

STAND-ALONE OFF-GRID SOLAR MARKET RESEARCH Nigeria

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Africa Clean Energy
Catalysing Africa's Solar Markets



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International Development





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Lastly the contents of this report have been generated from analyses of the primary data in determining the state of affairs of SAS products in Nigeria at the time of the study. The data has been carefully analysed, and its interpretation is under these specific contexts.



ABBREVIATIONS

Acronym	Definition
ACE TAF	Africa Clean Energy Technical Advisory Framework
CAPI	Computer Aided Personal Interview
COVID-19	Coronavirus disease 19
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
GESI	Gender Equity and Social Inclusion
GPS	Global Positioning System
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
LA	Lighting Africa
LG	Lighting Global
MFI	Microfinance Institutions
MSME	Micro, Small and Medium Enterprises
MSP	Mobile Service Provider
NGO	Non-Governmental Organization
NGN	Nigerian Naira
OGS	Off-Grid Solar
PAYG	Pay As You Go
PUE	Productive use of energy
PWD	Persons with Disabilities
QV	Quality verified
REA	Rural Electrification Authority
SACCO	Savings and Credit Cooperative
SAS	Stand-Alone Solar
SHS	Solar Home System
USD	United States Dollar
Wp	Watts peak



EXECUTIVE SUMMARY

The Africa Clean Energy Technical Assistance Facility (ACE TAF) commissioned this study of the stand-alone solar (SAS) market in Nigeria to gauge how well solar products are reaching vulnerable populations, and to provide the industry with an up-to-date understanding of the sector. The research looks at SAS penetration, quality product availability, consumer solar use and preferences, after-sales service offering and available financing – to inform all stakeholders on the potential avenues for future growth and support.

Nigeria Background and Context

There are an estimated 201 million people in Nigeria out of which about 77 million are currently without access to reliable power, making the country one of the largest potential markets for stand-alone solar (SAS) globally. There is market potential also amongst grid-connected customers as only 25 per cent of them receive up to four hours of daily power. By 2040, the Nigerian government aims to achieve 100 per cent rural electrification with a target of 5 per cent coming from SAS solutions.

The SAS sector has witnessed significant growth, fuelled by increased donor, government, and private sector investment. Most recently, the Nigerian government launched a plan to deploy 5 million solar connections via solar home system (SHS) and mini-grids by 2023. About 324,000 quality verified SAS units were sold in 2019, up from negligible sales five years earlier¹, ranking Nigeria as the fifth largest market globally by sales volume. The SAS market opportunity is estimated at USD 9.2 billion per year, with the sector attracting USD 227 million investment from 2015 to date.² There have been trends in product diversification and innovation across solar system size, productive use of energy (PUE) technologies and in the rising adoption of pay-as-you-go (PAYG) models. Market growth notwithstanding, some supply, demand, finance, technical capacity, and regulatory barriers still exist that inhibit the scaling of the SAS market.

Study Overview

Researchers sampled trade outlets (on the supply side) and household and small business consumers (on the demand side) across ten states in Nigeria to find out where SAS are being sold and what products are for sale. A trade ‘deep dive’ explored after-sales services and technical capacity; a consumer survey sought to understand who owns SAS and what their experiences and preferences are; and stakeholder interviews offered insights to trade and non-trade distribution channels as well as financing along the supply chain.

A gender and social inclusion (GESI) lens was applied across all survey tools, to ensure better understanding of the extent to which women, youth and people with disabilities (PWD) are represented among suppliers and customers.

Study Findings

Just 13.6 per cent of trade outlets are currently stocking solar – pointing to a sizeable opportunity to expand the market.

Indications that solar is being used as a primary lighting and electricity source rather than just grid backup can be seen in Northern States where there is higher SAS penetration and lower grid coverage. The opportunity is particularly attractive in populous states that have low grid connectivity, such as Bauchi and Plateau, or low solar product penetration, such as Oyo or Cross River.

The overall penetration of SAS is higher in urban trade outlets (15.2 per cent) than in peri-urban (9.3 per cent) and rural (5.6 per cent) areas. On the other hand, solar users are concentrated in peri-urban and rural areas.

Of the three product categories, lanterns have the highest penetration and are widely stocked alongside panels, and solar home systems are still viewed as a specialty item. Although PUE products are rare in trade outlets, of the 11,391 trade outlets visited that were not carrying any solar products, 62 per cent expressed an interest PUE solutions. Among the MSMEs covered in this study, 47 per cent had a SAS product on their premises, a further demonstration of the emerging potential.

1. GOGLA (2019) *Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data*

2. Africa Clean Energy Technical Assistance Facility (2021) *Stand-Alone Solar Investment Map, Nigeria*



SAS products remain a risky investment.

A common perception by consumers is that SAS products are expensive and perform poorly, which dictates how they fare in the market. The solar lantern category is extremely competitive, with 170 unique brands found in stock; d.light leads the market with a brand share of 22 per cent. Solar panels are available in a wide range of sizes, and Sunshine Solar leads the market by a large margin with 34 per cent share and the next competitor at only 6 per cent. SHS consumers are buying a less diverse range of SHS products than is being offered by the trade – 37 per cent of the SHS in households and MSMEs are from brands with each less than 2 per cent share; a whopping 59 per cent of SHS in the trade are from low-share brands.

The Nigerian market shows a similar prevalence of non-quality verified (QV) brands to SAS markets in Tanzania and Ethiopia, with the quality of products varying widely, and few instances of warranties and installation guidelines. Major discrepancies in the retail price for what appear to be the same products are likely due to counterfeiting – 64 per cent of traders believe there is a moderate to high presence of counterfeits in the market. However, it is important to note that when considering ‘quality’ products the Lontor, DP LED and Saroda brands are popular with traders, yet they do not have the QV status, potentially indicating that good quality products are recognized by consumers despite not having been accredited by Lighting Global.

Despite an evident need, most SAS traders do not offer after-sales services.

Just 25 percent of SAS suppliers provide installation or repair services. The most common after-sales needs are the return of faulty systems brought back by the customer and installation of component-based systems. Although some of the service requirements is taken on by “technician shops” that are primarily involved in installations and repairs, their contribution is limited as the majority of solar technicians are self-taught or have learned through apprenticeship and do not have proper training. Thirty-one per cent (31%) of interviewees cited insufficient training as the main challenge in properly servicing solar products.

The trade in SAS is conducted almost exclusively in cash, not credit.

Generally, traders self-finance their businesses or raise funds through friends and family, local cooperatives, or local banks. Less than 5 per cent of traders have received formal financing, mainly through MFIs and SACCOs. Similarly, just 5 per cent of SAS customers reported receiving credit from the solar shop, and the majority do not have loans from elsewhere. Though most traders did not differentiate their credit offering based on gender, 22 per cent expressed a preference for male borrowers, and 5 per cent for female. Traders cited loss of source of income as the leading reason given by customers (51 per cent) for default in payment; followed by competing priorities (37 per cent), poor performance of the products (24 per cent) and perceived high interest rates (16 per cent).

Many of the top QV brands use independent agents and door-to-door sales networks to distribute their products. At the intersection of distribution and financing are MFIs which are a major supply channel for SAS products, especially in cities. LAPO Microfinance Bank, for example, offers a solar loan product at 558 branches around the country.

The trade is dominated by men, with only 4 per cent of shops stocking solar owned by women.

Both the trade and consumer sides of the SAS market are significantly male dominated. Women account for only 4 per cent of SAS trade outlet owners and 20 per cent of trade employees. There were no Persons with Disability (PWD) found in the trade. As for consumers who purchased SAS products, only 30 per cent of are women and 10 per cent PWD, compared to 70 per cent men.

Recommendations

The Nigerian SAS market is growing rapidly and organically. As government and its partners seek to ensure that quality, affordable products reach the most vulnerable populations, there will be a need for a multi-faceted effort to boost the prevalence and awareness of quality products, deliberate development of after-sales capacity among the trade as well as consumer expectations of quality support, and a recognition of the important role of both trade and non-trade distribution channels in reaching the last mile / under-served populations, including the various pros and cons of each vis-à-vis consumer trust, financing and after-sales services.

1. INTRODUCTION

1.1 STUDY BACKGROUND

Nigeria's population is estimated at 201 million,³ of which 77 million are unelectrified⁴. Those connected do not necessarily fare better, as 80 per cent supplement unreliable electricity with a host of alternatives, largely diesel or petrol generators.

The International Energy Agency (IEA) estimates that in the next 10 years (until 2030), the national grid will not reach national coverage and hence a large part of the Nigerian population will still depend on off-grid solutions for electrification (see Figure 1).

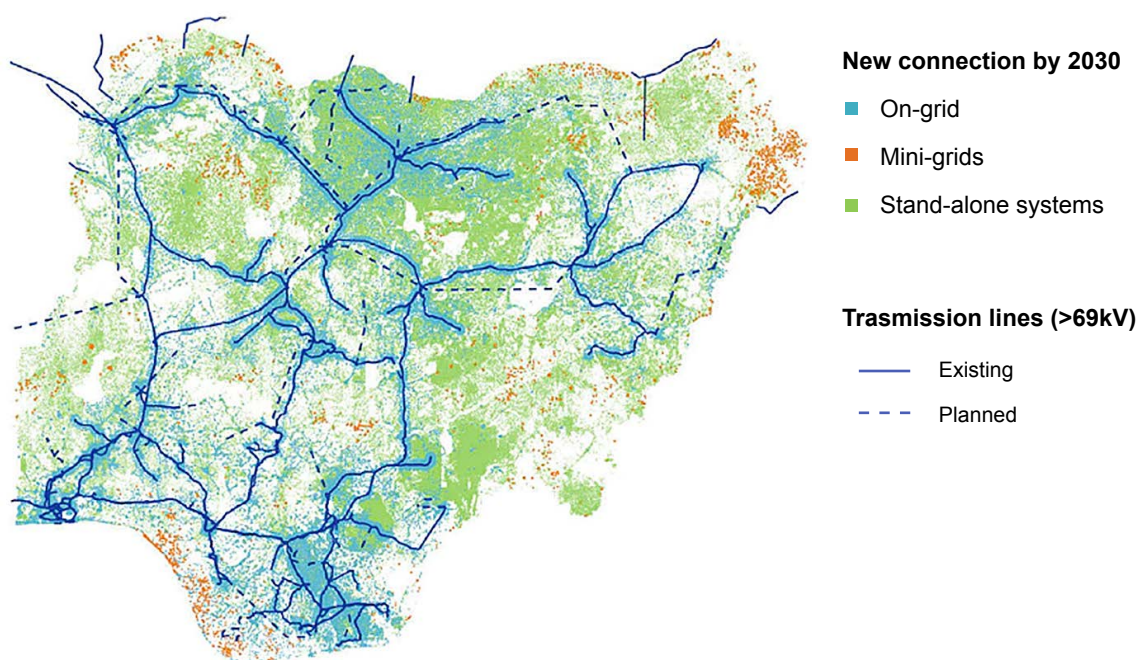


Figure 1 Nigeria Energy Outlook in 2030

There also remains a large market amongst grid-connected customers as only 25 per cent of them receive at least four hours of daily power. These off-grid and underserved markets exist all over Nigeria and across economic status. By 2040, the Nigerian government aims to achieve 100 per cent rural electrification with 5 per cent through stand-alone solar (SAS) solutions.

The SAS sector has witnessed significant growth evidenced through increased donor, government, and private sector investment, with the government now launching a plan to deploy 5 million solar connections via solar home systems (SHS) and mini-grids by 2023. About 324,000 SAS units were sold in 2019, up from negligible sales five years earlier and Nigeria currently ranks fifth globally in sales volume for key off-grid solar (OGS) markets. The OGS market opportunity is estimated at USD 9.2 billion per year, with the SAS sector alone receiving USD 227M between 2015 to date⁵. However, several supply, finance, demand, and regulatory barriers exist that inhibit scaling of the SAS market.

3. World Bank (2018)

4. International Energy Agency (2020) World Energy Outlook

5. Africa Clean Energy Technical Assistance Facility (2021) Stand-Alone Solar Investment Map, Nigeria

The SAS market has also seen a trend in product diversification and innovation across the pico-solar, solar home systems, component based solar systems, and productive use technology categories. This innovation is reflected in the rising adoption of PAYG business models.

With the realisation that universal grid coverage is neither possible, nor economic in the short to medium term, SAS can, and should, take a more prominent role in the electrification mix in Nigeria. However, the market suffers insufficient data on market size, segments, products penetration, potential opportunities in retail and wholesale, mini-grids, and standalone systems, after sale services, and support to help scale up financing models.

1.2 OBJECTIVE

ACE TAF commissioned Ipsos to conduct this study in order to assess the development of the SAS market in Nigeria with specific consideration for if, and how, vulnerable communities have gained access. This includes a focus on the availability of SAS products within rural markets; availability of quality certified products; after-sales services offered; and financing options available to both these communities and the retailers who supply them.

This study seeks to provide industry, key stakeholders from the commercial sector, investors, financial institutions, government, donors, civil society with an authoritative, insightful, and up to date overview of the off-grid solar space in Nigeria and key trends in the market and industry.

Specifically, the study sought to achieve the following objectives:

- ♦ Understand the degree to which the Nigerian SAS market is, or could be, reaching the most vulnerable populations.
- ♦ Provide up-to-date analysis of the state of the market to allow stakeholders to make informed decisions.

1.3 STRUCTURE OF THE REPORT

Section 2 summarises the methodology, including scope, definitions of terms, and the quantitative and qualitative research approach. Section 3 presents key findings on the supply of SAS (through traders) and demand (from household and MSME consumers). Sections 4 and 5 offer a closer look at two facets of the supply chain that pose challenges: after sales (including technical capacity) and financing. Section 6 provides a snapshot of gender and social inclusion (GESI) takeaways. Section 7 summarises key findings with a discussion on the implications and recommended actions to support the market.

2. STUDY DESIGN AND METHODOLOGY

2.1 SCOPE

This study was carried out between June and September 2020. It looked at trade and consumer segments across 10 states (Abia, Ado Ekiti, Bauchi, Cross Rivers, Ebonyi, Edo, Kano, Kogi, Oyo and Plateau) across six geo-political regions, highlighted in Figure 2. The northern regions are typically arid, with higher Muslim populations compared to the predominantly Christian south, and generally lower grid coverage.

As can be seen in Figure 2, the northern states typically have lower electrification rates and higher poverty rates than the southern states, an exception being Ebonyi in the South East which actually has the lowest electrification rate and highest poverty rate amongst the states surveyed

North Central

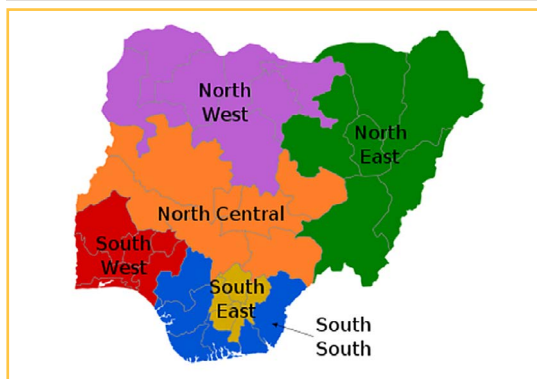
- The middle belt of Nigeria comprising Benue, Kogi, Nasarawa, Niger Plateau and the Federal Capital Territory -Abuja
- A transition zone between Muslim Northern and Christian Southern. The land is fertile and farming the major occupation. Benue is called the nations' food basket.
- Insecurity is a challenge
- Kogi and Plateau states chosen for this study have electrification rates of 50% and 31%, and poverty rates of 28.5% and 55% respectively.

North West

- The bedrock of the Fulani Caliphate in Nigeria, with predominantly Fulani states of Sokoto, Zamfara, Kebbi, Katsina, Jigawa, Kano and Kaduna. Islam is the dominant religion, and sharia law is interwoven in their culture
- The land is quite arid with a sizable number of cattle herders and many others engaged in the armed conflict
- The economic activities of this region are mainly farming, fishing (along river Niger) livestock rearing especially in cattle, sheep and goat, and mining of limestone in Sokoto
- Kano state chosen for this study has an electrification rate of 32% and poverty rate of 55%

North East

- The zone is made up of six states: Yobe, Borno, Bauchi, Gombe, Adamawa and Taraba states.
- There is a lot of pastoral farming and cattle herding done by Fulani Herdsmen in the region.
- There is quite a lot of commerce in the region, internally and with merchants who cross the border from Niger Republic, or Chad.
- Common security challenge due to Islamic Insurgents
- Bauchi state chosen for this study has an electrification rate of 56.5% and poverty rate of 61.5%



South-West

- The zone is made up of the six Yoruba speaking states of the country. Lagos, Ogun, Oyo, Ondo, Ekiti and Osun – which are predominantly Christian
- Endowed with both agricultural and commercial activities: Farming of cocoa, rubber, kola, oil palm, poultry, and piggery and limestone mining in Ogun state
- Proximity to Lagos state and port makes the zone a trade hub
- Oyo and Ekiti chosen for this study have electrification rates of 78% and 72%, and poverty rates of 9.8% and 55% respectively

South- East

- This zone is made up of the five Igbo speaking states of the country: Anambra, Imo, Enugu, Abia and Ebonyi – predominantly Christian
- The main economic activities are farming in crops like palm oil, rubber, kola and other food crops like yam, cassava, and rice.
- They are equally involved in mining activities in coal, petroleum, limestone etc.
- The zone is also noted for heavy trading and local manufacturing in Abia and Anambra state.
- Ebonyi and Abia states chosen for this study have electrification rates of 25% and 52%, and poverty rates of 79.8% and 30.7% respectively.

South- South

- Zone comprises six oil-producing states of the Niger delta. Edo, Delta, Rivers, Bayelsa, Cross River and Akwa-Ibom.
- The major economic drivers include the production of crude-oil (petroleum), limestone in Edo and iron-ore in Delta.
- States are equally involved in crop farming like cocoa, oil palm, kola, rubber etc, fishing due to their location in Niger Delta. Other economic activities are trading, banking, sea-port activities, etc
- Calabar Free trade zone, with Port Harcourt a gateway for import trade
- Edo and Cross River chosen for this study have electrification rates of 63% and 29%, and poverty rates of 12% and 36.3% respectively.

Figure 2 Geo-political regions of Nigeria at a glance a, b, c

A tiered approach was used to categorize the demographic, by urban towns (Tier 1), peri-urban (Tier 2) and rural (Tier 3).

The focus was on stand-alone solar products which were grouped into three categories according to structure and function; they were not grouped according to size (wattage).




Product	Description	Example
Solar lantern	Single piece lantern, with or without a separate charging panel.	
Solar Home System (SHS)	A complete unit including solar panel, multiple lighting points, control unit, and associated DC appliances that all come as a single kit.	
Solar panels	A solar panel that is independently sourced and coupled at the point of sale together with other power components to form a solar energy solution. Other associated components include batteries, charge controllers, inverters, and associated wiring.	

Figure 3 SAS Product description

2.2 SUMMARY OF APPROACH AND METHODOLOGY

2.2.1 Approach to this research

The driving questions informing the research design were:

- How common are SAS in the Nigerian market? This includes an understanding of the type, number, and geographic reach of shops – herein referred to as trade outlets – carrying solar.
- What products are for sale in the market? This includes estimating the proportion of products that have passed Global Quality Standards (Lighting Global, now IEC) versus those not quality verified, understanding market

and volume share, pricing, product features and counterfeits in the market.

- ♦ How many households and MSMEs are using SAS products and which products do they prefer? Our customer insights include demographic profiling of SAS owners, and understanding what they own, why they chose it, and any difficulties they have had.
- ♦ What after-sales services are provided by solar suppliers, and what technical capacity do they have to deliver these services? This sought to understand the extent to which customer services after the point of sale (installation, maintenance, and repair) are offered, who provides them and what challenges they face.
- ♦ What financing and distribution methods are being used? This looks at the availability of financing to traders and end users, including from solar suppliers, PAYG companies and formal institutions. It then explores the use of non-trade distribution models, such as through MFIs or brand agents.

2.2.2 Methodology

The study incorporated both quantitative and qualitative techniques to collect data. The quantitative approach involved a census of all potential trade outlets, followed by 'deep dives' of sampled SAS-dealing outlets, specialised technician shops, and consumers (households and MSMEs). The qualitative research involved in-depth interviews with stakeholders including PAYG companies, MFIs, Savings and Credit Organizations/Groups (SACCOs), NGOs, distributors / importers, and central and state government regulators.

The methodology is summarised below; further detail is in Appendix 1.

- ♦ A trade census was conducted among potential outlets in ten states spread across all zones in Nigeria to determine the penetration of SAS products in the trade. "Trade" included retail outlets of various sorts, regardless of whether they were selling solar products at the time of listing or not. A total of 13,235 outlets were scoped. Penetration is understood as the number of these retailers handling solar.
- ♦ A 'deep dive' sample of outlets that stocked solar products was drawn from the census in each town proportionate to the total number of outlets in the census count. In total, 726 solar traders were interviewed. Brand share is based on the total number of branded products available in the market.
- ♦ In addition, an "after-sales deep dive" used interviews with 288 specialised 'technician shops' that carry out installation, repair and maintenance of SAS to profile the technicians' skills and training; the most common repair issues that they faced; and their challenges.
- ♦ 40 in-depth key stakeholder interviews were conducted to understand the broader context of SAS market development in the country.
- ♦ Lastly, a consumer 'deep dive' interviewed a sample of 665 households and 222 micro, small and medium enterprises (MSMEs) to assess solar penetration and product preferences, as well as other characteristics of the demographic. This activity was designed with gender, equity, and social inclusion (GESI) lens.

3 SUMMARY OF FINDINGS

This chapter presents market data from supply (trader) and demand (consumer) angles. The supply side looks at penetration of SAS, SAS products in the market, and traders' views of consumer priorities. The demand side looks at penetration of SAS within households and MSMEs, consumer product preferences, and consumer priorities and spending patterns. The data is disaggregated by geography (Zone and State), demographic (Tier), product size (lantern, SHS, panel), and product quality (Lighting Global quality verified – LG QV – or non-QV).

3.1 SUPPLY OF SOLAR: THE RETAIL (TRADE) MARKET

Before the point of sale, a solar product may weave its way through several layers of handlers – importer, manufacturer, distributor / wholesaler – before reaching a variety of sales outlets. For this study, the terms trade and trader have been used to cover this customer-facing front of the business.

3.1.1 Penetration of SAS within the trade

Just 13.6 per cent of potential SAS trade outlets are stocking solar products, presenting a sizeable opportunity to expand the market. The trade market forms a parallel, albeit overlapping, supply chain to the “alternative” agent, franchise or partnership-based solar distribution networks used particularly by pay-as-you-go (PAYG) companies.

Of the three sizes of SAS observed, solar lanterns have the highest penetration overall. This holds true in urban (61 per cent), peri-urban (58 per cent) and rural (67 per cent) trade outlets. Solar panels are more prevalent in peri-urban outlets (33 percent) compared to urban areas (26%) and rural areas (25 percent). Few outlets in peri-urban and rural areas stock SHS, which are found predominantly in urban generator and battery shops, mobile service provider shops and retail hardware shops, all of which have the financial capacity to carry more expensive products.

Overall, penetration is higher in urban areas (Tier 1), and lower in peri-urban (Tier 2) and rural areas (Tier 3). As this does not correlate with low grid connection, it may have to do with limited distribution reach, lower trader awareness, and customer affordability. Interestingly, this is the opposite of what has been found in recent studies of the SAS market in Kenya, Tanzania and Ethiopia, where there has been deliberate targeting of rural customers who lack access to the grid (see Figure 4).⁶

Of the 11,391 trade outlets visited that were not carrying solar products, 62 per cent expressed an interest in doing so.⁷

Figure 4 Penetration of stand-alone solar products in African markets

GEOGRAPHIC TRENDS

High SAS penetration tends to correlate with low grid connection rates, but not always. States in the North (Central, West, and East) zones, where grid connectivity is lower, generally have higher SAS penetration compared to states in the Southern regions, where grid connection is higher. That said, Abia state in South East Zone has the highest penetration of SAS and very high grid connectivity – Abia cities Umuahia and Aba are trade towns with one of the largest electronics markets in West Africa, and as such could be a supply market for SAS across the country. High penetration of solar lanterns in these states supports the hypothesis that unstable grid power supply drives uptake of solar lanterns as an alternative.

6. *Lighting Africa (2017-18) Off-Grid Solar Market Deep Dive reports (Kenya, Ethiopia & Tanzania)*

7. *A database of these traders (disaggregated by state) can be provided for targeted communication with these potential distributors.*

The SAS opportunity is particularly attractive in populous states that have low grid connectivity such as Bauchi and Plateau, or low solar penetration, such as Oyo or Cross River⁸ – see Table 1.

Table 1 State by state comparison of SAS penetration, grid electricity and population

Zone	State	Trade outlets counted	Solar penetration	Grid connectivity	Population estimate
SW	Oyo	2,983	5.7%	67%	7,840,864
	Ekiti	887	13.0%	93%	3,270,798
SE	Abia	1,015	32.3%	82%	3,727,347
	Ebonyi	925	12.1%	39%	2,880,383
SS	Edo	1,267	11.8%	82%	4,235,595
	Plateau	1,254	13.9%	36%	4,200,442
NC	Cross River	1,004	4.9%	57%	3,866,269
	Kogi	820	19.4%	63%	4,473,490
NW	Kano	2,429	17.3%	52%	13,076,892
NE	Bauchi	661	19.7%	29%	6,537,314
	TOTAL	13,245	13.6%		

Whereas lanterns and panels are widely stocked across the country, SHS are more of a specialty item. Solar lanterns have higher penetration than SHS and panels in six of the ten states covered. Solar panels were found in only 26 per cent of the outlets, which were disproportionately located in Ebonyi, Edo and Kano states. SHS has the lowest penetration overall, though with some pockets of higher prevalence.

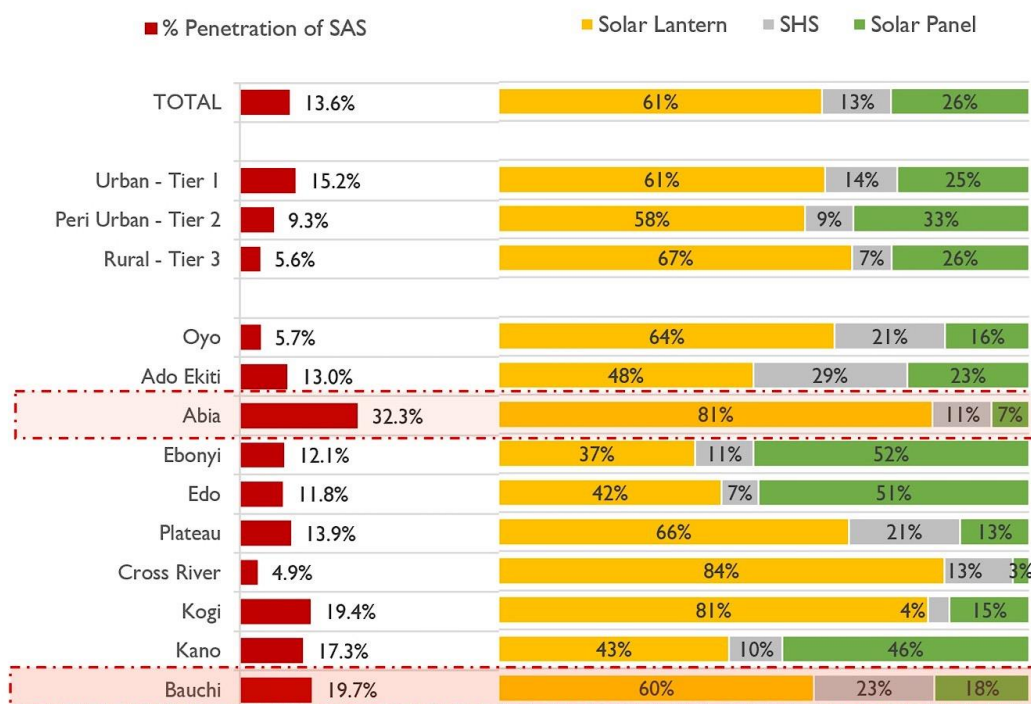


Figure 5 Penetration of SAS by tier and state

TYPES OF TRADE OUTLETS STOCKING SAS

SAS are typically stocked in electrical and electronic appliances wholesalers and distributors (32.5 per cent) and supermarkets (20.7 per cent). Solar specialty shops, not surprisingly, had the highest penetration (94.7 per cent⁹) – though these are few and sparsely distributed, and none were found in rural areas.

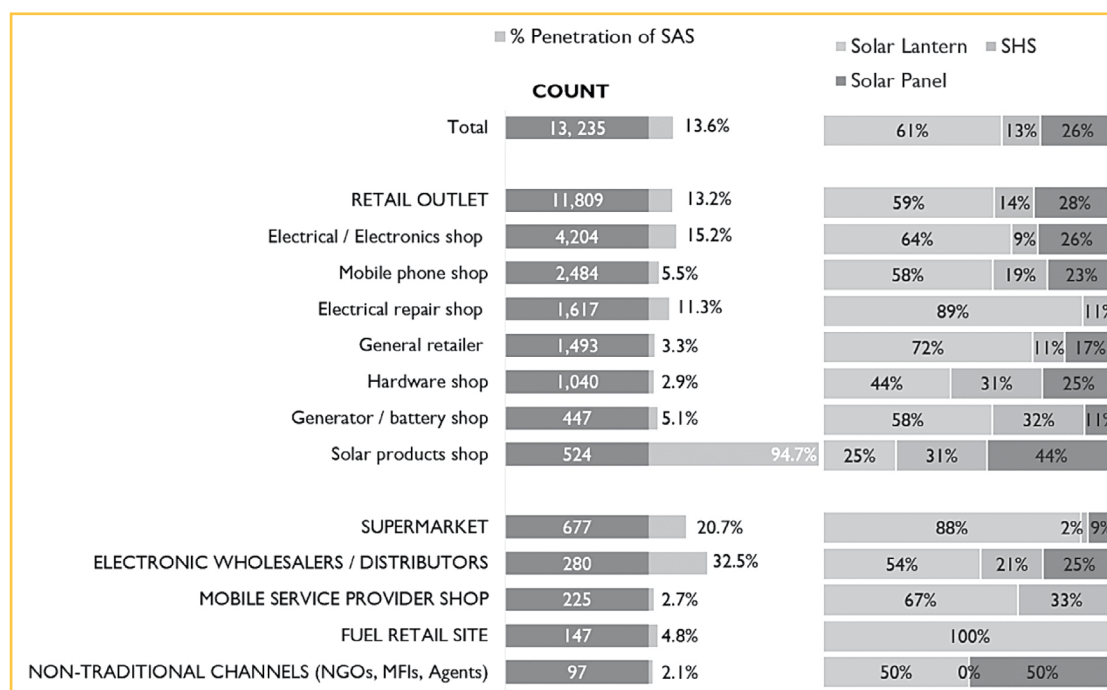


Figure 6 Penetration of SAS and SAS categories by type of trade outlets

The lower-case list under Retail Outlet is a breakdown of different retail outlets. Percentages in pink are of each sub-category on the left. For example, 3.3% of the 1,493 general retailers had solar in stock.

PRODUCTIVE USE APPLIANCES

Traders in urban and peri-urban areas are stocking productive use (PUE) solar products, with the exception of solar batteries and streetlights, at much lower penetration than SAS. Some products such as high-capacity panels are found predominantly in wholesalers and distributors, who will sell them to corporate clients.

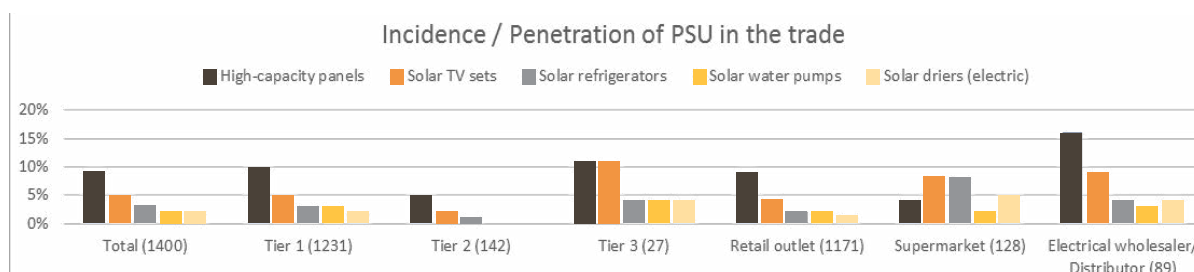


Figure 7 Selected productive solar use products found in the trade (base figure is number of total outlets scoped)

9. Some shops identifying as solar suppliers did not have any stock at the time of the visit.

3.1.2 SAS products in the market

This section looks at how many and which unique branded products are stocked, whether these brands are Lighting Global (LG) QV or non-QV, and in what numbers traders are stocking them. This last data point offers a proxy of consumer popularity, that is, what traders think are going to sell in volumes. The findings are organised by product size: lantern, SHS and panel.

Decisions on which SAS product(s) traders stock is driven by customer preference, profit margin and recommendations from suppliers. The quality of products varies widely, with few instances of installation guidelines or warranty. Under 10 per cent of customers reported getting a warranty, although 80 per cent of QV brands offer it. A common perception is that SAS products are expensive, perform poorly and are therefore a risky investment.

64 per cent of traders have the impression that there is a moderate to high presence of counterfeits in the market, mainly in Tier 1 areas and in the high-volume North-West and North-East regions. Less than half of traders say they can identify a quality product; those who can do so mainly through certain product features, availability of a warranty, or performance. Nearly half (44 per cent) have no knowledge of any solar product certification organization; 40 per cent volunteered the ISO standard, 10 per cent IEC and 11 per cent knew of Lighting Global.

The SAS market suffered somewhat – along with the rest of the economy – by measures taken to mitigate the spread of COVID-19. 87 per cent of traders felt an effect on their business from March-May 2020. They reported: reduced sales (67 per cent), higher cost of stock (52 per cent), business closure due to curfew and lockdowns (46 per cent), reduced customer numbers (41 per cent), reduced training hours (38 per cent) as well as challenges in restocking (38 per cent). Sales fell in March 2020 but seemed to ease by May 2020 (see Figure 8).

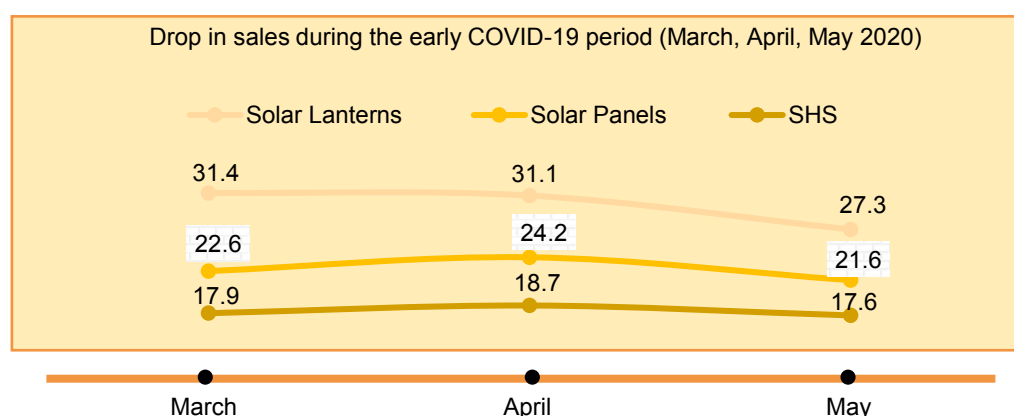


Figure 8: Impact of COVID-19 to traders over three months

SOLAR LANTERNS

The solar lantern category is extremely competitive, with 170 unique brands found in stock. The market leader is Lontor, with a 9 per cent brand share.

Lighting Global quality verified (QV) lantern brands comprise just 23 per cent of the brands in the market and are carried by 56 per cent of traders (see Table 2). Non-QV brands are more prevalent in the Northern regions, where there is an overall higher penetration of solar product compared to the Southern Regions. The Nigerian market shows a similar prevalence of non-QV brands to SAS markets in Tanzania and Ethiopia. Kenya trends ahead, with the highest share of QV brands and QV reach within the trade.

Table 2 Solar lanterns: comparison of Nigeria with other markets in Africa¹⁰

	Nigeria	Kenya ¹¹	Tanzania ¹²	Ethiopia ¹³
Total number of brands	170	92	148	165
Brand penetration (brands stocked) QV	23%	42%	20%	18%
Trade penetration (outlets stocking) QV	56%	65%	28%	54%

10. As the three earlier country deep dives are several years old, this cross-country comparison is presented as indicative of a point in market development.



There are sometimes major discrepancies in retail price for what appears to be the same product (see Table 3). The average selling price for the Lontor lantern, for example, is NGN 2,900 (USD 7.62), but in many instances, it sells at nearly half that. Similarly, the leading d.light products were found at fractions of their average price in some places. This points to the likelihood of counterfeits. It is useful to note that in practice the researchers conducting this study could not easily distinguish counterfeits – an indication of how difficult it is for traders and their customers as well.



Prices between products also vary widely. Over half of the non-QV lantern brands cost below NGN 2,000 (USD 5.26), but with brand shares of less than 1 per cent it seems they have been ‘dumped’ in the market. The cheapest lantern found was Lihong LH-404 (NGN 500 or USD 1.31), while the most expensive were OvBeacon MB2 – 200 (NGN 48,000 or USD 126.15) and Luminous (NGN 50,000 or USD 131.41).¹⁴ The latter brands are marketing to a different demographic, a higher income or even corporate segment looking for high quality, multiple function solar ‘lanterns’.

Lack of quality verified status can either mean a product is low quality or that it has not (yet) been tested. It is important to note this in a market dominated by non-QV product. The popularity of the Lontor, DP LED and Saroda brands with traders may warrant including them in future quality verification efforts.¹⁵

Table 3 Solar lanterns: brand share, QV status and price comparison of the top brands

Solar lantern	Brand share	Quality status	Selling price	
			Mean (NGN)	Mode (NGN) ¹⁶
Lontor	9%	Non-QV	2,905	1,500
d.light S2	8%	QV	2,870	3,000
P-Solar Lantern	8%	QV	4,484	1,500
d.light S20	6%	QV	7,399	5,000
DP LED (7084)	4%	Non-QV	1,225	700a
d.light A1	3%	QV	8,602	1500a
Saroda	3%	Non-QV	3,832	2000a
d.light S100	2%	QV	2,978	1,000
d.light S300B	2%	QV	12,609	3500a
DP. LED light (torch)	2%	Non-QV	2,109	2,000
Multifunction solar panel	2%	Non-QV	3,475	3,000
Sun King Boom	1%	QV	2,389	3,000
Sun King Pico Plus	1%	QV	7,850	7700a

11. Lighting Africa (2018) Off-grid Solar Retail Deep Dive – Kenya

12. Lighting Africa (2018) Solar Off-Grid Market Research in Tanzania

13. Lighting Africa (2017) Off-Grid Market Study – Ethiopia

14. As noted in the Methodology, SAS were not categorized according to wattage but rather structure. This large price differential shows the range of cost for a single basic solar lighting unit with the more expensive products having multiple features.

15. It is likely that the pervasiveness of counterfeits, and their indistinguishability from quality brand products, skews the data toward an over-reporting of QV in the market. The exclusion of some popular brands from QV status due to lack of testing (as opposed to lack of quality), potentially skews the data toward an under-reporting of quality product in the market.

16. “a” signifies more than one mode. The mode with most respondents is reported here.



Figure 9 Solar lanterns in a display outside a shop in Jos-Plateau

The top three brands are carried at similar levels by traders in urban and peri-urban areas, but d.light dominates the rural market. With one exception (DP LED), the only top brands available in rural (Tier 3) outlets are QV. Some are evenly distributed across the country, such as d.light, while a couple have larger shares in certain zones. P-Solar Lantern, for example, dominates the South East lantern market, and Lontor the North Central one. These differences in availability may point to distribution networks with deep regional reach, perhaps through family-owned businesses, corporate partnerships, or local franchises.

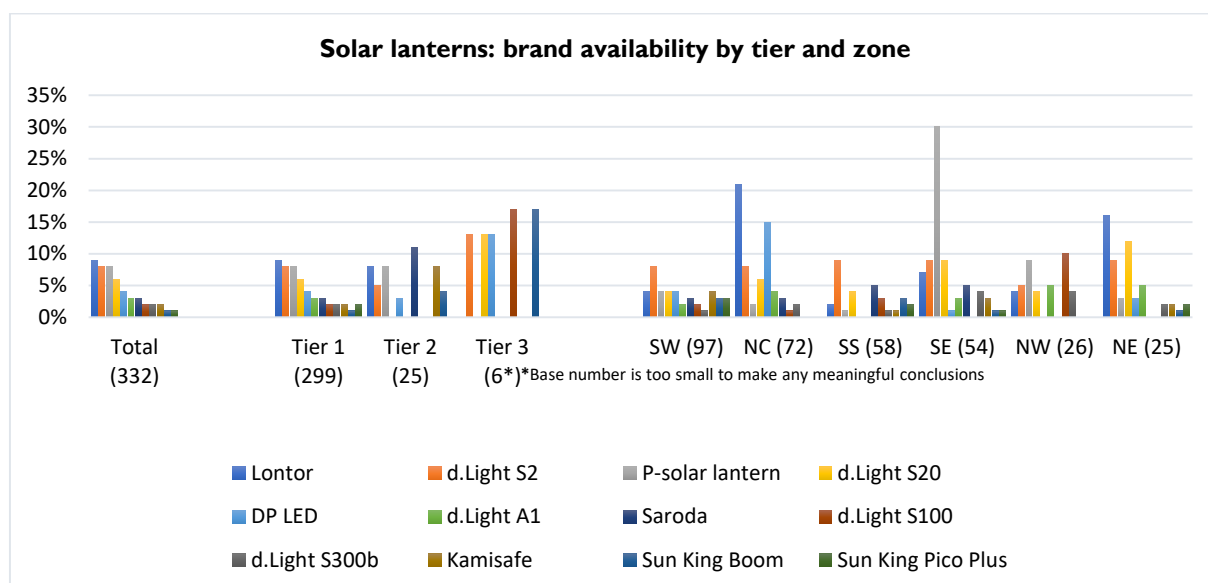


Figure 10 Solar lanterns: brand availability by tier and zone

As noted above and shown in more detail in Figure 11, the data appear to show that QV lanterns are stocked in more outlets and higher numbers disproportionate to the number of brands they represent. This could indicate an encouraging consumer preference for quality product or a prevalence of QV counterfeits at attractive prices.

Oyo and Ebonyi have the lowest share of QV brands (16 per cent and 21 per cent of the overall brands available, respectively).

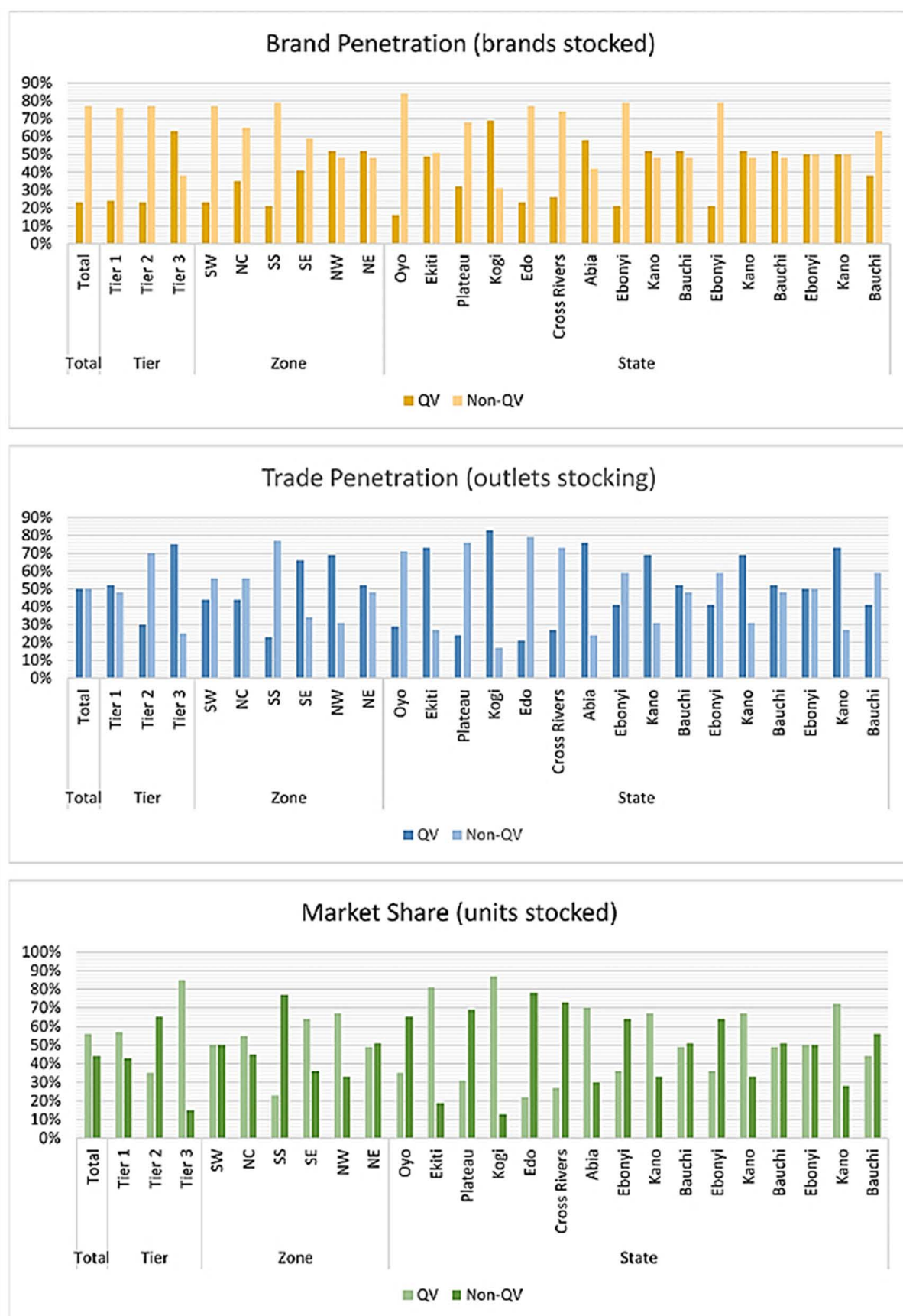


Figure 11 Solar lanterns: brand share v. volume share v. market share

SOLAR HOME SYSTEMS (SHS)

This study counted 99 unique SHS brands, of which 21 were QV. Penetration of QV SHS is remarkably high – in 60 per cent of trade outlets – which is about on par with Kenya and much higher than in the Tanzanian and Ethiopian markets (see Table 4).

Table 4 SHS: comparison of Nigeria with other markets in Africa

	Nigeria	Kenya ¹⁷	Tanzania ¹⁸	Ethiopia ¹⁹
Total number of brands	99	83	70	110
Brand share (brands stocked) QV	21%	51%	44%	24%
Trade share (outlets stocking) QV	60%	61%	43%	29%

Given that SHS have only 13 per cent penetration in the trade, the sample of SHS sellers is too small to draw meaningful insights about geographic differences or specific brands. However, when analysed at QV or non-QV level, Abia, Ebonyi and Kano had a higher proportion of QV SHS (over 50 per cent) than other states. The study did not find any QV SHS brands in Edo state (See Table 5).

Table 5 SHS penetration

		Brand penetration (brands stocked)		Trade penetration (outlets stocking)		Market share (units stocked)	
		QV	Non-QV	QV	Non-QV	QV	Non-QV
Total	Total	21%	79%	53%	47%	60%	40%
Tier	Tier 1	22%	78%	54%	46%	60%	40%
	Tier 2	18%	82%	22%	78%	29%	71%
	Tier 3	-	100%	-	100%	-	100%
Zone	SW	23%	77%	42%	58%	48%	52%
	NC	28%	72%	45%	55%	59%	41%
	SS	20%	80%	13%	88%	8%	92%
	SE	56%	44%	64%	36%	64%	36%
	NW	50%	50%	73%	27%	72%	28%
	NE	38%	63%	41%	59%	44%	56%
State	Oyo	24%	76%	35%	65%	47%	53%
	Ekiti	31%	69%	45%	55%	49%	51%
	Plateau	13%	87%	12%	88%	11%	89%
	Kogi	48%	52%	59%	41%	63%	37%
	Edo	-	100%	-	100%	-	100%
	Cross Rivers	25%	75%	17%	83%	10%	90%
	Abia	63%	38%	65%	35%	64%	36%
	Ebonyi	50%	50%	50%	50%	50%	50%
	Kano	50%	50%	73%	27%	72%	28%
	Bauchi	38%	63%	41%	59%	44%	56%

17. Lighting Africa (2018) Off-grid Solar Retail Deep Dive – Kenya

18. Lighting Africa (2018) Solar Off-Grid Market Research in Tanzania

19. Lighting Africa (2017) Off-Grid Market Study – Ethiopia

Six of the top ten SHS brands available in the Nigerian market are QV. Leading brands d.light and Sun King are competitively priced (see Table 5). The lowest-priced brand in this league is Saroda, which is not QV. There appears to be less of an issue with counterfeiting of SHS than with lanterns; here, price differences are likely to be related to geography (e.g., logistics costs from a main city) or sales channel particulars.

Table 5 SHS: brand share, price, and QV comparison of the top brands

Brand	Brand penetration	Selling price		Quality status
		Mean (NGN)	Mode (NGN)	
d.light D30	10%	22,152	15,000	QV
Sun King Home 120	5%	15,045	15000a	QV
Sun King Home Plus	5%	23,777	-	QV
Solar Home Lighting System	5%	56,782	10,000	QV
Saroda	3%	6,417	-	Non-QV
Home Mate H1/H1G	3%	28,667	2000a	Non-QV
Go So Firefly 12	3%	37,786	5000a	Non-QV
d.light D20 / D20-g	2%	13,160	30,000	QV
M-Power family (PAYG)	2%	52,000	-	QV
Gold Sunshine	2%	34,800	15000a	Non-QV
Others (<1% each)	59%			

SOLAR PANELS

Solar panels, as elsewhere, come in a wide range of sizes. As noted above, this study focused on smaller capacity panels that would, together with the other components of a system, appeal to buyers of SHS-sized systems.

Sunshine Solar leads the market by a large margin, with at least six panel sizes (see Figure 12) and strong brand share across all of them. Saroda comes a distant second with a share of 6 percent, available mainly in the 11-20Wp category.

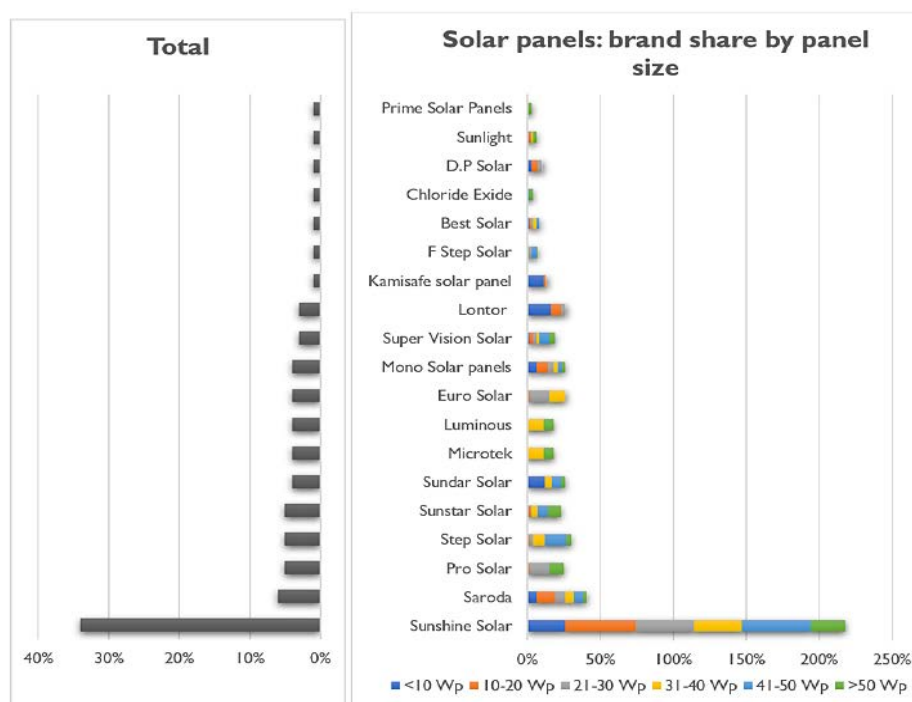


Figure 12 Solar panels: brand share by panel size

Smaller panels come with user guides explaining the gadgets that they can power, clearly competing with complete SHS units. This range (<10Wp – 20Wp) accounts for 33 per cent of all the panels we encountered in the trade. Mid-sized solar panels (21Wp – 50Wp) accounted for 38 per cent of all the brands, and were popular, especially for households with multiple uses beyond lighting.

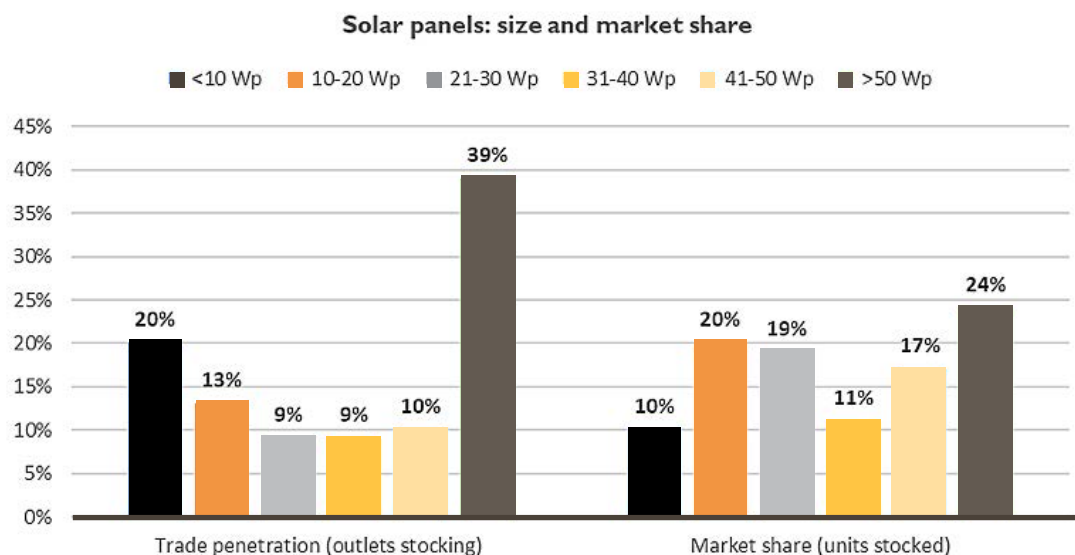


Figure 13 Solar panels: size and market share



Figure 14 Low-capacity panels on sale in the market

10Wp-50Wp panels are displayed out of their packaging. Traders have options to offer credit for some brands, such as Beebeejump (as pictured in the photo below).



Figure 15 Higher capacity solar panels in the trade

Solar panels performed better in North Central and North West, particularly the Sunshine brand – in line with overall higher SAS sales in the North.

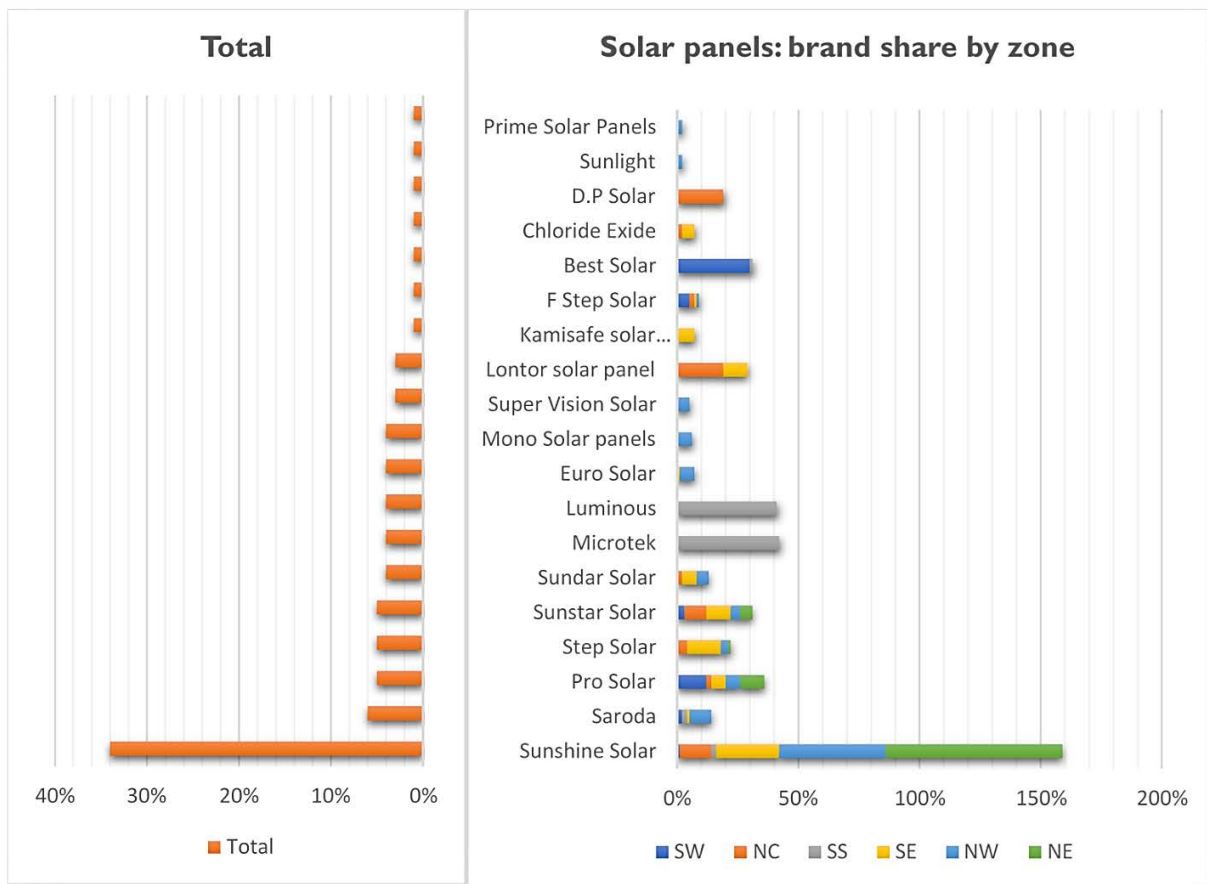


Figure 16 Solar panels: brand share by zone

3.1.3 Customer Priorities

The traders see their customers' SAS choices as driven by affordability, trust, and availability. Figure 17 shows the characteristics most associated with each of the most popular panel, SHS and lantern brands. Though the traders were describing what their customers favour about their purchases, their responses also shed light on the traders' own views of the relative merits of different brands and products

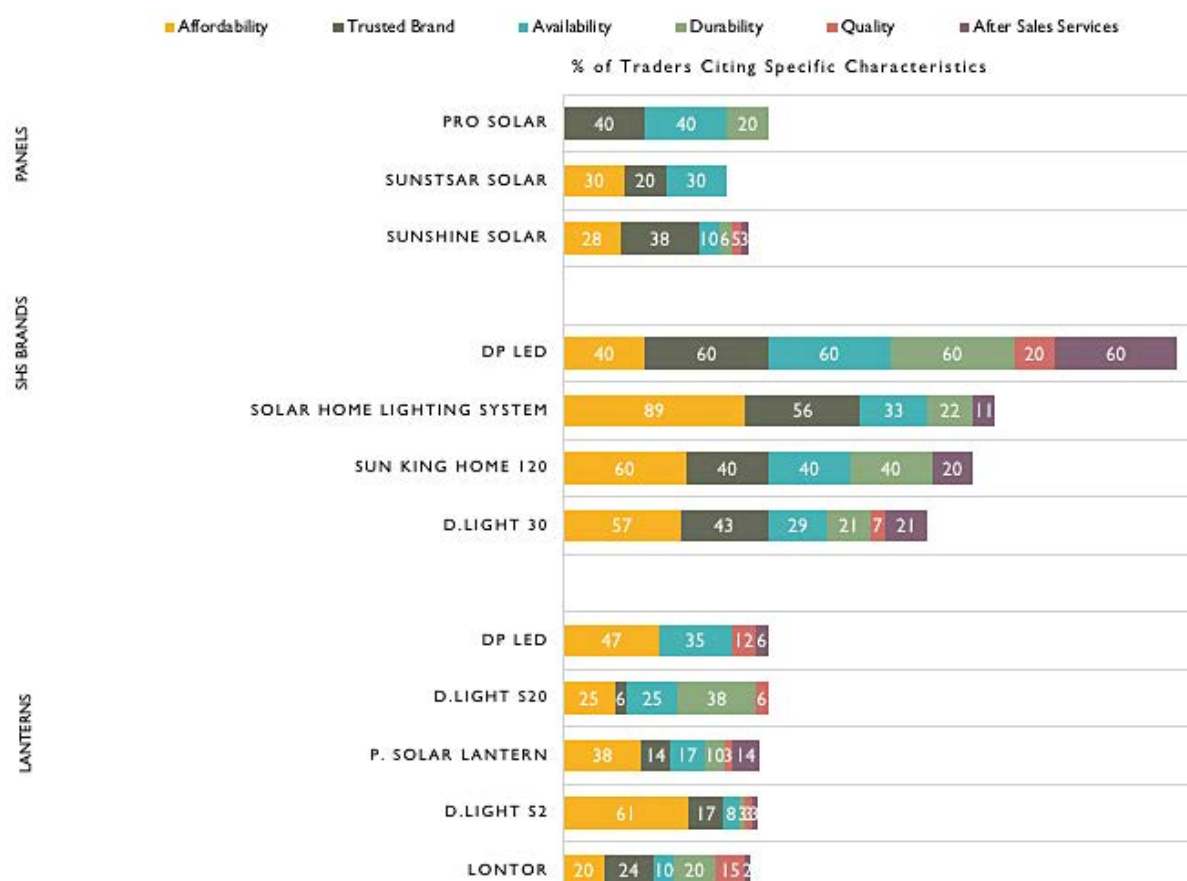


Figure 17 SAS: traders' views of customer choice drivers

3.2 CONSUMER DEMAND: HOUSEHOLDS AND MSMEs

The study looked at demand for and use of SAS by households and small businesses ("consumers"). This centred around penetration of SAS in homes and MSMEs, which products and brands were found, and consumer priorities in choosing solar.

3.2.1 Penetration of SAS among consumers

HOUSEHOLDS

27 per cent of the households visited had a solar product in the home. A higher penetration among end users than in the trade (double the rate) could signal latent demand, a large supply coming through non-trade channels, a concentration of supply, or other dynamics.

Solar is more prevalent among peri-urban and rural customers than urban ones, who are more likely to be grid connected. Penetration to some degree aligns to regional differences in grid coverage and trade penetration.

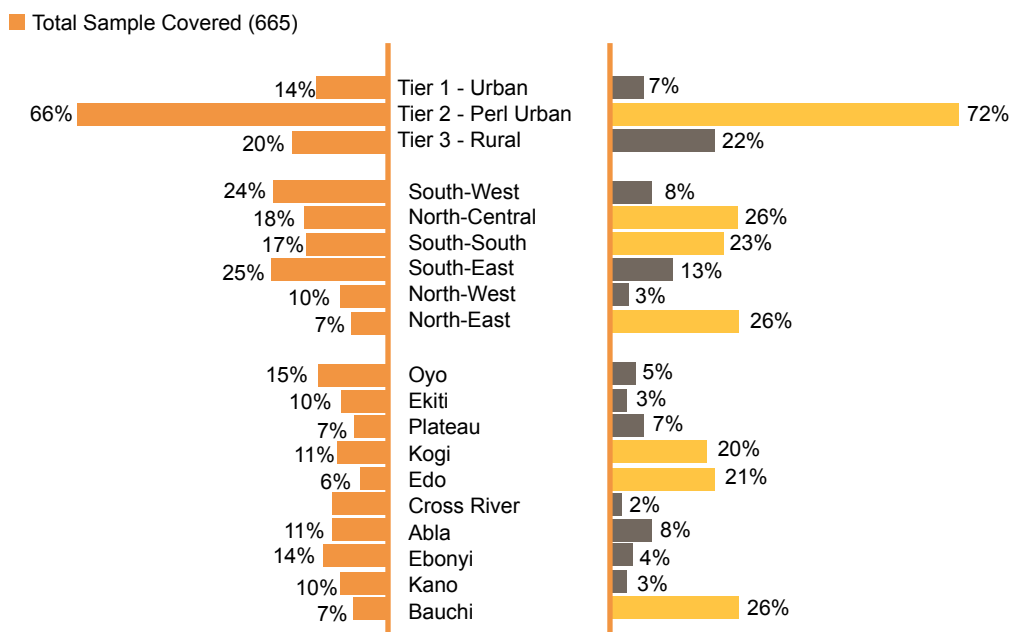


Figure 18 Profile of SAS consumers by tier, zone, and state

SAS remain largely a middle-class product. SAS users have slightly higher incomes and nicer homes than average. Most are in professional occupations such as teachers, lawyers, accountants, nurses, engineers, and administrators. A few inferences may be drawn: firstly, professionals are more exposed and adaptive to new technologies, and secondly, they have consistent income, which allows for planning and budgeting. Furthermore, they may socialise or work in networks that generate access to SAS products.

On average solar-owning households have six members living together, with two school going children, in three room homes. This is a relevant in understanding potential size and capacity needs.

Over 80 percent of peri-urban solar users are connected to grid, which is unreliable, with outages sometimes running for over three months. Nearly all solar users have a mobile phone, which is noteworthy in considering opportunities to leverage on mobile reach.

The study attempted to speak to more female respondents – either heads of household or decision-makers within the home. Of the 86 per cent of interviewees that were female, 79 percent were solar owners. Of the deliberately smaller sample of 14 per cent males, there was a relatively high proportion who had solar.

Youth below the age of 25 had slightly higher rates of SAS usage than other age brackets, pointing to the appeal of SAS among the younger generation. Previous studies have noted the difficulty of driving consumer adoption of SAS due to resistance towards ‘newer’ solar technologies.²⁰ Very few solar owning households had a family member with a disability.

The disaggregated profile analysis is presented in Figure 19.

20. Key Barriers to the Implementation of Solar Energy in Nigeria: A Critical Analysis, 2017, IOP Conference Series Earth and Environmental Science

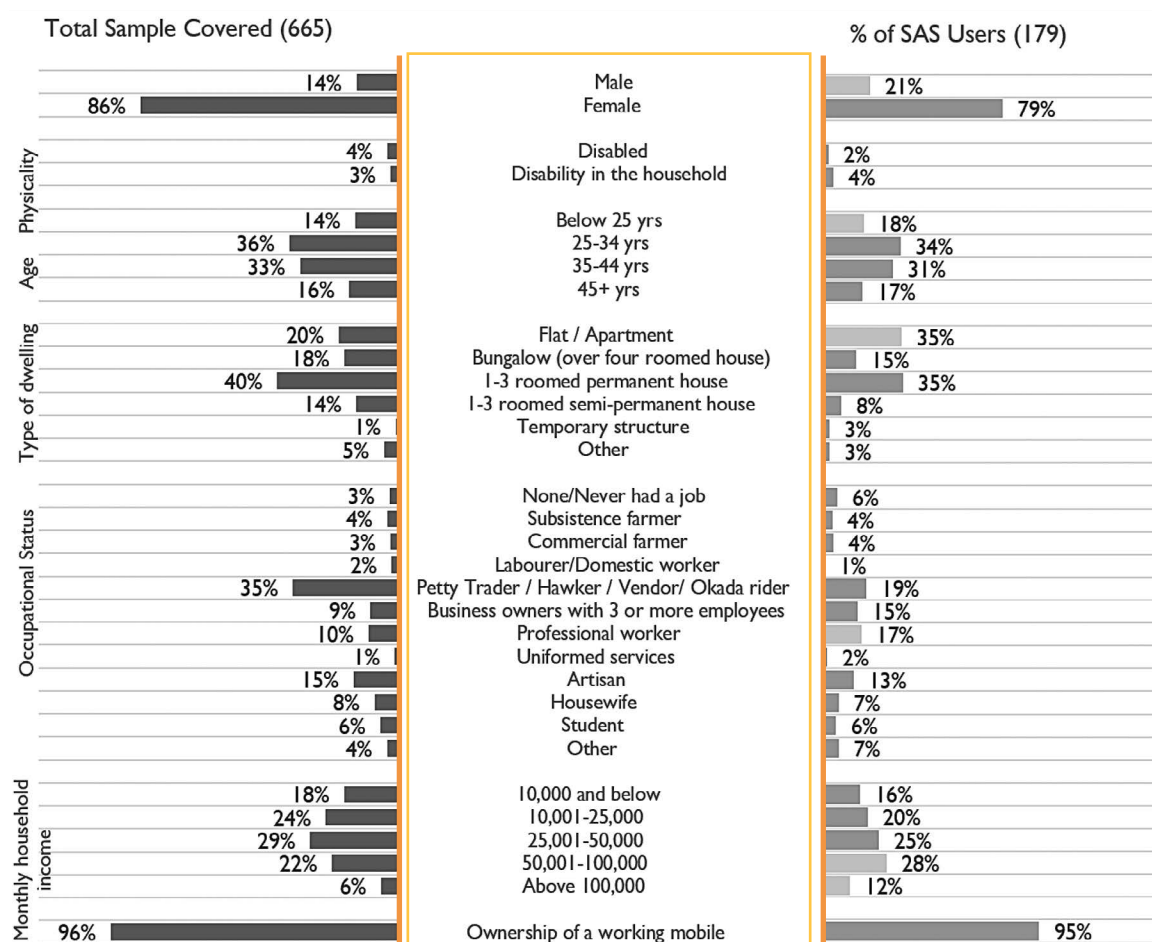


Figure 19 Consumer households: demographic profile

The SHS market remains largely untapped. 51 per cent of solar owners were using solar panels, 47 per cent solar lanterns and just 13 per cent SHS. In some cases, a user had more than one product, most commonly a lantern and a larger capacity panel.

Household SAS owners use solar alongside other sources of lighting. Those who are connected use grid electricity, and dry cell torches are also common. Nearly a third of SAS owners have generators, and a limited number also had kerosene lamps, candles or firewood. When asked which was the main source of lighting in the household, 19 per cent of SAS users indicated solar panels, while 12 per cent indicated solar lanterns and just 1 per cent indicated SHS. Solar is playing a backup role in the household power supply.

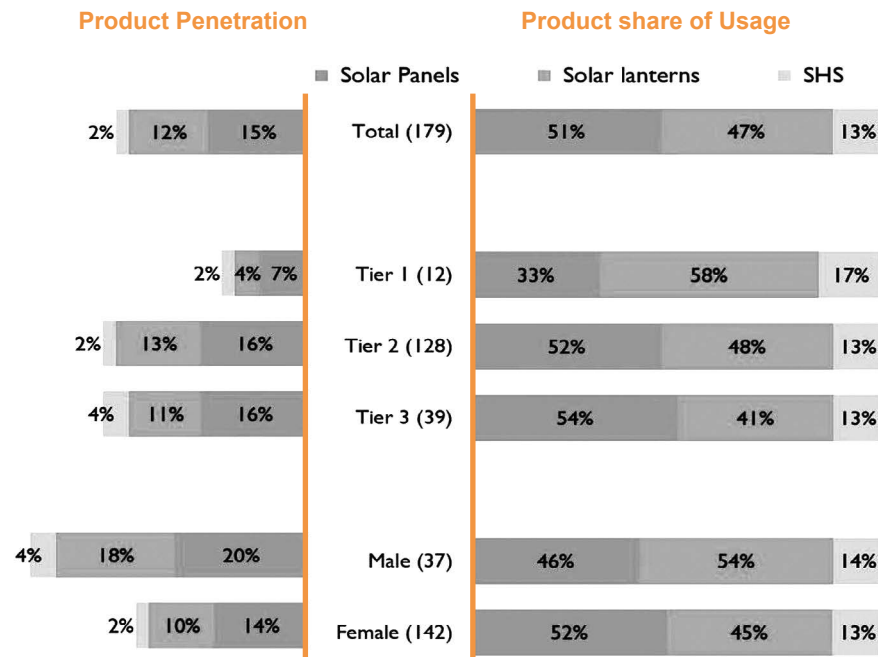


Figure 20 Consumer households: SAS product penetration

Two thirds of households use their SAS product for purposes other than lighting – primarily phone charging, TVs, and radios. Productive uses included shop lighting, phone charging and other business needs, such as equipment for a barbershop or salon.

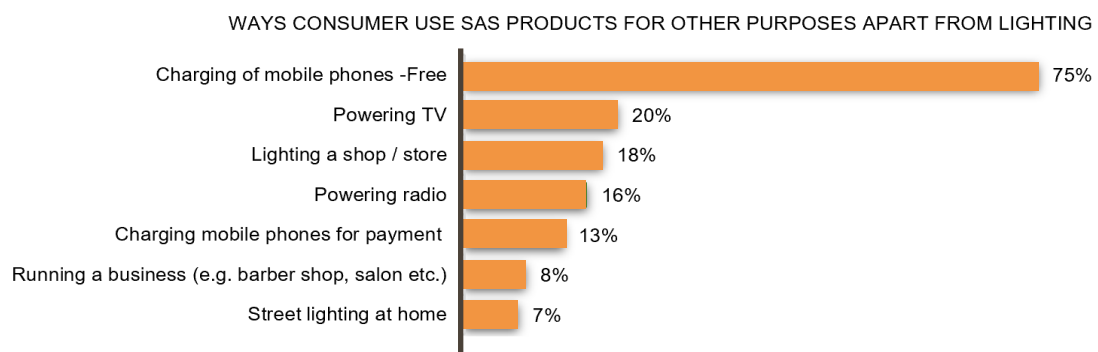


Figure 21 Consumer SAS uses beyond lighting

MICRO, SMALL AND MEDIUM ENTERPRISES (MSMES)

47 per cent of MSMEs had an SAS product on the premises, with a higher prevalence in peri-urban areas. Higher penetration was observed in male owned businesses and those more than five years old. SAS were particularly common at healthcare and social service, wholesale and trade, and ICT enterprises.

83 per cent of MSME lantern owners bought it from a retail shop or brand agent, while 17 per cent were given it. 97 per cent of MSMEs that owned panels bought them in the trade. On the other hand, 100 per cent of MSMEs with SHS bought them from brand agents. Similar to the consumer segment, solar panels have a higher penetration among MSMEs.

Consumers were affected by the worsening financial situation in mid-2020, as well as reduced variety of products in the stores, higher prices of goods and difficulties in accessing them. Half of the surveyed MSMEs reported feeling the impact of COVID-19 on the financial standing of their business.

11 per cent of MSMEs had a staff member or owner with a disability. Three quarters of MSMEs were housed in permanent structures, with no differences noted between those using SAS and those not.

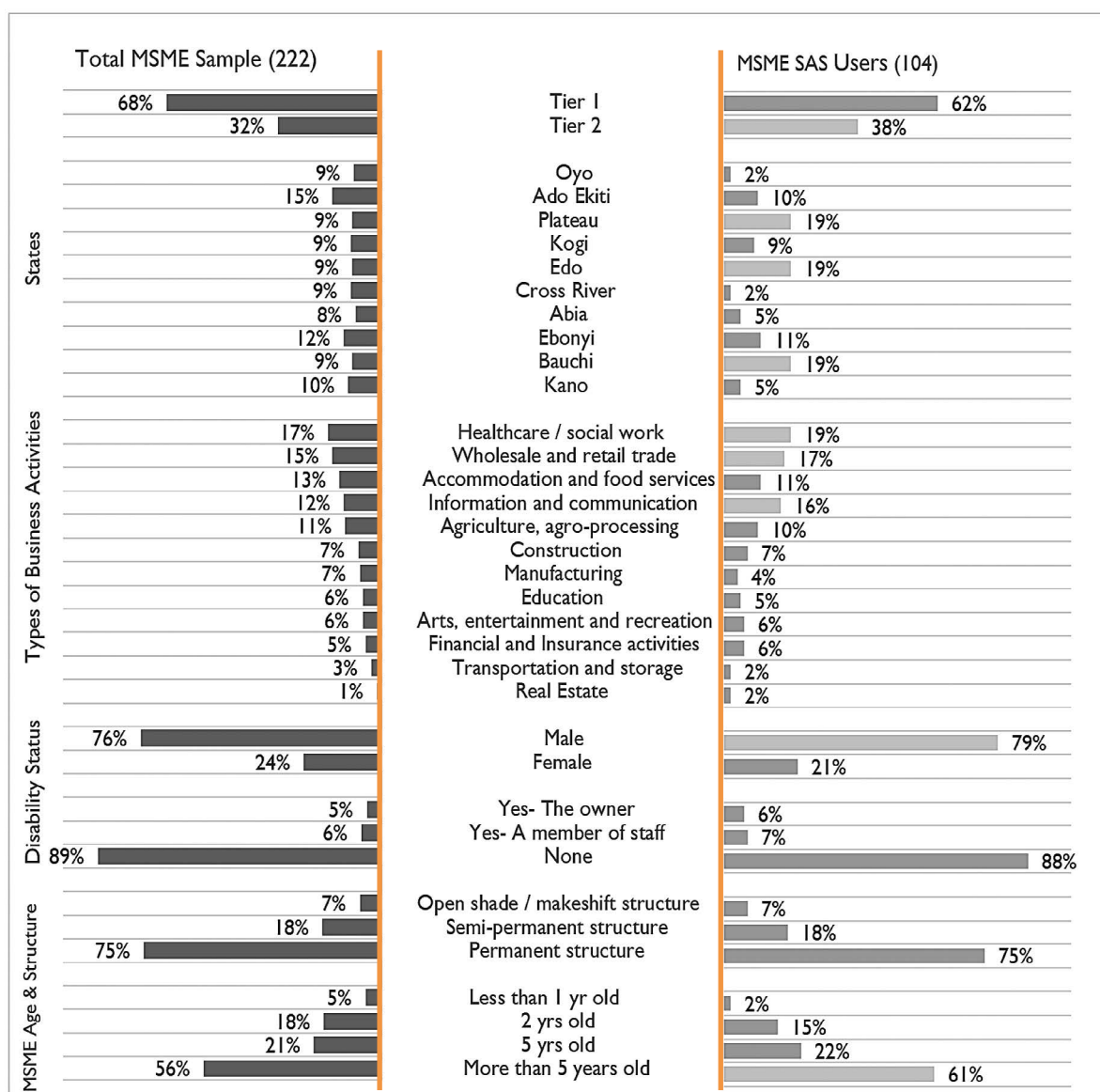


Figure 22 Consumer MSMEs: demographic profile

Notably, MSME SAS users are using solar panels at higher rates than generators – an indication that solar may to some extent be replacing fuel power. Solar lanterns and SHS had low penetration and share among this segment.

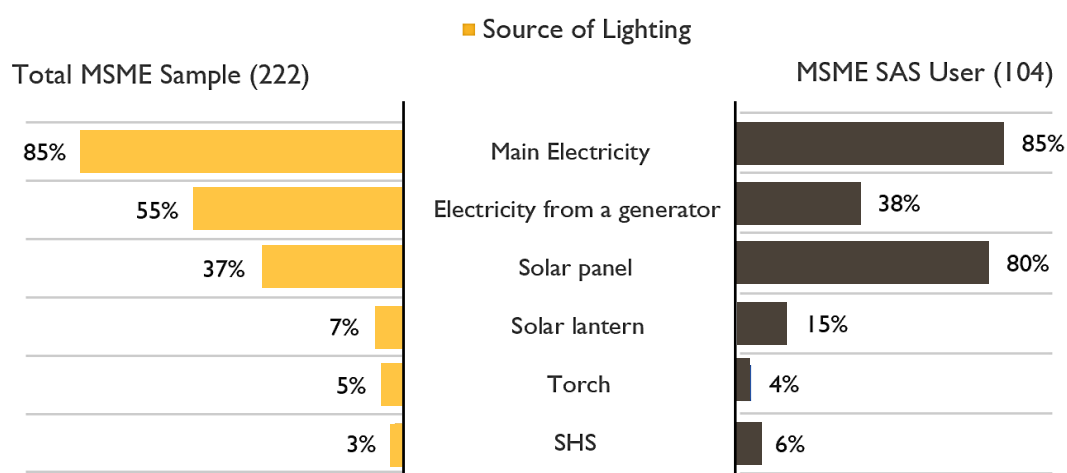


Figure 23 Consumer MSMEs: primary source of lighting

3.2.2 Consumer product preferences

This section links supply and demand with comparisons of what traders are selling to what consumers are using. Most solar users have bought their SAS product from an urban trader. Affordability, trust, availability, product life span and quality drive brand choice. Recommendations are important because SAS customers still have low brand recognition and quality awareness.

SOLAR LANTERNS

The most popular brand of solar lantern with consumers was d.light, with a combined brand share of 22 per cent (four products). This is followed by Sun King (12 per cent), Free Light (7 per cent) and DP.LED (5 per cent). d.light, Sun King and DP.LED also are widely stocked in the trade.

Lontor, the most-stocked brand by traders, has low traction among consumers. This may in part be due to an uneven distribution in the trade, focused on the Northern regions. On the other hand, Sun King, which has lower penetration in the trade, has a disproportionately higher usage among consumers – the result of a robust network of agents. Considering the population size, even brands with a 1 per cent consumer share can have significant volumes and are providing up to Tier 1 access to consumers in certain areas.

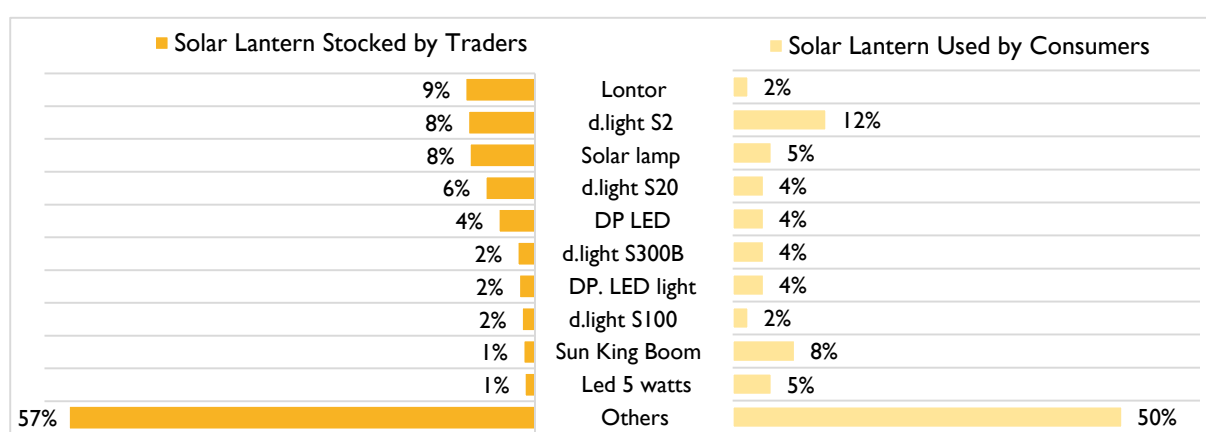


Figure 24 Solar lanterns stocked v. solar lanterns used by consumers

SOLAR HOME SYSTEMS

Consumers seem to buy SHS predominantly through non-trade channels. Of the most popular brands – Sun King (21 per cent), d.light (13 per cent), Luminous (13 per cent) and Lontor (8 per cent) – only d.light appears to be bought from trade (see Figure 25).

Consumers are buying a less diverse range of SHS product than is offered by the trade. 37 per cent of the SHS in households and MSMEs are from brands with each less than 2 per cent share; a whopping 59 per cent of SHS in the trade are from low-share brands.

Other than Lontor, all the top SHS brands used by consumers are QV, mirroring the (slightly lower) prevalence of QV brands sold in the trade (6 of the top 10 brands). The specialised nature of QV SHS – a pre-designed kit, often available with appliances, after-sales attention, and consumer financing through PAYG – seems suited to sales through networks of trained agents. Users of Lontor SHS praise it for its quality and durability, the more reason to target this brand for quality testing.

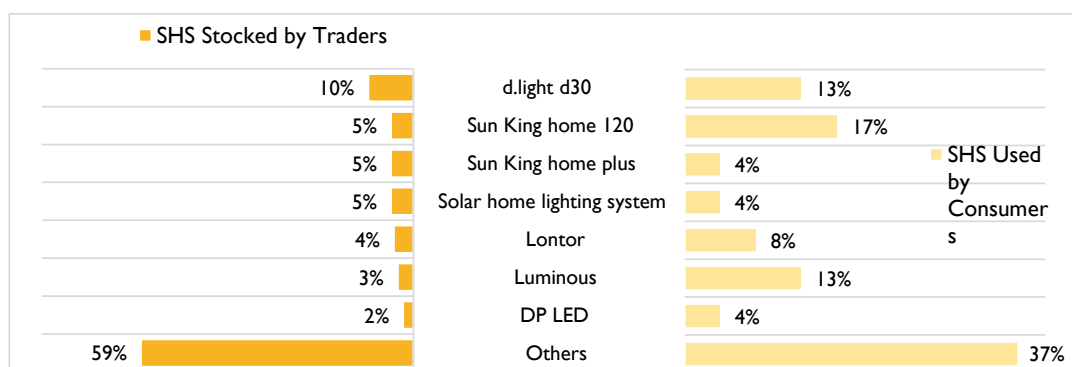


Figure 25 SHS stocked v. SHS used by customers

SOLAR PANELS

Sunshine is the leading solar panel brand in both the trade and among consumers, with a share of 35 per cent and 15 per cent, respectively. Some of the other top brands were found in homes and businesses at greater levels than in the trade – a discrepancy possibly attributable to alternative sales channels or stock shortages related to COVID-19 disruptions. Some of the ‘excess’ stock of Sunshine panels, additionally, would likely be sold to larger corporate or institutional clients.

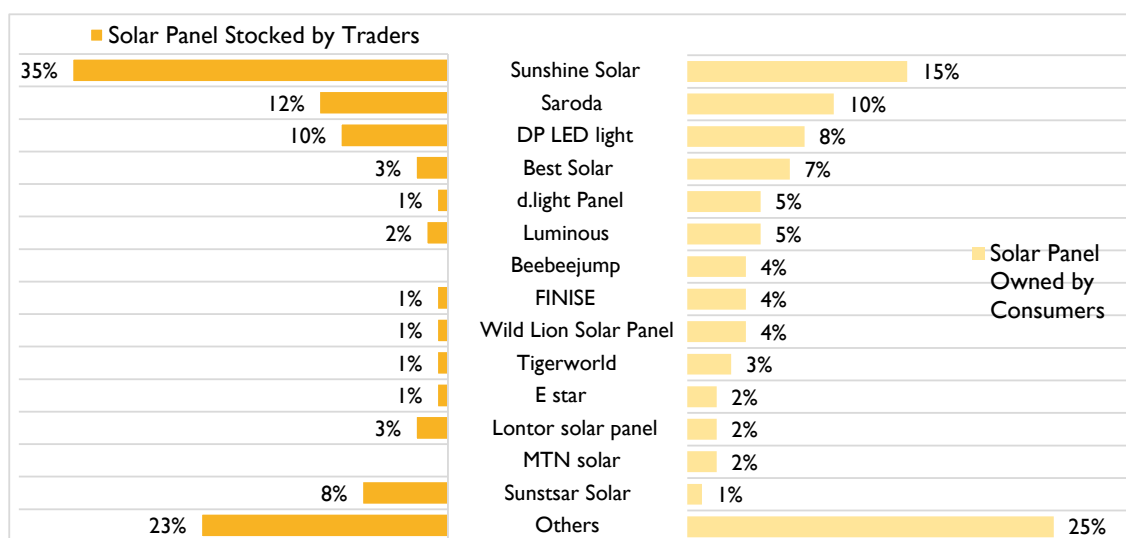


Figure 26 SHS stocked vs SHS used by consumers

CONSUMER PRIORITIES

Households and MSMEs were asked what drove their decision regarding an SAS product. Safety is important to lantern customers looking to switch away from kerosene or candles; SHS customers are looking to light more rooms in the house.

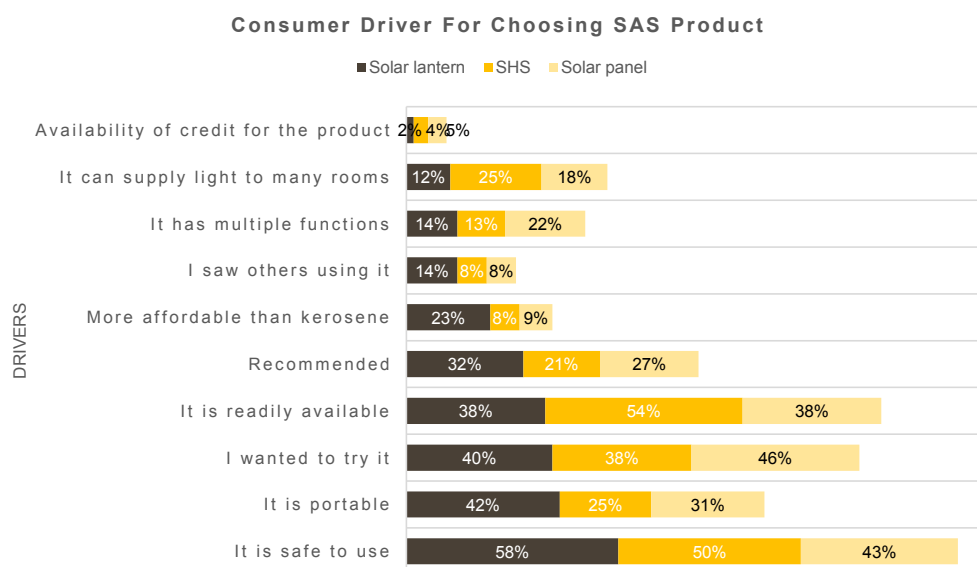


Figure 27 Consumer drivers for choosing SAS product

Most consumers reported buying their solar products from a trade outlet, and most paid cash (solar lantern – 94 per cent, solar home system – 67 per cent, and solar panel – 83 per cent). Although PAYG is being used only to a limited extent, it was more common for SHS (28 per cent) than other products, as could be expected given the focus of PAYG companies.

Consumers had limited means of identifying quality products. 12 per cent of households and 32 per cent of MSMEs volunteered that they could identify a quality SAS product by it having a warranty.

Adoption of SAS has significantly reduced monthly spending on lighting for MSMEs, from NGN 9,406 (USD 22.92) to NGN 4,738 (USD 11.55). Tier 1 MSMEs reported a 50 per cent reduction, from NGN 10,371 (USD 25.27) to NGN 5,182 (USD 12.63). The percentage gain varied geographically, ranging from 16 per cent less in Plateau state to a whopping 84 per cent savings in Oyo.

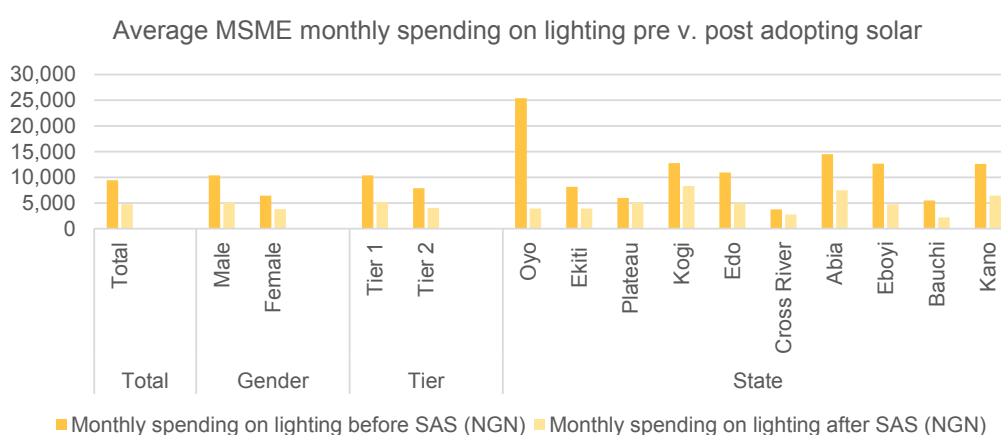


Figure 28 Average MSME monthly spending on lighting pre vs. post adopting solar

Consumers reported the most important benefits of SAS products – aside from cost savings – were charging phones at home, undertaking activities at night, the ability to use a television or fridge, and the possibility to start a business. Most of the MSMEs reported increased working hours and better yields.

4 AFTER-SALES SERVICES

4.1 AFTER-SALES SERVICES

The continuation of customer relationships after the conclusion of a sale – for installation, trouble-shooting or repairs – is one way to extend product lifetime and performance and enhance customer experience. This section examines after-sales services offered to customers by trade outlets. Though it does not specifically address services offered through non-trade channels – such as technicians employed by leading brands – it is of course possible that product sold through brand agents and MFIs could be taken for repair at a trade shop. More often, however, these companies have technical support teams engaging with customers from the time of purchase onward, including through warranties.

Most outlets selling SAS do not provide any additional after-sales services (75% per cent). Others sell products and provide installation or repair services, or both. 21 per cent of the surveyed outlets conduct repair and installation only, not sales – these are called “technician shops” in Nigeria.

The existence of semi-specialised installation and repair technicians shifts some of the burden of after-sales from sellers themselves, many of whom are general traders and not electricians. Technicians have experience fixing generators and other electronics, and can provide support for faulty solar, though their skill level and understanding of the technologies is variable. That said, this division of labour may make it harder for traders to make a connection between sale of low-quality product and its maintenance or disposal.

Though most SAS traders are in urban (Tier 1) areas, there are more specialised technician shops in peri-urban and rural areas – where most of the SHS and component-based system customers are. Figure 30 shows the relative availability of the difference types of services.

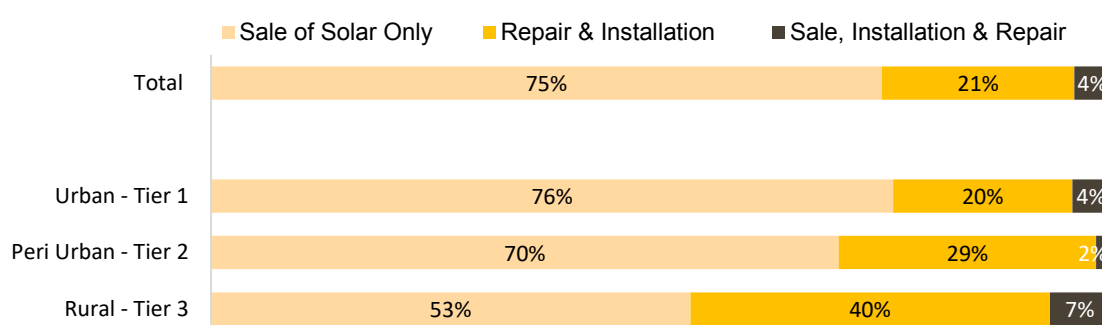


Figure 29 Average MSME monthly spending on lighting pre vs. post adopting solar

Not surprisingly, geographic areas with a wider variety of SAS products have more specialised technician shops. Abia and Kogi states have the lowest number of technician shops and are largely dominated by lanterns (see Figure 30).

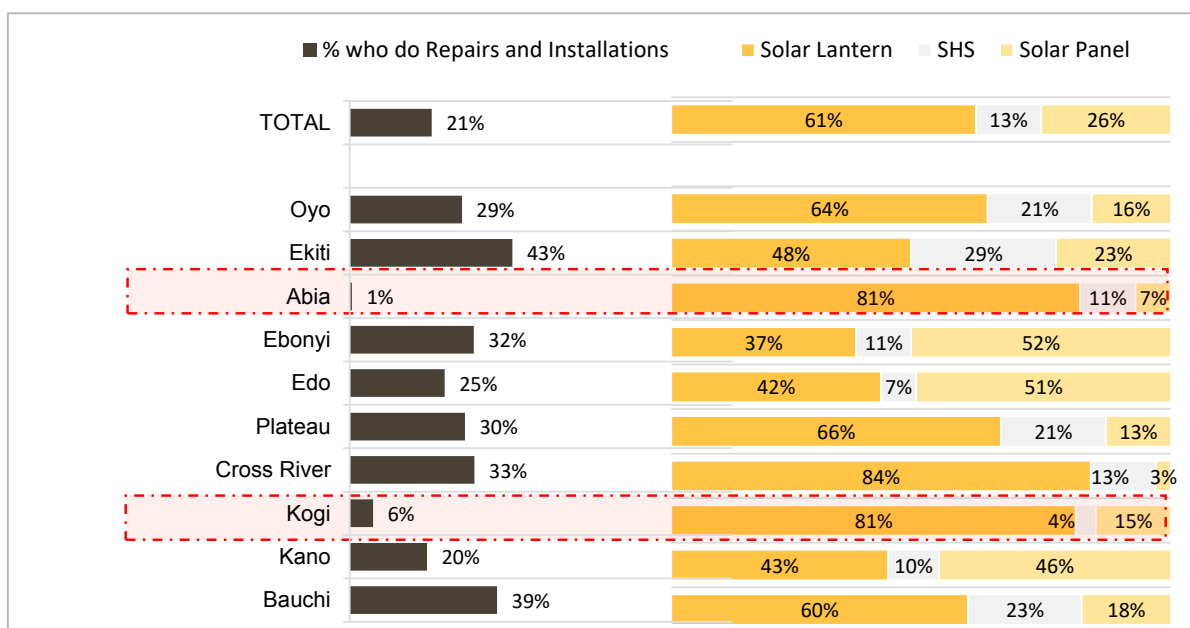


Figure 30 Prevalence of technician shops by state

The technician shops most commonly deal with faulty systems brought back by the customer (“end user fault cases”) (33 per cent), installation of component-based systems (19 per cent), maintenance of SAS products and issues with batteries (both 14 per cent), as seen in Figure 32 below

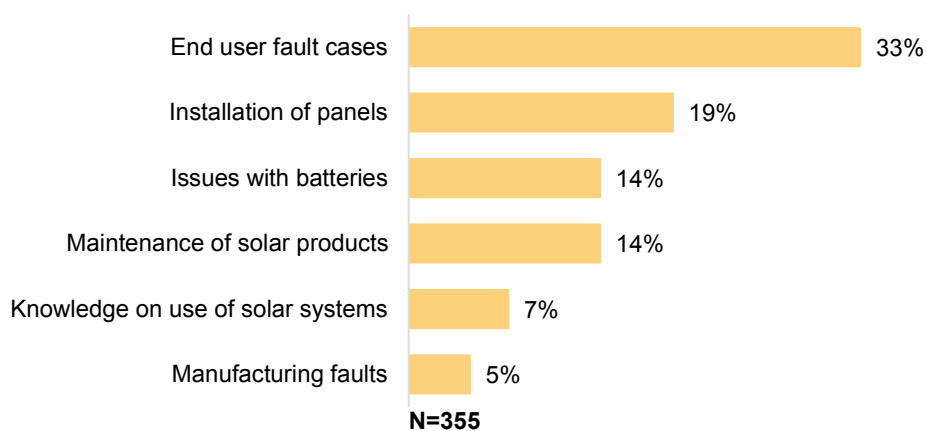


Figure 31 Most common issues requiring after-sales services

Both households and MSMEs reported having challenges with their SAS products, although at low levels (9 per cent of households). Household issues included batteries failing to charge (49 per cent), product failure (32 per cent) and dim light (30 per cent). MSMEs had similar issues: short product life span (39 per cent), product failing to charge (33 per cent) and dim light (28 per cent). It is assumed that technicians can prolong product lifetimes to some extent, which in itself is an important stop-gap mitigating electronic waste (e-waste).

Consumers by and large do not do anything with their faulty product – pointing to a possible glut of e-waste, as highlighted in Figure 33. A third of technicians interviewed reuse parts that can be recycled and sell the remainder to scrap collectors. The study did not find any obviously second-hand or repaired products for sale.

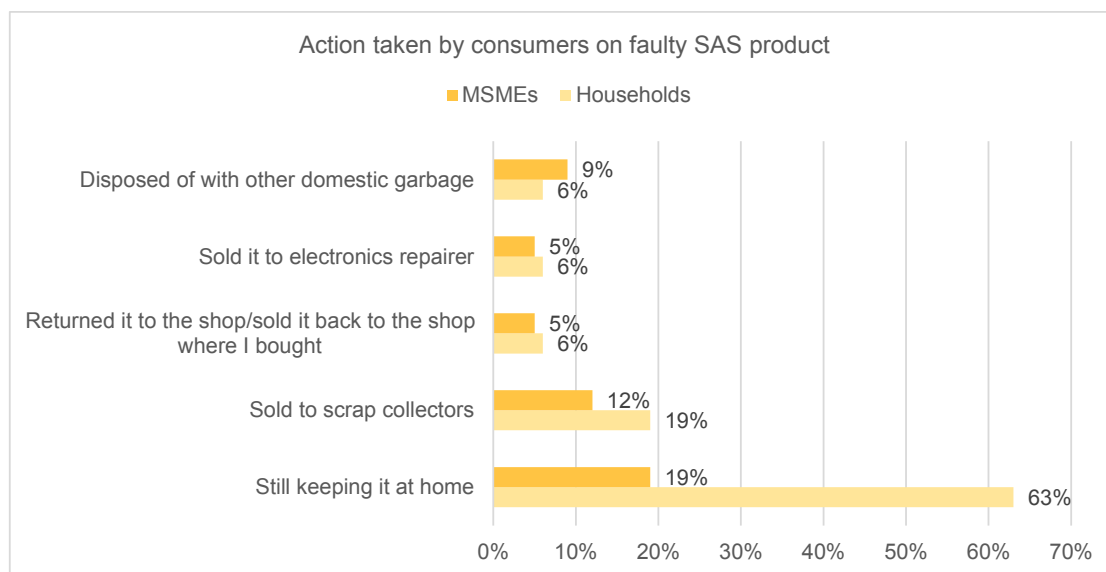


Figure 32 Action taken by consumers on faulty SAS product

Most solar customers want advice – how the product works, how to extend the battery life, how to install it, as highlighted in Figure 33.

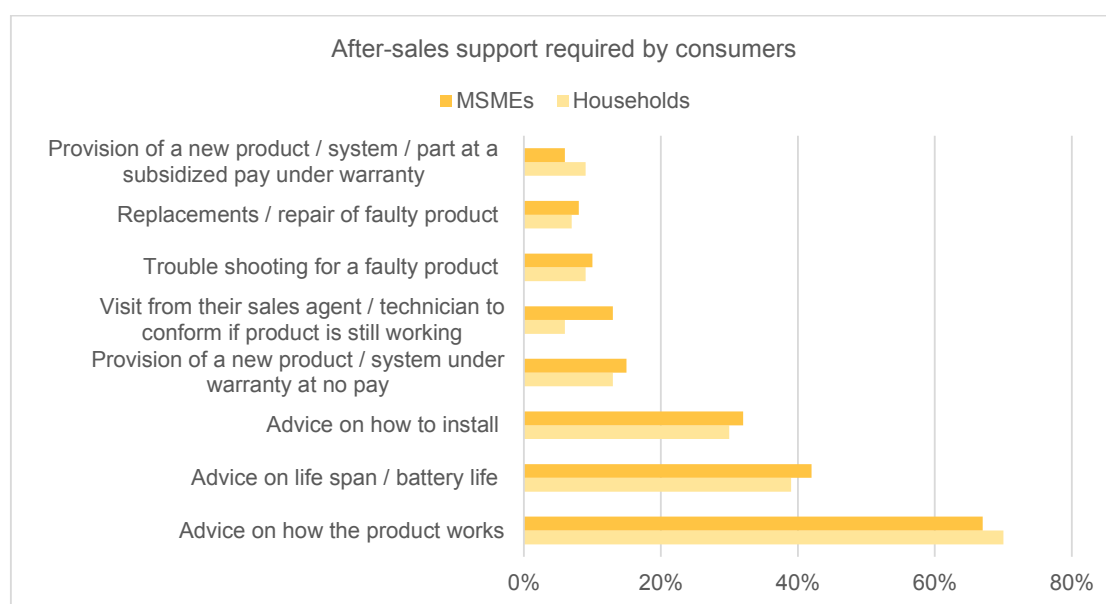


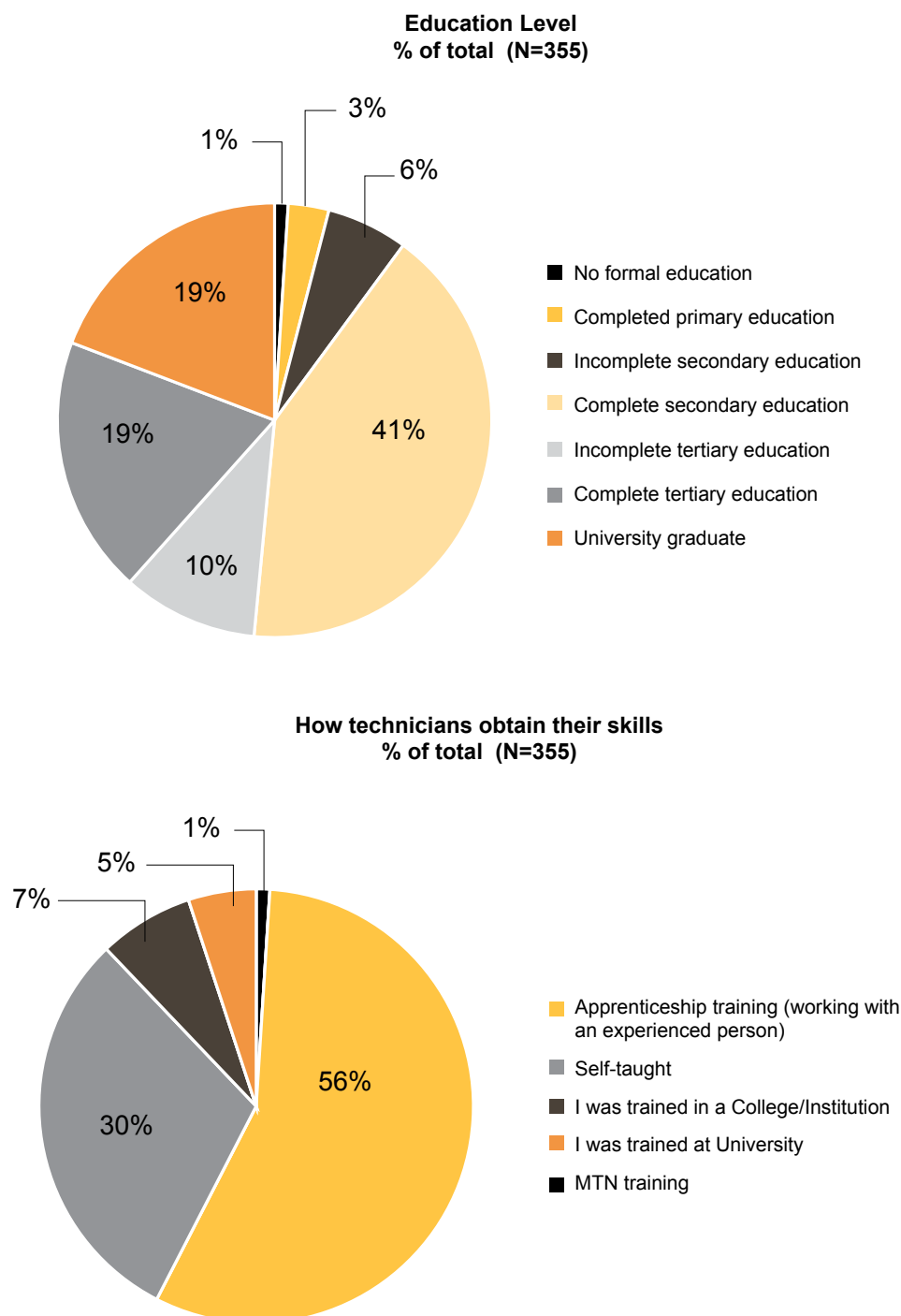
Figure 33 After-sales support required by consumers

4.2 TECHNICAL CAPACITY AND TRAINING

Solar technologies are changing, and technical skills must keep up. The majority of solar technicians are self-taught or have learned through apprenticeship; just 21 per cent have formal training in SAS solutions. Apprenticeship and on-the-job experience, of course, are legitimate ways of learning a skill, and are likely also the way most TV, refrigerator, mobile phone, or generator technicians learned their trades.

Although not new to Nigeria, SAS are relatively less familiar technologies to the trade, and technicians widely reported challenges in installation and repair. 31 per cent of interviewees said they had insufficient training to service solar products properly.

Figure 34 presents various facets of technician capacity at technician shops. To note, this does not speak to technical capacity at trade outlets that focus on solar sales and may conduct ad hoc repairs. Nor does it touch on the technical capacity of brand agents trained on specific products sold through non-trade channels. Building brand-specific skill sets for agents, however, is undoubtedly helpful across the trade, as some personnel may move between formal and informal employment and carry their expertise with them.



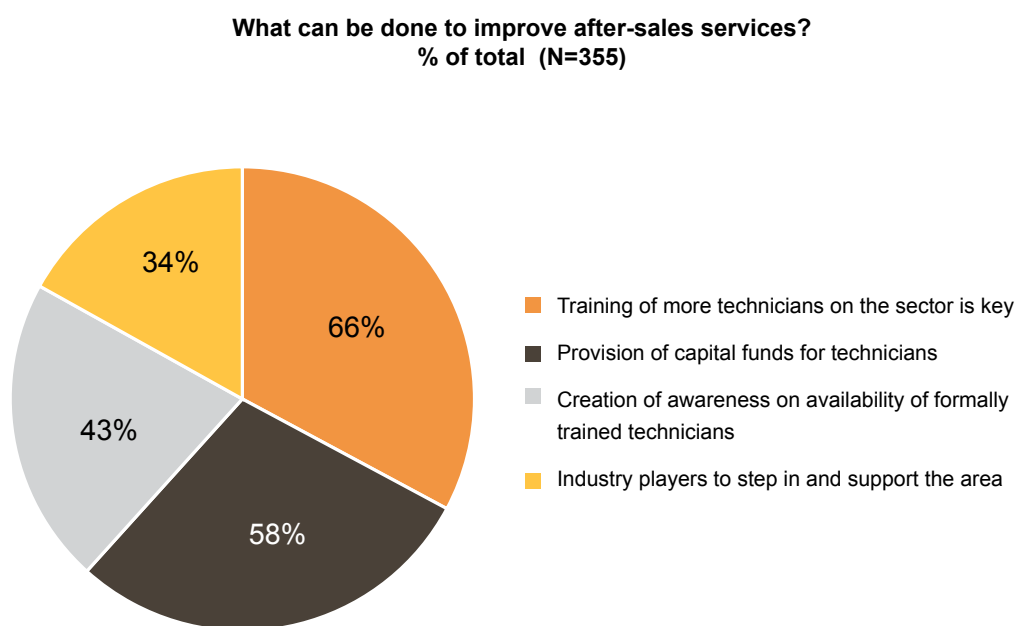
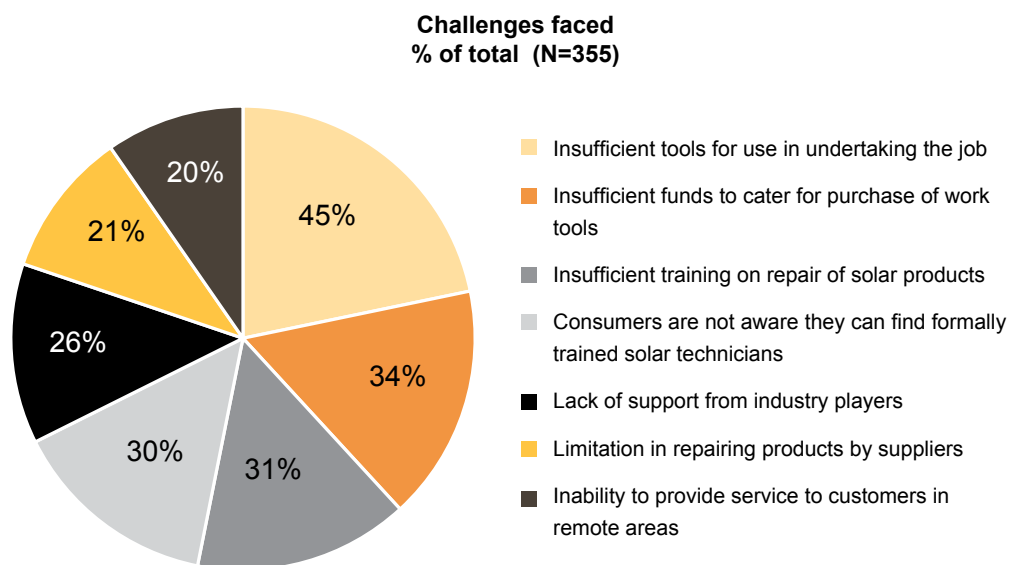


Figure 34 After-sales support required by consumers

5 FINANCING AND DISTRIBUTION MODELS

This chapter explores financing for the (trade) supply chain and consumers and presents a brief view of non-trade sales and distribution channels.

5.1 SUPPLY CHAIN FINANCING

A lack of business financing hinders traders from stocking higher quality products, expanding distribution efforts, providing after-sales services and more. Traders were asked about credit available from suppliers and loans from other sources.

17 per cent of traders have received credit from within the supply chain. Of these, 51 per cent had an arrangement with a distributor, 24 per cent had credit directly with a manufacturer, 20 per cent had credit from an overseas supplier, and 6 per cent had partnerships with other small-scale traders.

Just 4 per cent of traders had secured any other types of loans. These were from MFIs (35 per cent), commercial banks (30 per cent), friends and family (25 per cent), and cooperative societies (5 per cent). A significant number of traders (35 per cent) were not aware of any financial institution that offered financing. Those who were aware cited Lapo, a popular MFI providing solar loans (18 per cent), commercial banks (14 per cent) and other MFIs (5 per cent).

Among the 4 per cent of traders able to secure a loan, over 80 per cent were micro-borrowers of between 50,000-1,000,000 NGN (USD 122-2,437). Repayment periods varied depending to the loan amount, with smaller loans due within 2 years, while medium and large loans repaid over 5 years. Only 5 per cent of loans allowed more than 5 years for repayment. All formal lenders require collateral, which is usually a title deed or product inventory.

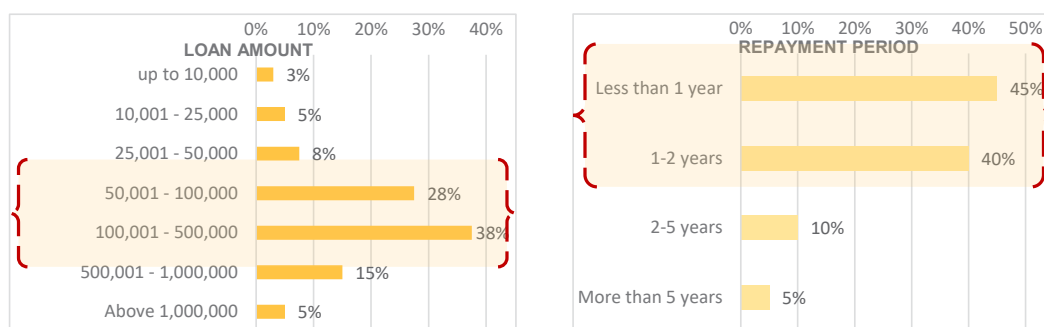


Figure 35 After-sales support required by consumers

Traders reported challenges repaying loans including irregular cash flow (43 per cent), high interest rates (28 per cent), short repayment periods (23 per cent) and high instalment amounts (20 per cent). About 14 per cent of traders mentioned that COVID-19 had affected their loan repayment capacity, while only 5 per cent had received support against the impact of COVID-19 by lenders' lengthening the repayment period or reducing the repayment amount.

5.2 CONSUMER FINANCING

Most interviewed consumers (households and MSMEs) had paid cash up front for their systems. This may in part reflect a tendency for PAYG solar to be sold through brand agents. About 5 per cent of SHS and solar panel owners reported getting credit from the solar shop, despite 24 per cent of traders saying they offered credit to their customers. Those who did not offer credit cited mistrust of consumers to repay as the main reason.

Among traders who gave credit to their customers, most (63 per cent) required repayment in one month, while others varied the terms depending on the amount owed or on the type of customer. Though most did not differentiate based on gender, 22 per cent expressed a preference for male borrowers, and 5 per cent for female, a reflection of their perceptions of risk.

Traders cited loss of source of income as the leading reason given by their customers for defaulting (51 per cent), other reasons being competing priorities (37 per cent), poor performance of the products (24 per cent) and perceived high interest rate (16 per cent). It was not clear what (if any) interest the trader charges, whether credit is offered for

low-cost lanterns or just larger SAS, nor whether the trader is offering credit equally on other expensive products in the shop.

Figure 36 shows how products were typically financed.

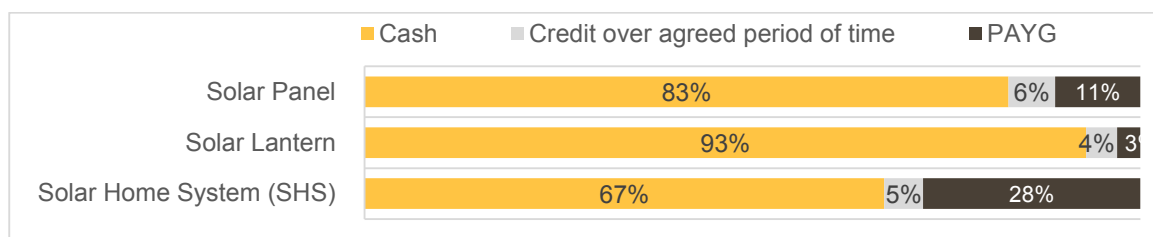


Figure 36 SAS product payment methods used by consumers

Some customers reported getting PAYG products, and two thirds (65 per cent) expressed interest in paying for future products, through a PAYG system. Of those who mentioned preference to PAYG, 37 per cent knew where to find the PAYG SAS products. Consumers in peri-urban areas had more access to PAYG traders (59 per cent) followed by urban consumers (50 per cent) while rural consumers had the least access (13 per cent).

Those already using PAYG systems paid primarily by mobile money; others paid at an agent outlet, by buying a voucher, and loading values via scratch cards. Most of these respondents found the PAYG system easy to use but expressed frustrations around inconsistent income to maintain repayments and not getting power if a payment is not made. They suggested adjusting PAYG options to include a weekly or monthly repayment plan (instead of daily), and allowance for online or debit/credit card payments.

5.3 NON-TRADE SALES AND DISTRIBUTION CHANNELS

Alongside selling their products through trade channels, most brand owners use independent agents and door-to-door sale networks, such as Solar Sister, to distribute their products. D.light and Greenlight Planet (Sun King product) also have their own branded shops that serve as retail outlets as well as mini-depots for agents carrying product into rural areas.

Larger SAS brands use social media, fliers, community sensitization and TV advertising to create traction on their products. Walk-in customers are given freebies and product education, as well as recruitment opportunities for brand ambassadorships.

Another significant channel for SAS is MFIs, who sell solar product to individuals or organised groups (including SACCOs) out of branches predominantly in larger (Tier 1) cities. The main MFI cited by stakeholders is Lapo, which offers a solar loan product at 558 branches around the country, in every state. Lapo organises their solar customers into Solar Unions, which act as marketing units to entice other members to buy. Brand owners and distributors take stock requests and make deliveries directly to the branch that has placed an order.

Solar loans are typically given at 6, 9 or 12-month terms depending on the cost of the product, charging interest of 3.2 per cent monthly plus a 10 per cent processing fee/deposit and insurance in case of default or breakage. Volumes of SAS sales vary between months and branches.

Examples of non-trade sales strategies include:

- ♦ Asteven Group uses graduates from its academy as distributors of their products. These are later promoted to agents of the franchise.
- ♦ GOS and Company has trained over 30,000 Nigerian youths across in 32 states, who sell, install, and explain products to consumers.
- ♦ Auxano Solar targets higher-income customers and medium to large enterprises through social media platforms. Most of their installations are based on referrals.
- ♦ Global Energy do physical marketing, working with social groups in villages to educate people on the benefits of solar and distribute their products.
- ♦ ESG works with regional agents.
- ♦ M-KOPA agents do one-on-one selling to customers.
- ♦ Solar Sisters supports mobile entrepreneurs who go door-to-door, giving them tools they need for distribution of SAS products such as branded T-shirts and bags to carry products.



6 GENDER AND SOCIAL INCLUSION IN THE SAS SUPPLY CHAIN

This study looked at the Nigerian SAS market through a gender and social inclusion (GESI) lens and found severe imbalances at all points of the supply chain including end users. For purposes of this analysis, 'vulnerable' populations included women, youth, and people with disabilities (PWD). This section provides some disaggregated findings.

Women account for just 4 per cent of SAS traders, and are under-represented as staff of these shops.

While trade outlets averaged 2.3 staff members, women represented just 0.43 (19 per cent) of those. On average, traders reported that women accounted for only 25 per cent of their customers. While no noticeable differences exist between male and female consumers in product preferences and usage, women are more predisposed to acquire the products through agents who approach them in their social groups.

36 per cent of vulnerable customers were in areas with no grid; in grid-covered areas 25 per cent could not afford grid electricity. Some vulnerable households with grid power opted for solar because of concerns over power outages. Overall, **vulnerable SAS users chose solar for its safety benefits (58 per cent), ease of use (42 per cent) and availability on the market (40 per cent)**. A third of solar users were influenced by a recommender, while 23 per cent were drawn to cost savings as compared to kerosene.

Two thirds of vulnerable SAS users (66 per cent) use their product for multiple functions beyond lighting, primarily phone charging (75 per cent) and TVs (20 per cent). 9 per cent of vulnerable consumers have experienced product malfunction; the majority cannot identify a quality product.

PWDs and other socially excluded groups make up just 2 per cent of consumers, and zero per cent of the trade. As governments, civil society and donors develop social empowerment programmes, SAS brand owners and traders could be incentivised to integrate GESI considerations and reach tier 3 communities through incentives such as tax waivers, product subsidies, and other forms of relevant government support.

7 DISCUSSION AND RECOMMENDATIONS

This chapter summarises the key findings and discusses implications for expanding the market and, as a priority, reaching vulnerable populations. Overall, the SAS sector is growing – in number and geographic reach of traders; in consumer awareness; in increased use of solar for commercial purposes and as grid power backup. Energy poverty in Nigeria is real, as is the air pollution resulting in part from millions of generators. Therefore, solar represents a major opportunity.

7.1 PENETRATION OF SAS PRODUCTS

KEY FINDINGS

- ♦ Just 13.6 per cent of potential SAS trade outlets are stocking solar products, presenting a sizeable opportunity to expand the market. States in the North have higher SAS penetration and lower grid coverage than states in the South, indicating solar may be used as a primary lighting / electricity source rather than grid backup. The SAS opportunity is particularly attractive in populous states that have low grid connectivity, such as Bauchi and Plateau, or low solar penetration, such as Oyo or Cross River.
- ♦ Solar lanterns have the highest penetration of the three categories observed. This holds true in urban (61 per cent), peri-urban (58 per cent) and rural (67 per cent) trade outlets. Solar panels are more prevalent in peri-urban outlets (33 percent) compared to urban areas (26%) and rural areas (25 percent).
- ♦ Overall, penetration is higher in urban areas (Tier 1), and lower in peri-urban (Tier 2) and rural areas (Tier 3). As this does not correlate with low grid connection, it may have to do with limited distribution reach, lower trader awareness, and customer affordability.
- ♦ Of the 11,391 trade outlets visited that were not carrying solar products, 62 per cent expressed an interest in doing so.
- ♦ Whereas lanterns and panels are widely stocked across the country, SHS are more of a specialty item.
- ♦ Traders in urban and peri-urban areas are stocking productive use (PUE) solar products, with the exception of solar batteries and streetlights, at much lower rates than SAS.
- ♦ At consumer level, penetration of SAS is 27 per cent – double that in the trade.
- ♦ There is an uneven correlation between supply and demand, with high concentration of SAS traders in urban areas (15 per cent), despite majority of consumers present in rural and peri-urban (72 per cent). About 10 per cent of rural consumers have bought their products through alternative channels (brand agents, MFIs, etc.).
- ♦ 47 per cent of all MSMEs covered in this study had a SAS product in their premises, which they sourced from different places depending on size. 83 per cent of MSME lantern owners bought it from a retail shop or brand agent, while 17 per cent were given it. 97 per cent of MSMEs that owned panels bought them in the trade. On the other hand, 100 per cent of MSMEs with SHS bought them from brand agents. Similar to the consumer segment, solar panels have a higher penetration among MSMEs.

DISCUSSION

Trade and non-trade are largely parallel markets. There is a supply chain moving product through the wholesale and retail trade and there is another moving product through networks of brand agents, MFIs, and others. SHS seem to move in greater numbers through non-trade channels. There are of course brands being sold both ways, and end-users sourcing both ways. However, the practical and qualitative differences in the ways SAS are reaching end-users have implications in terms of the trust between buyers and sellers; incentives to sell QV; credit or financing available; ability to access market intelligence; ability to reach the vulnerable; and more.

The finding that penetration of SAS among consumers (27 per cent) is double that in the trade (13.6 per cent) could signal unmet demand; a robust alternative (non-trade) supply channel; or a concentration of 'brick and mortar' (as

opposed to mobile) supply in urban areas (as most customers in these areas reported buying their products from trade outlets).

Both trade and non-trade channels pose opportunities for growth as well as improvement of the customer experience. In the trade, targeting sales through the thousands of outlets who expressed interest in carrying solar, but do not currently, is one starting point. SHS companies may explore trade partnerships as alternatives to expensive brand-managed networks.

Smaller traders will have difficulty scaling their sales without access to capital and a clear view of the market opportunity. Electronics wholesalers present opportunities for partnerships, since they have an advantage of handling bulk, and have stronger capital bases. As they are found in urban areas, they can effectively service the urban and peri-urban consumer, or those that buy to take back to their kin in the rural areas.

Imbalanced access means that the rural poor pay more to access products or after-sales services.

7.2 SAS PRODUCTS IN THE MARKET

KEY FINDINGS

- ♦ The quality of products varies widely, with few instances of warranty and installation guidelines. A common perception is that SAS products are expensive, perform poorly and are therefore a risky investment. Less than half of traders say they can identify a quality product.
- ♦ The SAS market suffered somewhat – along with the rest of the economy – by measures taken to mitigate the spread of COVID-19. 87 per cent of traders felt an effect on their business from March-May 2020.
- ♦ The solar lantern category is extremely competitive, with 170 unique brands found in stock.
- ♦ LG QV lantern brands comprise just 23 per cent of the brands in the market and are carried by 56 per cent of traders. The Nigerian market shows a similar prevalence of non-QV brands to SAS markets in Tanzania and Ethiopia.
- ♦ There are some major discrepancies in retail price for what appears to be the same product – pointing to the likelihood of counterfeits. 64 per cent of traders believe there is a moderate to high presence of counterfeits in the market.
- ♦ Prices of solar lanterns also vary widely – between USD 5 and USD 130 at the extremes.
- ♦ Lack of quality verified status can mean a product is low quality or that it has not (yet) been tested. However, the popularity of the Lontor, DP LED and Saroda brands with traders may warrant including them in future quality verification efforts.
- ♦ There appears to be less of an issue with counterfeiting of SHS than with lanterns, with price differences more likely to be related to distribution. Prices range between USD34 and USD148.
- ♦ Solar panels are available in a wide range of sizes, and Sunshine Solar leads the market by a large margin (at 34 per cent brand penetration with next competitor at 6 per cent; Sunshine has 15 per cent product market share). Sunshine is an entrenched brand, locally owned with strong distribution networks.
- ♦ The most popular brand of solar lanterns with consumers was d.light, with a combined brand share of 22 per cent. Their products are sold in both trade and non-trade networks, with quality products at several attractive price points.
- ♦ Consumers are buying a less diverse range of SHS product than is offered by the trade, as more are bought through agents selling a smaller selection of higher quality products.
- ♦ Other than Lontor, all the top SHS brands used by consumers are LG QV.

DISCUSSION

Price remains a major driver. Consumers want higher capacity SAS products at a cheaper price. SHS solutions could possibly be the default option for consumers as they tend to sit in the middle and balance this need (particularly higher capacity SHS systems between 50 W to 100W) they should therefore be a major part of the mainstream trade network with these brands.

Consumer behaviour and needs are also changing as the sector matures. Solar systems are replacing generators as both primary and backup power sources. More consumers are accepting solar energy for commercial uses unlike before, where solar solutions were only for lighting their homes.

Most productive solar appliances are still nascent, with less than 5 per cent penetration at the trade level, and less than 2 per cent usage at consumer level. Stakeholders in the SAS manufacturing space project an increase in demand of productive uses due to its range of solutions across multiple industries, like agriculture, security, cold storage, dryers, and domestic appliances.

Stakeholders believe there can be significant reduction in the price of SAS products through avenues like import duty and VAT reductions or exemptions, and tax breaks for traders.

Signals of “quality” are imperfect, and the market appears to be flooded with sub-standard product. Signals of quality at the point of sale include a warranty, instruction manual, and, of course, pricing. Lookalike counterfeiting is rampant and difficult to discern, except by its low pricing. The extent to which the brand penetration and sales volumes found in this study are affected by counterfeits is not clear, but for certain products it is potentially substantial.

Lighting Global quality verification is a signal to traders and consumers, but non-QV does not necessarily mean low quality. There is opportunity to widen the QV ‘net’ by testing and verifying additional brands, particularly those popular with consumers.

Enforcing quality standards at the ports and borders, and within the market, is likely to remain difficult for the immediate future. Ongoing work to stimulate consumer demand for quality product, including at point of sale, is as important as standards enforcement.

This is not unique to the SAS sector – indeed it may be worth looking at other sectors to learn and/or put the SAS situation in perspective. Is there effective quality control over other fast-moving consumer goods (FMCG), generators, other electronics? Is this a ‘natural’ stage in the progression of the market?

7.3 AFTER-SALES SERVICES AND TECHNICAL CAPACITY

KEY FINDINGS

- ♦ Most outlets selling SAS do not provide any additional after-sales services (75 per cent).
- ♦ There are “technician shops” that are only involved in installations and repairs, and shift some of the burden of after-sales from sellers.
- ♦ There are more specialised technician shops in peri-urban and rural areas – where most of the SHS and component-based system customers are.
- ♦ The most common after-sales needs are repair of faulty systems brought back by the customer (33 per cent) and installation of component-based systems (19 per cent).
- ♦ The majority of solar technicians are self-taught or have learned through apprenticeship, just 21 per cent have formal training.
- ♦ Technicians widely reported challenges in installation and repair, with 31 per cent of interviewees saying they had insufficient training to service solar products properly.

DISCUSSION

Specialised technicians working in their own premises are responsible for much of the trade-based solar installation and repair in the country – not traders or their employees. This is not considering brand-trained and brand-commissioned technicians – who may overlap in employment with those in the trade. It is not clear whether SHS are being serviced primarily by brand technicians / trouble-shooters or are coming into trade technician shops.

A focus on formal training requirements has created some challenges in other SAS markets where technicians lack official credentials but have learned skills. Vocational training is available in Nigeria and could be expanded and targeted. Deepening relationships between QV brand owners and their distributors could enhance understanding of quality and product maintenance. Some further analysis may be warranted, to understand the motivations of traders and technicians – particularly if both parties have some (financial) interest in product failure or customer misuse.

7.4 FINANCING AND DISTRIBUTION CHANNELS

KEY FINDINGS

- ♦ Trade in SAS is mainly transacted in cash, not credit. Generally, traders self-finance their businesses or raise funds through friends and family, local cooperatives, or local banks (the ability for the latter based on the type of product/good being financed).
- ♦ Less than 5 per cent of traders receive any formal financing, mainly from MFIs and SACCOs. This figure may be much lower than other well-established goods such as generators. Only 17 per cent receive credit from their suppliers.
- ♦ Most interviewed households and MSMEs paid cash up front for their systems. Only about 5 per cent of users reported getting credit from the solar shop. Sellers main reason for not offering credit was mistrust.
- ♦ Though most traders did not differentiate based on gender, 22 per cent expressed a preference for male borrowers, and 5 per cent for female.
- ♦ Where there were defaults in payment, traders cited loss of source of income as the leading reason given by customers (51 per cent), followed by competing priorities (37 per cent), poor performance of the products (24 per cent) and perceived high interest rate (16 per cent).
- ♦ Consumers in peri-urban areas had more access to PAYG traders (59 per cent) followed by urban consumers (50 per cent) while rural consumers had the least access (13 per cent). Of these, the primary mode of payment was mobile money.
- ♦ Many of the top QV brand owners use independent agents and door-to-door sales networks to distribute their products.
- ♦ MFIs are a major distribution channel for SAS products, especially in cities. Lapo offers a solar loan product at 558 branches around the country.

DISCUSSION

Consumer financing is predominantly via PAYG brands supplied through sales networks, or MFIs which supply financed solar directly to their customers. It appears that customers are less likely to obtain a micro-loan and take the borrowed money to a trade outlet to purchase a solar product.

Financing within the trade supply chain is limited, but available at low levels. Traders may not be willing to take chances on borrowing for stocking solar without a better sense of consumer demand. Market intelligence may not reach the trade, particularly non-specialist outlets such as electronics or hardware shops.

7.5 GENDER AND SOCIAL INCLUSION

KEY FINDINGS

- ♦ Both the trade and consumer sides of the SAS market are significantly male dominated. In the trade, women account for only 4 per cent of SAS trade outlet owners and 20 per cent of trade employees surveyed. PWDs are severely underrepresented.
- ♦ Traders estimate that only 30 per cent of SAS customers are women and 10 per cent PWDs, compared to 70 per cent men.

DISCUSSION

Whilst some research on SAS product utilisation shows more use by women, the current survey findings have shown that these are mostly purchased by the men who have the purchasing and household decision-making power.

The Nigerian SAS market is not yet reaching the most vulnerable – the rural poor, women, and youth, PWDs – at scale. GESI empowerment programmes that look to strengthen income generation and purchasing power among these populations is required. Targeted consumer awareness and marketing campaigns – through media or other means such as demonstrations and in-person activities – can empower the vulnerable to make good decisions about solar products so to minimise failure and waste. And efforts to target PWD and youth groups as sales channels – such as by Solar Sister with women – could generate knowledge, technical skill, and income.

7.6 RECOMMENDATIONS

The Nigerian SAS market is not fundamentally different to other SAS markets, in its gradual evolution toward 'maturity'. It is, however, maturing at a later stage in global SAS product and financing innovation than – for example – the Kenyan market, and so has the benefit of lessons learned and ideas generated elsewhere. Generators have polluted the air for that much longer, and of course, it is a much larger market than every other on the continent.

The following are areas for action and support, and the actors who could lead such efforts, to build the SAS market and improve the value and experience of solar for vulnerable populations:

1. A multi-faceted effort to boost the prevalence and awareness of quality products:

Table 6 Actions to boost quality products

Area	Action	Led by	Secondary support
Quality standards	Ongoing efforts to enforce quality standards at points of import and distribution	Nigeria Customs Service and Standards Organisation of Nigeria	Rural Electrification Agency, industry association
	Expanded testing of popular non-LG QV product to gauge its value in the market	Standards Organisation of Nigeria	VeraSol, development partners
Capacity building	Targeted guidance to traders alongside product demonstration to build capacity to identify quality	Standards Organisation of Nigeria	VeraSol, development partners, industry association
Consumer awareness	Consumer marketing campaigns based on local (sub-national) understanding of the perceptions, concerns, and barriers to choosing higher quality product, including financing options to afford more expensive quality systems	Standards Organisation of Nigeria; Consumer Protection Council	VeraSol, development partners, industry association, Rural Electrification Agency

2. Development of after-sales capacity among the trade as well as consumer expectations of quality:

Table 7 Actions to boost capacity and awareness

Area	Action	Led by	Secondary support
Capacity building	Provide ongoing vocational training as well as free remote modules, possibly through e-learning or other media, to disseminate brand-agnostic guidance	Standards Organisation of Nigeria, Vocational training centres,	Development partners, industry association, NGOs
	Target women and youth for information and training	Rural Electrification Agency, Federal and state government MDAs on gender and social inclusion	Development partners, NGOs, vocational training centres

3. Recognition of the important role of both trade and non-trade distribution channels in reaching the last mile / under-served populations, and the various pros and cons of each vis-à-vis consumer trust, financing, and after-sales services:

Table 8 Actions to boost sales through trade and non-trade channels

Area	Action	Led by	Secondary support
Business model support	Facilitate partnerships between distributors and quality brand owners, including via existing fast-moving consumer good (FCMG) or energy product (generator, torch, battery) networks.	Development partners, industry association	Trade and market associations
	Find ways to integrate consumer finance and education at the trade point of sale, much like customers would receive via mobile agents or MFIs.	Development partners, industry association	Consumer/social groups, NGOs
	Build out non-trade distribution options through additional microfinance institutions, social groups, farming, and labour cooperatives.	Development partners, industry association	Rural Electrification Agency, Financial institutions, consumer/social associations, NGOs
Supply chain & consumer financing	Provide incentives, such as results-based financing, end user subsidy or tax waivers, so that traders see business opportunity in reaching beyond their current markets	Rural Electrification Agency, State governments	Development partners
Policy & regulatory reform	Support the rapidly expanding digital payment infrastructure and regulatory environment, to boost digital payment options both via PAYG and direct to traders.	Central Bank of Nigeria, Rural Electrification Agency	Development partners, industry association; mobile money operators

8 APPENDICES

8.1 APPENDIX I: DETAILED STUDY APPROACH

The study incorporated both quantitative and qualitative techniques to collect data. The quantitative approach involved a census of all potential trade outlets, followed by ‘deep dives’ of sampled SAS-dealing outlets, specialised technician shops, and consumers (households and MSMEs). The qualitative research involved in-depth interviews with stakeholders including PAYG companies, MFIs, Savings and Credit Organizations/Groups (SACCOs), NGOs, distributors / importers, and central and state government regulators.

The locations chosen for this survey were categorised as Tier 1 (urban), Tier 2 (peri-urban) and Tier 3 (rural). They are listed below

Table 9 Tiered survey locations

Zone	State	Tier 1 (urban)	Tier 2 (peri-urban)	Tier 3 (rural)
South South	EDO	Benin	Ekpoma	Ehor
	CROSS RIVER	Calabar	Ikot Omin	Odukpani
North East	BAUCHI	Bauchi	Kafin-Madaki	Dass
South East	ABIA	Aba	Obehie	Awette
	EBONYI	Abakaliki	Ezzagu	Ishieke
South West	OYO	Ibadan	Agudu	Fiditi
	EKITI	Ado Ekiti	Ikere	Ilawe
North West	KANO	Kano	Kumbotso	Gezawa
North Central	KOGI	Lokoja	Okene	Otokiti
	PLATEAU	Jos	Bukuru	Vom

SAMPLING METHODOLOGY

Retailer penetration

To achieve this objective, in the first phase, we conducted a trade census among potential outlets in ten states spread across all zones in Nigeria. This helped us determine the correct number of retailers engaged in the solar business and the penetration of SAS products in the trade. “Trade” included retail outlets dealing in electrical and electronic goods, hardware shops, distributors, supermarkets, mobile phone shops, Mobile Service Provider (MSP) shops and petrol stations – regardless of whether they were selling solar products at the time of listing or not. A total of 13,235 outlets were scoped.

In the census “penetration” is understood as the number of these retailers handling solar – that is, the presence of solar products on the premises. This means the census did not distinguish between entities at different places in the supply chain (e.g., solar distributors who might sell to solar sellers also included within the count) nor those selling v. repairing solar (the latter being technician shops focused on repair, not retail). The premise, used across similar country studies, is that the incidence of solar gives a satisfactory indication of the prevalence of solar within the market. Drilling down, this analysis looks at the size, brand, or Lighting Global quality verified (LG QV) status of the solar products found.

The following steps were used to conduct the census.

Step 1: Creation of enumeration blocks

- Mapping out the boundaries of the trading areas (towns) considered for this study to get the limits for which we concentrated our efforts on. Note that we concentrated on the main commercial street of the towns/cities.
- Dividing the town limits into manageable enumeration blocks. This eased the census process and ensured teams worked within each block to avoid errors of omission or duplication. This was done on Google Earth. Each enumeration block was identified by a unique ID. The boundaries of the blocks were based on streets within the town

Step 2: Deploying field teams to the enumeration blocks

- Each block had its own detailed map.
- Supervisors establish the boundaries and landmarks of each enumeration block using ground-truthing techniques especially at the street junctions where the boundaries of the created blocks fell.
- A team was deployed to each block to start the census task.
- Assignments were finished systematically using an end-to-end approach to ensure that no street or outlet was left out of the designated area.

Step 3: Data collection and verification

We used Computer Assisted Personal Interviewing (CAPI) using Android based devices. A questionnaire with predetermined fields of information for the census was programmed and loaded onto the devices. A Situation Team based in Lagos tracked all the interviews via GPS with daily uploads of interviews done. The team verified information through assessing block by block coverage and call verification to the respondents. All data was cleaned and passed on to the next stage of analysis

Step 4: Data Processing and Analysis (including Spatial Analysis)

The data was analysed using SPSS and checked for consistency to ensure that the data produced was of the highest quality possible. Tabulations were done based on the objectives of the study and converted into charts for reporting. Additional statistical analyses were done to test relationships and associations among variables depending on the research questions. The total number of trade outlets achieved in the census are given in the table below.

Table 10 Census achievement

	TIER 1	TIER 2	TIER 3	Total
Ibadan	2,827	127	29	2,983
Ado Ekiti	631	192	54	877
Jos	976	177	101	1,254
Lokoja	426	325	69	820
Benin	996	253	18	1,267
Calabar	633	264	107	1,004
Abia	490	325	200	1,015
Abakaliki	457	391	77	925
Kano	2,270	80	79	2,429
Bauchi	538	54	69	661
Total	10,244	2,188	803	13,235

Product offering in the market (deep dive)

This phase of the study depended on the census phase. A 'deep dive' sample of outlets that stocked solar products was drawn from the census in each town proportionate to the total number of outlets in the census count. These traders were engaged in a longer and more detailed interview to provide further information on the nature of products carried. In total, 726 solar traders were interviewed to understand the product offering in the market.

"Brand share" is based on the total number of branded products available in the market. Drilling down, this could be categorised by size or LG QV status.

Determination of the sample size

At the inception of the study, we estimated that based on the results of the census, we take approximately 1,000 outlets for the deep dive (we achieved 1,014 complete interviews). The Small Population Sample Size Calculation formula was used to establish the optimum sample size. This formula takes into consideration the finite population size, level of confidence and margin of error.

The formula is $n = Nz^2pq / (E^2(N-1) + z^2pq)$ where:
N= census of trade population size
z=confidence level (1.96).
E=margin of error (5per cent).
p=the proportion of a trader population with a particular characteristic (0.5).
q=the proportion of a trader population not having this characteristic (0.5).

Sample size allocation across the key towns: The sample was then allocated across the towns based on the number of outlets in each town. Towns with a higher number of retailers were allocated a bigger sample size.

Information areas covered: Firmographics (length of time in business, ownerships, portfolio etc.), product stocked, product specs, volumes stocked, average monthly sales, source of stocks, customer type, consumer buying behaviour (fast moving, slow moving, etc.), pricing, purchase financing – any secured or financing arrangements from lenders, after sale services – and referrals and business sustainability mechanisms etc. Instrument for this category had both closed ended and open-ended questions – for capturing qualitative information.

Given that the study happened in the months of June / July 2020, we collected specific data on the impact of COVID-19 on trade. This was an added benefit, given that COVID-19 was not envisaged when this study was inception, despite its possible impact on businesses.

Sample achieved in the deep dives and its distribution is as given in the table below.

Table 11 Product deep dive achieved sample distribution

State	Tier 1	Tier 2	Tier 3	Total
Ibadan	132	3	-	135
Ekiti	82	18	7	107
Jos	115	19	4	138
Lokoja	52		4	56
Benin	103	24	1	128
Calabar	27	5	3	35
Abia	66	2	-	68
Abakaliki	50	33	7	90
Kano	188	3	-	191
Bauchi	64	1	1	66
Total	879	108	27	1,014

After-sales services (deep dive)

Like the above objective, this was achieved through an “after-sales deep dive” using interviews with 288 specialised ‘technician shops’ that carry out installation, repair and maintenance of SAS to profile the technicians’ skills and training; the most common repair issues that they faced; and their challenges, product warranty structure, take-back mechanism for damaged and expired products, and ideas on how best to scale up off-grid lighting and the assistance they would require, etc.

The interview also investigated how broken and solar e-waste products were collected, whether there were any incentives and how damaged products were disposed of.

Table 12 After-sales deep dive achieved sample

	Ibadan	Ado Ekiti	Jos	Lokoja	Benin	Calabar	Abia	Abakaliki	Kano	Bauchi	Total
Technician shops	56	55	49	13	47	14	20	34	37	30	355

Market dynamics, distribution and financing models

In-depth key stakeholder interviews were conducted to understand the broader context of SAS market development in the country. The 40 stakeholders included microfinance institutions (MFIs) and Community Savings and Credit Cooperatives (SACCOS) to understand the extent to which they are distributing or financing solar, and private companies and government representatives to understand solar market trends, barriers to growth, and opportunities, including how legislation can be used to support electricity access via solar.

The sample identification and achievement were as below:

Table 13 Stakeholder interviews achieved

Target	Number of In-depth interviews achieved
Manufacturers and brand owners	7
NGOs / solar associations	3
Microfinance Institutions (MFIs)	5
Government and regulatory agencies	5
PAYG providers	6
Retailers and distributors	13

The information sought in these in-depth interviews included alternative distribution models, challenges and opportunities and payment options given to consumers.

Case studies / Consumer survey

A consumer ‘deep dive’ interviewed a sample of 665 households and 222 micro, small and medium enterprises (MSMEs) to assess solar penetration and product preferences, as well as other characteristics of the demographic. This activity was designed with gender, equity, and social inclusion (GESI) lens, in that it deliberately targeted females within households and households that had a case of disability – all considered vulnerable. This lens also extended to the elderly, youth and households often targeted by government social protection and cash transfer.

A quasi-quantitative approach was used, where questionnaires with open-ended options helped collect data. This approach assisted in the estimation of solar market penetration by vulnerable demographic groups, non-vulnerable groups, and non-users of solar lighting products. This is not only robust but is more efficient as it offered advantages of un-biased responses to probing from an individualized perspective.

In this phase of the study we partnered with Solar Sister, who shared lists of MSMEs and consumers they targeted on the ground. These lists proved useful in identifying case studies. Solar Sister further advised on interview language and gave guidelines on interaction with vulnerable populations.

The sampling provided an estimated penetration of solar with vulnerable consumer groups as well as their product preferences. The household interviews was targeted to a woman head of the household (wife, if available, especially in communities where it is possible to talk to a woman head of household instead of a man) or their designate who was informed on decision-making. The samples achieved in both the household and MSME modules are given in the tables below.

Table 14 Households achieved sample distribution

State	Tier 1	Tier 2	Tier 3	Total
Ibadan	40	42	15	97
Ekiti	0	50	14	64
Jos	0	43	4	47
Lokoja	9	47	15	71
Benin	0	24	14	38
Calabar	36	23	14	73
Abia	0	57	16	73
Abakaliki	0	72	18	90
Kano	10	40	15	65
Bauchi	0	41	6	47
Total	95	439	131	665

Table 15 MSMEs achieved sample distribution

State	Tier 1	Tier 2	Total
Ibadan	11	8	38
Ekiti	25	9	68
Jos	12	8	40
Lokoja	12	9	42
Benin	12	8	40
Calabar	19	2	42
Abia	10	8	36
Abakaliki	20	6	52
Kano	15	8	46
Bauchi	14	6	40
Total	150	72	444

Challenges and Lessons Learned

While implementing this study, we encountered several challenges that are detailed below.

Table 16 Challenges encountered in the study

Challenge	Description
COVID-19 related interruptions	The trade census happened in June and July 2020 when there was a curfew in place in several states in Nigeria, and restrictions on state-to-state movement. In some State markets were only open on alternate days. This challenge was mitigated by having regional teams, thereby limiting inter-state travels. The implementation was also scheduled after a two-week waiting period after state opening or relaxing of restrictions. Ipsos also had a security protocol and clear COVID-19 protocols that were strictly adhered to.
Outlet closures	Where we found outlets closed, we revisited three times before declaring the outlet as not in operation. These were not counted in the final tally.
Refusals	This challenge was encountered in both the trade and consumer waves due to respondent discomfort. All such incidences were replaced according to the sampling guide.
Claimed but non-confirmed stocks	We encountered few traders who claimed to stock particular products but did not have stock/nor remembered the last stock. In such instances, we only recorded what could be visually verified or confirmed from records.
Questionnaire length	The deep dive interviews took nearly two hours. To maintain that length of conversations, our interviewers were trained on engaging the traders and allowing purchase activities to continue so that the trader did not consider the process as lost time.
Challenge of getting consumers	Penetration of SHS was low, and it was difficult to trace consumers. Households reached through referrals (by Solar Sister) were more easily assessable and welcoming during the study.

8.2 APPENDIX II: PRICING DATA

Table 17 Lantern pricing

	Lantern Brands	Category			
		QV		Non QV	
		Mean	Mode	Mean	Mode
1	d.light S610	1,500	1,500		
2	Free Light L1	1,550	1000a		
3	LED Solar lantern	1,760	1500a		
4	Led light	2,000	2,000		
5	Sun King Pico 50	2,003	2,500		
6	Led 9 watts (Trineta)	2,080	500		
7	Sun King Boom	2,389	3,000		
8	Sun King Pico	2,525	3,000		
9	OvBeacon MB2 - 090	2,600	1200a		
10	d.light S2	2,870	3,000		
11	d.light S100	2,978	1,000		
12	Sun King Mobile	3,500	1000a		
13	d.light S3	3,800	3,800		
14	Solar Lantern	4,484	1,500		
15	d.light S30	4,500	4,500		
16	Sun King Pro 2	6,475	1500a		
17	d.light S20	7,399	5,000		
18	Sun King Pro	7,750	3500a		
19	Sun King Pico Plus	7,850	7700a		
20	d.light A1	8,602	1500a		
21	Family sunshine	11,000	11,000		
22	d.light S300B	12,609	3500a		
23	Sun King Eco	16,167	3000a		
24	Niwa Multi 300 XL	17,883	1650a		
25	Sun King Pro All Night	18,083	6000a		
26	OvPilot X	22,000	22,000		
27		6,783			
28					
29	OvBeacon MB2 - 200	48,000	48,000		
30	Luminous	50,000	50,000		

	Lantern Brands	Category			
		QV		Non QV	
		Mean	Mode	Mean	Mode
1	Liuhong LH-404			446	500
2	C- touch or vemass			500	500
3	AKT Lighting			700	700
4	Smart charge			700	700
5	Yj 404			775	750a
6	Solar rechargeable touch			800	800
7	Juanita JA-1987			900	900
8	Unbranded			950	900a
9	Junai JA-1907			1,000	1,000
10	Linon			1,000	1,000
11	Loney			1,000	1,000
12	MPPT			1,000	1,000
13	Phillips Solar lantern			1,000	1,000
14	S2000,d100,m100			1,000	1,000
15	Shai hu			1,000	1,000
16	Shuai Hu			1,000	1,000
17	Virony			1,200	1,200
18	Solar torch			1,200	1,200
19	DP.LED			1,225	700a
20	Dk light			1,250	1,250
21	Lonan			1,350	1200a
22	Dp lite			1,400	1300a
23	Carmoli			1,500	1,500
24	Dp lamp			1,500	1,500
25	JA-1907			1,500	1,500
26	Sarda			1,500	1,500
27	Shuang Fei			1,500	1,500
28	Solar rechargeable led touch			1,500	1,500
29	Solar touch			1,500	1,500
30	SOLAR WORK LIGHTNING			1,500	1,500
31	Torch			1,500	1,500
32	High mountain camping light			1,700	1,700

	Lantern Brands	Category			
		QV		Non QV	
33	Smart power box			1,700	1,700
34	Junai			1,750	1500a
35	Casa			1,800	1500a
36	d.light Li21			1,800	1,800
37	Uy023			1,800	1,800
38	Work lighting			1,800	1,800
39	Free Light L2+			2,000	2,000
40	Do . Led light panel			2,000	2,000
41	GBC emergency led			2,000	2,000
42	J Y 819			2,000	2,000
43	Lon			2,000	2,000
44	C J-1929.			2,000	2,000
45	Cob work lighting			2,033	1500a
46	Cob work light JY-819A			2,067	1200a
47	Dp			2,070	1200a
48	DP. Led light			2,109	2,000
49	LONTOR SOLAR LIGHT CTL OL054U			2,200	2,200
50	DPLi21			2,250	2000a
51	Dp lighting			2,300	1800a
52	Camisave			2,333	2,000
53	Hurry bolt			2,400	2000a
54	Hongtai			2,500	2,500
55	NNS solar powered radio			2,500	2,500
56	Odling			2,500	2,500
57	Solar lighting			2,500	2,500
58	Swift solar panels			2,500	2,500
59	Work light			2,500	2,500
60	X F			2,500	2,500
61	Street light panel			2,500	2,500
62	NOOR			2,500	2,500
63	Camping Light			2,600	2,000
64	Qasa solar lantern			2,700	2,700
65	NS-S8			2,800	2,800
66	Lontor			2,905	1,500

	Lantern Brands	Category			
		QV		Non QV	
67	Intelligent emergency light			3,000	3,000
68	Solar lamp			3,000	3,000
69	Sun Africa			3,000	3,000
70	XF-7787			3,000	3,000
71	Little Sun			3,000	5,000
72	M5P18			3,200	3,200
73	MT8806A LIGHTING			3,250	3000a
74	Multifunction solar panel			3,475	3,000
75	NNS NS-S352			3,500	3,500
76	Solar power bank			3,500	3,500
77	NNS portable active speaker			3,800	3,800
78	Saroda			3,832	2000a
79	Blue Connect			4,000	4,000
80	Lontor solar charge			4,000	4,000
81	NS-S285 MODEL			4,000	4,000
82	Panel			4,000	4,000
83	Secodi			4,333	0a
84	Tiger world			4,400	1,500
85	DP 7707B			4,750	3000a
86	WAXIBA			5,000	5,000
87	Wild Lion			5,000	5,000
88	NNS			5,667	6,000
89	GSE Solar			6,500	3000a
90	Kamisafe - pass- km-7657			6,696	15,000
91	JUYAN LIGHTNING			7,000	7,000
92	Bilitong 10000mah			8,000	8,000
93	HB-9707A-1			8,000	8,000
94	Solar Fitila			8,000	8,000
95	Charge 2200			8,250	1500a
96	Gold Sunshine			9,583	500a
97	Cafini			10,000	10,000
98	Saper			10,000	10,000
99	Charge 4400			10,167	2500a

Table 18 SHS pricing

	SHS Brands	Category			
		QV		Non QV	
		Mean (NGN)	Mode (NGN)	Mean (NGN)	Mode (NGN)
1	d.light D20 / D20-g	13,160	30,000		
2	Sun King Home 120	15,045	1500a		
3	OvBeacon MB2 - 380	20,000	20,000		
4	d.light D30	22,152	15,000		
5	Sun King Home Plus	23,777	0a		
6	Luminous	30,000	30,000		
7	OvCamp HS1-144_LB2244	31,500	18000a		
8	Sun King Home 60	33,450	20000a		
9	M-POWER family of kits (PAYG)	52,000	0a		
10	10W Quad Solar Home System	54,125	16500a		
11	Solar Home Lighting System	56,782	10,000		
12	Fenix int F0113NG-AA0	60,000	60,000		
13	M-KOPA III	66,667	10000a		
14	Mobisol Family SHS - 19 TV (PAYG)	71,000	15000a		
15	OvCamp Solar Home Systems	73,000	73,000		
16	OvBeacon MB2 - 290	95,000	95,000		
17	MSS Modular Solar Systems	95,000	95,000		
18	M-POWER M120 (PAYG)	100,000	100,000		
19	Sun King Home 400	185,000	185,000		
20	Fenix	230,000	230,000		
	Average price	66,383			
21	Saroda			6,417	3a
22	Salpha blaze			9,000	9,000
23	Barefoot Connect 3050			9,725	450a

		Category			
	SHS Brands	QV		Non QV	
		Mean (NGN)	Mode (NGN)	Mean (NGN)	Mode (NGN)
24	Salpha			10,000	10,000
25	Indigo Duo Solar Home System			17,900	3500a
26	HS1-36_LB1122 / HS2-36_LB1122			18,000	18,000
27	Panmic			20,000	20,000
28	Yingli			20,000	20,000
29	FMS solar fan			22,000	22,000
30	Sunlight solar			22,000	22,000
31	Estar solar			23,000	23,000
32	Out back			23,000	23,000
33	BLT loyal home system			25,000	25,000
34	Four solar			25,000	25,000
35	Famy care			28,000	28,000
36	Home Mate H1/H1G			28,667	2000a
37	CENTURY			30,000	30,000
38	GOLD SUNSHINE			34,800	15000a
39	Boscon solar generator			35,000	35,000
40	Dura volt			35,000	35,000
41	Office 200 X2			35,000	35,000
42	Sunshine solar home kit			35,000	35,000
43	Go So Firefly 12			37,786	5000a
44	Global Led			40,000	40,000
45	Sinergy			41,000	41,000
46	Home Run 400 X3			42,500	35000a
47	Prime solar			45,000	45,000
48	Flames			50,000	50,000
49	L.G			50,000	50,000
50	Secodi			71,000	12000a
51	Barefoot Connect 600			75,000	75,000
52	GBM			75,000	75,000
53	King Light			75,000	75,000

		Category			
	SHS Brands	QV		Non QV	
		Mean (NGN)	Mode (NGN)	Mean (NGN)	Mode (NGN)
54	15W Quad 600			80,000	120,000
55	Mercury			85,000	85,000
56	Ever gold			85,000	85,000
57	GSE SOLAR			88,333	30000a
58	Blue gate			105,000	105,000
59	GENUS			110,000	110,000
60	SAFE POWER			110,000	110,000
61	EAST MAN			110,000	110,000
62	Eastman			115,000	115,000
63	Star time solar S210J			121,000	121,000
64	Microtex			135,000	120000a
65	Bona freezer			140,000	140,000
66	Soelis			185,000	185,000
67	Beebeejump			188,000	188,000
68	Lomus by MTN			241,000	241,000
	Average			62,773	
69	Beebeejump H series			1,500,000	1,500,000

Table 19 Solar panel pricing

	Solar panel brands	Trade Pricing	
		Mean (NGN)	Mode (NGN)
1	Sunmate	1,000	1,000
2	No.:HT_003 Solar	1,200	1,200
3	DD solar panel	1,800	1,800
4	GD Lite Solar Panels	2,000	1,500
5	DP.LED light	2,012	2,000
6	XF7787	2,050	3,000
7	D.P Solar	2,071	3,000
8	Wild Lion Solar Panel	2,250	1500a
9	Dp light	2,364	1500a
10	Tigerworld	2,467	1700a
11	Kame Solar panels	2,500	2,500
12	Swift Solar	2,500	2,500
13	GD Lite Solar	2,667	1500a
14	Dp light Li21	2,857	2,500
15	Histar solar	3,000	3,000
16	Saroda	3,089	2,000
17	Multipurpose solar panel	3,250	3000a
18	XF	3,250	2,500
19	Lontor solar panel	3,550	3,500
20	Ctorch	4,500	3000a
21	Boscon	5,000	5,000
22	MT	5,000	5,000
23	S Sodar	5,250	4500a
24	Sunfield solar	5,500	4000a
25	Kamsafe solar panel	5,583	3,500
26	Dp light Li27	6,000	5000a
27	Motion Solar	6,400	4000a
28	SunDar Solar	6,583	80a
29	Rubitech	6,800	3500a
30	SunKing	8,500	2000a
31	Gold Starshine	9,230	50a
32	SMS	10,000	10,000
33	Npp	11,000	11,000

	Solar panel brands	Trade Pricing	
		Mean (NGN)	Mode (NGN)
34	Sunlight	11,364	8000a
35	Poly and moni	11,500	11,500
36	Cowin	11,600	1200a
37	Asteven	12,250	2000a
38	Poli solar	12,500	12,500
39	Casa	13,500	0a
40	Aia Hech	15,000	15,000
41	Hongtai	15,000	15,000
42	Sungene Solar	15,000	15,000
43	Best Solar	15,441	0a
44	Super Vision Solar	15,568	5000a
45	WSC	16,000	16,000
46	D. Light Panel	16,760	1800a
47	Win	17,000	17,000
48	Mono Solar panels	17,565	7500a
49	Step Solar	17,591	10000a
50	Davis & Shirliff	18,733	1200a
51	XPN	19,000	19,000
52	Bona	19,147	12a
53	MTN solar	19,500	19,500
54	Gold sun	20,000	20,000
55	Oxano	20,000	20,000
56	Stronger	20,000	20,000
57	Sunfit	20,000	20,000
58	Winlamp	20,500	18000a
59	Sun ground	21,000	21,000
60	Sunshine Solar	21,059	6,000
61	Prime Solar Panels	21,250	23,000
62	Yingly	21,250	18000a
63	CLOUD ENERGY	22,000	22,000
64	Yinglee	22,000	22,000
65	Sungene Solar Panels	23,000	23,000
66	M.s solar	23,333	25,000

	Solar panel brands	Trade Pricing	
		Mean (NGN)	Mode (NGN)
67	Genus solar	25,000	5000a
68	Goldstar	25,000	25,000
69	Lion star	25,000	25,000
70	Queenswing	25,000	25,000
71	Sun power	25,000	25,000
72	Felicity solar	25,313	10000a
73	Nezus	26,000	26,000
74	De bull	27,000	27,000
75	Beebeejump	27,500	20000a
76	Joy solar	28,100	21,000
77	Polycrystalline	29,000	29,000
78	F Step Solar	29,233	48,000
79	Franchise	30,000	30,000
80	Mini grid	30,000	30,000
81	Monocrystalline	30,000	20000a
82	Rester Solar	30,201	10a
83	Euro Solar	30,267	1400a
84	Super master	32,750	15000a
85	Tigerland	33,000	33,000
86	E star	33,500	17,000
87	Flames solar panels	33,818	25000a
88	THS	34,900	3500a
89	Derik	35,000	20000a
90	Crock	37,000	37,000
91	Africell solar	37,500	30000a
92	BLT solar panels	40,000	40,000
93	Mithstar	40,000	40,000
94	Synery	40,000	40,000
95	Toplight	40,000	40,000
96	Suncrown solar	42,500	20000a
97	Mercury	43,000	43,000
98	FINISE	44,000	40000a
99	Famicare	45,000	45,000

	Solar panel brands	Trade Pricing	
		Mean (NGN)	Mode (NGN)
100	Gpower	50,000	50,000
101	Sunstsar Solar	53,146	50,000
102	Era	55,000	55,000
103	Microtek	58,750	90,000
104	Plims	60,000	60,000
105	Foresolar	64,550	9500a
106	Sunpower	70,667	4000a
107	Pro Solar	92,263	2500a
108	Luminous	110,938	100,000
109	Secodi	120,000	120,000
110	DURAL	150,000	150,000
111	Pomo	160,000	160,000
112	BASS	188,000	188,000
113	Chloride Exide	249,800	1200a



Africa Clean Energy



TETRA TECH
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