

**ENERGY
CATALYST**

Technical Guide: Domestic Off-Grid Solar

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Currently, 840 million people worldwide live without access to affordable, reliable and safe modern energy. Collectively, they spend about USD \$27 billion each year on lighting and mobile phone charging with kerosene, candles, battery torches or other fossil fuel-powered transitional technologies. These traditional solutions are expensive, harmful to health, hazardous and polluting. They resign the poorest people on the planet to a life of energy poverty which constrains economic development and impedes access to education, health and basic services including communications, water and transportation. Off-grid domestic solar energy products provide a safer, cleaner, cheaper and reliable alternative to conventional solutions.

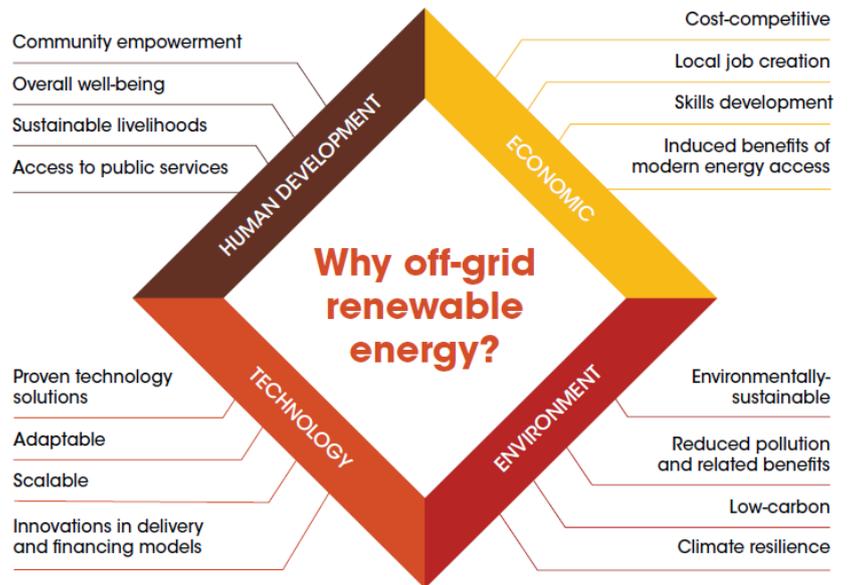


Figure 1 Summary by IRENA on the benefits of off-grid renewables

Off-grid solar products

Broadly, the main off-grid solar household product segments can be classified into three major categories differentiated by price and function: pico, solar home systems (SHS), and appliances. Pico-scale solar devices have the lowest cost of entry for most rural, low-income households. Solar home systems, which can be designed pre-assembled for plug-and-play or based on open-market components, provide multiple energy functions, such as powering appliances, at increasingly higher price points. Finally, solar-powered appliances, which are energy-efficient and powered by direct current, include both household appliances (e.g. televisions and refrigerators) and productive-use appliances (e.g. waterpumps and agricultural cold storage).

Pico products include small, portable solar lanterns, flashlights, or lanterns designed to meet basic lighting needs as a direct replacement for kerosene lamps. These products are typically packaged either as a simple, one-light system with one LED light, an embedded 0.5–3.0 Watt-peak (Wp) solar panel, and an internal rechargeable lithium-ion (Li-ion) battery or as multi-light systems of up to three or four LED lights with a standalone solar panel rated up to 10 Wp and a rechargeable Li-ion battery. Some models include USB charging for mobile phones.

Solar home systems have a solar panel rated at least 11 Wp and include home lighting systems for the smaller ones and can power appliances for the larger ones. Typically service providers do offer customers the option to gradually increase the size of their solar home system as and when more power is required and available cash flow allows.

Off-grid solar market growth

The off-grid solar sector has seen sustained growth over the last couple of years. This is partly fueled by cost reductions in the solar PV technology, but also due to the integration of mobile money and Pay-As-You-Go technologies (PAYG). Increased sales of higher-priced, PAYG-enabled products that provide increased levels of energy services drove the recent growth in company turnover.

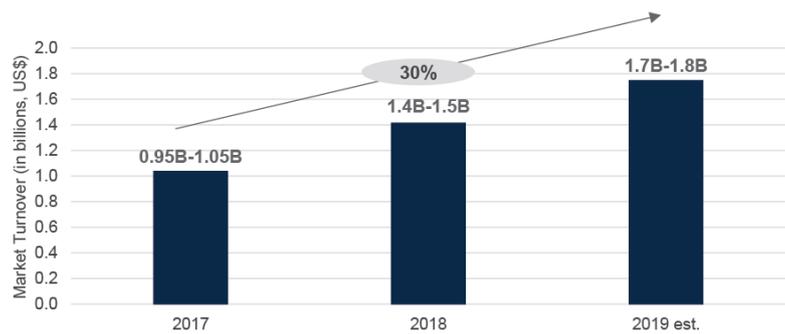


Figure 2 Sales of off-grid solar technologies worldwide, Source: The Global Off Grid Solar Market Trends Report, 2020.

Off-grid solar business models

All off-grid products serve identified energy service needs of the customer rather than the need for kWhs. Particular for the solar home systems, many companies in the market use a service delivery approach, ensuring the energy service rather than selling a generation unit. Therefore, SHS should not be compared with other technologies only by evaluating the cost of delivered energy (\$/kWh), but rather the level and quality of the energy provision.

The business models used by companies in the off-grid solar space include:

- 1) **Retail/Over the Counter:** Where in the past solar products were typically sold as an additional product within a larger business, recently a large number of dedicated solar retailers have emerged. Their survival and success is dependent on effective marketing, supply and distribution models.
- 2) **Pay-As-You-Go (PAYG) Consumer Financing:** This is effectively a consumer financing model that takes advantage of mobile money systems and combines this with remote monitoring and control of solar systems to remotely disconnect a system in the event of default. Ownership of the system is transferred once the customer finalises their repayments. The model offers flexible customer repayment options and enables the business to easily and effectively manage a large portfolio of dispersed borrowers. With repayments typically ranging from six months to three years, proper cash flow management is essential.
- 3) **Consumer Financing (via Partner Financial Institution):** In partnership with a financial institution, the PV supplier provides products and associated services, while the financial institution provides the consumer financing and collects repayments.
- 4) **Fee-for-Service:** An approach based on customers paying a monthly fee for electricity services, similar to a standard utility model, but using stand-alone systems. Ownership of the system is not transferred to the customer, with the business remaining responsible for maintenance. This model is well suited to providing electricity to dispersed communities, where large distances between customers make mini/micro-grids unviable. However, a significant upfront cost has to be borne by the business and the payback period is relatively long.

Each of these models is suited to different market segments: the retail model is best suited for task lighting products, the PAYG and consumer financing models are suited for general lighting and phone charging systems (with or without TV), and the fee for service model is suitable when income levels are very low and customers cannot afford outright purchase, as well as for large solar PV systems where PAYG might become unaffordable.

Although it has potential, the fee-for-service model is very difficult to run sustainably on a fully commercial basis. Some level of financial support will be required to deliver a certain volume of systems, at which point sufficient revenues can be collected from existing customers to ensure sustainable finance operations and expansion. It is also important to note that where there is competition between PAYG and fee-for-service solutions, customers prefer the PAYG option, as that will eventually result in ownership of the system.

Energy access and the Multi-Tier Framework

Traditionally, energy access has been reported using a binary methodology (access or no access). This, however, does not make any distinction between providing one task light to a household versus a full-service solar home system that arguably provides more energy services. With more and more companies and projects reporting on their contribution to reaching SDG7 in energy access, it is important to understand what constitutes “energy access”.

The Multi-Tier Framework evaluates electricity access in a non-binary fashion, measuring the quality of access rather than merely access to any source of electricity. Developed in the context of the Sustainable Energy for All (SE4ALL) initiative, the Multi-Tier Framework is being used as a more nuanced measure of progress towards the Sustainable Development Goal 7 (SDG7).

The framework redefines energy access to a multi-dimensional definition as “the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy and safe for all required energy services.” The mere fact of having an electricity connection does not necessarily imply having access to electricity under the new definition, which takes into account additional aspects, such as reliability and affordability. Energy access is measured on a tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access).

Error! Reference source not found. provides indications of the MTF level of services associated with certain off-grid solar products. Very clear from this overview is that individual portable lanterns, although providing an essential service to their customers, may not be counted as providing energy access.

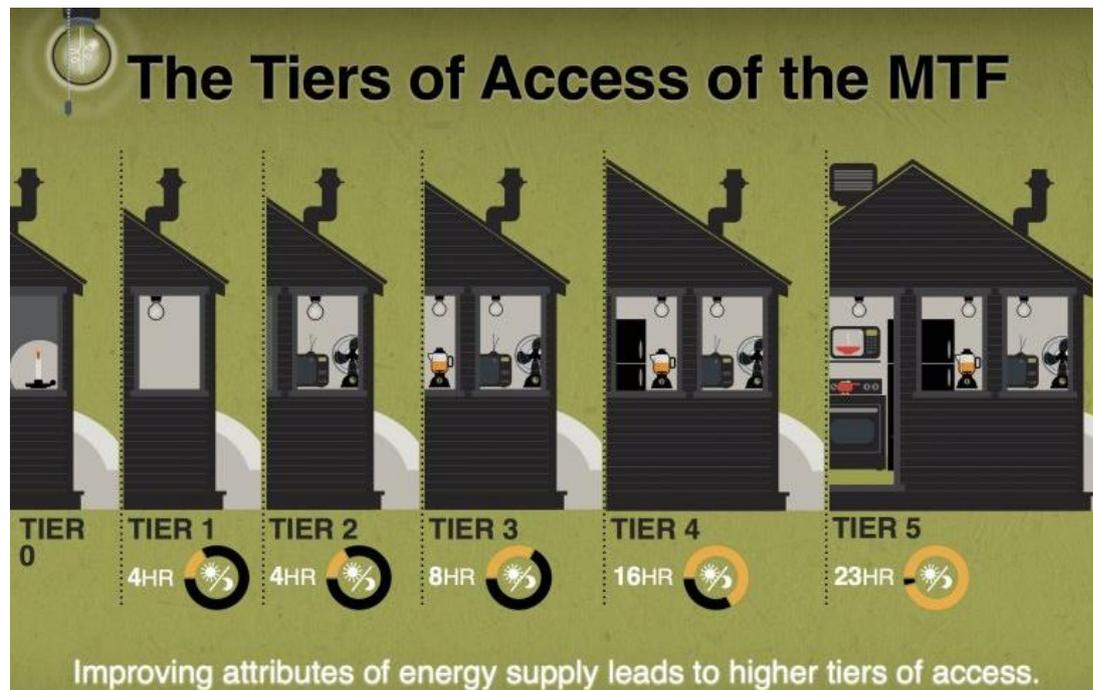


Figure 3 Visualisation of the different tiers of energy access, Source: World Bank ESMAP.

PAYG Market Attractiveness Index

The Pay-As-You-Go Market Attractiveness Index (PAYG MAI) indexes 24 countries across Sub Saharan Africa and Asia and provides businesses, policymakers, and practitioners with a flexible and accessible tool that can be used to assess the profitability of a national market for PAYGO energy services.

The tool provides a structure for decision-making criteria for use on:

- Entry into a new market
- Deepening market penetration
- Favourable conditions and challenges in each market by comparison
- 71 indicators of market attractiveness, organised under three main pillars – demand, supply and enabling environment and other aspects of market attractiveness
- Additional quantitative and qualitative market research

Example	Product Category	Definitions	Power Ranges (W)	MTF Level
 SunKing Pico Plus	Portable lanterns	Single light only	0.1499 (indicative)	Enables Tier 0 (or partial Tier 1) Electricity Access for an individual person
		Single light & mobile charging	1.5 – 2.999 (indicative)	Enables Tier 1 Electricity Access for at least one person and contributes for a full household
 GDLITE 8006-A	Multi-light systems	Multiple light & mobile charging	3 – 10.999 (indicative)	Enables Tier 1 Electricity Access for at least one person and up to a full household
 M-KOPA 6	Entry-level SHS	three to four lights, phone charging and powering a radio	11-20.9	Enables Tier 1 Electricity Access for a household
 d.light X850	Basic-capacity SHS	As above, plus power for a television, more lights, appliances & extended capacity	21-49.9	Enables Tier 2 Electricity Access for a household when coupled with high-efficiency appliances
 Niwa Energy 50	Medium-capacity SHS	As above, but with extended capacities	50-99.9	Enables Tier 2 Electricity Access for a household even using conventional appliances
 Mobisol Bright Future	Higher-capacity SHS	As above, but with extended capacities	100+	Enables Tier 2 Electricity Access for a household, even using conventional appliances ^{iv}

Figure 4 Typical off-grid solar products and associated tier of access, Source: The Global Off Grid Solar Market Trends Report, 2020.

The yearly report comes with an Excel-based tool that surveys a total of 24 countries: Angola, Cameroon, Congo, DRC, Cote d'Ivoire, Ethiopia, Guinea, India, Indonesia, Kenya, Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Papua New Guinea, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

Table 1: Active support programmes for off-grid solar

Programme	Main activities
Lighting Global	Lighting Global is the World Bank Group's initiative to rapidly increase access to off-grid solar energy for the 840 million people worldwide living without electricity. Lighting Global works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market.
Africa Clean Energy Technical Assistance Facility (ACE TAF)	ACE TAF aims to complement government, private sector and donor initiatives to overcome many of the barriers preventing the development of markets for high quality stand-alone solar systems.
Beyond the Grid Fund for Africa	Power Africa's Beyond the Grid initiative focuses on unlocking investment and growth for off-grid and small-scale energy solutions on the African continent. Beyond the Grid is accelerating off-grid electricity access, focusing on two strategic priorities – household solar and micro-grids – to add 25-30 million new connections by 2030. Beyond the grid is active in Zambia, Mozambique, Burkina Faso and Liberia, while preparing for a start in Uganda.
REACT Window - Household Solar (HS)	The window will support innovative and transformational business models that help people to access electricity through off-grid solar household systems, and give commercially viable businesses developmental support to create sustainable household solar markets. The countries targeted in round 1 were Malawi, Zambia, Zimbabwe and Sierra Leone, while round 2 covered Ethiopia, Senegal, Nigeria, Ghana and Somalia.
The Results-Based Financing (RBF) for Pico-Solar Market Development	The RBF facility focuses on the application of a temporary financial product in mainstream banking that serves to assist the private sector in developing the market for pico-solar products (lanterns, phone chargers and small solar home lighting kits) in rural areas of Tanzania's Lake Victoria Zone.
Regional Off-Grid Electrification Project (ROGEP)	A \$200 million project funded by the World Bank and managed by ECREEE. Targeting 15 countries in the ECOWAS region and four countries in the Sahel region, with a focus on mobilising private sector investment in the off-grid electrification space. The project has three main components: <ul style="list-style-type: none"> • Technical assistance to the public and private sectors • Access to finance for off-grid energy projects through local financial institutions • Support to electrify public institutions

Investments in the off-grid solar sector

While there is no detailed, publicly available data on off-grid PAYG market share, **Error! Reference source not found.** (on the disclosed financing in the sector in 2018) does give an indication of the main market players. Although this does not provide details on market share, in May 2019, the CEO of M-KOPA stated that, to the best of his knowledge, his company accounts for about 30% of all sales in the PAYG sector. Based on that assessment he was expecting the off-grid solar sector collectively to reach 10 million people and \$1 billion in revenue by early 2020.

In early 2019, the sector did see a prominent player in the market, Mobisol, filing for insolvency. General opinion in the sector is that events such as this are not very surprising, as the off-grid solar space is a fast-moving industry, operating in a difficult environment. Eventually Mobisol was able to emerge out of this crisis, as it was acquired by Engie. (In parallel, although not a domestic solar PV provider, Solarkiosk went through a similar process and re-emerged as the refocused Solarkiosk Solutions.)

Top 10 SHS recipients by disclosed financing type, cumulative to year-end 2018

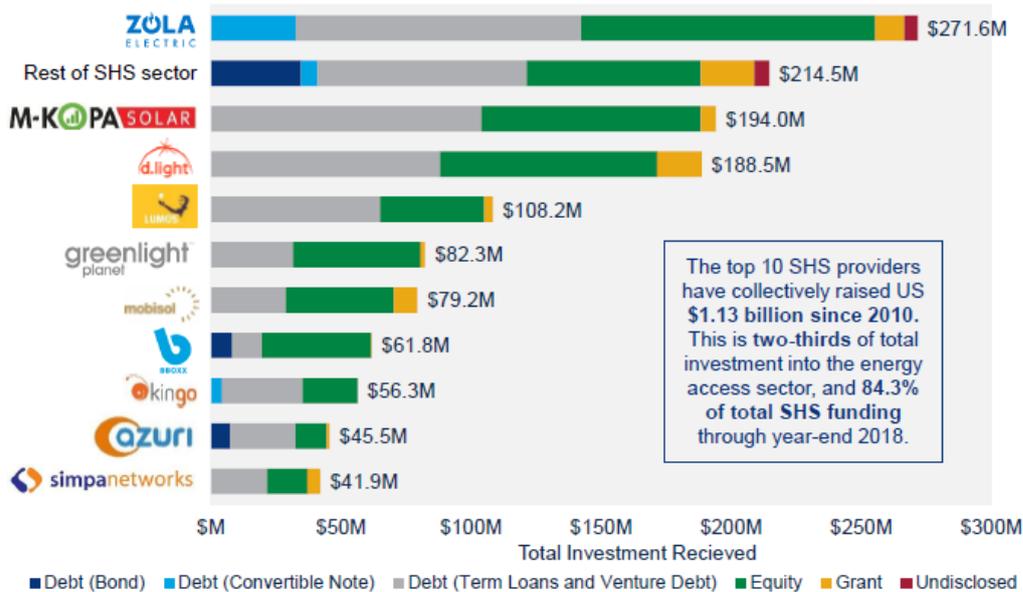


Figure 5 Investments in SHS companies, Source: Strategic investments in off grid energy access, 2019.

Industry associations

GOGLA is the global association for the off-grid solar energy industry. Established in 2012, GOGLA now represents over 180 members as a neutral, independent, not-for-profit industry association. Its mission is to help its members build sustainable markets, delivering quality, affordable products and services to as many households, businesses and communities as possible across the developing world.

References and further reading

The Global Off Grid Solar Market Trends Report

<https://www.lightingglobal.org/resource/2020markettrendsreport/>

PAYGo Market Attractiveness Index

<https://www.lightingglobal.org/resource/paygo-market-attractiveness-index-2019/>

Multi-Tier Framework for energy access

<https://mtfenergyaccess.esmap.org/>

Solar PV business models in East Africa: lessons learnt from EEP supported projects

https://eepafrica.org/bfd_download/solar-pv-study/

Strategic investments in off grid energy access

<https://www.energy4impact.org/strategic-investments-grid-energy-access-scaling-utility-future-last-mile-0>

Useful contacts

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Please contact your Client Relationship Manager if you want help with introductions to specific individuals within these institutions.