benefits of PUE is clear: in cases where OGS appliances have been deployed for productive use, 81% of customers saw their incomes rise.[132]

Affordability is a core challenge for PUE appliances. OGS solar water pumps (SWPs), refrigerators, and milling machines are expensive compared to customers' incomes and require relatively large upfront payments. Prices of SWP vary from USD 750 to over USD 1,200 depending on size and features.[133] SWPs tend to have lower lifecycle costs than engine water pumps; however, SWPs cost more upfront, which prompts most farmers to opt for engine pumps. Ongoing PAYG payments for SWP are also a challenge for farmers, who, in some cases, are forced to make unacceptable sacrifices to afford them.[134] Similarly, cooling appliances like solar refrigerators and cold-storage units remain relatively expensive. These PUE products range from USD 600 to USD 30,000, depending on the size and capacity of the unit. Their high price points place them out of the reach of most small businesses and farmers: for the poorest 50% of off-grid households, solar-powered refrigerators can cost 2.5 times their annual disposable income.[135, 136] These affordability constraints have only grown with the current challenging macroeconomic conditions.

Business models in the productive use sector are evolving to reduce the cost of appliance access and increase customer reach. For example, in water-as-a-service models—such as those offered by Oorja Development Solutions in India—farmers pay an initial membership fee and then pay per liter used, eliminating the need for individual farmers to purchase pumps. Others have experimented with bundling appliance service with other services such as market linkages. For example, Raheja Solar in India sells affordable, easily assembled, locally manufactured solar dryers to rural farmers—and buys their dried produce before selling it on.[137]

Affordability of OGS for Social Infrastructure

Development organizations have set ambitious targets to electrify social infrastructure. However, affordability and budgeting concerns on the public sector side require a dramatic change of approach to sustainably electrify schools and health centers globally.

Affordability remains a major challenge in scaling up OGS electrification for social infrastructure like public schools and health centers. Government funding for these projects is often very limited; most are financed by donor capital and grants. Typically, projects are delivered through a design, build, operate, and transfer (DBOT) model, in which the government—often through line ministries like Health or Education—takes ownership of the systems once the work is completed. However, this model poses significant sustainability challenges. Both the facilities and ministries often lack the budget to cover ongoing operations and maintenance, especially when expensive components, such as batteries, need replacement. As a result, many schools and health centers are forced to operate without electricity until new components can be centrally procured.[132] Such challenges are, however, less pronounced in private facilities. Private schools and health centers are able to tap into sources of revenue such as student admission fees, patient fees, and more. Consequently, these facilities often have resources to cover the costs of system operations and maintenance, which in turn allows for reliable electricity supply.

130. Note: The PUE sector appliances refer to solar pumps and refrigerators.
131. Source: GOGLA, Affiliate sales data; Efficiency for Access, Global Addressable Market Projection; Dalberg analysis, 2024
132. Source: 60 Decibels, Why Off-Grid Energy Matters, 2024
133. Source: Dalberg analysis, 2024
134. Source: Efficiency for Access, Tech Trends in Electricity access: Assessing the Solar Water Pump Market, 2023
135. Source: ESMAP, Sustainable cooling in Off-grid Rural Areas: Nexus between Access to Energy and Clean Cooling, 2024 [upcoming]
136. Source: ESMAP, Sustainable cooling in Off-grid Rural Areas: Nexus between Access to Energy and Clean Cooling, 2024 [upcoming]
137. Source: CLASP, Leave no one behind, 2024 [upcoming]

To address the challenges experienced in the electrification of public schools and health centers, new private sector-driven models are emerging, such as energy-as-a-service (*explained further in Box 6*). These business models are just one of several essential components needed to sustainably electrify schools and health centers. Donors and investors must also move away from simply funding the purchase of systems, and instead focus on supporting long-term service delivery. Donors and investors need to partner with governments—whose budget constraints could hamper the widespread adoption of service-oriented models—to secure dedicated resources on an ongoing basis that would be deployed for long-term service contracts.

Box 6: Energy-as-a-service for public institutions in Uganda

The World Bank Uganda Electricity Access Scale-up Project (EASP) targets the electrification of public institutions like schools, health centers, and the public water supply system located far from the grid. Lessons learned from previous projects showed that a traditional public procurement approach, whereby the Government acquires and installs solar systems in schools and health facilities in need, does not pass the test of time, as most solar systems fail because of lack of maintenance and component replacement. For this reason, EASP implements a service delivery model whereby the Ministries of Health and Education coordinate with the Ministry of Energy and Mineral Development to select contractors responsible for the design, installation, operation, and maintenance of solar systems. Such contractors are required to deliver reliable and sustainable electricity against a set of predefined Key Performance Indicators over a 10-year period. The Uganda Energy Credit Capitalization Company provides a grant to the energy service providers to cover a portion of the capital cost of the systems and bring down the cost of the ongoing service payments. In addition to the above, the World Bank provides performance-based grants to the Ministries of Health and Education for 5 years on the condition that timely payments are made to contractors.

There is an opportunity to improve the sustainability of financing dedicated to social infrastructure. A significant amount of financing is currently being used to maintain social infrastructure by governments—a minimum of USD 175 million have been invested in healthcare facilities by donors in seven countries (Nigeria, Kenya, DRC, Sierra Leone, Malawi, Zambia, India). Yet, until the barriers above are addressed, inconsistent delivery of quality operation and maintenance limits the efficiency and the impact of such financing.[138]

138. Source: SEforALL, Health facility electrification capital landscape, 2023

CHAPTER 4

Investment and Funding Trends

photo credit: d.light

KEY MESSAGES

Investment in the OGS sector reached USD 1.2 billion during the 2022–23 period, up from USD 773 million in 2020-2021. Investment reached a peak of USD 746 million in 2022 before dropping to USD 425 million in 2023. Between 2021 to 2023, total investment in the OGS sector grew by almost 30% compared to all investment made in the sector before 2021.

Local currency financing has been growing, especially for larger companies. **Over a third of total investment in 2023 were in local currencies.**

Off-balance-sheet financing is now a significant funding source for the sector: a set of large securitization transactions has been closed—much of it in local currency aligned with the companies' receivables.

Despite positive developments in funding in the past two years, **access to finance remains a challenge for the OGS industry.** In particular, the availability of patient capital and equity financing for OGS companies remains limited.

Public funding for OGS is growing; the World Bank lent a record USD 660 million to governments to scale proven solutions in fiscal year 2024 and a range of development partners are supporting innovation in new technologies, business models, and financing, mainly for productive uses.

Results-based financing (RBF) is being scaled up, with USD 733 million committed and 350 million disbursed since 2018. An increasing number of RBFs offer end-user subsidies to address affordability challenges.

While the use of credit lines is being scaled back, **the use of guarantees to unlock debt investments appears to be growing.**

Climate finance and carbon credits are currently underutilized in the OGS sector, with some notable exceptions, including the Green Climate Fund's USD 65 million commitment to the Hardest-to-Reach Fund in 2021.

Access to finance remains a challenge for the OGS industry, with over 60% of small and mid-sized companies identifying it as a "significant challenge." A key barrier to fundraising is the heightened risk perception associated with smaller firms, which often deters investors. More equity financing, patient capital, impact-linked concessional debt, and long-term end-user subsidies are all needed.

Investments

Investment Flows

Key Concept: Investment types in the OGS sector

The main types of investments in the OGS sector considered in this chapter are equity, debt, and grants. These investments can originate from a wide array of sources, including equity investors, debt providers such as commercial banks and financial institutions, multilateral organizations, and other institutional or impact-driven funders. Each type of funding serves a specific purpose in the financial development of an enterprise, supporting growth from early-stage ventures to more established operations.

Equity financing is critical for early and growth-stage companies, as it offers long-term funding without the pressure of immediate repayment (particularly in the case of "patient equity"). It is also important for growing companies seeking to fund scale-up, such as expanding operations or entering new markets. Equity investors often bring additional value beyond capital, such as strategic guidance, governance, and access to networks, helping OGS companies scale up operations and expand into new markets.

Debt financing, on the other hand, allows OGS companies to access capital through loans from commercial banks, microfinance institutions, or development partners. Debt financing is essential for companies that have reached a stage of stable cash flow and are looking to fund working capital or expansion projects without diluting ownership. It plays a key role in sustaining growth, enabling companies to manage operational costs while scaling up their business models.

Grants, while not technically a form of "investment," are treated like investment and tracked by the GOGLA Investments Database. These are typically concessional and are provided without the expectation of repayment. Much like angel investments or early-stage equity, grants aim to de-risk a company and catalyze additional commercial capital.[139]

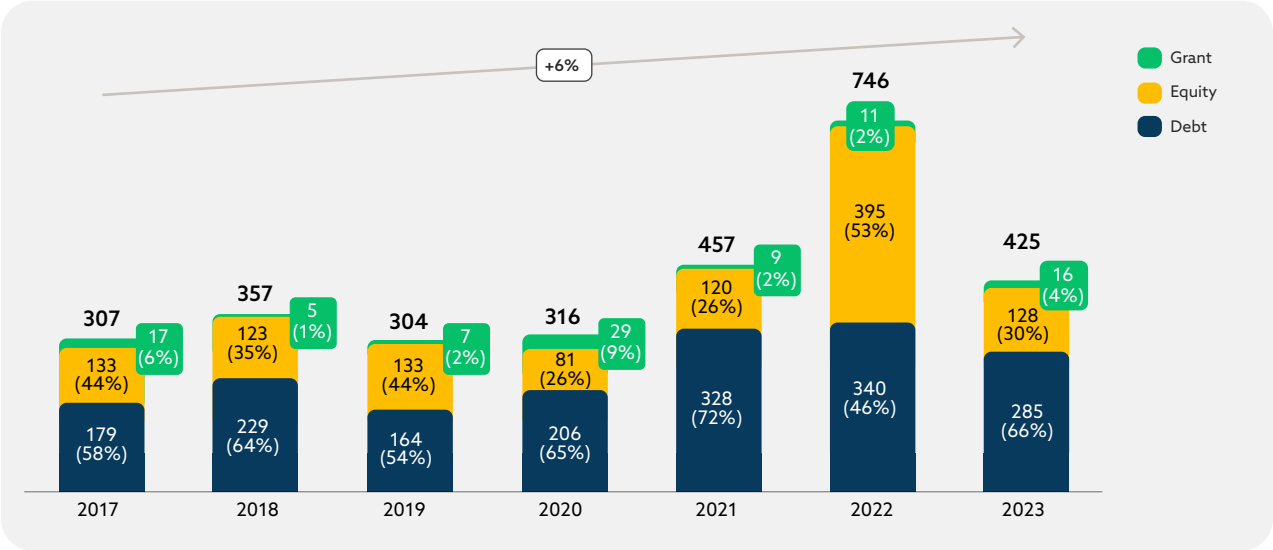
All three investment types tracked in this chapter come from both private actors, such as commercial banks or equity investors, and public actors, like governments and development partners. However, even when privately sourced, debt and equity are often unlocked and de-risked by public investments. Conversely, grants are mostly provided directly by the public sector.

Investment in the OGS sector reached USD 1.2 billion during the 2022–23 period, up from USD 773 million in 2020-2021. Investment in the OGS sector reached a remarkable USD 746 million in 2022, followed by USD 425 million in 2023 (Figure 24).[140] The sharp rise in 2022 was largely driven by a significant equity raise from Sun King, one of the largest companies in the industry, which secured USD 330 million and demonstrated the viability of building a profitable and impactful off-grid solar company with private investor support. Large individual deals can have a significant impact on annual figures, making it important to focus on longer-term trends.

Investment in the OGS sector has been growing steadily since 2017 and grew significantly from 2021 onwards. Since 2017, investment flows have steadily increased by about 6% each year. Debt financing played a key role, growing at an average annual rate of 8% during this period. From 2017 to 2020 total investment ranged from USD 307 to USD 357 million, but from 2021–2023 it ranged from USD 425 to USD 746 million.[141]

139. Note: [1] Subsidies and Results Based Financing (RBF), are considered a market incentive and as such, accounted separately; [2] Results Based Financing (RBFs) are dependent on the verification of sales, acting effectively as a subsidy to the purchase of goods or services delivered by the awarded companies during a period of time within a specifically designated geography to boost revenues for otherwise non-commercial markets. This generates revenue for the company for sales they have already delivered or will be delivered in the short term, i.e. the funding comes upon sales / after verification of sales. However, it does not provide pre-sale financing (i.e. investment) like a grant would do; [3] Some new RBF structures are quite similar to grants in timing and use, and some grants are aimed at geographical expansion, which makes the difference between some RBFs and grants blurry.
140. Source: GOGLA, investments database; Dalberg analysis, 2024
141. Note: However, when excluding Sun King's USD 330 million Series D in 2022, the investment amount in 2022 decreased by 9% from 2021

Figure 24: Investment amount by type (excluding RBFs), 2017–2023 (USD millions)[142]



The sector attracted a large amount of equity investment between 2022 and 2023. The peak in equity investment was largely a result of Sun King's Series D investment round in 2022, which raised USD 330 million and set a new benchmark for capital raising in the industry.[143] Another USD 38 million in equity investment was injected into companies including BBOXX, SunCulture, Qotto, and Yellow, reflecting investor confidence in the potential of diverse business models within the sector.[144] Grants remain a small and relatively stable portion of the overall investment flows, accounting for about 2% of total investment since 2021.[145]

Large, international, and vertically integrated companies keep capturing 70–80% of the total amount invested in the sector, which reflects their share of the market.[146] The remaining share of investment in the sector is directed to smaller companies, mostly in their seed or start-up stages. Both firm categories are critical to achieving SDG 7: while larger firms can disseminate OGS products at scale, smaller firms are key to providing first-time access, particularly in remote areas with distribution challenges that larger firms may avoid.[147] For more details on the key actors in the market, *refer to OGS Market Landscape and Dynamics*.

In 2023, the capital concentration expanded to 45 companies receiving funding, up from 30 in 2022.[148] This growth in the number of recipients highlights an increasing role of smaller OGS providers, although the amounts raised are often modest compared to those of larger OGS companies.

Despite their critical role in achieving SDG 7, smaller companies face challenges raising investment for several reasons. First, in the eyes of investors, smaller OGS firms have a higher perceived risk profile due to lower profitability, vulnerability to macroeconomic shocks, and limited ability to access international private capital sources. Second, they are often too small to absorb the large investment amounts, or "ticket sizes," offered by commercial investors, which are typically in USD millions.[149] This holds true even for debt investors, who prefer to mitigate their risks by co-investing with equity investors—but the equity ticket size often exceeds what smaller companies can absorb. Third, local financial institutions who might lend to smaller companies often have limited exposure to PAYG models and are unable to accurately evaluate OGS company performance. For these reasons, compounded with the above, they may be hesitant to fund smaller OGS companies.

Consequently, smaller OGS companies rely on the support of funds co-financed by development financial institutions (DFIs) and multilateral development banks (MDBs), in the form of grants or patient, flexible, concessionary capital (Box 7). In 2022 and 2023, approximately 57% of the funding for these smaller companies came from public and donor sources, compared to only 20% for larger global companies.[150, 151]

Click to further explore the investment and funding trends

142. Source: GOGLA, investments database; Dalberg analysis, 2024
143. Source: GOGLA, investments database; Dalberg analysis, 2024
144. Note: Percentage breakdown of investments excludes confidential investments
145. Source: GOGLA, investments database; Dalberg analysis, 2024
146. Note: Percentage breakdown of investments excludes confidential investments
147. Source: Stakeholder consultations
148. Note: Based on GOGLA investments database, and excludes confidential investments
149. Source: Stakeholder consultations
150. Source: GOGLA, Investments database; Dalberg analysis, 2024
151. Note: (1) This is an indicative estimation based on the non-confidential investments disclosed in GOGLA's Investment database. (2) Many investments were made by several co-investors, some of which consisted of both private and public capital, so estimates are based on the lead investors. (3) Note: 'large global companies' include BBOX, d.light, Engie Electricity access, Sun King, M-KOPA, Lumos Solar, and Zola Electric.

Box 7: Example of a fund co-financed by DFIs and MDBs

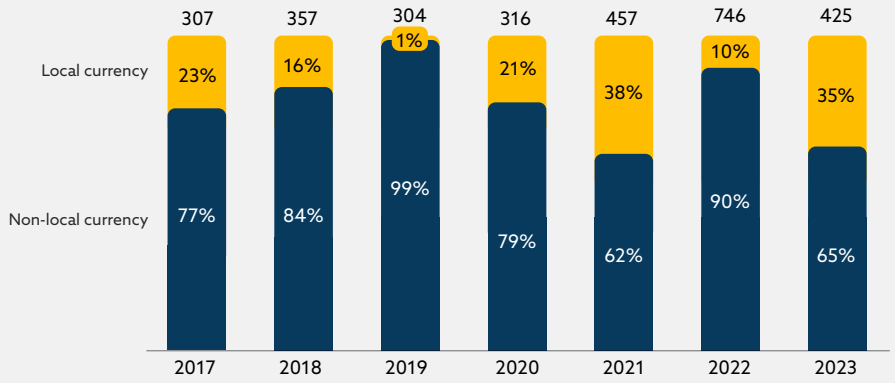
The USD 120 million Energy Entrepreneurs Growth Fund (EEGF)—created by Shell Foundation, co-funded by FMO and UK Aid, among others, and managed by Triple Jump—provides tailored mezzanine, equity, and debt investments combined with technical assistance to early- and growth-stage OGS companies (namely BaoBab+, Yellow Solar, and Redavia). As of June 2024, the fund has helped electrify more than 115,000 households through OGS.[152]

Finally, there has been growing interest in productive use of energy (PUE) markets, with continued investments signaling the sector's expansion beyond household electrification to income-generating appliances. SunCulture, for example, secured USD 27.5 million in 2024 to support its solar-powered agricultural solutions, underscoring the rising importance of PUE in attracting investment and driving broader economic development in off-grid regions.[153]

Investment Trends

Local currency financing has been growing over the past years, especially for larger companies. Over a third of total investments in 2023 were in local currencies, partially driven by the securitization from some of the industry's largest players (Figure 25). Between 2017 to 2023, local currency debt financing averaged 20% of investments, with large global companies securing most of this funding. Unfortunately, smaller OGS companies have struggled to access local currency financing, mainly due to the prohibitively high interest rates charged by local financial institutions. This limitation reduces their resilience to severe currency fluctuations in critical markets.

Figure 25: Investment amount split by type of currency, 2023 (USD millions)[154]



Evidence from recent local currency debt transactions in the OGS sector reveals a notable increase in substantial financing deals (Box 8). These include the USD 75 million loan to Sun King Kenya and the USD 171 million co-financing approved for the AfDB's LEAF Framework, indicating growing interest and investment in local currency debt. Another significant example is the rise of multi-currency financing solutions, as demonstrated by d.light and Solar Frontier Capital's facility, which underscores a move toward more flexible financing structures to manage currency risks. Overall, these trends reflect a more sophisticated and expansive approach to securing local currency debt in the off-grid solar sector.

152. Source: LinkedIn, Malawi Ngwee Ngwee Ngwee Fund, 2024
153. Source: Sun-connect, SunCulture Raises Oversubscribed $27.5m Series B Funding, 2024
154. Source: GOGLA, investments database; Dalberg analysis, 2024

Box 8: Recent local currency debt transactions

- **Bboxx** secured approximately USD 16 million in local financing loans from Banque Populaire du Rwanda, Togolaise de Banque (UTB), and AfDB-backed FEI OGEF (2017–2019)
- **South Africa's Standard Bank, Citi, Norfund, and CDC** Group partnered to provide Sun King Kenya with a KES-denominated loan equivalent to USD 75 million (2021)
- **Green Climate Fund** approved USD 171 million in co-financing for the AfDB's Leveraging Electricity Access Finance (LEAF) Framework, a USD 959.9 million initiative that aims to crowd in local currency debt and commercial capital for mini grid and SHS projects in Sub-Saharan Africa (2021). Note that this is a capitalization of a fund and not the funding of a company at this stage[155, 156]
- **Bboxx** raised USD 15 million from SBM Bank, a local commercial bank in Kenya (guaranteed by GuarantCo) (2022)
- **d.light** and Solar Frontier Capital established a multi-currency receivable financing facility (up to the equivalent of USD 238 million in face value of receivables) (2022)[157]
- **Sun King** secured a Kenyan-shilling denominated securitization transaction, valued at USD 130 million (KES 18 billion) (2023)[158]

The expansion of local currency financing is critical for the development of the OGS sector. USD financing creates a mismatch between the currencies of OGS companies' assets (primarily future PAYG payments in local currency) and liabilities (loans in USD), thereby exposing OGS companies to currency risk. Local currency debt financing can address this challenge. OGS companies that can access local currency financing find it very effective in mitigating currency risk created by receiving revenue in local currency while paying expenses (e.g., for stock) in hard currency.[159]

A related innovative trend in OGS investment is the rise of securitization deals, particularly in local currency. After several years of limited activity, 2023 saw a resurgence in securitization transactions totaling USD 160 million, accounting for approximately 35% of total OGS funding. Notably, about 77% of the value of the securitization deals was raised in local currencies. Securitization deals are inherently complex due to the legal and structuring requirements, involving the transfer of ownership and ongoing servicing of assets. As a result, they generally necessitate large transaction sizes—typically USD 100 million or more—making them accessible primarily to OGS companies with substantial balance sheets.

Sun King and d.light, two of the sector's largest players, were able to capitalize on this trend. In 2023, Sun King partnered with Citi to establish a USD 130 million securitization deal, while d.light secured USD 30 million in securitization funding from the Eastern and Southern African Trade and Development Bank (TDB) as part of a World Bank project, allowing for the purchase of up to USD 125 million in receivable assets. This momentum carried into 2024, with d.light closing an NGN 10 billion securitization deal with Chapel Hill Denham in Nigeria and a USD 176 million facility covering Kenya, Tanzania, and Uganda. These deals signal the increasing sophistication and scalability of OGS financing mechanisms.[160]

155. Source: GCF, Leveraging Electricity access Finance (LEAF) Framework
156. Note: GCF has disbursed only USD 1 million thus far. Funding is planned to roll out over the next 10 years, as direct lending is not the highest priority; the focus is on establishing the guarantee product.
157. Source: d.light, d.light and SFC announce industry-leading USD 238 million multi-currency receivable financing Facility, 2022
158. Source: Business Daily, Sun King gets Sh18bn to finance solar customers, 2023
159. Source: Stakeholder consultations
160. Source: d.light, d.light closes new USD$176 million securitization facility for affordable off-grid solar in Kenya, Tanzania and Uganda, 2024

Box 9: What factors have contributed to the recent emergence of successful securitization deals?

Several elements have driven the recent increase in securitization in the OGS sector. First, the PAYG market has matured, particularly in some geographic areas. Investors have a better understanding of the sector and of the risk-return profile of such transactions, supported by an increasing amount of data on PAYG repayment rates. The result has been greater investor confidence and therefore stronger availability to invest. Second, the ticket size of financing facilities has grown large enough to make securitization economically viable. Early attempts, such as Bboxx's 2015 securitization transaction of USD 500,000, were far smaller than recent transactions of USD 30–170 million. With larger securitization deals, enabled by larger portfolios and higher sales of high-value products (TVs, inverters, smartphones etc.), deal structuring costs become more attractive.

A final emerging trend is the entry of new investors in the OGS sector. While many investors have been supporting OGS development for over a decade, relatively new players such as Convergence Partners, At One Ventures, and the Global Energy Alliance for People and Planet (GEAPP) have made significant contributions in 2022 and 2023.[161] These investments reflect a broadening base of financial backers, with a diverse mix of equity and debt investments entering the space. For instance, Convergence Partners invested USD 10 million in Yellow Solar in 2023, while At One Ventures contributed USD 7.9 million to Okra Solar. However, despite these notable inflows, the sector continues to face challenges, particularly with respect to investor exits, which may limit investor appetite to invest in the sector going forward.[162] This issue of exit pathways remains a key obstacle to the sector's long-term appeal to institutional investors.

Additional examples of significant debt and equity investments made by relatively new funders can be found in Box 10. These developments underscore the growing interest from a wider array of investors and the evolving financial landscape of the OGS sector.

Box 10: Recent investments made by funders relatively new to the off-grid solar sector

- **Convergence Partners** – USD 10 million equity investment in Yellow Solar (2023).
- **At One Venture** (alongside others) – USD 7.9 million equity investment in Okra Solar (2023).
- **CitiBank Kenya** (alongside others) – USD 127.4 million debt investment in Sun King (2023).
- **Private Infrastructure Development Group** (PIDG) – USD 15 million equity investment in BBOX (2022).
- **Eastern and Southern African Trade and Development Bank** (TDB) – USD 75 million debt investment in d.light (over 2022 and 2023).[163]
- **GEAPP** – USD 36.5 million funding committed to the productive use of energy (since 2021).[164] [165]
- **Chapel Hill Denham** – NGN 10 billion securitized financing facility for d.light (2024).
- **Nuveen** – USD 12.5 million equity investment for Ecozen (2023).

161. Source: GOGLA, Investments database; Dalberg analysis, 2024
162. Source: Next billion, AFC and d.light Achieve Off-Grid Solar Industry Milestone with Full Repayment of Senior Debt for $110 Million Securitization Facility, 2024
163. Note: TDB made a relatively small investment in 2021--so it did not just enter the space in last two years
164. Source: GEAPP, Powering People and Planet Impact report 2023, 2023
165. Note: GEAPP launched in 2021 and has provided grants since then so it did not just enter the space in last two years

Public Funding

Key Concept: The public funding toolkit[166]

Governments and development partners can use a range of public funding mechanisms to leverage private co-investment and achieve impact through scaling up off-grid solar markets. These mechanisms have been proven in a range of countries and contexts around the world over the last 30 years.

Public funding mechanisms that channel non-repayable funds to companies include upfront grants, results-based financing mechanisms, end-user subsidies, public procurement, and tax exemptions. **Upfront grants** are non-repayable funds to help companies develop technologies and business models, or expand into new markets, with payments typically linked to agreed milestones. **Results-based financing** is when companies are paid based on achievement and verification of a predefined result, typically a sale. **End-user subsidy** is when grants are used to directly reduce the price paid by end-users for an OGS system – this is usually done through results-based financing. **Public procurement** is when government agencies purchase systems through an organized bid and distribute the systems to end users, typically through contractors who are paid for their services through upfront grants or result-based financing. **Tax exemptions** involve governments foregoing revenue and reducing costs for OGS companies, enabling them to offer products at lower prices.

Governments can also provide debt to OGS companies through ***credit lines*** to help them grow, which may or may not operate on concessional terms. They can also offer **risk mitigation instruments, such as guarantees** that enable investors to make debt or equity investments that would otherwise have been too risky, and help companies access these forms of financing.

Climate finance and carbon credits are considered a form of public funding in this report. Climate finance channels resources from both public and private actors to support climate mitigation and adaptation efforts. However, most of the climate finance provided in the OGS sector so far has come from public sources.

Public Funding Flows

> **The World Bank is the main source of public funding for electricity access and the OGS sector, providing governments with International Development Association (IDA) loans to invest in large-scale, national, and regional OGS market development programs.**

World Bank lending for electricity access has grown since 2016 and peaked at USD 2.5 billion in fiscal year (FY) 2022. OGS solutions, while fluctuating in their annual allocations, have increasingly received notable support, particularly in FY 2019 and from FY 2022 onwards. The proportion of electricity access lending committed to off-grid solar increased from 12% in FY 21 to 30%—or USD 626 million—in FY 24. Increased government borrowing to invest in the OGS sector reflects growing recognition of the sector's potential contribution to universal access, as well as other development goals (Figure 26 and Figure 27).

166. World Bank, Designing Public Funding Mechanisms in the Off-Grid Solar Sector, 2022

Figure 26: World Bank lending for electricity access by fiscal year and support type, 2017–2024 (USD billion)

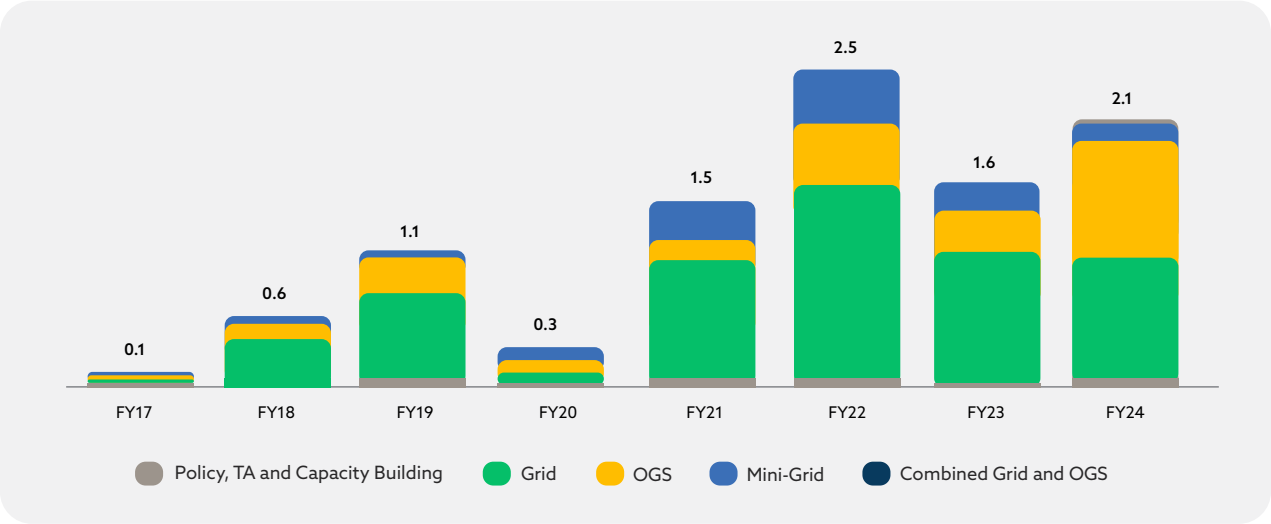
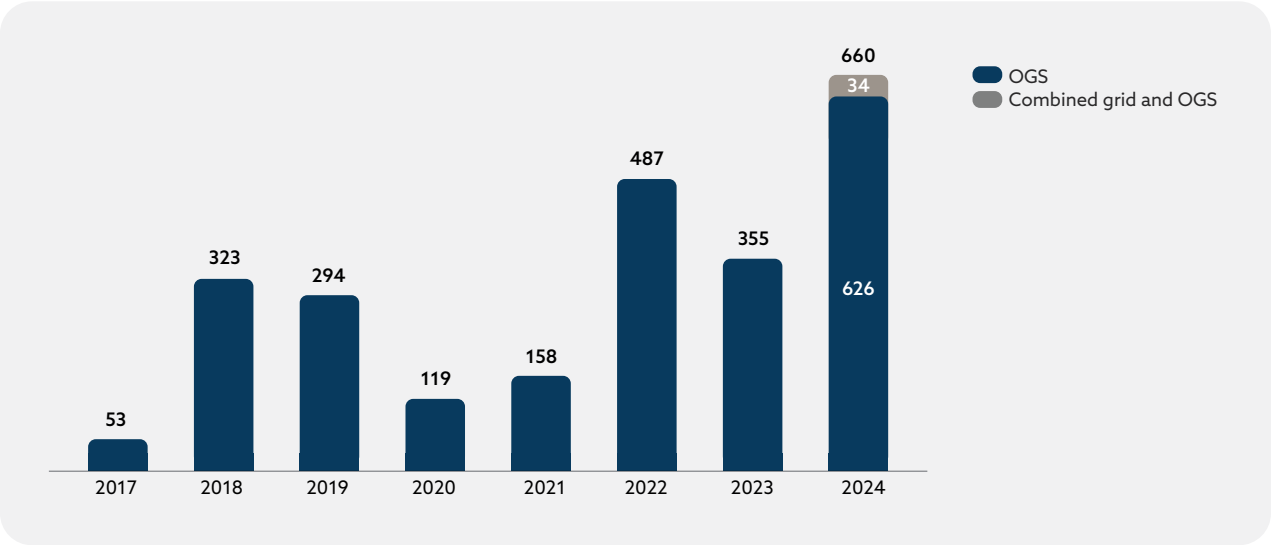


Figure 27: World Bank funding approved for off-grid solutions, 2017–2024 (USD millions)[167]



World Bank lending for off-grid solar reached an all-time high in FY 2024 at USD 660 million—and is likely to continue to grow. 67% of the current portfolio of active projects is allocated to households and productive uses, 15% to public institutions, 9% to technical assistance, and 8% is unspecified. Funding mechanisms include 39% allocated to RBFs, and 22% to credit lines, supporting the financial sustainability of off-grid solutions. Upfront grants make up 13% of the funding, which provides essential early-stage capital. The World Bank's indicative pipeline of new projects demonstrates a strategic commitment to OGS—given that a further USD 772 million is earmarked for the sector.

Table 1 below summarizes the activities of major development partners (other than governments and the World Bank) active in the sector over the past two years:

167. Source: World Bank Energy Portfolio data and analysis.

Table 1: Non-exhaustive list of major public funders of off-grid solar including total funding committed (not exclusive to OGS) and summary of strategies[171, 172]

Name: Global Energy Alliance for People and Planet (GEAPP)

Total Amount committed: USD 10 billion (cumulative across all types of energy access)

Summary of public strategies as it relates to OGS

- GEAPP—founded by the Rockefeller Foundation, IKEA Foundation, and Bezos Earth Fund—has a goal of mobilizing USD 10 billion to accelerate renewable energy projects to provide access to modern levels of energy, including off-grid, mini grids and other decentralized energy solutions.
- An estimated USD 36.5 million has been committed to the productive use of energy since 2021, including off-grid solutions, across several projects including the Productive Use Appliance Financing Facility (PUAFF). [168, 169]

Name: Green Climate Fund (GCF)

Total Amount committed: USD 10 billion (cumulative)

Summary of public strategies as it relates to OGS

- GCF has committed over USD 10 billion globally for climate-related projects, including large-scale renewable energy and off-grid energy access solutions.
- It provides concessional financing for both mitigation and adaptation projects in developing countries.
- Thus far, GCF has committed over USD 400 million to OGS projects, including Hardest-to Reach-Fund, LEAF Framework, and KawiSafi Ventures Fund.[170, 171]

Name: World Bank

Total Amount committed: USD 10 billion + (cumulative)

Summary of public strategies as it relates to OGS

- The World Bank has committed over USD 10 billion for electricity access since 2017, including on-grid, mini grid, and off-grid projects
- The funding committed to off-grid projects has grown from ~USD 300 million in 2019 to over USD 600 million in 2024.[172]

Name: IKEA Foundation

Total Amount committed: USD 500 million (cumulative)

Summary of public strategies as it relates to OGS

- IKEA Foundation has committed over USD 500 million to support climate action, renewable energy access, and energy poverty eradication, with a portion allocated to off-grid energy solutions, particularly in rural and underserved regions.

Name: EnDev

Total Amount committed: EUR 500 million + (cumulative)

Summary of public strategies as it relates to OGS

- EnDev, supported by multiple donors (including Germany, the Netherlands, Norway, and others), has allocated over EUR 500 million to support energy access initiatives, including both household and productive use technologies.
- EnDev's support specifically for household energy access includes scaling up the provision of standalone systems through an end-to-end approach by deploying supply-side subsidies, demand-side subsidies, and business development support (BDS).[173]

168. Source: GEAPP, Powering People and Planet Impact report 2023, 2023
169. Source: CLASP, Productive Use Financing Facility
170. Source: GCF, Project Portfolio; Dalberg analysis, 2024
171. Note: Some of these commitments also include funding for OGS alongside other renewable energy projects (e.g., mini grids)
172. Source: World Bank Energy Portfolio data and analysis.
173. Endev, Energising Development Progress Report, 2023

[Continuation]

Name: Shell Foundation

Total Amount committed: USD 500 million + (cumulative)

Summary of public strategies as it relates to OGS

- Shell Foundation has provided over USD 500 million in patient capital since its inception.
- It focuses on off-grid energy, supporting enterprises with seed funding, grants, and low-interest loans for scaling up energy access projects.

Name: USAID Power Africa (Beyond the Grid)

Total Amount committed: USD 500 million + (cumulative)

Summary of public strategies as it relates to OGS

- Shell Foundation has provided over USD 500 million in patient capital since its inception.
- It focuses on off-grid energy, supporting enterprises with seed funding, grants, and low-interest loans for scaling up energy access projects.

Name: EEP Africa

Total Amount committed : USD 200 million + (cumulative)

Summary of public strategies as it relates to OGS

- EEP Africa has provided over EUR 70 million in grants, leveraging additional funding to mobilize over EUR 200 million for clean energy projects across Southern and East Africa. In 2023, 55% of the portfolio was primarily for solar photovoltaic (PV) solutions.[174]

Name: Get.Invest

Total Amount committed: EUR 2 billion + (cumulative)

Summary of public strategies as it relates to OGS

- Get.Invest primarily focuses on mobilizing private investment, with projects typically leveraging its advisory support to secure investment for decentralized renewable energy projects, including off-grid solutions.
- To date, EUR 2.9 billion has been mobilized, with 29% specifically for standalone solar systems and productive use (approximately EUR 800 million).[175]

174. Source: EEP Africa, Annual Report, 2023
175. Source: Get.Invest, Insights into our portfolio of projects and companies

Public Funding Trends

National governments, backed by the World Bank, are playing a key role in scaling up RBF to enable growth in the OGS sector. RBF mechanisms have proven to be effective in helping OGS companies serve hard-to-reach markets by mitigating increases in operational costs and enabling more affordable prices.[176] Around USD 733 million has been committed to the OGS sector through RBF instruments since 2018, of which USD 350 million has been disbursed.[177] National governments—supported by the World Bank—are at the forefront of scaling up results-based financing, committing USD 527 million to OGS RBFs between FY 2022 and FY 2024 (roughly four times the amount committed in the previous three-year period) (Figure 28).[178]

Figure 28: World Bank funding toward results-based financing for the off-grid solar sector by fiscal year, 2017–2024 (USD millions)[179]

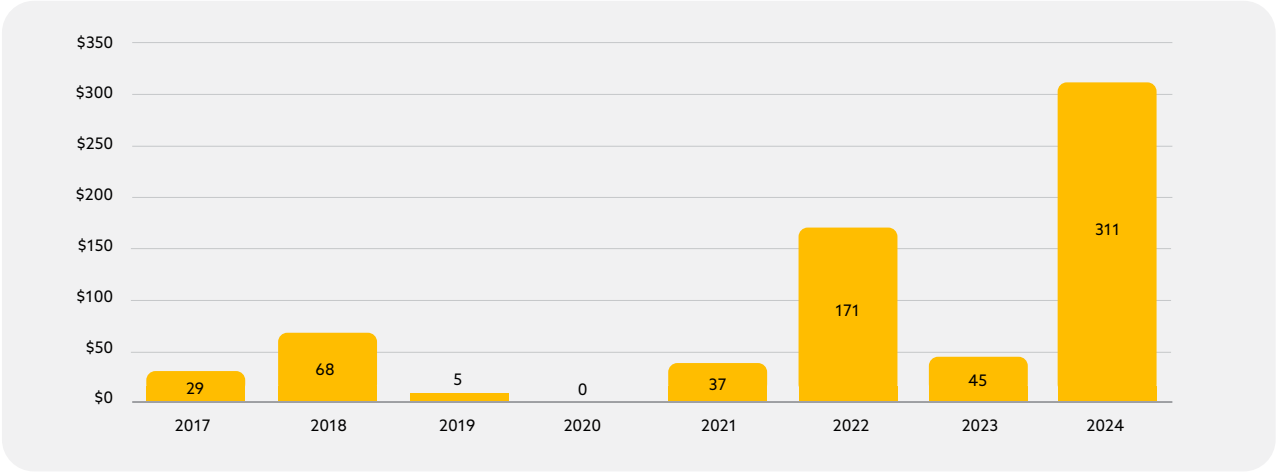
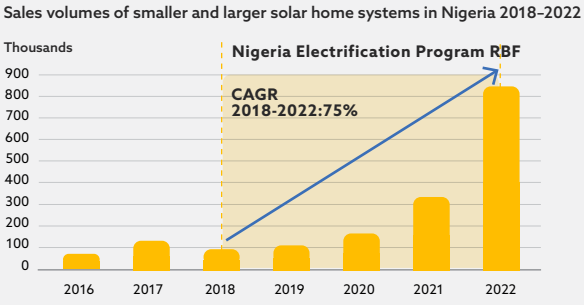
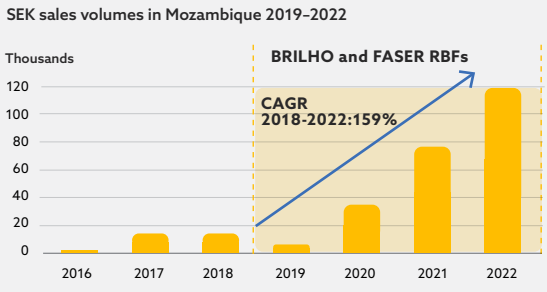


Figure 29 below shows how RBFs have played a critical role in enabling compound annual growth rates ranging from 75% to 159%, delivering access to millions of households.[180]

Figure 29: Sales volume growth in countries implementing results-based financing, 2018–2022[181]



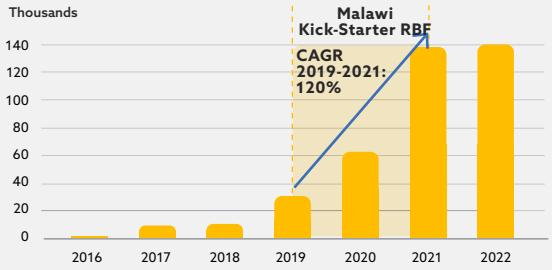
- 75% CAGR for smaller and larger SHS, leading to an additional 1.5 million units sold.
- Annual solar lantern sales grew 72% from 195,000 to 335,000.
- Household appliance sales (fans and TVs) grew from just below 5,000 units sold per year to 274,000 units.



- 159% CAGR for SHS leading to an additional 236,000 units sold.
- Annual solar lantern sales grew to 31,000.
- TV sales grew from around 100 units to 2,700.

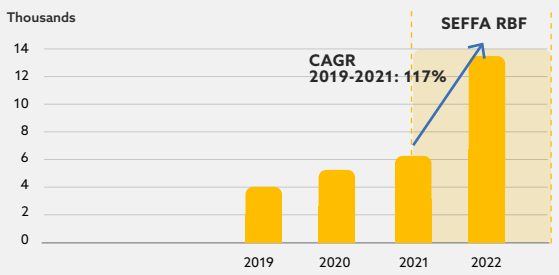
176. Source: Stakeholder consultations
177. Source: GOGLA, RBF Data; Dalberg analysis, 2024
178. Note: The 2023 spike in RBF is largely dure to the approval of the Nigeria DARES project, which committed USD 300 million in RBF.
179. Source: World Bank Energy Portfolio data and analysis
180. Source: GOGLA, Unlocking Off-Grid Solar: How Results-Based Financing is driving energy access and powering productivity, 2023
181. Source: GOGLA, Unlocking Off-Grid Solar: How Results-Based Financing is driving energy access and powering productivity, 2023

SEK sales volumes in Malawi 2019–2021



- 120% CAGR for SHS leading to an additional 230,000 units sold.
- Annual solar lantern sales grew 47% from close to 17,000 to 24,000.

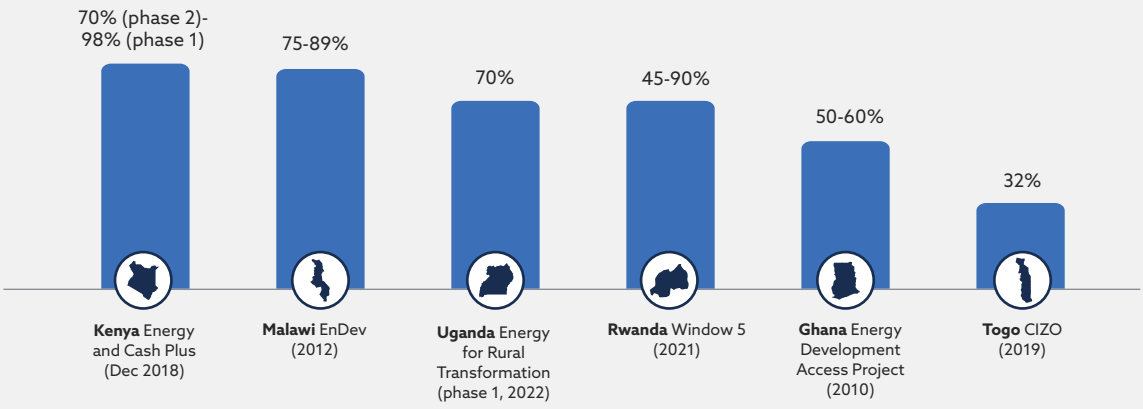
Solar water pump sales volumes in Kenya 2021–2022



- 19,066 farmers with improved irrigation powered by renewable energy.

RBFs are increasingly being used to provide end-user subsidies, helping to address affordability challenges. End-user subsidies lower the cost of a product for consumers, specifically targeting those with very low incomes to help them access off-grid products. These subsidies can be applied directly to the product price by the company, which then receives RBF to cover the difference. Alternatively, customers may receive a voucher or direct cash transfer to assist in purchasing the product. End-user subsidy programs typically allow customers to pay 30–90% less than the unsubsidized retail price of OGS products, with the average subsidy in the 60–70% range (Figure 30).[182, 183] The World Bank's publication on designing responsible end-user subsidies for electricity access shares best practices for the design of such instruments.[184]

Figure 30: Percentage of total cost covered by consumer subsidies for off-grid solar products by program (non-exhaustive)[185, 186, 187, 188, 189]



Public funding is needed to test and innovate new models to use and deploy end-user subsidies for household OGS most effectively. Household solar is perceived by many to have reached commercial viability—government-led end-user subsidies are now required for it to scale up. As a result, some funding has switched from household models to supporting business model innovation in the more nascent PUE and social infrastructure markets, which are perceived to i) have more direct links to social (health and education) or economic (business performance) impacts and ii) require more innovation in technology and business models. However, large amounts of public funding for household OGS models are still needed to:

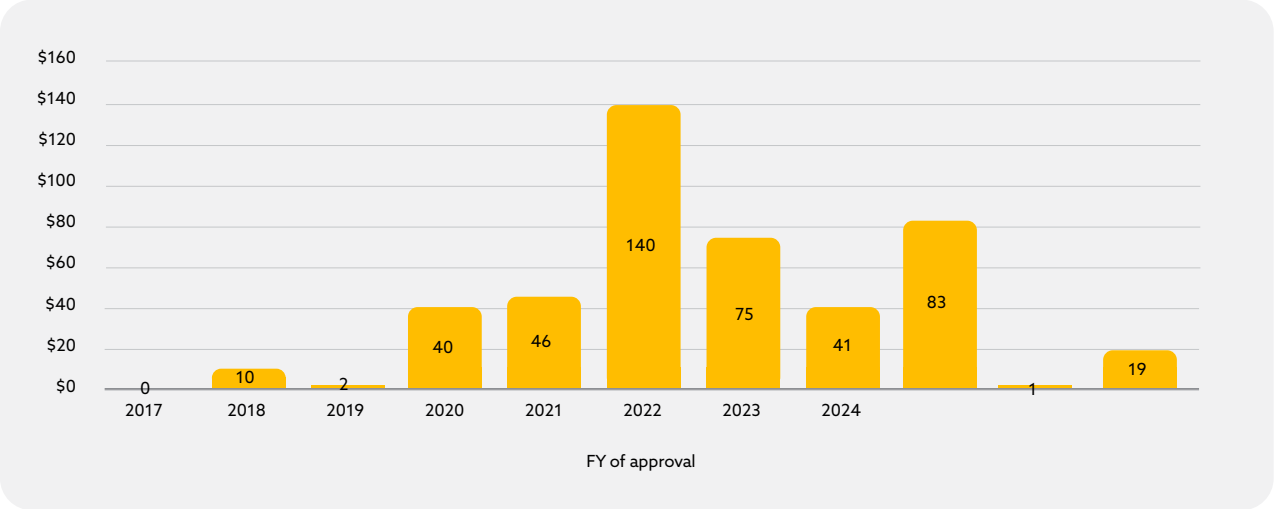
182. Source: Dalberg analysis
183. Source: Stakeholder consultations
184. Source: World Bank, Designing Responsible End-User Subsidies for Electricity access, 2024
185. Source: SEforALL, The role of end-user subsidies in closing the affordability gap, 2022
186. GOGLA, Conditional Cash Transfers in Kenya for Off-Grid Solar Energy Cash Plus / Mwangaza Mashinani Programme, 2021
187. Source: End User Subsidies Lab, Rwanda End User Subsidy (Pro Poor RBF), 2018
188. Source: DfID, Energy Africa – Uganda Fiscal policy options for Solar Home Systems: Final report, 2018
189. Note: Togo CIZO Cheque provides a monthly subsidy of USD 4 for the Bboxx SHS payment plan over three years. Bboxx Power 20 was priced at USD 449.28 in 2022

- Develop and test large-scale end-user subsidy models, requiring complex data analysis and funding structures involving national and regional governments, multilateral development banks, and private sector partners; help build capacity with these partners.

- Develop and test business models that move beyond consumer PAYG and can lower the cost to serve low-income customers by reducing bad debt and operational costs.

In parallel with a growth in RBFs, the use of credit lines has been scaled back over the past years. Funding allocated to World Bank credit lines between FY22 and FY24 amounted to USD 103 million, compared to USD 256 million provided between FY19 and FY21 (Figure 31). Some credit lines have struggled with implementation challenges linked to a) getting established and deploying capital within the timeframe of World Bank projects, given their complexity; b) providing a credit offering that matches market maturity; and c) limited appetite of local financial institutions to act as intermediaries. Others have been successful, such as the Rwanda Renewable Energy Fund (REF) which built flexibility into its design with multiple windows, one of which provided direct financing for locally registered OGS companies providing Tier 1 and above OGS systems. The opening of this window in 2019 triggered an increase in interest from OGS companies, following the low uptake of the credit line through commercial banks.[190]

Figure 31: World Bank funding toward credit lines for the off-grid solar sector, 2017–2024 (USD millions)[191]



Guarantees are playing an increasingly important role in unlocking debt through risk mitigation. By issuing guarantees, governments or financial institutions can protect investors against potential losses due to non-commercial risks, such as political instability or currency fluctuations. This encourages investment by reducing risk, increasing the flow of capital into the OGS sector. Guarantees can also support loan facilities, making it easier for companies to secure financing from commercial banks and other lenders. This is especially important for expanding OGS solutions in areas where political instability, currency risks, and limited financial infrastructure often deter investment.

Box 11 shows several examples of these instruments. One notable instance is the Multilateral Investment Guarantee Agency's (MIGA) issuance of USD 43 million in guarantees to support Bboxx's subsidiaries in Rwanda, Kenya, and the Democratic Republic of Congo (DRC). These guarantees provided protection against non-commercial risks such as war, civil unrest, and currency inconvertibility, which are common concerns in these regions. In a similar vein, GuarantCo and SBM Bank Kenya provided a USD 15 million loan to Bboxx Kenya, with GuarantCo offering a 75% credit guarantee (USD 11.25 million) to support the transaction. This partial guarantee significantly reduced the risk for the local bank. By stepping in to absorb potential losses, GuarantCo facilitated the flow of capital into a critical market, helping to provide clean energy access to many households. The Mirova Gigaton Fund, which has raised USD 171 million so far, blends senior and junior investments to tailor investment opportunities to investors' risk appetites, and helps create a structure that can absorb potential losses, attracting more private capital into climate-friendly projects like OGS.

190. Source: World Bank, Designing Public Funding Mechanisms in the Off-grid Solar Sector, 2022
191. Source: World Bank Energy Portfolio data and analysis.

Box 11: Examples of guarantees and blended finance instruments deployed in the off-grid solar sector

- **MIGA** issued guarantees totalling USD 43 million to cover equity and quasi-equity / shareholder loan investments by AIIF 3 Clean Energy (AIIF 3) in Bboxx's subsidiaries in Rwanda, Kenya, and DRC, as well as a non-shareholder loan provided by the Facility for Energy Inclusion Off-Grid Electricity access Fund (FEI-OGEF) to Bboxx DRC in 2020 and 2021. The MIGA guarantees offer protection to AIIF3 and FEI-OGEF against non-commercial risks such as war, civil disturbance, and currency inconvertibility and transfer restrictions.[192]
- **GuarantCo and SBM Bank Kenya** provided a USD 15 million loan to Bboxx Kenya to invest in offering affordable SHS to 470,000 Kenyans. GuarantCo supported the transaction with a USD 11.25 million partial (75%) credit guarantee of the loan facility.[193]
- **Mirova Gigaton Fund,**194 a blended finance vehicle, raised USD 171 million for its first closing. The fund includes a EUR 75 million senior commitment from European Investment Bank and EUR 5 million of junior investment under the Luxembourg-EIB Climate Finance Platform.
- **Green4Access** (G4A) First Loss Facility[195] is a risk mitigation facility aiming to encourage increased local currency financing of electricity access projects by local financial institutions. G4A's facility has a tiered structure, blending grant funds in the first loss tranche of the fund's capital stack, with private philanthropic and impact junior debt in the middle tranche, followed by senior loans from DFIs in the top tranches.

Furthermore, climate finance is being underutilized in the OGS sector.[196] Though the OGS sector is gradually being recognized for both its climate mitigation and adaptation potential, the sector has mobilized only a small fraction of climate finance deployed thus far.[197] For instance, the world's largest multilateral climate fund (Green Climate Fund (GCF)) committed an estimated 3.1% of its total fund size to OGS.[198, 199]

Box 12 highlights key examples of climate finance commitments and carbon credit initiatives in the OGS sector, showcasing how these mechanisms are driving both energy access and emissions reductions. The GCF's USD 65 million commitment to the Hardest-to-Reach Fund in 2021 exemplifies the role of climate finance in expanding OGS access in underserved markets. This fund, aimed at delivering affordable, clean electricity to first-time users in 16 African countries, is part of a larger USD 250 million initiative. By supporting projects like KawiSafi II[200] and AfDB's LEAF program,[201] the fund has prevented 5.1 million metric tons of CO2 emissions, demonstrating the dual impact of increasing energy access and mitigating climate change.

Carbon credit initiatives, as seen in the cases of Namene and SunCulture, further illustrate how carbon finance can make OGS products more affordable. Namene's sale of Verified Emissions Reductions in Zambia enables rural families to purchase solar lights at a 50–60% discount, making clean energy more accessible. Similarly, SunCulture's pilot aims to expand access to solar water pumps for Kenyan farmers by reducing upfront costs through carbon monetization. These examples underscore the potential of combining climate finance and carbon credits to accelerate the growth of the OGS sector and enhance energy affordability for low-income populations. This opportunity highlights the importance of integrating OGS into broader climate finance strategies, as even small shifts in funding priorities could unlock critical resources for the sector and accelerate the path to SDG 7.

192. Source: MIGA, Investment Guarantee Guide, 2021
193. Source: Bboxx, GuarantCo, 2021
194. Source: Mirova, Mirova announces the first closing of the Gigaton stategy, 2023
195. Source: GreenMax Capital Group, Green for Access First Loss Facility (G4A), 2022
196. Note: For the purposes of this report, climate finance is considered a public funding mechanism given that the majority of the funding currently provided in the OGS sector comes from public sources.
197. Note: Data limitations, likely due to very little climate financing being deployed for OGS, mean are unable to provide the exact proportion
198. Note: Some of these commitments also include funding for OGS alongside other renewable energy projects (e.g., mini grids)
199. Source: GCF, Project Portfolio; Dalberg analysis, 2024
200. Source: GCF, KawiSafi II; Note: KawiSafi II is a USD 200 million venture equity fund aimed at closing the investment gap in three key areas where Sub-Saharan countries including in the energy transition.
201. Source: AfDB, African Development Bank Group approves LEAF program to promote investment in decentralized renewable energy, 2022; Note: The LEAF program aims to promote access to decentralized renewable energy in Ghana, Guinea, Ethiopia, Kenya, Nigeria, and Tunisia by unlocking commercial and local currency financing.

Box 12: Examples of climate finance commitments and carbon credit in the off-grid solar sector

Climate finance

The Green Climate Fund committed USD 65 million in grants and equity to the Hardest-to-Reach Fund in 2021, which helps OGS companies enter and grow in underserved markets, with the aim of providing affordable and green electricity access to first-time users in 16 African countries. The USD 250 million fund has so far supported several projects (including the KawiSfi2 and AfDB LEAF program) that have prevented the emission of 5.1 million metric tons of CO2.

Carbon credit

Namene sold its first gold-standard certified Verified Emissions Reductions, a type of carbon offset exchanged for carbon credits, from its Zambia climate project to STEAG Solar Energy Solutions (SENS) in 2021. The project has distributed over 600,000 lights in Zambia since 2021. The carbon revenue generated allows Namene to sell the lights to rural families at a 50–60% discount on their retail value.[202]

SunCulture, BII, and Shell Foundation launched an innovative climate financing pilot to accelerate access to solar water pumps for Kenyan farmers. The pilot aims to reach an additional 9,000 smallholder farmers through a 25–40% reduction in upfront product cost offset by carbon monetization. The USD 2.6 million investment will be repaid with future sales of carbon credits; BII bears the risk of price volatility in the carbon markets.[203]

Finally, trends concerning tax exemptions are explored in *Chapter 5 – Enabling Environment*; the role of public procurement in serving lowest-income households is outlined in *Chapter 8 – Enabling OGS to Meet its Full Potential*.

Access to Finance Needs and Challenges

Despite positive developments in the last two years, access to both finance - both public and private - remains a constraint for the OGS industry. The investment needed to achieve SDG 7 is an order of magnitude greater than historical annual investment. As well as this step change in total financing, the OGS industry requires a higher proportion of equity financing; patient, concessional, and local currency capital; and long-term commitments to end-user subsidies to lower the risk to investors

A survey performed for this report confirmed that access to funding is a "significant challenge" for (over 60% of) small and mid-sized companies. This issue is notably less prevalent among large global firms, which benefit from better access to both local and international financing sources. In contrast, smaller regional and domestic companies struggle to secure the necessary capital for expansion, often due to higher interest rates and limited availability of local currency financing. This disparity in access to funding creates a considerable growth bottleneck for smaller players in the sector (see *Figure 21*).

202. Source: Namene, Solar Lighting Project in Zambia, 2024
203. Source: Shell Foundation, BII, Shell Foundation, and SunCulture pilot innovative carbon financing, 2023

A key barrier to fundraising is the heightened risk perception associated with smaller firms, which often deters investors. One respondent pointed out that local businesses are frequently viewed as lacking in financial management and bookkeeping skills, further diminishing their appeal to investors. Another respondent noted that while some of the larger companies are beginning to access local currency financing, and there are specialized facilities for certain markets, smaller markets and players remain largely excluded from these opportunities.[204] The uneven distribution of financing options perpetuates a gap in capital access, making it difficult for local companies to grow and compete with the bigger, more established firms.

More specifically, equity financing is essential to fund growth, product development, and market expansion, particularly for smaller players. However, excluding a single equity investment into Sun King in 2022, debt has comprised 75% of investments into OGS from 2021 to 2023 leading to the market becoming over-leveraged compared to historical levels. Many companies interviewed, particularly smaller ones, noted they couldn't access equity or take on more debt to grow. Equity investors typically expect higher returns and often require a clear path to profitability. This creates a barrier for many OGS companies that operate in markets with longer payback periods, high customer acquisition costs, and fluctuating demand. Accessing equity financing is particularly challenging for smaller and medium-sized enterprises in the OGS sector, as they may not have the financial track record or risk profile attractive to traditional equity investors.

More patient capital is needed to enable OGS companies to focus on long-term strategies without the immediate pressure of rapid returns. Actors like impact investors, development financial institutions, or philanthropic entities are willing to accept slower and lower financial returns in exchange for substantial social and environmental impact. The OGS sector is capital intensive and operates in challenging, low-income markets with volatile local currencies and repayment rates. Patient capital is needed to enable companies to scale up operations, innovate, expand their reach to underserved areas, and ride out downturns without being hindered by the need for quick profits.

Furthermore, there needs to be more concessional capital that accounts for the impact achieved to help companies overcome high costs of financing. The cost of financing in low-income markets is around 14% of total costs for OGS companies and presents a barrier to growth. Guarantees or blended finance structures can lower the total cost of financing for OGS companies, which can lower the effective cost to consumers and stimulate growth. Combining this with local currency financing or low-cost hedging products can help partially de-risk companies whose receivables are denominated in local currencies. Concessional capital can also be directly linked to impact outcomes (e.g., first-time users) to further incentivize companies to reach underserved populations.

Finally, there must be a commitment to end-user subsidies over a long period. End-user subsidies are critical to closing the affordability gap: according to the universal electrification scenario presented in this report, USD 9.2 billion is needed for universal household access (*refer to Chapter 7 for further details*). However, a long-term commitment of five years or more is needed to maximize the value of subsidies. This reduces the risk for companies and investors and incentivizes investment in growth, lowering the cost of capital and increasing the effectiveness of subsidies. Rather than being developed in isolation, subsidies for off-grid solar should ideally be developed in a way that also considers other avenues for energy access (grid and mini grid) to avoid distorting the market away from the most cost-effective solution for a given customer.

204. Source: GOGLA member survey conducted in Spring 2024

CHAPTER 5

Enabling Environment

photo credit: Baobab+

KEY MESSAGES

OGS is gaining momentum on the international agenda; the World Bank and AfDB have made a joint commitment to electrify 300 million people across Africa, creating an opportunity for governments to access financing for new OGS programs from multilateral development banks.

Recognizing the sector's role in climate adaptation, mitigation and resilience, governments continue to integrate OGS into national electrification plans and are starting to integrate OGS into energy transition plans.

Although some countries are introducing new tax exemptions for the sector, others are rolling them back.

While many countries are adopting quality standards, implementation challenges are preventing these standards from driving up the proportion of quality-assured products in the market. Since the last MTR, the VeraSol quality assurance program supported ECOWAS, the political and economic union of 15 West African states, in adopting quality standards for OGS products that are harmonized with the International Electrotechnical Commission.

An estimated 58 OGS programs use VeraSol product certification linked to the IEC quality standards as eligibility criteria. These programs represent at least USD 411 million in donor investment available to companies with VeraSol-certified products.

Governments are starting to address challenges around OGS e-waste management through their national-level policies and initiatives.

Most governments have yet to actively address gender inclusivity in the OGS sector through state programs or policies.

Some governments are increasing their efforts to promote local OGS manufacturing.

OGS in the International Agenda

The international agenda increasingly is recognizing the importance of off-grid solar (OGS), creating an opportunity for governments to access financing for new OGS programs from multilateral development banks. At COP27, the World Bank announced the Distributed Access through Renewable Energy Scale-up (DARES) platform, a multi-stakeholder collaboration across the World Bank, IFC, MIGA, and other development partners to engage the private sector in ramping up the rate of electrification via distributed renewable energy, including OGS, in Sub-Saharan Africa.[205] The World Bank has since started to implement the objectives of the DARES platform through several projects, including the Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) project and DARES Nigeria. ASCENT is a multiyear, multi-billion-dollar project aimed at expanding access to clean and sustainable energy across Eastern and Southern Africa. It aims to provide electricity access to 100 million people and clean cooking technologies to 20 million people (*see Box 13*). In parallel, the Nigeria DARES project aims to provide electricity access to over 17.5 million Nigerians through renewable solutions (including OGS) in a USD 750 million initiative—the World Bank's largest-ever single-country distributed energy project.

The World Bank and African Development Bank (AfDB) have made a significant new pledge to electrify 300 million people across Africa.[206] This ambitious commitment reflects growing momentum within the global community to address Africa's energy access deficit and provides national governments with a unique opportunity to leverage substantial international support for electrification projects.

OGS in Integrated Electrification and Energy Transition Plans

Governments continue to integrate OGS into national electrification plans and policies, sending a powerful signal of commitment to the private sector and helping to boost investment.[207] Several countries have taken this step since the last MTR, while others are reviewing and updating existing plans. For example, Uganda updated its Energy Policy in 2023, to replace the 2002 Energy Policy. The updated Energy Policy emphasizes the core role OGS must play in rural electrification and outlines how OGS must integrate with national electrification plans.[208] Rwanda's revised National Electrification Plan (NEP 2023)[209] aims to connect 52% of households to the national grid and 48% to off-grid solutions and micro-grids. A clearer understanding of OGS's role in Rwanda's electrification plan, along with a supportive enabling environment, has contributed to solar adoption and investment.[210]

Governments are starting to integrate OGS into energy transition plans, recognizing the sector's role in climate adaptation, mitigation, and resilience. For example, in 2022, Nigeria publicly launched its national plan showcasing a pathway to achieving net-zero emissions by 2060.[211] In 2023, Ghana launched its Energy Transition and Investment Plan for creating 400,000 jobs and achieving net-zero emissions by 2060.[212] In the same year, Kenya also launched its Green Growth and Investment Plan.[213] In all of these plans, governments see a clear role for OGS in keeping emissions low as electricity consumption rises, especially in rural areas, and in supporting the transition to renewables in the power generation mix.

Fiscal Incentives

Although some countries are introducing new fiscal incentives for the sector, other countries are rolling them back. Tax incentives, such as VAT and duty exceptions, help improve affordability by lowering product prices. Many countries, such as Nigeria and Sierra Leone, already have VAT or duty exemptions in place.[214] More recently, in early 2024, Cameroon's government introduced in the country's Finance Law custom duty exceptions for key photovoltaic (PV) components of rooftop solar systems,[215] while Liberia has renewed an executive order to suspend tariffs on OGS products.[216] However, some countries have chosen to remove tax exemptions for the OGS industry. Sierra Leone, for example, re-introduced a goods and services tax (GST) on solar equipment in 2023, while continuing to exempt these items from import duties.[217, 218]

205. Source: World Bank, World Bank Group Announces Major Initiative to Electrify Sub-Saharan Africa with Distributed Renewable Energy
206. Source: World Bank, New Partnership Aims to Connect 300 Million to Electricity by 2030, 2024
207. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
208. Source: Ministry of Energy and Mineral Development, Energy Policy for Uganda, 2023
209. Source: EDCL, Rwanda National Electrification Plan 2023 Revision, 2023
210. Source: PV Magazine, Renewable energy adoption taking off in Rwanda, 2024
211. Source: SEforALL, Launch of Nigeria's Energy Transition Plan, 2022
212. Source: SEforALL, Ghana launches USD 550 billion Energy Transition and Investment Plan for achieving net-zero emissions, creating 400,000 jobs by 2060, 2023
213. Source: SEforALL, SEforALL CEO, President of Kenya, country partners unite around key energy transition efforts, 2023
214. Source: FIRS, Nigeria Federal Republic of Nigeria Official Gazette, 2021; GOGLA, Off-Grid VAT and Duty Tracker
215. Source: PV Magazine, Cameroon exempts imported PV components from customs duties, 2024
216. Source: Republic of Liberia, EXECUTIVE ORDER NO. 134, 2024
217. Source: Stakeholder consultations
218. Source: GOGLA, Policy and Regulations Repository

Quality Standards

While many countries are adopting quality standards, implementation challenges are preventing standards from driving up the proportion of quality-assured products in the market. With only around 27% of all OGS sales being quality-verified, the prevalence of poor-quality products remains a major barrier to market growth in many countries, leading to consumer dissatisfaction and suppressing demand (*Refer to Key Concept: 'Affiliate' vs. 'non-affiliate' OGS companies in Chapter 2*). Since the last MTR, the VeraSol quality assurance program supported ECOWAS, the political and economic union of 15 West African states, in adopting quality standards for OGS products that are harmonized with the International Electrotechnical Commission (IEC).[219] Since the 2020 publication of the IEC quality standard for OGS products, VeraSol has engaged with over 20 countries to facilitate adoption of the harmonized standard. An estimated 58 OGS programs use VeraSol product certification linked to the IEC quality standards as eligibility criteria, including EnDev, World Bank, Beyond the Grid Fund for Africa, and USAID. These programs represent at least USD 411 million in donor investment available to companies with VeraSol-certified products.

Standards are applied inconsistently, and capacity constraints hinder the ability of authorities to fully utilize and enforce them. In addition, financial incentives are needed to enable quality-verified products to compete with non-verified products on price, and consumer awareness campaigns are needed to encourage end-users to "choose quality." Fortifying quality assurance frameworks for OGS products is an essential precursor for governments to ensure quality and protect the most vulnerable customers as they scale up support to productive uses and social infrastructure.

E-Waste Management

Governments are starting to address challenges around OGS e-waste management through state-run programs or through national-level policies. The management of OGS e-waste faces a wide range of challenges, including hard-to-reach customers with limited awareness, an abundance of poor-quality products, complicated reverse logistics supply chains, little/ no e-waste management infrastructure in many countries, informal recycling sectors, and few meaningfully implemented e-waste policies.[296] Companies are addressing the e-waste challenge through the use of standards that enhance product durability, repairability, and interoperability;[297] by raising consumer awareness; by setting up product takeback schemes; through the establishment of reverse logistics; and by strengthening repair capability, either in-house (typically for more complex products such as PAYG, productive uses, or social infrastructure) or through third-party repair shops (typically for simpler products such as solar lanterns).[220] OGS programs can accelerate adoption of sound e-waste management business practices—particularly in-house or third-party repair capability—through financing mechanisms, technical assistance, and standards / eligibility requirements.[221]

In recent years, a few countries have introduced e-waste management policies and regulations to codify or strengthen extended producer responsibility (EPR) and address current e-waste management challenges. To improve its e-waste efforts, Kenya is currently developing a framework for operationalizing the extended producer responsibility regulation introduced in 2020. The industry has responded by establishing the E-waste Producers' Responsibility Organisation of Kenya (E-PROK) to respond to this regulation and collaborate on improving circularity and e-waste management. The Zambian government is currently developing regulation on e-waste management and is making progress on introducing e-waste management standards.[222] India, meanwhile, recently added solar modules to e-waste management rules.[223]

Gender Inclusivity

Most governments have yet to actively address gender inclusivity in the OGS sector through programs or policies. Local women-led companies reach a higher proportion of female customers, and their clients experience fewer usage challenges and lower over-indebtedness rates, but these enterprises have fewer business and technical skill development opportunities and find it harder to access finance.[294] Many gender-inclusive business strategies—such as recruiting more female agents / staff; targeted training and skills development; company policy development (e.g., in hiring, equal pay, anti-harassment); or use of digital marketing to reach female customers—have a positive impact on commercial performance, but uptake remains mixed. Market development programs can accelerate adoption of gender inclusive business practices through the provision of financial incentives and technical assistance, as well as the use of eligibility requirement / standards, to incentivize companies.[224]

219. Note: The IEC quality standard and laboratory test methods for OGS products with peak PV power up to 350 watts are IEC TS 62257-9-8 and IEC TS 62257-9-5, respectively.
220. Source: Solaraid, Off-grid solar repair in Africa: From Burden to Opportunity, 2023
221. Source: GOGLA, E-waste Toolkit.
222. Source: ITU, Zambia Country Status
223. Source: Ministry of New and Renewable Energy, Solar Waste Treatment under E-Waste (Management) Rules, 2022
224. Source: World Bank, Gender Equality in the Off-Grid Solar Sector Primer, 2022

Box 13: Example of gender inclusivity initiatives in the off-grid solar sector

WidEnergy is an example of a women-led, women-focused OGS company providing last-mile distribution of SHS. It empowers door-to-door female distribution agents and ambassadors by providing capacity-building training focused on increasing their knowledge of the benefits of OGS, including the risks of climate change for women's health.[295]

Government agencies implementing OGS programs play a critical role in enhancing gender inclusivity, but lack sufficient female representation, especially in decision-making roles. The scarcity of female staff—particularly in technical roles—coupled with limited opportunities for career progression restricts the influence of women in government decision-making processes. These issues can be addressed through the proactive recruitment and training of women, establishment of gender equity policies, gender-sensitivity training, and mentorship schemes to support women's career development.

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Local Manufacturing

Finally, some governments are increasing their efforts to promote local OGS manufacturing. Local OGS manufacturing in Sub-Saharan Africa has historically occurred on a very small scale, contributing little to national GDP. However, some governments are taking steps to boost local manufacturing. For example, the Central Bank of Nigeria has declined to finance SHS companies that fail to demonstrate their use of local components—or a clear plan for near-term integration of local components.[225, 226] In the same direction, the custom duty exceptions for key PV components of solar systems introduced by Cameroon this year aim to boost national production of goods to gradually replace imported goods in the long term.[227]

photo credit: Terhas Berhe

225. Source: ACE Technical Assistance Facility, Assessment of Local Manufacturing of Off-Grid Solar in Sub-Saharan Africa, 2021
226. Source: Central Bank of Nigeria, Framework for Implementation of Solar Connection Facility, 2020
227. Source: PV Magazine, Cameroon exempts imported PV components from customs duties, 2024

PART 2

Market Outlook

photo credit: d.light

CHAPTER 6

The Case for Off-Grid Solar

KEY MESSAGES

The use of OGS by households, businesses, and public facilities improves quality of life, education, and health, while contributing to economic growth (through job creation and enhanced productivity) and climate adaptation and resilience.

Public funding for OGS is proven to accelerate access, creating jobs and driving economic growth.

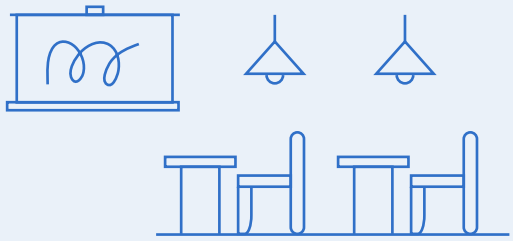
Growing the OGS sector can generate tax revenue and reduce fossil fuel subsidy expenditure, in some cases enabling governments to make a net profit on their OGS programs.

The cost of inaction is extremely high. The "left behind" today will be left even further behind tomorrow as the world continues to make significant strides in digital literacy and connectivity, intensifying the need for electricity.

Achieving universal Tier 1 access for households could save USD 15.5 to USD 16.7 billion per year—equivalent to USD 142 per household—by reducing inefficient lighting expenditure and increasing incomes.

Replacing diesel generators used by businesses with OGS could save an estimated USD 6.3—12.5 billion in fuel costs, while avoiding a significant 8.3–16.6 MTCO2e of greenhouse gas emissions per year.

Electricity access is crucial for the effective operation of social infrastructure like schools and healthcare facilities. Currently, more than 1.87 million schools and 146,000 healthcare facilities lack adequate and consistent access to electricity.



The Social Impact of Off-Grid Solar

There is a compelling case for governments and other stakeholders to invest in OGS, given the sector's profound social and economic impacts, its contribution to climate goals, and its ability to offer an attractive return on public investment.

OGS products have a profound social impact; customers report reduced energy spending, significantly improved quality of life, and good or very good value for money—both for solar lanterns and solar home systems. 64% of solar lantern users and 62% of solar home system users report significantly improved quality of life.[228] In households lacking access, OGS products reduce dependence on inefficient sources of lighting such as kerosene, candles, and battery-powered torches. OGS products in households enable children to study longer at night and improve connectivity through charging phones that provide internet access. Acquisition of a first OGS product often leads to the purchase of a system providing a higher level of service in the future, through enabling savings on inefficient lighting, establishing trust in OGS technology, and building credit history.[229]

OGS helps to address energy poverty, which disproportionately affects women and girls. It reduces the need for unpaid domestic tasks that typically fall to women, such as fuel collection. This frees up time to invest in activities that boost economic and social mobility, such as education, employment, or micro-entrepreneurship—cultural norms permitting.[230] A study in Bangladesh found that women in households with an SHS spent approximately 49% less time collecting fuel, while a study in Kenya found that electricity access can free up ~72 hours per month for women and girls to spend on education or leisure.[231] Reduced indoor air pollution from kerosene or woodsmoke improves respiratory health, particularly for women who typically spend more time in the home. Outside of the home, OGS-powered street lighting creates safer communities, while OGS-powered health facilities enhance maternal and child health and OGS-powered schools boost educational opportunities.

OGS supports climate change mitigation, adaptation, and resilience to climate shocks. A least-cost approach to achieving universal access would result in estimated emission reductions of ~200 MTCO2e from residential uses,[232] 8.3–16.6 MTCO2e from businesses, and 0.9 MTCO2e from public facilities per year. An estimated 600 million climate vulnerable people live without access to electricity. OGS creates climate resilient electricity infrastructure for households and businesses, while improving resilience to shocks through reducing poverty and creating financial safety nets, improving health, and enhancing the capacities of women. The millions of phones, radios, and TVs powered by OGS are vital for sharing information as part of emergency planning and response. Fans are critical to addressing extreme heat, while solar water pumps and refrigerators contribute to access to clean, safe drinking water; food security; and vaccine storage.

Impact and limitations of OGS on the environment Coming soon: Explore the qualitative and quantitative benefits of OGS in terms of climate adaptation and mitigation—and examine the environmental challenges associated with OGS, such as e-waste management and the potential ecological impact of production and disposal.

228. Source: 60 Decibels, Why Off-Grid Energy Matters, 2024
229. Source: GOGLA, Powering Opportunity, 2018
230. Source: UNWomen, Gender Equality in the Sustainable Energy Transition, 2023
231. Source: Citizen Digital, How Kenyan Women And Girls Are Taking Centre Stage In Africa's Energy Transition, 2023
232. Source: GOGLA, Impact metrics. Dalberg analysis

The Return on Public Investment for Governments

Governments that have provided public funding for OGS and created an enabling policy environment have seen a rapid acceleration of their electrification rates. For example, Kenya's encouragement of private sector financing for electrification enabled a 51% increase in electricity access between 2010 and 2019, with OGS connecting over 20% of the population.[233] Rwanda's electricity access increased by 35% from 2016 to 2022, with OGS connecting 16% of the population.[234]

By investing in OGS, governments are creating jobs, expanding opportunities across the value chain, and boosting local economies. As of 2022, over 221,000 direct jobs had been created across India, Kenya, Nigeria, Uganda, and Ethiopia in the decentralized energy sector; in Kenya and Nigeria, women occupied 40% and 35% of these jobs, respectively.[235] OGS technologies are relatively labor-intensive, requiring extensive customer service—both pre- and post-sale. As a result, OGS companies, particularly solar lantern and SHS companies, account for the largest share of employment in the distributed renewable energy sector.[236] Overall, ending energy poverty by 2030 could potentially create 25 million direct jobs in the clean energy sector in Asia and Africa, and enable 500 million jobs through the productive use of electricity generated, in turn boosting tax revenues for local governments.[237]

Growing the OGS sector can generate tax revenue and reduce fossil fuel subsidy expenditure, in some cases enabling governments to make a net profit on their OGS programs. For example, the IDCOL SHS program in Bangladesh— the largest and longest-running national off-grid electrification program in the world—generated USD 1.5 billion in financial benefits after accounting for the cost of the program. This included USD 654 million in benefits for the government, primarily through SHS taxes earned and kerosene subsidies avoided.[238]

OGS represents an opportunity for governments to access climate finance from advanced economies. Advanced economies have committed to USD 100 billion of climate finance per year to support the development of low-carbon, climate-resilient economies, and surpassed that goal in 2022.[239] Countries with robust, nationally-determined contributions that include off-grid solar are in a strong position to secure investment. Key actors, including the Green Climate Fund (GCF), now recognize the potential of off-grid solar to reduce emissions and increase the resilience of the poorest and most climate vulnerable.

The cost of inaction, on the other hand, is extremely high for those left behind. There is a risk that the "left behind" today will be left even further behind tomorrow—the importance of digital literacy and digital connectivity is only growing and will be a fundamental part of life in 2030. Communities that lack access to electricity will struggle both to develop the necessary skills, infrastructure, and abilities to thrive in a digital world and to remain informed in order to adapt to a changing climate.

The Impact of Achieving Universal Access with Off-Grid Solar

In the context of this report, universal access represents an optimistic scenario in which Tier 1 OGS products are provided to all households, businesses, farmers, and social infrastructure lacking access to electricity for whom OGS represents the least-cost solution.

The costs and the implications of this scenario will be further explained in *Chapter 7*. This chapter will focus on the positive impacts of OGS electrification, which are presented below categorized by beneficiaries.

Households

The impact of achieving universal household access was modelled starting from data from the Global Electrification Platform (GEP). The GEP is an open access, interactive online platform that models future electrification scenarios for countries with high access deficits (*refer to the Methodology of the Global Electrification Platform in Annex 6 for further details*). In a universal Tier 1 access scenario, there are nearly 398 million people for whom OGS is the least-cost electrification technology between now and 2030.[240]

233. Source: World Bank, Kenya Energy Access Diagnostic Report Based on the Multi-Tier Framework, 2019
234. Source: World Bank, Rwanda Energy Survey, 2024
235. Source: PowerForAll, Powering Jobs Census: The Electricity access Workforce, 2022
236. Source: PowerforAll, Powering Jobs Census 2022: The Electricity access Workforce, 2022
237. Source: Rockefeller Foundation, Transforming A Billion Lives: The job creation potential from a green power transition in the energy poor world, 2021
238. Source: GOGLA, How IDCOL Addressed the Affordability Gap: Lessons from Bangladesh's Solar Home System Program, 2022
239. Source: OECD, Developed countries materially surpassed their USD 100 billion climate finance commitment in 2022, 2024
240. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation is based on the bottom-up scenario from the platform. OGS represents the least-cost solution for 41% of about 1 billion people that will require access to electricity between today and 2030, including population growth. GEP estimates considered OGS to be the least-cost solution for 423 million people in 2022; to project the figures for 2024, a 6.15% growth in electrification is applied over two years of anticipated growth.

> **Providing a Tier 1 OGS system to all households for whom OGS is a least-cost solution by 2030 would provide a direct benefit of around USD 15.5–16.7 billion per year.**

This comes from savings on inefficient lighting and fuels, as well as additional income generated—working out to USD 142 per household, equivalent to ~10% of the average annual income in Sub-Saharan Africa. Analyses show that households switching to OGS avoid an estimated USD 72 in annual expenditure on kerosene and diesel, leading to an overall benefit of USD 11.2 billion.[241] Additionally, this shift would potentially reduce CO2 emissions by over 200 million tons.[242]

Furthermore, as seen above, an average of 20% of households use OGS for income-generating purposes. Evidence from East and West Africa indicates that households can boost their average incomes by 8.5% to 14% through OGS. As the average income for Sub-Saharan Africa corresponds to USD 105.5, the additional productivity from OGS would lead to an additional benefit of USD 3.3–5.5 billion.[243]

Businesses and Farmers

> **OGS products could help businesses in off- and weak-grid areas reduce the use of generators, saving an estimated USD 6.3–12.5 billion per year in fuel costs while avoiding significant greenhouse gas emissions.**

An estimated 50.5 million MSMEs globally can benefit from OGS electrification.[244] Nearly a third of these businesses own a generator, amounting to nearly 18 million generators, most of which are small diesel or gasoline generators producing less than 60 kilowatts (kW).[245] These generators need to be run for 84.8 hours annually on average to compensate for power outages.[246] At USD 0.8 per kilowatt-hour (kWh),[247] an enterprise must spend USD 339–678 annually on fuel to "keep the lights on." Shifting to an OGS solution not only helps enterprises avoid these costs—with an estimated five-year cost savings of USD 1,696 to 3,392—but also reduces the significant GHG emissions these generators produce. By simply substituting SHS systems for generators, between 8.3–16.6 MTCO2e of emissions can be avoided.[248]

Businesses are also likely to realize income growth from productivity gains and longer hours of operation. In Kenya, rural electrification focused on small enterprises increased productivity per worker by almost 20% daily.[249] The ability to power appliances through reliable and stable OGS sources can lead to significant increases in commercial output, preventing interruptions and enabling businesses to serve more customers and generate greater income. Businesses can also use OGS to power new appliances that enable them to provide new services (e.g., shopkeepers can use fridges to stock perishable goods) or to charge a premium (e.g., by installing fans on the premises).

OGS products can help farming households improve yields and diversify their crops as a result of better irrigation, contributing to food security. Nearly 31 million farming households lacking access to electricity could benefit from irrigation provided by a solar water pump.[250] In India, solar pumps have led to an estimated 35% increase in income for women farmers.[251] Access to water can also create opportunities for farmers to produce crops with higher commercial value. Recent field testing across India, Kenya, Rwanda, and Senegal, confirms these trends—87% of farmers who acquired an SWP reported an increase in their monthly incomes. Similarly, 64% of those who acquired a, SWP are indicated plans to hire additional laborers and add new crops.[252]

Finally, solar refrigerators and cold storage solutions provide another set of opportunities. Improved storage of non-cereal produce such as dairy, horticulture, and meat can not only help farming households avoid spoilage but also provide an opportunity for farmers to benefit from alternating between cereal and non-cereal production throughout the year.

241. Source: World Bank, Accelerating Sustainable & Clean Electricity access Transformation Program Using the Multiphase Programmatic Approach, 2024
242. Source: GOGLA, Impact metrics
243. Source: GOGLA, Powering Opportunity - Energising Work, Enterprise and Quality of Life with Off-Grid Solar, 2023
244. Source: Based on World Bank's enterprise surveys and GEP data
245. Source: ODI, Electricity insecurity and SMEs, 2014. Source: IFC, The Dirty Footprint of the Broken Grid, 2019.
246. Source: World Bank, SIADI-D indicators. Data reported is for Sub-Saharan Africa
247. Source: World Bank, Accelerating Sustainable & Clean Electricity access Transformation Program Using the Multiphase Programmatic Approach, 2024
248. Source: World Bank, Accelerating Sustainable & Clean Electricity access Transformation Program Using the Multiphase Programmatic Approach, 2024; Dalberg Analysis, 2024
249. Source: Fedderke, J. and Bogeti´c, Ž., Infrastructure and Growth in South Africa: Direct and Indirect Productivity Impacts of 19 Infrastructure Measures, 2009
250. Source: Dalberg Analysis, 2024
251. Source: CEEW, How Micro Solar Pumps Are Changing the Lives of Women on Indian Farms, 2023
252. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024

Social Infrastructure

Access to electricity is essential for the effective operation of social infrastructure such as schools and healthcare facilities.

Currently, over 1.87 million schools and over 146,000 healthcare facilities lack proper and reliable access to electricity.[253] Electrification is directly linked to improved education outcomes, as it enables better learning environments in schools, supports technology use, and extends study hours.

> **In Africa and Asia, electrifying schools could help reduce the estimated USD 5 billion annual cost associated with illiteracy, as it has been shown to increase school enrollment and completion rates.**[254]

Similarly, electrifying healthcare facilities is critical for the nearly 1 billion people who currently rely on unelectrified health centers.[255] Without reliable electricity, these facilities are forced to rely on costly and environmentally harmful diesel generators. On average, schools spend around USD 10,000 annually on fuel for generators, while healthcare facilities spend roughly USD 30,000. Without reliable electricity, these facilities are forced to rely on costly and environmentally harmful diesel generators. For many institutions, failure to cover these costs can result in closures, creating further pressure to seek fuel subsidies, which come with a substantial environmental impact.[256] Transitioning these institutions to large solar home system (SHS) installations would not only reduce operational costs but also avoid 0.9 MTCO2e emissions annually, while dramatically improving access to education and healthcare services. This shift is a critical step toward sustainable development and more resilient social infrastructure.[257] It would also deliver better healthcare outcomes—as evidenced by studies and examples across service delivery, diagnostics, and other areas across India and Africa.[258] Electrification also brings benefits to the delivery of healthcare: for example, data from India suggests that Primary Health Centers (PHCs) with access to solar power were able to conduct 50% higher institutional deliveries, achieve a 45% improvement in laboratory services, and increase outpatient services by 59%. Solar-powered PHCs were also reported as more likely to provide round-the-clock emergency services seven days a week, compared to PHCs that did not have access to solar power.[259]

253. Source: Dalberg Analysis, 2024
254. Source: World Literacy Foundation, The economic & social cost of illiteracy: A snapshot of illiteracy in a global context, 2023
255. Source: SEforALL, Energizing health: accelerating electricity access in health-care facilities, 2023
256. Source: World Bank, Accelerating Sustainable & Clean Electricity access Transformation Program Using the Multiphase Programmatic Approach, 2024; Dalberg Analysis, 2024. The analysis assumes an annual power usage of 1582kWh for schools and 5424kWh for healthcare facilities
257. Source: Dalberg Analysis, 2024
258. Source: SEforALL, Powering Healthcare Impact Factsheet, 2022
259. Source: Hem H. Dholakia, Solar powered healthcare in developing countries, 2018

CHAPTER 7

Funding Needed to Achieve Universal Access for Households, Business, and Social Infrastructure

photo credit: Baobab+

KEY MESSAGES

On current trends, OGS is estimated to electrify only 55%, or 216 million, of the 398 million people for whom OGS is the least-cost electrification solution, at a cost of USD 9 billion by 2030.[260] Current growth trajectories in productive use of energy (PUE) and social infrastructure are also significantly lower than what is required for universal electrification.

A "universal access" scenario requires USD 21 billion to electrify all 398 million people who would be most efficiently connected via OGS, with roughly half coming from public and half from private sources.

- Public funding will need to scale up from USD 1 billion in 2025 to USD 2.1 billion per year in 2028–2030 – a significant increase from current levels.
- This would unlock a corresponding private investment of USD 1.4 billion in 2025, peaking at USD 2.7 billion in 2027.
- During this period, sales are projected to steadily increase from 1 billion systems sold in 2025 to 3.5 billion in 2027.

Only USD 2.4 billion is needed to electrify more than 750,000 schools and healthcare facilities that require electricity.

A further USD 74 billion is needed to cover the total addressable markets for solar water pumps, cold storage solutions, and Tier 2+ OGS solutions for micro, small and medium-sized enterprises (MSMEs).

The cost of electrifying households, businesses, and social infrastructure with OGS is affordable and attractive compared to alternative development pathways:

- OGS remains the least-cost solution for 41% of unelectrified people; mini grid or grid electricity would be significantly more expensive and take longer to implement
- The required investment is far less than current levels of expenditure on fossil fuel subsidies—which, across SSA, amounted to USD 50 billion in 2022 alone
- Electrification via OGS would deliver meaningful returns to governments from i) reduced fossil fuel subsidies as customers switch away from using generators and ii) tax revenues from improved business performance—although the estimated uplift is not included in this report due to data limitations

Governments would need only to cover around 30–40% of the total cost of universal electrification. Public funding would unlock a further 60–70% in public and private co-investment from development partners and private investors.

260. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation is based on the bottom-up scenario from the platform. OGS represents the least-cost solution for 41% of about 1 billion people that will require access to electricity between today and 2030, including population growth. GEP estimates considered OGS to be the least-cost solution for 423 million people in 2022; to project the figures for 2024, a 6.15% growth in electrification is applied over two years of anticipated growth.

The Cost of Accelerating Access for Households, Businesses, and Social Infrastructure

A significant increase in public and private investment is required if off-grid solar (OGS) is to fulfill its potential and enable the achievement of SDG 7—universal access to electricity for households by 2030— while scaling up access for businesses, farmers, and public institutions

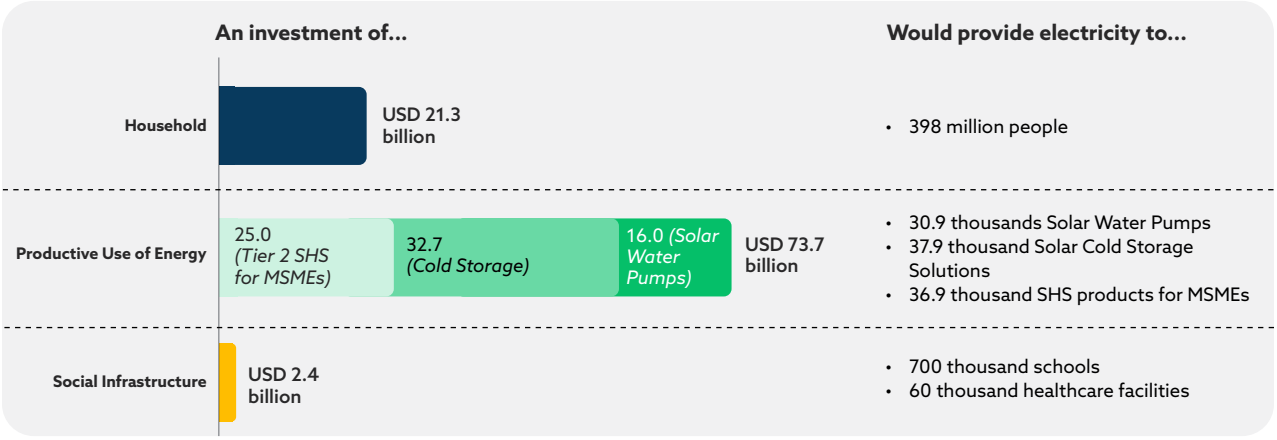
To model the sector's funding needs, we considered two scenarios. The "current trends" scenario is based on existing funding patterns and assumes continued slow growth in the household solar market, with some increases in the productive use and social infrastructure markets. The "universal access" scenario envisions providing OGS to all households, businesses, farmers, and public institutions for whom OGS is a least-cost solution. Figure 32 below provides a breakdown of the investment required to achieve each scenario and the number of households, businesses, and public facilities that are reached in each case. This analysis is based on what households can afford at a stretch (i.e. at 10% of household income).

Figure 32: Investment needed for, and electrification realized, in "current trends" scenario[261]

The current trends scenario leaves over 660 million people unelectrified in 2030. In this scenario, OGS will provide access to electricity to an additional 216 million people between 2024 and 2030 at a cost of approximately USD 9 billion. Continued trends in PUE investment would lead to USD 182 million investment in SWPs, meeting the needs of roughly 1% of the total addressable market, USD 50 million in cold storage solutions, and USD 460 million in Tier 2 and above SHS solutions for MSMEs. Notably, this would result in just above one million OGS products sold for productive uses between 2024 and 2030—350,000 SWPs, 60,000 cold storage solutions, and 680,000 SHS products for MSMEs. An extra USD 710 million investment is needed to maintain the current pace of off-grid electrification of schools and healthcare facilities, which would result in the electrification of about roughly 250,000 schools and healthcare facilities between 2024 and 2030. This would likely result in further cost savings from improved health and education outcomes, which were not quantified in the model given limited data.[262, 263] Finally, this scenario will not support consumers living in weak-grid areas, whose quality of life, livelihoods, and public services will be impaired by unreliable electricity.

261. Source: Dalberg analysis
262. Note: [1] This does not factor in cost savings from improved health outcomes (due to reduced exposure to pollution from fossil fuels) and increased potential productivity associated with a higher quality of lighting. Additionally, this scenario models the investment required to maintain the pace of growth of PUE at its current levels and electrify vital social infrastructure (schools and healthcare facilities) through OGS. [2] We assume the same rate of electrification for healthcare facilities as schools and assume that the same proportion of schools and healthcare facilities are best served by OGS as households. This assumption is grounded in the fact that the GEP model estimates suitability for electrification by geographical proximity to existing and planned grids, which should similarly apply to schools and healthcare facilities.
263. Source: World Bank, Accelerating Sustainable & Clean Electricity access Transformation Program Using the Multiphase Programmatic Approach, 2024

Figure 33: Investment needed for, and electrification realized, in "universal access" scenario[264]



The universal access scenario will electrify 398 million people, over 750,000 schools and health facilities, and the total addressable market for income-generating OGS products.

In this scenario, USD 21 billion is required to electrify 398 million[265] people for which OGS represents the least-cost electrification solution (Figure 33). The deep dive later in this chapter explores the funding needed to enable OGS to play its critical role in achieving universal household electrification in detail.

In addition to households, USD 74 billion is required to cover the total addressable market for solar water pumps, cold storage solutions, and the electrification of MSMEs. Finally, only USD 2.4 billion is needed to electrify over 1 million schools and health facilities. Below are the funding levels required to meet productive use and social infrastructure electrification needs:

- USD 16.0 billion provides solar irrigation to 30.9 million farming households that are either unelectrified or do not have access to irrigation[266]
- USD 32.7 billion covers the cost of a solar refrigeration unit for 37.9 million households that can benefit from owning one
- USD 25.0 billion provides reliable electricity to over 35 million MSMEs[267]
- USD 2.4 billion provides access to electricity for 0.7 million schools and 60,000 healthcare facilities[268, 269]

The cost of electrifying households, businesses, and social infrastructure with OGS is affordable and attractive compared to alternative development pathways. OGS is the least-cost electrification solution for the households, businesses, farmers, and public institutions modeled—the cost of OGS electrification per household is 3.7 times lower than through grid, and 5.7 times lower than through a mini grid, as explained in *Chapter 1*.[270] Mini grid or grid electrification would also take longer to implement than OGS. The cost of OGS electrification is also far less than current levels of expenditure on fossil fuel subsidies, which cost USD 50 billion in Sub-Saharan Africa in 2022.[271] At USD 97 billion, the cost of the universal access scenario—which would dramatically reduce the need for fossil fuel subsidies—is less than Sub-Saharan Africa spends on fossil fuel subsidies in two years. OGS market growth will also lead to significant additional tax revenues in the future, as highlighted in *Chapter 6*.

264. Source: Dalberg analysis
265. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation is based on the bottom-up scenario from the platform. OGS represents the least-cost solution for 41% of about 1 billion people that will require access to electricity between today and 2030, including population growth. GEP estimates considered OGS to be the least-cost solution for 423 million people in 2022; to project the figures for 2024, a 6.15% growth in electrification is applied over two years of anticipated growth.
266. Note: This estimate excludes those households that do not have access to water aquifers and therefore cannot benefit from a SWP
267. Note: While there will be an overlap between household electrification and electrification of MSMEs, this estimate is built on providing higher tiers of access to MSMEs to allow appliances to run and basic electrification using a 3-11Wp product for households. As a result, it is safe to ignore the overlap.
268. Source: SE4All, Energizing Health: Accelerating Electricity Access in Health-Care Facilities, 2023; Dalberg Analysis, 2024
269. Note: WHO/WB estimate the funding needed for electrifying health facilities at USD 4.9 billion, according to the Health Facility Electrification Capital Landscape. This estimate aligns with MTR 24 projections, which assume that approximately 41% of currently unelectrified health facilities will need off-grid solutions (based on GEP's 'lowest cost to serve' model, applying the same proportion for households as for health facilities – refer to annex)
270. Note: Global Electrification Platform (GEP) model, bottom-up demand scenario. The average investment cost per household for grid is USD 1145, and the average investment cost per household for mini grid is USD 1846
271. Source: IMF, Fossil Fuel Subsidies Data, 2023

Governments would most likely only need to cover around 30–40% of the total investment, since doing so would unlock around 60–70% in public and private co-investment from development partners and private investors.

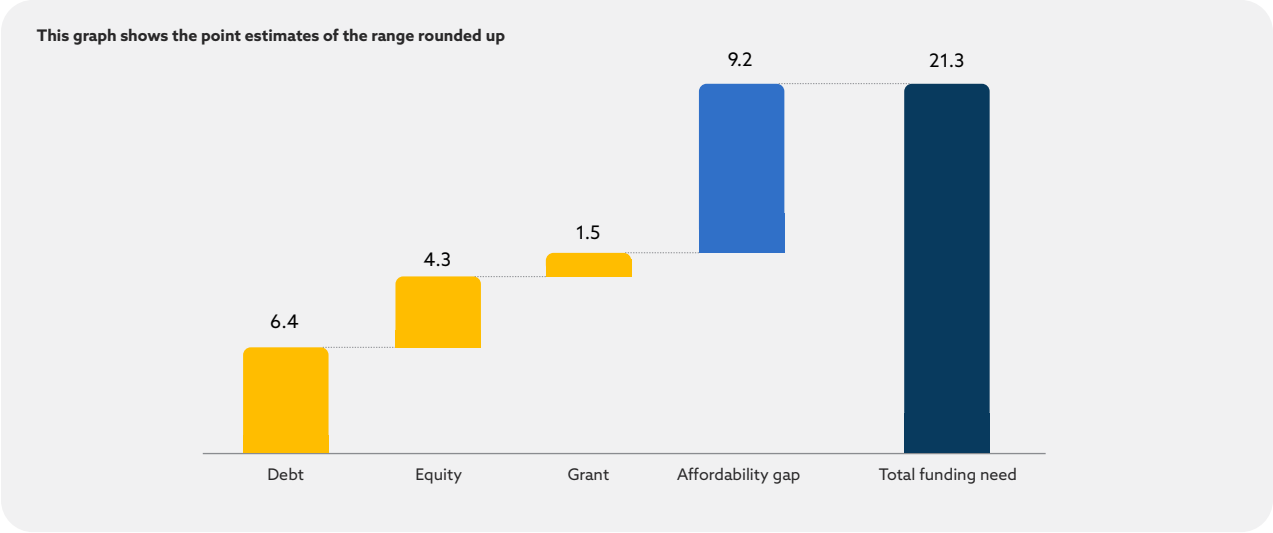
For instance, Nigeria would require approximately USD 5.2 billion to close its energy access gap, with about USD 1.9 billion needed from donors and the government, primarily to address affordability challenges and provide grants.[272] This public funding would catalyze the remaining USD 3.3 billion in investment, mainly from private investors through debt or equity. Similarly, the ASCENT project envisages leveraging an IDA financing envelope of USD 5 billion to raise a further USD 10 billion, with USD 5 billion from the public sector and a and a further USD 5 billion from the private sector.[273]

In-Depth Analysis: Funding Needed to Provide Universal Access to Households

USD 21.3 billion—or USD 3.6 billion per year from 2025 to 2030—is needed to enable OGS to play its critical role in achieving universal household access by 2030. This is ~6 times the USD 3.5 billion invested in OGS to date.

This deep dive explores the funding needed to provide Tier 1 PAYG OGS products to 398 million people with first-time access for whom OGS is the least-cost solution according to the Global Electrification Platform (GEP).[274] However, this analysis provides an estimate of the funding required to achieve universal access for households 'in a vacuum," ignoring the OGS sector's activities in grid backup markets. For the sector to achieve its first-time access goals, profitable OGS companies with a diversified set of activities—including reaching higher-income customers with higher-margin products—need to be in place. It is important to note that data limitations constrain how these data can be used.[275]

Figure 34: Total funding required to provide first-time access to 398 million people, for whom OGS is the least-cost solution, using Tier 1 OGS PAYG systems (USD billions)[276]



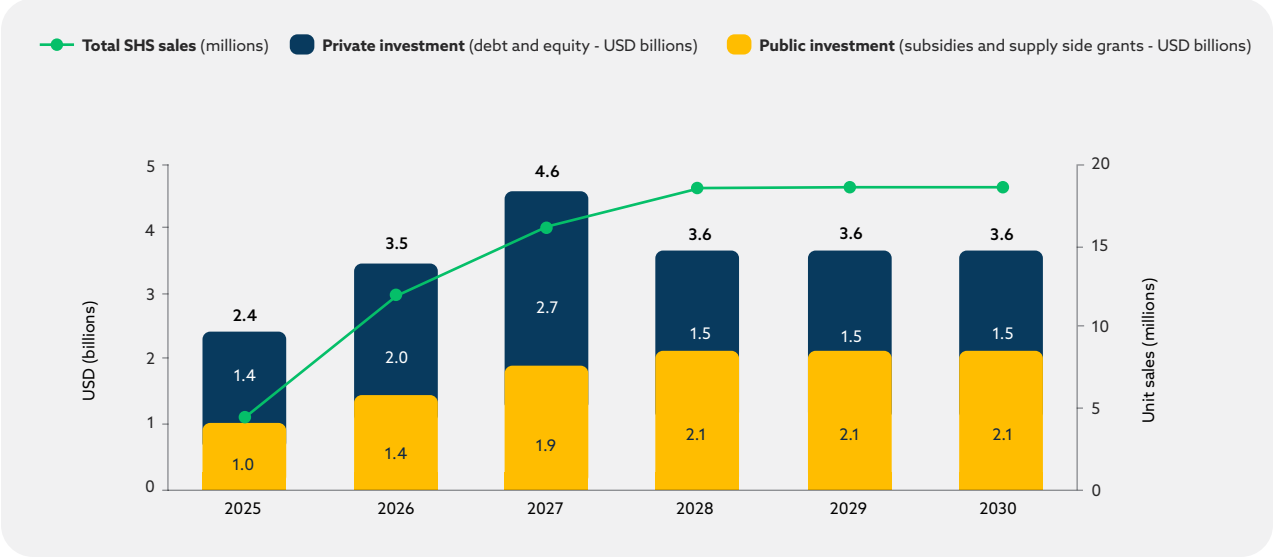
Coming soon: Explore the funding and subsidies needed for universal electrification.

272. Source: Dalberg analysis, based on funding gap analysis for Nigeria
273. Source: World Bank, 100 Million People in Eastern and Southern Africa Poised to Receive Access to Sustainable and Clean Energy by 2030, 2023
274. Note: Assuming GEP least cost scenario for OGS, 4.5 people per household
275. The model does not take account of other potential business models or access to productive use of energy. The model assumes a constant PAYG price and product replacement rate, which may not account for market fluctuations or differences in product quality and lifespan. The model also assumes a steady cash flow and consumer repayment rate, which is unlikely in practice given the fluctuating household incomes and economic instability.
276. Note: Total funding need estimations differ from MTR 2022 due to slight methodological differences. The MTR 2024 methodology assumes funding needs based on companies' annual cash flow and this approach reflects higher costs for serving hard-to-reach populations. (See Annex 6 for further details)

The USD 21.3 billion in funding needed breaks down into USD 10.7 billion of commercial debt and equity investment, USD 1.5 billion in grants, and USD 9.2 billion for addressing the affordability gap through subsidies. Debt and equity investments of USD 10.7 billion are needed for companies to cover initial capital costs and ongoing operating costs, with equity accounting for 40% and debt for 60%.[277] Equity supports companies in scaling up operations and expanding to new markets. Debt financing covers upfront capital costs and lending to customers. Grants of USD 1.5 billion help companies cover the higher costs of operating in hard-to-reach or fragile locations without passing these on to end-users through higher prices.[278] USD 9.2 billion is required to address the affordability gap for those who cannot afford Tier 1 OGS products. This population constitutes about 240 million, or 59% of the 398 million people that will receive access under this scenario.[279, 280] The total subsidies needed could potentially be lowered through innovative business models and funding mechanisms such as energy-as-a-service and public procurement (*refer to Chapter 8 – Enabling OGS to Meet its Full Potential*). Addressing key barriers such as low affordability, narrow company margins, limited access to capital, high costs to enter remote settings, and high levels of perceived risk can drive first-time access and accelerate the pace toward SDG 7. The availability of subsidies is critical to attracting private sector co-investment—grant, debt, and equity financing must all be available in parallel if OGS companies are to sustainably serve hard-to-reach populations that cannot be reached on a fully commercial basis.

Achieving universal Tier 1 electricity access for households requires rapid scale-up of OGS businesses and commensurate levels of public and private investment (Figure 35). Public funding will need to scale up from USD 1 billion in 2025 to USD 2.1 billion per year in 2028–2030—a significant increase from current levels: the World Bank lent USD 626 billion for OGS in FY 2024 (*refer to Chapter 4 - Public Funding*).[281] This would unlock a corresponding private investment of USD 1.4 billion in 2025, peaking at USD 2.7 billion in 2027. During this period, revenue from OGS sales is projected to steadily increase from USD 1 billion in 2025 (4 million units) to USD 3.5 billion (19 million units) in 2027. After that, the sector will need a commitment to significant long-term subsidies to close the affordability gap and boost investors' confidence in the long-term revenue and viability of OGS companies, while providing electricity access to those on the lowest incomes and in the most remote areas.

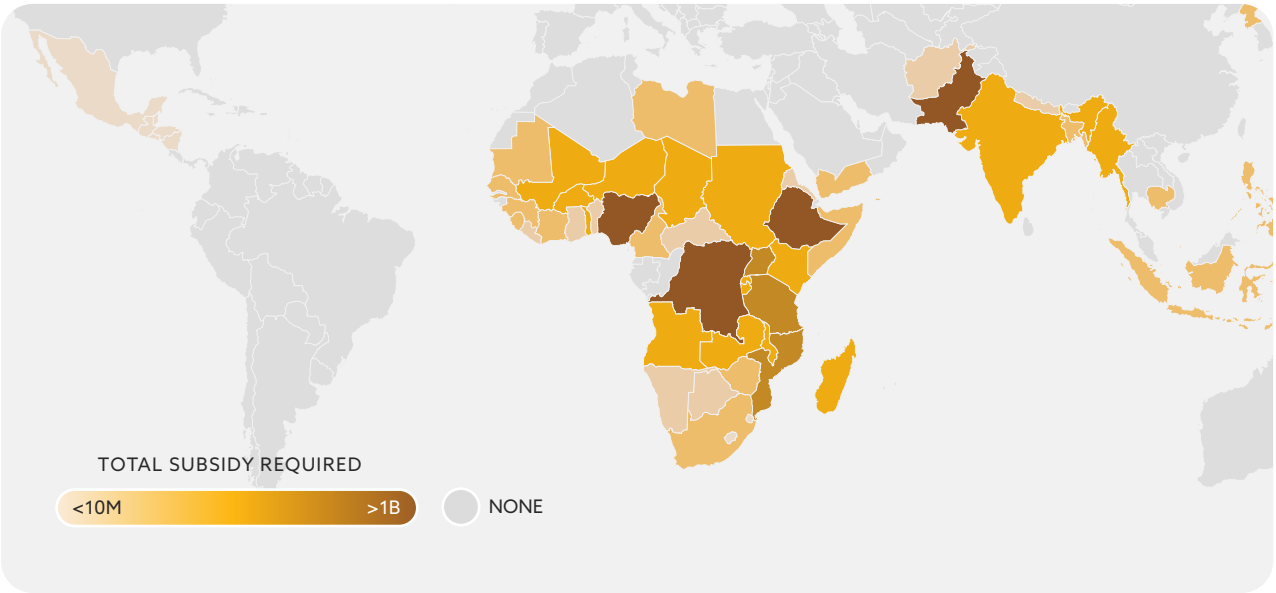
Figure 35: Estimated annual investment required to achieve universal household access by 2030 (billions), and estimated annual SHS sales by 2030 (millions)[282]



277. Note: These include the cost of acquiring Tier 1 OGS products, selling them to customers, collecting monthly payments until customers repay the full value of a kit, and scaling up operations.
278. Note: These includes higher distribution and finance costs, greater credit risk, and other operating costs.
279. Note: 398 million people are best served through OGS solutions (GEP analysis) from 2024 to 2030. We assume the 398 million people are mostly in rural areas. In this case, 55-60% of the 398 million (240 million) cannot afford the monthly PAYG payment, resulting in a USD 9.2 billion affordability gap
280. Note: Assumes all unelectrified households spend 10% of their monthly income on energy through OGS products, the total subsidies needed to reach these 240 million people
281. Note: The USD 311 million committed for RBFs by the World Bank is allocated to both Solar Energy Kits and Productive Uses Appliances.
282. Source: Dalberg analysis

Analysis of investment needs by country reveals that fragile or conflict-affected countries need USD 8.7 billion of the total USD 10.7 billion—over 80% of the total debt and equity investment required (Figure 36). Nigeria, DRC, Ethiopia, and Pakistan together account for over half (53.4%) of this need among fragile and conflict-affected countries. Nigeria and DRC are home to large, conflict-affected populations who cannot afford—even at a stretch—OGS products for Tier 1 access. People in Ethiopia and Pakistan are better able to afford Tier 1 access, but OGS suppliers have had difficulty keeping operational costs under control in these markets and have struggled to remain viable.

Figure 36: Total subsidy required to achieve universal Tier 1 electricity access by 2030 by country



There is strategic alignment between profitability and companies' ability to deliver subsidized first-time access. Typical customers of the OGS sector tend to be lower-income households with unpredictable revenues. Their ability to repay PAYG loans is highly sensitive to macroeconomic shocks. In traditional markets, the return on riskier transactions is higher; however, passing on the cost of risk to customers negatively affects affordability, reducing demand and preventing the sector from achieving universal access. It is far easier for companies to deliver first-time access at scale with subsidies if they have a profitable core business serving a more commercial segment of the market. Asking unprofitable companies to take on greater risk by focusing on first-time access with limited public funding support is unlikely to gain traction.

AI-supported microsite - coming soon.

CHAPTER 8

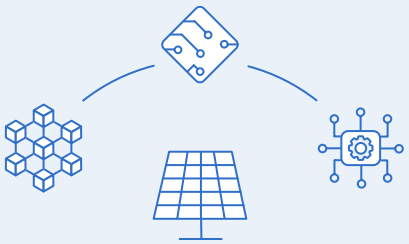
Enabling OGS to Meet its Full Potential

photo credit: Azuri

KEY MESSAGES

A set of "game changing" business models, approaches, and support mechanisms is needed to 1) improve the commercial viability of the industry, 2) enable OGS companies to scale up provision of first-time access, 3) help the industry move beyond traditional PAYG models when serving hard-to-reach groups, and 4) accelerate the uptake of OGS for productive use and social infrastructure.

Many such game changers were already identified in the previous edition of this report; a few new additions include impact-linked concessional finance and tailored financing instruments for smaller companies and there has been positive developments on existing game changers, such as local currency and off-balance-sheet financing.



Game changers for improving commercial viability include improved repayment rates, higher-margin products, off-balance-sheet and local currency financing, tailored financing instruments for smaller companies, and technical assistance.

Game changers for supporting first-time access include availability of public funding, impact-linked concessional financing, multi-country financing facilities, upfront grants, and partnerships in humanitarian settings.

To move beyond PAYG, **new forms of public-private partnerships (PPPs) could be a game changer.**

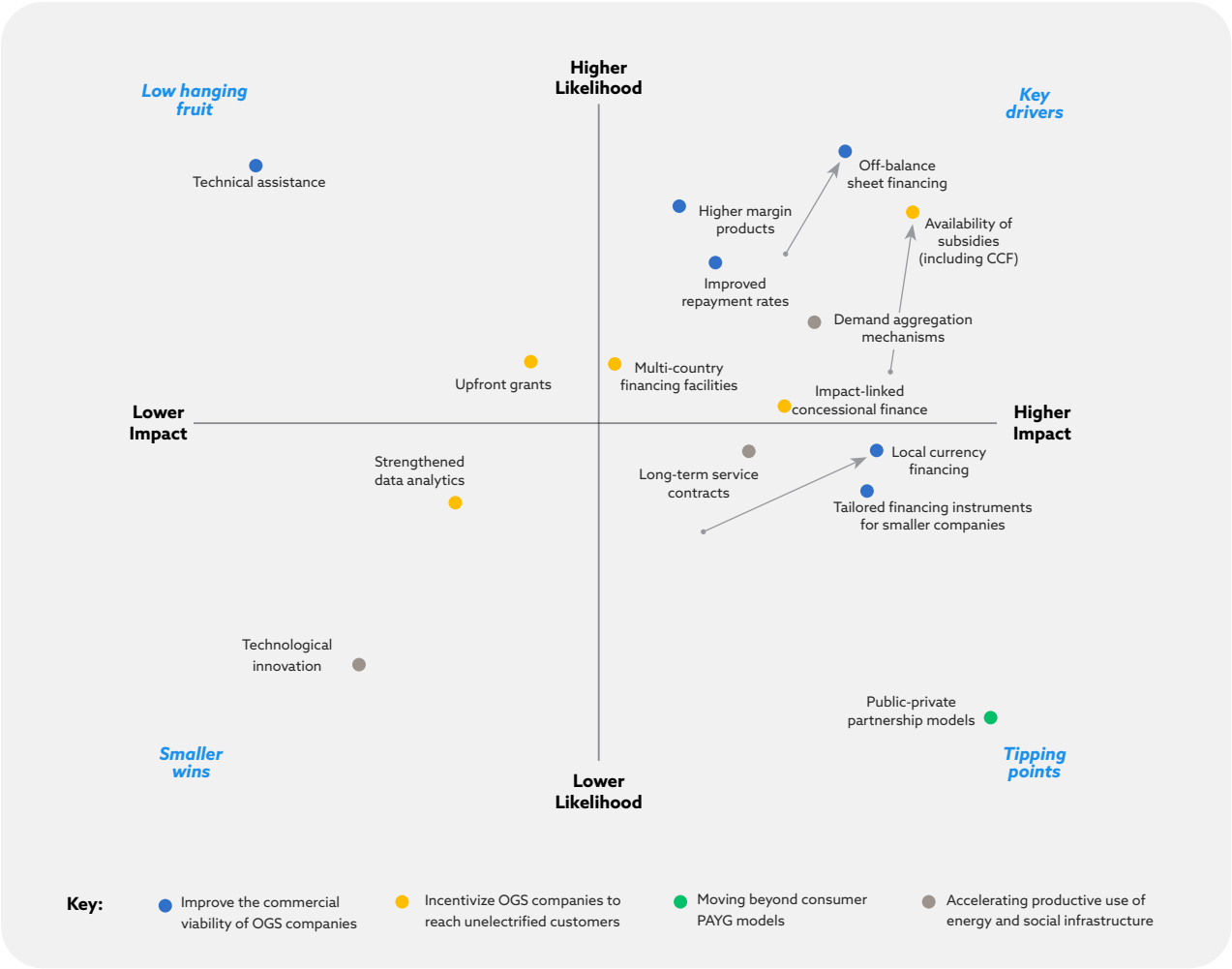
Game changers to accelerate the productive use of energy (PUE) include technological innovation and demand aggregation mechanisms; social infrastructure game changers include long-term service contracts and de-risking instruments.

We are not on track to achieve SDG 7, but it is not out of reach. Addressing key barriers such as low affordability, narrow company margins, limited access to capital, high costs to enter remote settings, and high levels of perceived risk can drive first-time access and accelerate the pace toward SDG 7.

Figure 37: Summary of challenges for the off-grid solar sector

This chapter outlines potential "game changers" that could 1) improve the commercial viability of the industry, 2) enable OGS companies to scale up provision of first-time access, 3) support the industry in moving beyond traditional PAYG models when serving hard-to-reach groups, and 4) accelerate the uptake of OGS for productive use and social infrastructure. Figure 38 summarizes the key game changers according to their likelihood of being implemented and their potential impact, including new opportunities that have emerged since the previous Market Trends Report (MTR) in 2022.

Figure 38: Game changers for the off-grid solar sector[283]



283. Note: The game changers chart was originally published in the 2020 MTR and included in the 2022 MTR as a recap. This chart includes game changers that were previously identified in those editions, alongside additional game changers identified in 2024.

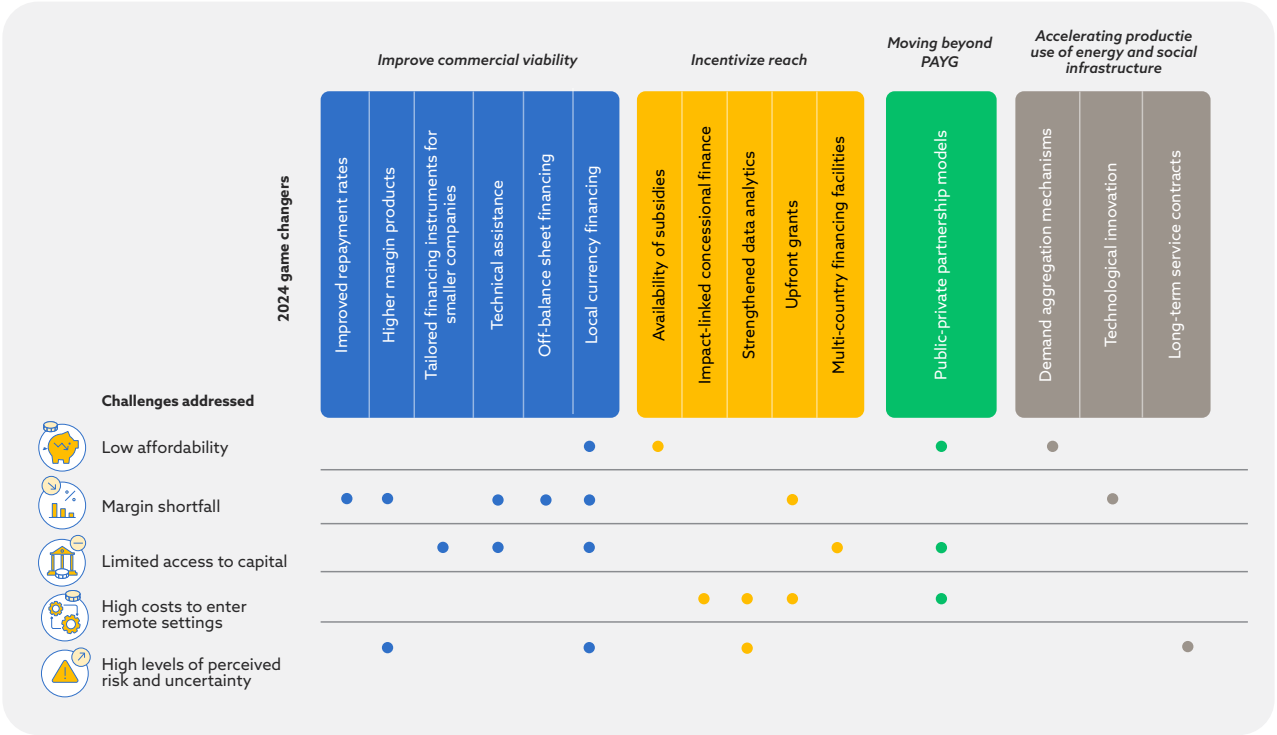
Game changers

Coming soon: Explore what constitutes a game changer for the OGS sector and what some potential game changers for the sector could be.

Several game changers have increased in likelihood or impact since the 2022 MTR—including local currency financing, off-balance-sheet financing, and increased availability of subsidies. OGS companies are increasingly able to obtain local currency financing aligned with the currency of their receivables. A few companies have also been able to tap into off-balance-sheet financing through securitization.[284] The entire sector is benefiting from increasing availability of subsidies, on both the supply and consumer sides, as well as impact-linked concessional financing. For example, over USD 300 million in RBFs were announced in 2024, compared to less than USD 100 million in 2022.[285]

Some opportunities identified in the 2020 and 2022 MTRs have not developed as expected. Strategic investor engagement—particularly of energy conglomerates—proved to be less promising than initially anticipated. Investor appetite to invest in scaling up household solar solutions is less than expected due to uncertainty about the sector's commercial viability. Investor interest has shifted toward the productive use space, particularly among philanthropic investors such as GEAPP. The availability of PAYG has improved, which has helped to drive first-time access, but affordability constraints are increasingly limiting the model's reach. Technological innovations, such as the internet of things (IoT), continue to improve offerings but their impact on company margins has been minimal relative to the negative effects of macroeconomic headwinds such as currency fluctuations and inflation.

Figure 39: Summary of how 2024 game changers could address challenges in the off-grid solar sector[286]



284. Source: Sun King, Sun King and Citi Close First $130 Million Securitisation to Broaden Access to Finance for Off-Grid Solar in Kenya, 2023; d.light, d.light and SFC announce industry-leading USD 238 million multi-currency receivable financing Facility, 2022
285. Source: GOGLA, RBF data; Dalberg analysis
286. Note: Many of the potential opportunities across the spectrum are also applicable to the expansion of productive use, as they are cross-cutting, and the opportunities included in the 4th category are additional opportunities specific for the productive use space that should be deployed alongside tried and tested solutions in the broader OGS sector

Game changers to improve the commercial viability of OGS companies

The OGS sector has been grappling with persistent, long-term barriers to growth, such as affordability, exacerbated by short-term issues such as devaluations of local currencies and spikes in the cost of living. While the sector has demonstrated resilience in the light of these challenges, and profitability in the sector is steadily improving, the commercial viability of many companies still needs to improve.

To strengthen commercial viability, the unit economics of OGS companies must improve through improved repayment rates and upselling higher-margin products. Companies should prioritize high repayment rates and improved portfolio quality by (i) conducting or leveraging data analysis to refine the risk profile of customers and tailoring upfront and monthly prices accordingly, (ii) training and incentivizing distribution agents to accurately assess ability to pay, and/or (iii) taking a community-based approach to building trust among customers.[287] OGS companies could also improve margins by providing higher-value and higher-margin products to higher-income customer segments, potentially including commercial and industrial customers.

Making off-balance-sheet and local currency financing more widely available in the sector— beyond just the market leaders—could help to improve profitability, given the high cost of financing and long-term cash flow challenges across the sector. Off-balance-sheet financing, through securitization of receivables, unlocks cash that would otherwise would be inaccessible for up to two years.[288] Local currency financing mitigates the foreign exchange risk companies face from earning local currency revenues while paying hard currency costs. While large global players such as Sun King and d.light have access to off-balance-sheet and local currency financing, smaller, regional and domestic companies report not being able to access this kind of financing at all.

Aggregation can play a crucial role in making off-balance-sheet and local currency financing more widely available. Several specialist intermediary investors, such as Charm Impact, SIMA, VentureBuilder and Persistent, play an aggregation role, raising funds from larger investors and channeling it to smaller companies, often accompanied by long-term technical assistance. However, fundraising can be challenging for these specialist intermediaries. In the debt space, one innovative example of aggregation is Solaris's Bridgin platform, which aims to address the financing challenges faced by smaller OGS companies through aggregating receivables financing. The platform allows smaller OGS firms to pool their receivables, or outstanding payments from customers, into larger bundles that can be sold to investors. By doing so, Bridgin facilitates a more efficient and accessible way for investors to purchase these receivables.[289]

Improving the commercial viability of small to mid-size companies requires tailored financing instruments for smaller companies—offering smaller ticket sizes, providing guarantees for investors to reduce risk, and providing recipient companies with technical assistance. Small to mid-size companies have a critical role to play in driving the next wave of OGS market growth, especially in more nascent or challenging markets that are less commercially attractive to larger players. Although some new facilities offering smaller ticket sizes have emerged in recent years, such as Acumen's new Hardest-to-Reach fund, supply of this kind of finance falls short of demand.[290] Guarantees can be further leveraged to shield investors from risks (e.g., forex risk or climate risk), and possibly investees as well. Grants can also be used to lower due diligence costs and help standardize due diligence processes. Technical assistance has helped smaller companies improve operations, including internal company systems; improving the availability and quality of technical assistance can strengthen investment readiness and help attract financing.

Better and more widely available data analytics can support commercial viability by improving company decision-making and enhancing investor confidence in the OGS sector. Data platforms such as Odyssey, Prospect, Waya Energy, the Electricity Access Explorer, and the GEP are enabling companies to more effectively identify customers—particularly for commercial and productive use applications— while facilitating access to finance and demand aggregation.[291] These tools can help

287. USAID, Helping Off-grid Companies Enhance Credit-risk Management Practices, 2023
288. Source: USAID, Demystifying Securitization for Solar Pay-as-you-go Companies, 2023
289. Bridgin, Bridgin and UNDP CAP: New Reports on Financial Aggregation, 2024
290. Acumen, Acumen Launches New Hardest-to-Reach Initiative to Achieve Universal Electricity access, 2023
291. Source: ESMAP, Global Electrification Platform (GEP)

governments develop more robust and granular national electrification plans and enhance the management of public funding instruments such as results-based financing facilities through digitization and automation.

In the future, artificial intelligence could play a role in increasing the visibility of risks, enhancing resource exploration and assessment, and optimizing asset operations and maintenance (O&M).[292]

Game changers to support first-time access with PAYG

For first-time access, availability of public funding at the required scale would be the biggest game changer. A significant increase in public funding is needed to enable OGS companies to extend first time access to the 424 million people for whom OGS is the least-cost solution (*refer to Chapter 7*), most of whom cannot afford a Tier 1 PAYG system at current prices (*refer to Chapter 3*). This public funding can take the form of RBF, end-user subsidies, and other approaches (*refer to Chapter 4*). Concessional consumer financing (CCF) models, which use subsidies to reduce the costs and risks of lending for OGS companies as well as borrowing for end-users, also have the potential to help address affordability through enabling lending over longer periods. While widely used globally in renewable energy and energy efficiency markets, this subsidy mechanism has not yet been tested in the OGS sector.[293]

As well as subsidies, impact-linked concessional financing that ties financing to impact-based outcomes can be used to incentivize OGS companies to provide first-time access. For example, Acumen's Hardest-to-reach Fund, launched in 2023, uses an innovative, impact-linked approach. The Fund offers impact-indexed loans for companies scaling up operations in hard-to-reach markets, with interest rates that go down as companies reach poorer communities.

In nascent markets, many of which are affected by fragility and conflict, multi-country financing facilities and upfront grants are required to overcome the barriers that companies and governments face. Single-country projects in these settings are often too small to justify the establishment of more complex public funding mechanisms such as credit lines or the recruitment of professional fund managers. Multi-country projects and financing facilities—with centralized systems and processes—can enable smaller countries and more nascent markets to benefit from aggregation and economies of scale in fund management. Additionally, in these markets, results-based financing is often insufficient on its own because the limited capacities and working capital constraints faced by small, early-stage companies limit their ability to fully participate in and benefit from this model. A multifaceted approach that combines upfront grants linked to commercial milestones rather than sales—alongside results-based financing, credit lines, technical assistance, and other instruments—is often most effective.

292. LSE, AI can lower the cost of the clean energy transition in Africa, 2024
293. Energy Saving Trust, The Road to Zero Interest: The potential role of concessional consumer financing in energy access, 2023

Box 14: The Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) Project

The World Bank ASCENT project is a multi-country project designed to exponentially accelerate sustainable and clean energy access to 100 million people in up to 20 countries across Eastern and Southern Africa over the next seven years. ASCENT pools resources across the World Bank—including the International Development Association (IDA), the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA)—in addition to stakeholders from the public and private sector. ASCENT's IDA financing envelope amounts to USD 5 billion and will attract an additional USD 10 billion.

The project is organized into three pillars, one of which focuses on the development of regional and national platforms to enable economies of scale and cost-reduction strategies. This pillar enables participating countries to benefit from an RBF facility, a credit line, an equity fund, access to carbon financing, and potentially a range of risk mitigation instruments.[294, 295] This way countries benefit from standardization, automation, and economies of scale in fund management, while also being able to customize funding mechanisms as needed for their country context.

In humanitarian settings, including both conflict-affected areas and displacement settings, OGS companies need partnerships as well as financial support, to ensure that their business models are tailored to the specific needs of the market. Humanitarian organizations can help OGS companies enter these markets by helping to raise awareness, connecting them with potential customers, providing market intelligence and insight, and assisting OGS companies with adaptation of distribution models to these unique settings (*see Box 14 and Box 15*). Additionally, to provide electricity to households in these settings, OGS companies and humanitarian organizations require additional public support and may need more public-led approaches (*refer to Game changers to move beyond consumer PAYG section below*).

Box 15: Example of humanitarian partnership with OGS companies

Practical ACTION

Practical Action partnered with Bboxx and Belecom to deliver clean electricity access in three refugee camps in Rwanda. It supported them by promoting economic activity for refugees, helping the two companies to adapt their business models for these refugee settings, and sharing valuable insights about the camps.[296]

294. Source: World Bank Group, Accelerating Sustainable & Clean Energy Access Transformation Program Using the Multiphase Programmatic Approach, 2023
295. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
296. Source: Practical Action, Renewable Energy for Refugees (RE4R)

Box 16: Achieving SDG 7 in displacement settings

In displacement settings, strong collaboration among governments, development institutions, humanitarian agencies, the private sector, and other stakeholders is needed. Key interventions identified include (1) deploying innovative data collection methods to fill the severe data gaps and (2) targeted measures to expand access to finance for displaced people that mitigate lending risks due to instability, remoteness, very low incomes, restrictive regulations, and minimal collateral or income in remote or unpredictable environments. Multi-pronged interventions are needed to generate electricity demand, including innovative business models, productive uses of electricity, and cooperation with cash assistance and cash-for-work schemes. Finally, collaboration with governments to promote an inclusive enabling environment, particularly toward the forcibly displaced, is crucial.[297]

Game changers to move beyond consumer PAYG

Consumer PAYG may not be the most appropriate business model for serving the lowest-income households. Energy-as-a-service (Eaas) is one potential alternative. While the average subsidy needed to address the affordability gap for a USD 199 system is USD 75, for the lowest-income households this increases to USD 138–163. At this level of subsidy, PAYG may not be the most efficient model, as it is difficult to tailor subsidies to household income levels, leading companies to cherry-pick the most profitable customers, and creating a risk of inefficient use of public funds. High subsidies relative to product price may incentivize companies to distribute as quickly as possible without considering long-term usage, maintenance, or sustainability, leading to wasted assets. Additionally, even with substantial subsidies, many people cannot afford regular payments over the lifetime of the contract, leading to loss of access to the system for the consumer and loss of revenue for the company, and high interest rates on consumer financing loans.

Alternative public-private partnership models could align incentives around long-term, low-cost access and make better use of scarce public funding. In an energy-as-a-service approach, the solar system typically remains the property of the subsidy provider, and customers are asked to pay a service fee aligned to what they are able to afford. The subsidy provider might cover up to 100% of the initial capital cost for the SHS, with the OGS company covering the cost of providing O&M services and the remaining capital, if any, through customer service fees. The model could be implemented through a public procurement approach which gives one OGS company the exclusive right to serve a given location, without facing competition, in order to increase customer density and minimize O&M costs. Alternatively, it could be implemented through a results-based financing approach that allows multiple operators, with companies competing to offer the best possible service for the lowest possible user fee and offering a wider range of products/services. Energy-as-a-service has been successfully deployed in several Latin American countries but remains relatively unproven in Sub-Saharan Africa.[298]

Box 17: Example of energy-as-a-service for households and schools

SolarAid

SolarAid's Light a Village program is an innovative initiative to provide affordable SHS to households and schools in the remotest areas of Sub-Saharan Africa by employing an energy-as-a-service model. The program both addresses electricity access and creates sustainable income through training local customer service representatives on installation and maintenance. The pilot in Malawi has transformed community life by successfully equipping 2,500 homes and 12 schools with solar systems.[299]

297. Source: ESMAP, Leave No One Behind, 2022
298. Note: For further details, refer to World Bank's Designing Public Funding Mechanisms in the Off-Grid Solar Sector report.
299. Source: SolarAid, Light a Village

Game changers to accelerate productive use of energy and social infrastructure

Potential game changers for the productive use sector include business models with demand aggregation mechanisms and technological innovations. Demand aggregation strategies include i) building partnerships with prominent buyers or MFIs to sell PUE products and services to networks of farmers, piggybacking on established commercial relationships; ii) innovative models such as farming-as-a-service (FaaS) that enable multiple farmers to access assets as needed; iii) bulk procurement by groups of distributors, or public funders / MFIs acting as intermediaries, to bring down the cost of goods through unlocking economies of scale; and iv) platforms that raise awareness of PUE among farmers and help suppliers connect with established farmer cooperatives. For more nascent technologies, technological innovation with a focus on improving durability, repairability, performance and cost—for example in areas such as brushless DC motors, or the use of AI or IoT for predictive maintenance—will help improve commercial viability and attract investor capital.

Box 18: Examples of demand-aggregation mechanisms

Oorja Solutions is an OGS company that works at the nexus of clean energy and agriculture by providing EaaS. Oorja offers solar-powered irrigation and milling services to smallholder farmers on a pay-per-use basis.[300]

SokoFresh is a social enterprise that aims to address post-harvest loss through providing cooling-as-a-service, alongside market linkage services to smallholder farmers and aggregators. SokoFresh's key services include cold storage rental, market access through demand assurance, and support with pre-harvest readiness.[301]

Potential game changers for off-grid electrification of social infrastructure, include long-term service contracts and de-risking instruments. Programs focused on installation of OGS systems have often failed because of challenges financing and implementing adequate O&M to keep systems operational. Long-term service contracts, where OGS companies are paid based on service performance over 10 or 15 years, have the potential to transform the sustainability of social infrastructure electrification programs (see *Box 6*). This requires innovation to ensure the availability of funds to pay contractors for the provision of continued energy services that meet predefined key performance indicators.[302] Several strategies can be utilized to achieve this, including de-risking instrument such as guarantees for government non-payment or delayed payment, and ringfenced accounts (either government- or donor-funded) that secure a pre-established amount of service fees.[303]

300. Source: Oorja Solutions, About us
301. Source: SokoFresh, About Us
302. Note: For an overview of a predetermined set of key performance indicator and a quality assurance framework for energy-as-a-service via OGS for public facilities, please refer to Requirements and Guidelines for Installation of Off-Grid Solar Systems for Public Facilities.
303. Source: SEforALL, State of the Market Report for Heathcare Facility Electrification, 2024

CONCLUSION

The Path Forward

photo credit: BioLite

Achieving SDG 7 by 2030 is not out of reach, but it is at risk. A significant increase in public funding is needed—unlocking a corresponding increase in private investment—to enable progress to accelerate.

As outlined in Chapter 2 to Chapter 5,the OGS sector has faced a challenging period in recent years but has remained resilient. As outlined in Chapter 6, OGS is a critical enabler of electrification and livelihoods. As described in Chapter 7 and Chapter 8, additional funding and a greater focus on innovation to unlock some of the potential game changers are critical to improving the commercial viability of the OGS sector and delivering first-time access at scale.

Governments need to set ambitious OGS access targets backed up by clear, well-funded implementation plans. In mature markets like Kenya, Uganda, and Rwanda, governments should focus on scaling up first-time access using RBF and end-user subsidies, while using guarantees and credit lines to address equity and debt financing constraints. Tax exemptions remain critical to lowering the cost of OGS products, while meaningful enforcement of quality standards is needed to protect consumers. In nascent markets, many of which are fragile, upfront grants and technical assistance can complement RBF, end-user subsidies, and credit lines, enabling smaller companies to grow. Multi-country financing facilities can enable smaller countries to benefit from standardization, automation, and economies of scale in fund management, and help to attract larger companies into smaller markets. Finally, in conflict-affected and humanitarian settings, there is no one-size-fits-all approach, but finding the right implementing partners—such as local OGS companies, microfinance institutions, or development agencies—is key, as are mechanisms to bring down upfront costs and risks for implementing partners.

As public funding from governments enables companies to scale up through delivering first-time access, investors need to co-invest, providing equity and debt to catalyze sector growth. In mature markets, equity financing, patient capital, and local currency financing are needed to scale. For nascent and fragile, conflict-affected, and vulnerable (FCV) markets, smaller-ticket financing is needed to support smaller OGS companies. In all markets, collaboration with development partners is needed to develop blended financing solutions that deploy guarantees, grants and technical assistance—as well as aggregation—to reduce costs and risks for both investors and investees, and that support companies at all stages of growth.

Development partners also need to scale up their support to the OGS sector, funding technology and business model R&D, as well as the development of innovative public and private financing mechanisms. Once technologies, business models, and financing mechanisms are proven, development partners should work closely with governments to integrate them into large-scale programs through technical assistance and capacity building. In more mature markets, development partners should focus on innovative ways to deliver first-time access while also ensuring the commercial viability of companies—for example, through linking RBF or end-user subsidies not only to sales but to service over time, and monitoring repayment rates, or through exploring business models beyond PAYG. For nascent markets, donor interventions should include technical assistance, upfront grants, and financial support mechanisms that enable companies to enter new markets and scale operations. Expanding impact-linked financing models, such as Acumen's Hardest-to-Reach fund, can help incentivize companies to target underserved populations. In conflict-affected and humanitarian settings, development partners—like governments—must fund innovation to identify technologies, business models, financing mechanisms, and partnerships able to deliver access in those settings.

The private sector must use public funding and private investment to improve profitability, while continuing to scale up. In mature OGS markets, OGS companies must prioritize profitability and growth through robust credit management, minimizing bad debt, and keeping operational costs low. Companies should focus on upselling to customers with established credit histories and tapping into new segments that can afford more profitable products, while participating in public funding schemes that deliver first-time access. They should collaborate with investors to develop innovative financing mechanisms, such as local currency financing and off-balance-sheet solutions, to maintain liquidity and growth. The private sector can also play a pivotal role in scaling up productive use of energy (PUE) solutions and OGS for social infrastructure by developing business models for these market segments. In nascent markets, OGS companies should focus on leveraging public funding mechanisms, including RBFs, credit lines, and upfront grants, to provide first-time access to underserved communities while exploring opportunities to serve higher-income households with high-margin products. In conflict-affected and humanitarian settings, the private sector must adapt its business models to the context, often working closely with international organizations or local NGOs already operating on the ground, to facilitate distribution and after-sale services.

In conclusion, the need to accelerate electricity access through OGS has never been more urgent. Over the last decade, the OGS sector has demonstrated its ability to deliver high-quality, affordable products and services at scale through lean, resilient, and proven business models. While significant public and private investment is needed to meet the sector's development goals, the path forward is clearer than ever. With just five years to 2030, the sector is at a critical juncture. The time is right for companies, investors, governments, and development partners to unite in a new effort to ensure that OGS fulfills its potential—enabling the achievement of SDG 7, while having a transformative impact on households, businesses, farmers, and social infrastructure.

photo credit: Fosera

Annexes

Annex 1: OGS Use case and product typology[304]

Uses	Product category	Definition/application	Typical range	Use cases			
				Residential	Productive (Enterprise)	Productive (Agriculture)	Social Infrastructure
Lighting and Power	Solar lanterns	Lanterns with single light or single light and mobile charging Enables tier 0 to partial tier 1 access (partial basic energy access) for an individual person	0 – 2.99 Wp	✓	✓		✓
	Smaller SHS	Systems with multiple lights that can power mobile charging, radio and/ or television and additional lights Enables tier 1 to tier 2 access (basic to higher energy access) for at least one person, up to a full household	3 – 49.99 Wp	✓	✓		✓
	Larger SHS	As above, with extended power capacities Enables tier 2 access (higher energy access) for a household, even using conventional appliances	50 + Wp	✓	✓		✓
	Solar inverters/ generators	Coverts DC electricity generated by solar panels into AC electricity to power conventional appliances/ includes a battery to store the electricity (nascent market) Enables tier 2 access (higher energy access) for a household, even using conventional appliances	N/A[1]	✓	✓		✓
Access to information and entertainment	Televisions (TVs)	Television sets provide access to entertainment, educational content, and news	40 – 100 W	✓	✓		
	Radios and sound systems	Radio and sound systems provides access to entertainment (including music), and news	10 – 20 W	✓	✓		
Cooling	Refrigeration units (up to 300L capacity) Refrigeration units (up to 300L capacity)	Refrigeration units reduce the risk of food contamination and preserve perishable produce and beverages for both households and small businesses in rural, communities	300 – 600 W	✓	✓		✓
	Cold storage units (over 300L capacity)	Cold storage units enable larger scale preservation of produce, meat, and dairy products, targeted mostly at smallholder farmers	1000 W +		✓	✓	
Irritating	Solar water pumps	Solar water pumps improve irrigation and extend the growing season for rural smallholder farmers	Up to 2 kW	✓		✓	
Processing	Fans	Fans improve household comfort, especially during hot seasons	30 – 50 W	✓	✓		✓
Improving living conditions	Solar mills	Solar mills are milling systems designed to grind grains, targeted mostly at agro-processors in rural communities (nascent market)	500 W +			✓	

Note(s): 1. Power range of solar generators/ inverters typically depends on the watt peak of solar panels

304. Note: [1] Certain products, particularly solar mills and solar inverters/generators, have been excluded from the report analyses due to the nascency of the market and resulting lack of data. [2] Power range of solar inverters/ generators typically depends on the watt peak of solar panels.

Annex 2: OGS Company segmentation (non-exhaustive)

	Large global companies	Mid-size regional companies	Small domestic companies
	Footprint: 5+ countries	Footprint: 1 – 5 countries	Footprint: 1 country
Vertically-integrated	BBOXX, d.light, M-KOPA, sun king, ENGIE, ZOLA ELECTRIC	SureChill., KOOLBOKS LIFE IS KOOL, LUMOS	RAHIMAFROOZ solar, DEVIDAYAL SOLAR SOLUTIONS
Distributors		BAOBAB+, Bright Life, easy solar, MOON power to communities, Simusolar, SOLAR SISTER, VITALITE, SunCulture, Yellow	altech energie du moment, FONBOLENERGY, zuwa, FRES, VILLAGE SOLAR, ZONFUL ENERGY
Manufacturers[305]		AGSOL, ecozen, Amped, ennos, BioLite energy everywhere, Futurepump, LORENTZ	
Service providers		angaza, KPay, Paygee The PayAsYouGo Ecosystem, SOLARIS OFFGRID	There is a long tail of local service providers (including those providing business data and analytics, online storefront software and digital payment collection)

305. Note: Although some of the manufacturers distribute products globally, they are typically only present in 1 country (hence included in the mid-size regional company category)

Annex 3 – Methodology to estimate the funding need for OGS for productive use (agriculture, enterprises) and social infrastructure (schools, healthcare facilities)

We have estimated the funding need for providing higher electricity access and PUE for households, farmers, MSMEs, and schools based on estimates of available sources and basic assumptions.

We estimate the number of farming households by using labor force data (including the share of labor force involved in agriculture) and the average household size for each country. We then use the rural electrification rate of the country as a proxy to calculate the number of unelectrified farming households.

We then compare the total addressable market (TAM) for solar water pumps (in units) to their current sales to calculate how many more products need to be sold to achieve universal coverage of the TAM. The investment needed is a product of the price of a solar water pump and the volume that needs to be sold to achieve universal access.

Funding need for providing solar water pumps to farmers	
Unelectrified farming households	38.7 million[306]
Farming households not suitable for pumps due to lack of water resources	20%[307]
Total addressable market for solar water pumps (units) (A)	30.9 million
Sales of solar water pumps – 2023 (units)	23,000
CAGR for solar water pumps	19.6%
Expected total sales of solar water pumps in continued trends scenario – 2024 to 2030 (B)	354,000
Price of solar water pump (P1)	USD 514.4[308]
Total funding need in continued trends scenario = (P1*B)	USD 0.2 billion
Total funding need in universal access scenario = (P1*A)	USD 16 billion

To estimate the funding need for solar refrigerators, we use the total addressable market (in units) based on SOGAM 2024 estimates. We then compare this figure to their current sales to calculate how many more products need to be sold to achieve universal coverage. We assume a near flat growth rate for the appliance since growth has been fluctuating due to challenges faced due to COVID-19 and global conflicts. The investment needed is a product of the price of a solar refrigerator and the volume that needs to be sold to achieve universal access.

Funding need for providing solar refrigerators to farmers	
Total addressable market for solar refrigerators (units) (C)	37.9 million[309]
Sales of solar refrigerators – 2023 (units)	7,000
CAGR for solar refrigerators	4.1%
Expected total sales of solar refrigerators in Continued Trends scenario – 2024 to 2030 (D)	56.4 thousand
Price of solar refrigerators (P2)	USD 860.6
Total funding need in continued trends scenario = (P2*D)	USD 0.05 billion
Total funding need in universal access scenario = (P2*C)	USD 32.7 billion

306. Source: Dalberg Analysis, 2024. Estimated based on various data for each country from the World Bank database including Total Labour Force, Proportion Involved in Agriculture, Average Household Size, and Rural Electrification Rate
307. Source: Lighting Global, The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa, 2019
308. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024.
309. Source: Efficiency for Access, The state of the off-grid appliance market report, 2024.

To estimate the funding need for providing SHSs to MSMEs, we calculate the total number of MSMEs using MSME Economic Indicators and use World Bank Enterprise Surveys to estimate the proportion of those MSMEs without electricity. We assume that the same proportion of MSMEs is viable for electrification through OGS as households (41%). This provides the total addressable market (in units) for SHSs to electrify MSMEs. We then compare this figure to current PUE sales to calculate how many more products need to be sold to achieve universal coverage based on the current growth rate. The investment needed is a product of the price of a SHS and the volume that needs to be sold to achieve universal access.

Funding need for providing SHSs for MSMEs	
MSMEs experiencing electrical outages	90 million[310]
Unelectrified MSMEs for which OGS is viable	41%
Total unelectrified MSMEs needing OGS (E)	36.9 million
CAGR for SHS – 50–100Wp	9.9%
Total SHS sales for PUE in 2023	65,000
Expected total sales of SHSs in continued trends scenario – 2024 to 2030 (F)	677,000
Price of SHS (P3)	USD 678.2
Total funding need in continued trends investment scenario = (P3*F)	USD 0.46 billion
Total funding need in universal access scenario = (P3*E)	USD 25.0 billion

To estimate the funding need for electrifying schools, we estimate the total number of schools by country by using the net enrollment rates by country (based on World Bank estimates) and the absolute number of school age population based on UIS Statistics. Based on an assumption of an average school size of 130 students, we estimate the total number of schools in each country. We further use the UIS database to estimate the number of unelectrified schools; where such data are not present, we use the rural electrification rate to approximate the number of unelectrified schools. We assume that 41% of schools are viable for electrification using OGS.

Using the progress in electrification in schools from the UIS database, we estimate the number of schools that would be left unelectrified by 2030. The investment needed is a product of the price of a 3kWp SHS and the volume that needs to be sold to achieve universal access.

Funding need for providing SEKs to schools	
Total unelectrified schools	1.8 million[311]
Schools viable for electrification by OGS	41%
Total unelectrified schools viable for electrification by OGS (G)	0.7 million
Rate of electrification of schools	3.4%[312]
Expected total schools electrified in continued trends scenario – 2024 to 2030 (H)	225,000
Price of 3kWp SEK (P4)	USD 2859
Total funding need in continued trends scenario = (P4*H)	USD 0.64 billion
Total funding need in universal access scenario = (P4*G)	USD 2.1 billion

310. Source: Dalberg Analysis, 2024: Estimated based on various data for each country from the World Bank database including MSME Economic Indicators
311. Source: Dalberg Analysis, 2024: Estimated based on various data for each country including Net Enrollment Rate, School Age Population, and an assumed school size of 130 students per school.
312. Source: UNESCO Institute for Statistics, SDG 4 Indicator Dashboard

To estimate the funding need for electrifying healthcare facilities, we estimate the total number of healthcare facilities using research by SE4All. This dataset covers 84% of the unelectrified population; the number of facilities is linearly scaled to cover all unelectrified people. The total number of facilities requiring electricity access is estimated using available research. 41% of these are assumed viable for electrification through OGS. We estimate the same rate of electrification of healthcare facilities as with schools to estimate the number of facilities that would be left unelectrified by 2030. The investment needed is a product of the price of a 5kWp SHS and the volume that needs to be sold to achieve universal access.

Funding need for providing SEKs to healthcare facilities	
Total healthcare facilities in LMICs	198,000[313]
Proportion of healthcare facilities with no electricity	15%[314]
Proportion of healthcare facilities with unreliable electricity	58.8%[325]
Healthcare facilities with no or unreliable electricity	147,000
Healthcare facilities viable for electrification by OGS	41%
Total unelectrified healthcare facilities viable for electrification by OGS (I)	60,000
Rate of electrification of healthcare facilities	3.4%[316]
Expected total healthcare facilities electrified in continued trends scenario – 2024 to 2030 (J)	17,000
Price of 5kWp SEK (P5)	USD 4165
Total funding need in continued trends scenario = (P5*J)	USD 0.07 billion
Total funding need in universal access scenario = (P5*I)	USD 0.25 billion

313. Source: SE4All, Energizing Health: Accelerating Electricity Access in Health-Care Facilities, 2023; Dalberg Analysis, 2024
314. Source: SE4All, Energizing Health: Accelerating Electricity Access in Health-Care Facilities, 2023
315. Source: Cronk, R., Bartram, J., Environmental conditions in health care facilities in low- and middle-income countries: Coverage and inequalities, 2018
316. Note: We assume that the rates of electrification of schools and healthcare facilities are nearly similar for simplicity

Annex 4 – Methodology to estimate global OGS market sales volumes and market turnover

Note: difference between MTR 2024 and MTR 2022 models is colored in **green**

To estimate global sales volumes and market turnover for the off-grid solar kit sector, we follow the approach taken in the Off-Grid Solar Market Trends Report 2022, with slight revisions:

Step 1: Estimate the proportion of affiliate and non-affiliate off-grid solar energy kit sales

We first estimate the number of live solar kits products in 16 countries where the Multi-Tier Framework (MTF) Survey data are available. We then estimate the number of live affiliate solar kit products per market using affiliate sales data from GOGLA. With these two data sets, we can estimate the Non-affiliate market share per MTF country (*see table below*). We then calculate the weighted average of the non-affiliate market share and the 'market share that a country has among the 16 countries'. The weighted average is 71%, and we apply this number to the global market sales to calculate the non-affiliate market sales.

	Non-affiliate market share per MTF country	
Country	Market share for 0-10 Wp product	Market share for 11-100+ Wp product
Bangladesh	0%	93%
Cambodia	83%	47%
Ethiopia	68%	99%
India	75%	91%
Kenya	58%	60%
Malawi	51%	43%
Myanmar	98%	65%
Nepal	95%	80%
Niger	85%	99%
Nigeria	66%	85%
Papua New Guinea	94%	95%
Rwanda	3%	2%
Tanzania	72%	60%
Togo	96%	79%
Uganda	47%	96%
Zambia	62%	44%

Note: MTR 2024 evaluated various methods to triangulate the market share for non-affiliate companies, including country import databases and GOGLA Member Survey. The MTF survey provided the most comprehensive data, so MTR 2024 used MTF data to estimate market size, following the same methodology from MTR 2022.

Step 2: Estimate market turnover for solar energy kit

We estimate the global market turnover using total global solar kit sales volumes multiplied by aggregate product pricing estimates across each target market segmentation level; we assumed:

1. Price of different products (in USD terms) leveraging the Mangoo Marketplace[317] (from MTR 2022 database), and the GOGLA member survey to estimate changes in price (*see table below*)
2. PAYG down payment of 20%, the tenure is two years, and the average collection rate is 65% to calculate the PAYG market turnover[318]
3. 100% of payment collected at the time of sale for cash sales

Finally, we conducted a sense check of market sales estimates based on historical published off-grid appliance sector reports, stakeholder consultations, and existing firm sector expertise

Summary of prices considered – based on MTR 2022/Mangoo Marketplace[319] and adjusted from GOGLA MTR 24 survey data (-1 to -3%)

Product	Est. price change from 2022 – based on survey	Est. price in 2024 (USD)
Solar lantern	-3%	USD 7
Smaller SHS	-2%	USD 194
Larger SHS	-2%	USD 572
Solar fans	-1%	USD 35
Solar TVs	-1%	USD 187
Solar fridges	-1%	USD 941
Solar pumps	-1%	USD 1261

To estimate global sales volumes and market turnover for solar appliances market, we use a similar methodology to off-grid solar kits with key modifications due to significant data limitations:

Step 1: Estimate proportion of affiliate and non-affiliate solar appliance market sales

Due to significant data limitations, we leveraged assumptions of affiliate vs. non-affiliate market proportions used in the 2024 State of the Off-Grid Market (SOGAM) report,[320] which analyzed global trends in the off-grid appliance sector and estimated that affiliate sales account for between 30% and 70% of total off-grid appliance market sales

Testing the range with stakeholders during consultations, e.g., appliance manufacturers and distributors based in key countries in Sub-Saharan Africa and Southeast Asia – we made the assumption of a global non-affiliate appliance market split of 50%.

317. Note: Mangoo Marketplace discontinued in 2023.
318. Source: GOGLA, PAYG Perform Monitor (PFM) data.
319. Note: Mangoo Marketplace discontinued in 2023 – considering survey data to estimate price drop.
320. Source: Efficiency for Access, The State of The Off-Grid Appliance Market, 2024.

Step 2: Estimate global proportion of affiliate and non-affiliate market split, scale up affiliate sales to global level, and estimate market turnover using pricing data

We assumed a 250% scale-up factor to account for incompleteness and / or under-reporting of GOGLA affiliates' appliance sales data. Based on the market model from Off-Grid Solar Market Trend Report 2022, Efficiency for Access estimated that, on average, only 4 out of every 10 affiliate companies contacted report appliance sales data.

We then estimated the global appliance market turnover using resulting total global appliance sales volumes multiplied by pricing estimates across each target segmentation level, with the following considerations:

- We removed the bundled sales turnover in Sub-Saharan Africa from the total appliance market turnover to avoid double-counting
- Conducted a sense check of market sales estimates based on historical published off-grid appliance sector reports, stakeholder consultations, and existing firm sector expertise

Annex 5 – Methodology for estimating total affordability gap

Note: Difference between MTR 2024 and MTR 2022 model is colored in **green**

We estimate the affordability by comparing the ability to pay with a monthly two-year PAYG installment using World Bank's Poverty and Inequality Platform Percentiles database[321]

We first calculate the average monthly income across quintiles for each country at 2017 PPP USD values and subsequently calculate the average monthly expenditure of energy. Due to data limitations, we have built on the assumptions of the OGS MTR 2022, which assumes between 5% and 10% of monthly income is spent on energy

We estimate the number of people without electricity access **who cannot afford a monthly PAYG payment for respective prices** (*refer to Figure 23 – USD 127 for urban, USD 199 for rural)* based on the closest quintile that cannot afford to pay for each country, based on the following steps:

- Find the closest quintile that can afford a monthly PAYG payment for the product and assume that all quintiles below this cannot afford the product
- Using the World Bank's Global Monitoring Database, calculate the share of unelectrified households in each quintile
- Combining these data, calculate the share of unelectrified households that cannot afford a monthly PAYG payment (assuming that if the average electricity expenditure of a quintile is lower than the monthly PAYG payment, then all households in that quintile cannot afford the product)
- Assume that the same proportion of people (as households) cannot afford a monthly PAYG payment – the number of unelectrified people within a country who cannot afford is the product of this proportion and the total number of unelectrified people in the country
- Since the World Bank PIP data are available for 169 countries (which accounts for 95% of the population lacking access), we linearly scale the affordability for the remaining 5% of the population

321. Source: World Bank, Poverty And Inequality Platform (PIP): Percentiles

Annex 6 – Methodology for estimating total funding needed to reach universal household Tier 1 access by 203

What has changed from MTR 2022

- MTR 2024 estimates funding need based on companies' annual cash flow
  - » This approach reflects higher costs for serving rural populations and considers financing mechanisms such as debt investors' interest rate)
- MTR 2022 estimated funding need based on historical investment cost per USD 1 in sale and included sales for power backup for weak grids

To estimate the total funding needed to achieve universal Tier 1 access by 2030, we use the following approach:

Step 1: Determine the number of households needing a first-time Tier 1 energy connection through Tier 1 OGS products (3–10 Wp), based on the model from the Global Electrification Platform (GEP)[322]

- GEP estimates 398 million new connections through OGS by 2030[323]

Methodology of the Global Electrification Platform[324]

To estimate demand, GEP uses population density maps to identify settlements. Geospatial information such as distance to the closest electricity grid, population density, and brightness at night (using satellite imagery) is used to determine the size and current electrification status of each settlement. Commercial electricity demand is added as a multiplier of residential demand (30–60 percent), estimated using an economic index measuring GDP and accessibility (e.g., travel time to major cities). The location and size of education and health institutions are gathered from national data sets and OpenStreetMap, with electricity demand estimated based on the size of the institutions. Least-cost technologies for each settlement are identified based on the levelized cost of electricity, considering the costs of transmission, distribution, and generation as applicable for each technology type and including both up-front capital costs and ongoing operation and maintenance costs. The model assumes linear progress toward a final electrification rate of 100 percent by 2030. Based on a review of the rate of progress in a range of countries, it also assumes that the grid can at most double its generation capacity and connect an additional 2.5 percent of the population per year until 2025. Between 2025 and 2030, no such limitations are applied. The model indicates the technology mix, capacity, and investment requirements for achieving universal access in the modeled countries.

Step 2: Use PAYG prices of Tier 1 OGS product for urban and rural population (*refer to Figure 23 – USD 127 for urban, USD 199 for rural*)

Step 3: Calculate the consumer subsidy needed for people who cannot afford the monthly PAYG price for Tier 1 OGS products

322. Source: ESMAP, GEP, data accessed May 2024; Dalberg analysis
323. Source: ESMAP, Global Electrification Platform; Dalberg analysis, 2024. The calculation is based on the bottom-up scenario from the platform. OGS represents the least-cost solution for 41% of about 1 billion people that will require access to electricity between today and 2030, including population growth. GEP estimates considered OGS to be the least-cost solution for 423 million people in 2022; to project the figures for 2024, a 6.15% growth in electrification is applied over two years of anticipated growth
324. Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024; ESMAP, Global Electrification Platform

We then calculate the unelectrified households in each percentile for each country.

- The population within each percentile is the product of the population share of the percentile (from World Bank PIP) and the country population
- The number of households in the percentile is estimated using the national average household size
- The number of unelectrified households is the product of the proportion of unelectrified households in the percentile (calculated above) and the total number of households in the percentile
  - » Based on GEP – we assume that OGS electrification is viable for 41% of these households

Based on the number of unelectrified households for which OGS is viable, we calculate the subsidy needed to cover monthly PAYG payments for each country, with the following assumptions

- People can spend 5%-10% of their monthly income for electricity
- One person earning an income in each household

We then calculate the gap to a monthly PAYG payment for each percentile and aggregate this across all percentiles.

To calculate the subsidy needed to cover the downpayment for each country, we made the following assumptions:

- Assume that people can spend 5 times of their monthly electricity spend as upfront downpayment costs - this aligns with the market standard which assumes 3 months of electricity spend to be needed for upfront payment but has been adjusted to reflect the lower monthly incomes of unelectrified populations today
- Assume one person earning an income in each household

From that, we calculate the gap to the downpayment for each percentile and aggregate this across all percentiles. This allows us to calculate the total subsidy needed for each country as the sum of total downpayment subsidy and total PAYG subsidy – this is the affordability gap to be covered

Step 4: Calculate OGS companies' cashflow for each year

We assume OGS companies can serve the same amount of households without access in rural areas from 2025 to 2030 (~21.5 million rural households per year) to achieve universal Tier 1 access by 2030

We then estimate the annual number of replacement products sold from 2025 to 2030, assuming

- The lifetime of OGS Tier 1 products sold before 2025 is four years, and the lifetime of OGS Tier 1 products sold start in 2025 is six years[325]
- Assume all Tier 1 products are replaced upon reaching the end of their lifespan

We then calculate OGS companies' operating revenue from new products sales and replacement sales, assuming a PAYG down payment rate is 20%, and consumers' repayment rate is 65%[326]

From there, we calculate OGS companies' operating costs and expenses, including interest expenses, taxes, loan repayment, and investment activities (e.g., scale up, expand to new geographic markets)

325. Source: Stakeholder consultations
326. Source: GOGLA, PAYG Perform Monitor (PFM) data.

We use the World Bank Poverty and Inequality Platform to calculate the average monthly income for each percentile of each country – assuming that the share of unelectrified households in a percentile is the same as the corresponding quintile as estimated by the World Bank Global Monitoring Database (i.e. the proportion of unelectrified households in all percentiles of the 1st quintile of a country is the same)

- Assume land costs are approximately 43%, and sales, marketing, service, and customer care costs are 22% of the PAYG price to calculate gross profit - financing costs, bad debt costs, and margins make up the remaining cost drivers
- Assume overhead costs are 5% of the costs before gross profit to calculate earnings before interests and taxes (EBIT)
- Assume loan has a three-year tenure and interest rate is 13.5% to calculate capital repayment and interest expenses
- Assume corporate tax rate is 30% to calculate tax expenses
- Calculate the scale-up investment (required for the company to invest in scaling its operations) per USD 1 value of sale from the GOGLA investment database; multiply the number of target products sold by this investment scale-up factor to calculate the investment expenses

Step 5: Calculate the investment need for OGS companies each year

- Assume companies invest their cash in next year's operations
- Assume the debt-to-equity ratio is 1.5
- Assume grants accounts for 12% of the total funding need[327, 328]
- Calculate the gap between revenue and expenses each year and ensure that companies always have enough cash to support their operations in the next year

327. Notes: Based on historical data
328. Source: Stakeholder consultations

Summary of scenarios

Scenario	Description	Electricity access provided by OGS (millions)	Products sold (millions)	Total funding needed[255]
Business as usual Partial Universal access for households, businesses and public facilities	Growth in household electrification continues based on current trends	216 million people	45.6 million Tier 1 OGS products (3–10Wp)	USD 9.3 billion
	Continuation of current growth trajectory of PUE investment	0.35-0.41 million farming households 0.68 million MSMEs	0.35 million SWPs - 0.06 million cold storage solutions 0.68 million SHS units	USD 0.18 billion (SWPs) USD 0.05 billion (RUs) USD 0.46 billion (SHS)
	Partial universal access for households, businesses and public facilities	0.23 million schools 0.02 million healthcare facilities	0.23 million 3kWp OGS products 0.02 million 5kWp OGS products	USD 0.64 billion USD 0.07 billion
Universal access for households, businesses and public facilities	Providing Tier 1 OGS products to the entire unelectrified population for whom it is the least-cost electrification technology	398 million people	121 million Tier 1 OGS products (3–10Wp)	USD 27.6 billion
	Investing to cover the total addressable market for PUE	30.9-68.9 million farming households 50.4 million MSMEs	30.9 million SWPs 37.9 million cold storage solutions 50.4 million SHS units	USD 15.9 billion (SWPs) USD 32.7 billion (RUs) USD 34.2 billion (SHS)
	Investing to electrify all social infrastructure in need of electrification	1 million schools 0.08 million healthcare facilities	1 million 3kWp OGS products 0.08 million 5kWp OGS products	USD 3 billion USD 0.3 billion

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