

COUNTRY PROFILE

OFF- AND WEAK-GRID SOLAR APPLIANCE MARKET NIGERIA

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EFFICIENCY FOR ACCESS COALITION



This country profile covers relevant market and appliance performance data for off-grid appliances sold in Nigeria based on findings from Efficiency for Access market surveys. The profile explores the overall market landscape in Nigeria, the common power type, size, price and warranty of off-grid appliances sold in retail markets, and other findings relevant to sector stakeholders working in Nigeria.

This profile was developed by the UK's Energy Saving Trust and CLASP as part of the Low Energy Inclusive Appliances programme, a flagship programme of the Efficiency for Access Coalition. Efficiency for Access is a global coalition promoting energy efficiency as a potent catalyst in clean energy access efforts. Currently, Efficiency for Access Coalition members lead 12 programmes and initiatives spanning three continents, 44 countries and 22 key technologies. The Efficiency for Access Coalition is jointly coordinated by CLASP, an international appliance energy efficiency and market development specialist non-for-profit organisation, and the UK's Energy Saving Trust, which specialises in energy efficiency product verification, data and insight, advice and research.

This report was authored by Bex Paffard of Energy Saving Trust, as well as Elisa Lai and Riley Macdonald of CLASP.

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INTRODUCTION

Efficiency for Access Country Profile Series

Insufficient data about off-grid appropriate appliances¹ makes it difficult for manufacturers, policymakers, distributors, mini-grid operators, investors and other market actors to make informed decisions and identify high quality, efficient products. To help address this challenge, Efficiency for Access has worked to gather data on the availability of off-grid appropriate appliances in key countries.

Since 2018, Efficiency for Access has been conducting market scoping surveys in 10 countries.² The countries were selected based on the population size, solar home systems (SHS) sales volumes³ and uniqueness of the market.⁴ The survey results have informed program decisions, such as selecting products for testing through [VeraSol](#).⁵ To utilise this data and share insights from the surveys more broadly, Efficiency for Access has developed a series of country profiles that share market intelligence and contextualise data with supporting research and stakeholder feedback.

Product specifications collected through market surveys may not be accurate. Some of the data cited in this country profile includes claimed values provided by shopkeepers or from consumer-facing materials, such as a product's packaging or user manual. As such, it may differ from data generated through third-party testing which is available on the [VeraSol Product Database](#). Still, this data provides preliminary and useful observations about Nigeria's local off-grid appliance market.

About Nigeria

With 220 million people,⁶ Nigeria has the largest population and one of the biggest economies—which is based primarily on the petroleum industry—in Africa. Nigeria also has one of the greatest energy access challenges in the world.⁷ Almost half of the population (48%) does not have access to electricity (9% for urban areas, 60% in rural areas).⁸

Nigeria also has a relatively low per capita electricity generation capacity. This is primarily due to an outdated grid,⁹ and transmission constraints. Where grid electricity is provided, it is notoriously unreliable and has frequent power outages. This means people who can afford generators rely on them as their primary energy source.¹⁰ The International Finance Corporation estimates that there are 2.8 million residential and 210,000 commercial generators in active use in Nigeria, with one generator estimated for every 60 people. Backup generators refer to both large commercial diesel units and small gasoline-powered generators, known locally as “I better pass my neighbour”.

Nigerians spend approximately USD\$12 billion each year on the purchase, maintenance and fuel costs for gasoline only generators.¹¹ Currently, generators are considerably cheaper to purchase than SHSs. One study from A2EI found that on average, generators are 16 times cheaper than an SHS of similar power capacity given current conditions. In addition, they also found that due to the high upfront costs of solar systems, it would take 8-9 years before the total lifetime costs of a solar system would become cheaper than purchasing a generator of similar size.¹² This is a key limiting factor in transitioning to cleaner, healthier solar energy sources. In addition, generators are a significant source of air pollutants that negatively impact health and the environment. Some studies have shown that exposure to generators could increase the chance of lung cancer by 70%.¹³ This exposure



of people in Nigeria do not have access to electricity

1. In this document, off-grid appropriate appliance refers to appliances that can be powered by distributed energy systems like SHSs and mini-grids, or are appropriate to use in weak-grid conditions.

2. The selected countries are India, Sierra Leone, Uganda, Nigeria, Cote D'Ivoire, Ethiopia, Kenya, Myanmar, Tanzania, and Pakistan.

3. Sales volumes of SHS kits can be an indication of off-grid appliance ownership.

4. Uniqueness of market is used as selection criteria to enable data collection on a larger variety of brands and models, and to have a wider geographical scope.

5. VeraSol tests and generates consistent and comparable performance data to support scalable markets for durable, high-performing, and affordable off-grid appliances and productive use equipment.

6. CIA, The World Factbook. 2021. <https://www.cia.gov/the-world-factbook/field/population/country-comparison>

7. Power For All, Nigeria Call to Action. 2017. <https://www.powerforall.org/application/files/9715/3308/4537/Nigeria-Call-to-Action.pdf>

8. CIA, The World Factbook. 2021. <https://www.cia.gov/the-world-factbook/countries/nigeria/#energy>

9. A2EI, Putting an End to Nigeria's Generator Crisis: The Path Forward. 2019. https://a2ei.org/resources/uploads/2019/06/A2EI_Dalberg_Putting_an_End_to_Nigeria%E2%80%99s_Generator-Crisis-The_Path_Forward.pdf

10. IFC, The Dirty Footprint of the Broken Grid. 2019. https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/financial+institutions/resources/dirty-footprint-of-broken-grid

11. A2EI, Putting an End to Nigeria's Generator Crisis: The Path Forward. 2019. https://a2ei.org/resources/uploads/2019/06/A2EI_Dalberg_Putting_an_End_to_Nigeria%E2%80%99s_Generator-Crisis-The_Path_Forward.pdf

12. Id.

13. Id.

to harmful pollutants is not well monitored or understood globally.¹⁴

Meanwhile, Nigeria's solar market is witnessing tremendous growth,¹⁵ and the country has a strong potential market for small-scale solar through the use of SHSs. Recent estimates show that SHSs and mini-grids could provide energy to over 88 million Nigerians by 2030.¹⁶ This is highlighted by the fact that in the first half of 2020, sales of off-grid solar products¹⁷ in Nigeria reported by GOGLA affiliates were estimated at about 200,000 units, making it the fourth largest market for GOGLA-reported off-grid solar sales during this time period. This is also a significant (94%) increase compared to the first half of 2020, and a 21% increase compared to the second half of 2019.¹⁸

Efficiency for Access market surveys found that the majority of products available to off-grid consumers were alternating current (AC) appliances that are typically used with generators. Field consultants indicated that demand for SHSs in Nigeria is growing. Lab testing of some of these local Nigerian brands also showed that these products were extremely efficient, especially for TVs and fans.



COVID-19 IMPACT

During the time of the 2020 surveys, Nigeria was suffering from the COVID-19 outbreak. Due to COVID-19, the Nigerian economy experienced its deepest recession since the 1980s and contracted by 4%.¹⁹ The importance of energy access was heightened by the pandemic, and off-grid solar was deemed an “essential service” from January to June 2020 to enable companies to maintain vital services.²⁰ Following the lockdown, 85% of businesses reported to be operating, but are not seeing the same level of business as pre-pandemic. Half of the traders interviewed in the 2020 market survey reported that they had not needed to restock in 2020 and very few have been able to import the required products.

Other impacts of COVID-19 on the market include issues with transportation, economic downturn, currency devaluation and reduced production output from China. COVID-19 has pushed more customers to shop online and has increased familiarity with phones and e-market platforms. Based on feedback from stakeholders during the market surveys, one silver lining of the pandemic is increased demand for low energy consuming appliances and solar systems, particularly for homes and health centres.

Nigeria has also positioned itself as a leader in using the pandemic to build the market for clean energy solutions. In response to COVID-19, Nigeria released its Nigeria Economic Sustainability Plan in June 2020. One of the highlights from the plan is a commitment from the government to deliver and maintain 5 million new solar connections under a 'solar power strategy'. "This strategy is expected to support 250,000 new jobs and impact up to 25 million people through the installation of 5 million SHSs and mini-grids."²¹ The plan also promotes large-scale assembly of solar components in Nigeria.²²

14. IFC, The Dirty Footprint of the Broken Grid. 2019. https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/financial+institutions/resources/dirty-footprint-of-broken-grid

15. Research and Markets, Nigeria Power EPC Market Growth, Trends, and Forecasts Report 2021-2026: Focus on Power Generation and Power Transmission & Distribution (T&D). 2021. <https://money.yahoo.com/nigeria-power-epc-market-growth-092600150.html>

16. Roche, Maria Yetano, et. al, Achieving Sustainable Development Goals in Nigeria's power sector: assessment of transition pathways. 2019. <https://doi.org/10.1080/14693062.2019.1661818>

17. This includes both solar systems up to 350 W and small solar lighting.

18. Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data GOGLA 2020, H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

19. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

20. Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data GOGLA 2020, H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

21. World Economic Forum, How Nigeria is using the pandemic to build a sustainable energy future. 2020. <https://www.weforum.org/agenda/2020/09/nigeria-using-pandemic-build-sustainable-energy-future/>

22. Id.

MARKET LANDSCAPE

Market Conditions

According to the 2019 State of the Off-Grid Appliance Market Report, the market for off-grid appliances in Nigeria is categorised as “high potential”, meaning the country has a large off-and weak-grid population, relatively high disposable incomes and rapidly growing but immature off-grid solar and mini-grid industries.

However, compared to other markets, Nigeria has less access to finance and lower levels of government support. The off-grid appliance market in Nigeria was valued at USD\$537 million in 2018, and the obtainable market size, or capturable share of the market given current demand-side and supply-side constraints, is expected to almost double by 2030 to USD\$929 million.²³ When looking at the obtainable market size by appliance type, the Nigerian market is expected to grow to USD\$140 million for fans, USD\$470 million for TVs and USD\$280 million for refrigerators by 2030.²⁴ There is also a relatively high existing penetration of appliances in rural Nigeria households, with 28% owning a TV, 11% owning a refrigerator and 26% owning a fan. For comparison, the penetration of appliances in rural Kenya²⁵ is 19% for TVs and 1.5% for fans.²⁶

Consumer Awareness

Although there is a relatively high market penetration of appliances in rural Nigerian households, awareness of the existence of DC products designed for use with SHSs is low. While many energy-efficient AC appliances advertise being suitable for use with SHSs, there are very few DC appliances designed specifically for use with SHSs readily available on the market. Energy-efficient appliances are targeted primarily at generator owners and consumers who use prepaid electricity metres. Shopkeepers stated that consumers view DC products as more efficient than AC products, and so some customers purchase DC appliances and use a rectifier to reduce fuel costs for their generator.

Historically, there has been a lack of trust in the quality of solar products. For example, Nigeria introduced solar

streetlamps, but they did not work consistently and consequently damaged the reputation of other solar powered products, such as SHS kits and off-grid appliances.²⁷ However, there is good progress being made to promote the sales of quality solar products in Nigeria. Programmes such as Lighting Africa-Nigeria have laid the groundwork to improve consumer awareness and promote the benefits of off-grid solar products. As time progresses, consumers are expected to grow more discerning of the products available on the market and to demand higher quality appliances, especially for larger investment products like refrigerators and solar water pumps (SWPs).²⁸

Government Policy

In 2018, the Nigerian government launched the Nigeria Electrification Project (NEP), which aims to expand access to electricity through mini-grids and standalone solar systems. Through the NEP, the World Bank is providing USD\$350 million, of which USD\$75 million comprises an investment fund, to encourage market growth for faster uptake of SHS kits.²⁹ The project will also require mini-grid developers to make household and productive-use appliances available to end-beneficiaries.^{30,31} The NEP has also been instrumental in the COVID-19 response, with the project selecting 100 healthcare facilities for the deployment of solar hybrid systems and a further 400 facilities selected for the second phase.³²

The government has adopted several other initiatives to increase access to electricity and foster the growth of renewable technologies. For example, the government recently adopted SEforALL's action agenda, which plans to achieve 30% of electricity generation through renewable energy by 2030. The government will also participate in the Regional Off-Grid Electrification Project (ROGEP), which aims to promote a harmonised regional market for high-quality standalone solar equipment to boost uptake of SHSs and associated appliances.^{33,34,35} In addition, in June 2020, the government of Nigeria adopted the test methods (IEC 62257-9-5) and quality standards (IEC 62257-9-8) for off-grid energy systems up to 350 W. These standards will play a critical role in keeping sub-standard products out of the market and ensuring market stakeholders can have confidence in

23. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

24. The total addressable market size is estimated by overlaying affordability on off-grid and weak grid household numbers. The obtainable market is further constrained by the availability of consumer finance and accessibility of the household to off-grid appliance distributors

25. No data is available on the penetration rate of refrigerators in rural households in Kenya.

26. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

27. Id.

28. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

29. Lighting Africa, Nigeria. 2019. <https://www.lightingafrica.org/country/nigeria/>

30. The World Bank, Nigeria Electrification Project: Project Appraisal Document. 2018. <https://projects.worldbank.org/en/projects-operations/project-detail/P161885>

31. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

32. Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data GOGA 2020, H1 2020. <https://www.goga.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

33. Lighting Africa, Nigeria. 2019. <https://www.lightingafrica.org/country/nigeria/>

34. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

35. <https://www.powerforall.org/application/files/9715/3308/4537/Nigeria-Call-to-Action.pdf>

supporting and using off-grid products. The government of Nigeria is making good progress to promote the use of off-grid solar, but more policy support will likely be needed to help households switch away from generators in order to grow Nigeria's off-grid appliance market.³⁶

In addition to government support, in 2019, the Rockefeller Foundation provided a USD\$3.5 million grant with All On to fund the establishment of a support facility for off-grid energy entrepreneurs in Nigeria. The supported companies are expected to provide thousands of new connections to low-income households and small and medium enterprises in Nigeria by 2022.³⁷

Consumer Financing

In 2019, the Efficiency for Access State of the Off-Grid Appliance Market Report identified that affordability and a lack of financing remain major constraints to the growth of the off-grid market in Nigeria.³⁸ During this time, upfront cash payments were the most common financial model for purchasing products, and mobile money penetration was relatively low.³⁹ However, the usage of mobile money has grown significantly in the last several years, likely due to relaxed licensing regulations from the Nigerian central bank. For example, the Nigerian Inter-Bank Settlement System reported that the country experienced an 88% year-on-year growth in electronic payments in Q1 2021,

totalled at USD\$133 billion.⁴⁰ In addition to mobile money, other finance mechanisms authorised through microfinance institutions, such as loans and PAYGO, are in their infancy but gaining popularity.

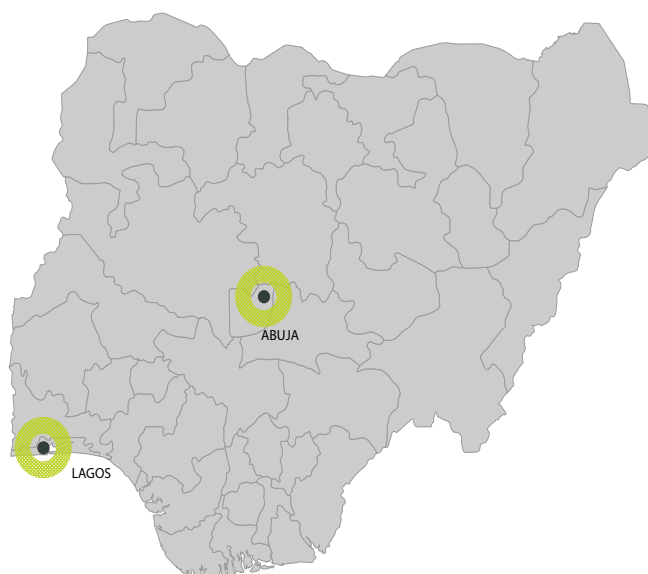
Off-grid appliances imported into Nigeria have historically faced high duties, between 5-20%.⁴¹ TVs, fans and refrigerators are categorised as luxury items and are therefore subject to 5% value-added tax (VAT).^{42,43} These duty and VAT rates are in line with other West African countries. However, in response to COVID-19, the government announced VAT exemptions for solar technologies through the Emergency Economic Stimulus Bill 2020. It is not clear, however, whether or not this exempts solar appliances.⁴⁴

Product and Technology

Methodology and Sample Source

Efficiency for Access engaged field-based consultants to survey key off-grid retail markets in Nigeria. The first round of surveys was completed in 2018 and consultants revisited the markets in 2020. The purpose of these surveys was to identify product models sold in the retail markets and to identify any changes in the market over time. Unless otherwise specified, we combined the datasets from 2018 and 2020 to show an overall market picture.

Figure 1: Geographic area covered



36. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

37. The Rockefeller Foundation, All On and The Rockefeller Foundation Launch All On Hub to Support Off-Grid Entrepreneurs in Nigeria. 2019. <https://www.rockefellerfoundation.org/news/rockefeller-foundation-launch-hub-support-off-grid-entrepreneurs-nigeria/>

38. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

39. Id.

40. Forbes, Who Will Capture The Merchant Payment Opportunity In Africa? 2021. <https://www.forbes.com/sites/columbiabusinessschool/2021/06/04/who-will-capture-the-merchant-payment-opportunity-in-africa/?sh=b84b03b2b988>

41. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

42. Id.

43. Id.

44. Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data GOGA 2020, H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

The field consultants visited retail shops, reviewed online stores and evaluated e-commerce platforms to collect data on brand, model name/number, appliance size, power input, voltage, warranty and retail price. This data was pulled from rated claims on the product packaging or user manual, or from a shopkeeper's knowledge of the product, and thus may not be as accurate as tested data.

The Efficiency for Access team also purchased nine TVs, six fans and two refrigerators identified during the surveys for further performance and quality evaluation through laboratory testing. The analysis of this lab-tested data is included in each product specific section below, and the detailed data of the tested products are available on the [VeraSol Product Database](#).

In addition to gathering data on product specifications, the field consultants conducted interviews with owners of small shops to collect qualitative evidence and anecdotes. This anecdotal evidence complements quantitative data and may provide more insights on perceived product demand, quality and performance.

Field consultants stated that off-grid appliances are not sold in rural communities, but rather, sold in the city markets such as Lagos, Abuja, Aba and Kano. Informal markets account for approximately 90% of retail in Nigeria, consisting of a mix of open-air and in-store shops. Field consultants undertook surveys of off-grid TVs, fans, refrigerators and SWPs in retail markets in Lagos (across market hubs Ojo, Ikeja, Orile and Lagos Island) and Abuja.

Lagos is the commercial hub of Nigeria with an estimated population of 20 million. Approximately 90% of all goods come through its port, and the markets of Lagos are considered the origin of goods distributed throughout the country. Abuja is in the North Central region and is the capital of Nigeria. It was selected for its strategic position as an entry point into the north of the country. These distribution channels are representative of the range of existing markets, namely the quality solar market, large electrical stores and street vendors.

Data Analysis on Appliances

The below section analyses off-grid appliances available in Nigerian retail markets in 2018 and 2020, primarily focused on TVs, fans, refrigerators and SWPs. In 2020, Efficiency for

Access expanded the survey to collect data on other products found in the market, such as hair clippers, cooling units and water dispensers, and to document the type of connectors or plugs integrated into or sold with the product. The data was analysed based on the following characteristics:

- **Power type:** Are there more AC or DC appliances available?
- **Size:** What are the most prominent sizes of the products?
- **Price:** What is the range of product retail price?
- **Warranty:** How many products are covered by a warranty and how long is the warranty?
- **Power consumption (for TVs, fans and refrigerators only)⁴⁵:** What is the lab-tested power consumption of TVs, fans and refrigerators sampled from Nigeria?
- **Connector/Plug:** What kind of connectors and plugs are provided with the products?

TV MARKET INSIGHTS

The penetration of TVs in rural Nigerian households is the highest of all off-grid appliances we surveyed at 28%.⁴⁶ TVs have become a key driver of off-grid solar uptake, representing the most in-demand appliance for off-grid households.⁴⁷ In 2020, GOGLA affiliates sold over 12,000 TVs in Nigeria, and between the first half and second half of 2020, sales rose by 40%.^{48,49} In terms of sales with a solar system, Efficiency for Access field consultants found that 3% of TVs from retail shops, or two models, were sold with an SHS kit.

Field consultants captured technical specifications and price data for 75 unique TV models from 34 different brands. By far the most common brand is LG, representing 31% of the models, with Samsung as the second most common at 7% of the samples. The market includes DC compatible TVs from local Nigerian companies, such as Cloud Energy and Qasa. The consultants found that there was less variety and fewer television brands and models in Abuja compared to Lagos markets. This might be due to more appliances being imported through Lagos.

45. Data is only available for TVs and refrigerators because we lab tested six TVs in 2018, three TVs in 2021, and two refrigerators in 2018 sourced from Nigeria. At the time of this report, we are also currently testing one refrigerator, one freezer, and one SWP, all sourced from Lagos.

46. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

47. Id.

48. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

49. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

Power Type

The surveys show that despite visiting shops where off- and weak-grid consumers would shop, DC-compatible TVs are less common on the market than AC models.

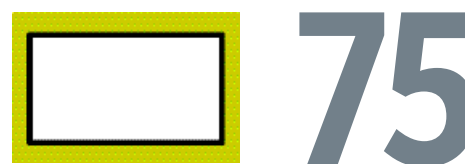
More than three quarters (77%) of the models surveyed during the market visits are AC. The remaining 21% are AC/DC compatible and one model is DC, which is consistent with other product categories. This may be due to reliance on on-grid supply and generators, which are directly compatible with AC products, or because DC-compatible products tend to be more expensive.

Product Size

TVs available on the Nigerian market range between 15-65 inches and tend to have larger screen sizes compared to other countries where Efficiency for Access has conducted market surveys. Although the TVs' sizes were larger in Nigeria than other markets surveyed, there is a general increase in off-grid TV sizes globally. This is partially because TVs are becoming more efficient, so the difference in power consumption between larger and small TVs is minimal. This means customers can either benefit from a larger screen without needing to expand the capacity of solar panels and battery if they are using a solar system, or they don't need to use as much fuel with their generator.⁵⁰

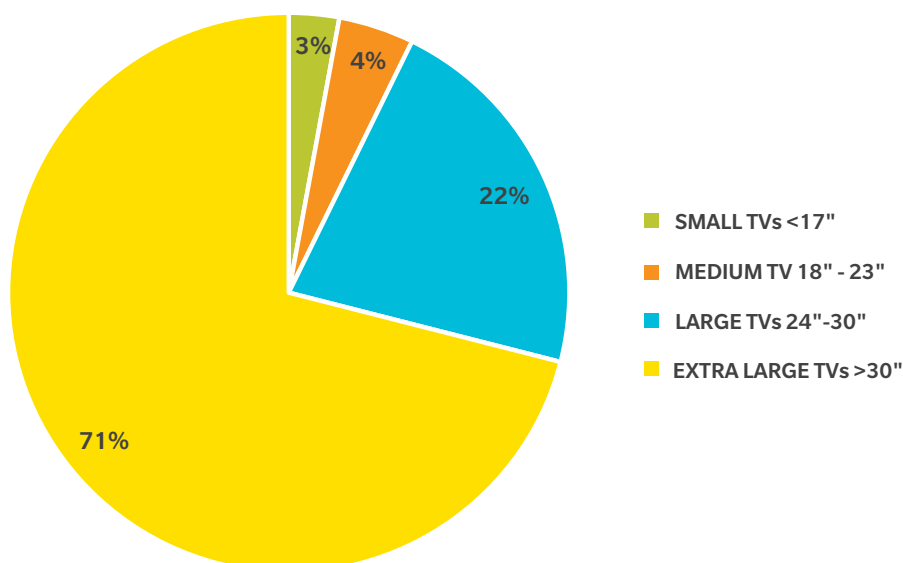
The survey screen size data is divided into four categories (small, medium, large and extra-large) based on diagonal screen size, measured in inches. The addition of the "extra-large" category reflects the shift to larger TVs available on the Nigerian market compared to those observed in the [Sierra Leone](#) and [India](#) Country Profiles. TV models with a diagonal screen size of 50 inches and above are excluded from the analysis, as they are most likely suitable for commercial purposes rather than energy constrained households.

The vast majority (71%) of models surveyed in the 2018 and 2020 surveys are in the extra-large category, with a diagonal screen size of 30 inches or greater (Figure 2). The



Field consultants captured technical specifications and price data for 75 unique TV models sold by 34 brands

Figure 2: Different TV sizes available on the market in 2018 and 2020



50. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

most common TV size is 32 inches. In the 2020 surveys, field consultants found no TVs that fell into the small and medium category, suggesting that the Nigerian market is moving away from smaller, less expensive TVs.

Retail Price

As may be expected, there is a strong correlation between screen size and price, with larger TVs having higher prices. This trend can be seen in Table 1. The extra-large TVs, the most popular in Nigeria, have an average price of USD\$185. Without financing, the upfront expense of a TV remains beyond what most households can afford, especially if sold as part of an SHS package. A report by Efficiency for Access found that the average price of a TV unit sold with an SHS kit in Nigeria is approximately USD\$800, which is more than twice the average monthly income (USD\$200-300) for most rural off-grid consumers. This makes consumer financing, even for smaller products like TVs, essential to growing the market. Currently, only 2.2 million households in Nigeria (10%) can afford an off-grid TV, but when financing is available, that number jumps to 7.7 million (40%).⁵¹

Warranty

The most commonly offered warranty for TVs sold in the Nigerian market is one year (38%), followed by two years (32%). As shown in Figure 3, warranties vary from six months to four years. The longest warranties (four years) come from one local solar brand, which are longer than any TV warranty identified in India and Sierra Leone market surveys. For comparison, in Sierra Leone, the majority (61%) of TVs are sold with a warranty of one month or less. The availability of these longer warranties suggests that the manufacturers may be working to build brand loyalty, but as with all other products, we cannot verify what percent of these warranties are truly being honoured.

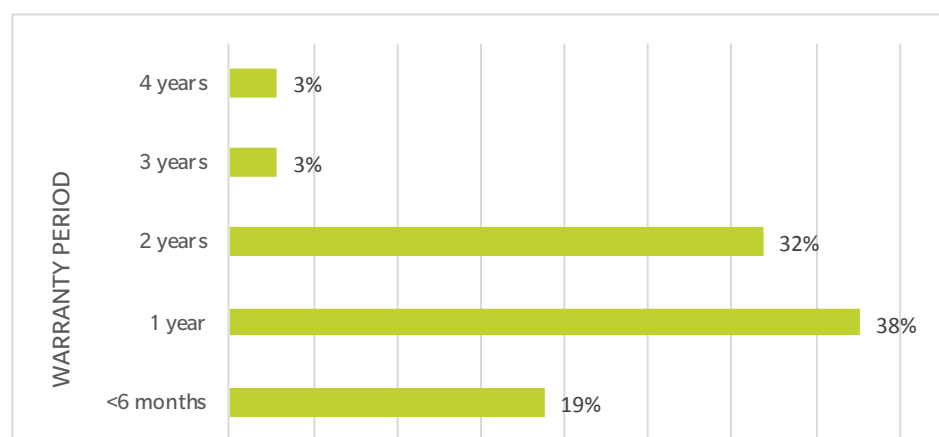
Power Consumption

When looking at manufacturer-reported power ratings, the surveyed TVs show a positive correlation between screen size and power rating, with the larger TVs typically having higher power ratings. For example, in the most popular screen size category of 32 inches, there is a wide range of power ratings (between 15 to 56 W). It's also important to note that 23% of samples did not include any power rating.

Table 1: Average retail price for TVs categorised by size

DIAGONAL SCREEN SIZE (INCHES)	AVERAGE RETAIL PRICE (USD)	
	2018	2020
Small TVs <17"	52	N/A
Medium TVs 18" - 23"	76	N/A
Large TVs 24" - 30"	95	130
Extra-Large TVs >30"	187	183

Figure 3: Warranty period offered for TVs

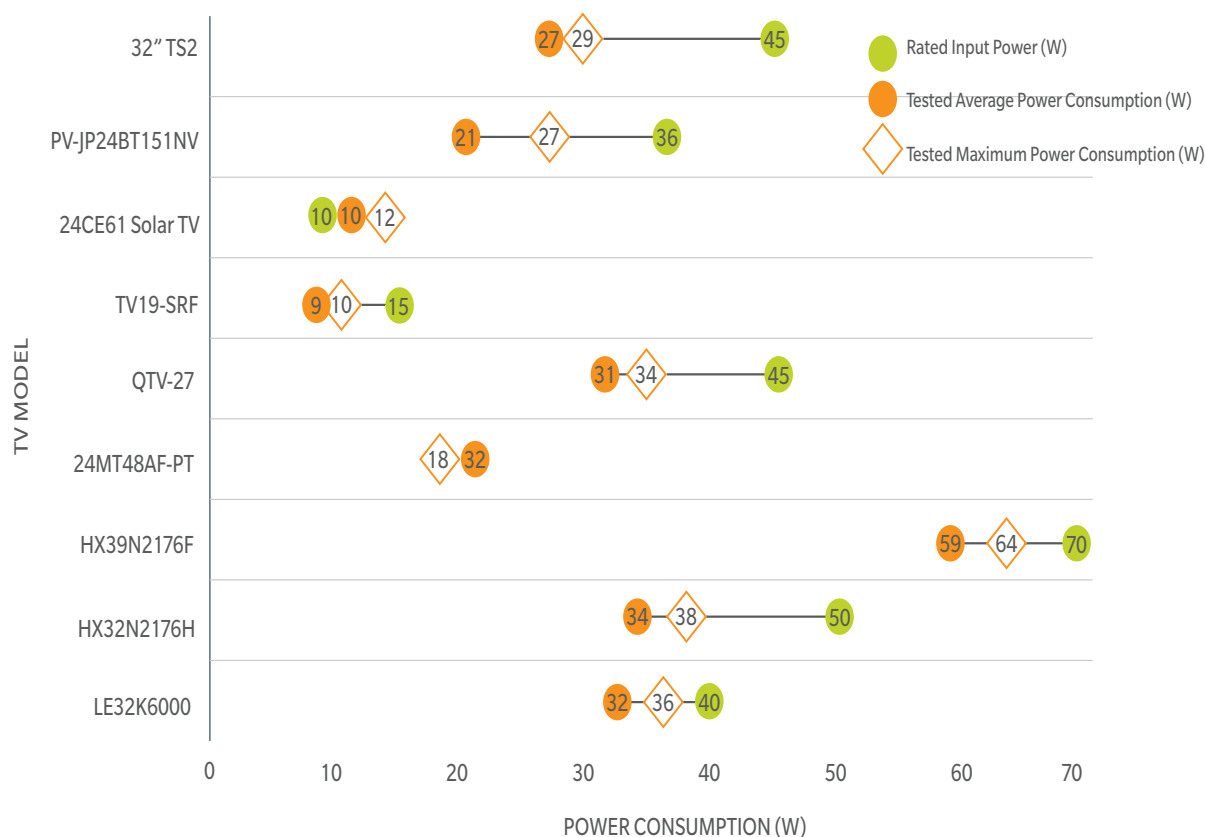


51. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

The Efficiency for Access team procured six of the TVs identified during market surveys in Abuja and Lagos to conduct laboratory performance testing. To identify differences between tested and rated data, we compared the lab-tested power consumption with the power rating included on the product's packaging (Figure 4). The results show that in all but one case, both the average tested power and maximum tested power is lower than the rated power. This is consistent with other analysis from Efficiency for Access which found that manufacturers typically over-state the power consumption of their products in order to ensure that they don't underreport the energy requirements. However, if a buyer uses the rated energy consumption to size their system, it would likely result in an oversized SHS.

Although the sample size is relatively small, the results show that the six TVs tested from Nigeria are on average more efficient than the average TV included in the [VeraSol Product Database](#). However, it's important to note that the TV brands chosen were from more reputable brands with low power ratings, and are not likely representative of the off-grid TV market as a whole in Nigeria. When looking at power consumption relative to size, the Nigerian samples are 23% more efficient than the average TV included in the database. One particular DC model from a local Nigerian brand, Cloud Energy, performed particularly well in terms of power consumption. It was the third best TV for power consumption compared to 22 other 23.5 inch TVs tested through VeraSol.

Figure 4: Comparison of rated power consumptions versus tested power consumption of TVs from Nigeria

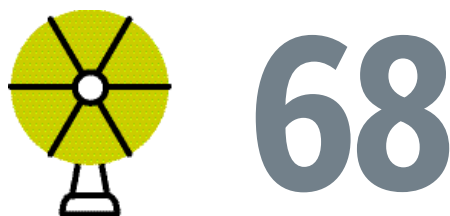


FAN MARKET INSIGHTS

Nigeria is one of the few markets in West Africa where sales of fans are gaining momentum and is considered a key market for potential sales of off-grid electric fans.⁵²

In 2020, GOGLA affiliates reported selling around 17,000 fans in Nigeria, making it the biggest market for off-grid fans in Africa.^{53,54} The overall penetration of fans in Nigeria is 26%, which is much higher than the regional penetration rates of 6-8% for fans in rural Africa.⁵⁵ The high demand for fans in Nigeria is likely linked to the hot and humid climate.⁵⁶

Field consultants collected data for 68 fan models from market shops in Lagos and Abuja, as well as local online stores, such as Jumia.



Data were collected for 68 models from market shops in Lagos & Abuja

Power Type

Just over half (54%) of the fans available on the Nigerian market are AC models. Of the other surveyed products, 41% are AC/DC compatible and only 3% are DC. Compared to TVs, there are significantly more AC/DC products. This may be because AC/DC fans are often promoted by retailers as a feature that enables flexibility for consumers to use the product with different types of electricity, including generators, an SHS kit or on-grid.



Product Type and Size

The most common type of fans are pedestal fans, representing 62% of the surveyed models, followed by ceiling fans, wall fans and table fans. Wall fans are popular in the Nigerian market, accounting for 11% of all fans surveyed, but are not included in further analysis given that Efficiency for Access does not currently include these fan types in their scope. Wall fans have cages mounted onto the wall, typically at eye level and are slightly less efficient than ceiling fans, as their motors tend to be less powerful and are less effective at displacing air.⁵⁷ According to field consultants, these are popular because they are relatively cheaper than pedestal fans, are more compact, and also because they have better prevention from theft. While pedestal fans are identified as the most popular fan type in Nigeria, GOGLA sales data showed that table fans were the most popular fan type sold in West Africa in 2020. This may be because they are commonly sold with SHS kits, and thus more likely to be reported by GOGLA affiliates.^{58,59}

52. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

53. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

54. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

55. Id.

56. Id.

57. Ceiling Fans Direct, Wall Vs. Ceiling Fans – Which is Better. 2012. <https://www.ceilingfansdirect.com.au/blog/ceiling-fans/wall-vs-ceiling-fans-which-is-better>

Retail Price

As shown in Table 2, pedestal fans are the most expensive fan type, nearly double the price of table fans.

This could be explained by pedestal fans being larger and requiring more materials to manufacture. The range of prices for pedestal fans in 2018 was large—between USD\$14 and USD\$122. In 2020, this gap narrowed, with the range of prices between USD\$36 and USD\$95. The average price of all fans increased from 2018 to 2020, potentially due to the impacts of COVID-19 on supply chain or the decrease in fan sales observed in 2020.⁶⁰ Due to lower upfront costs compared to other appliances, cash sales are the dominant business model in West Africa, with volumes more than double mobile money purchases.⁶¹

Warranty

Of the fans surveyed in 2018 and 2020, 79% offer some type of warranty, with the most common (46%) being one year (Figure 5). The second most popular offering is

six months (18%), followed by two years (15%). An additional 22% of models offer no warranty for their product. All of the models surveyed in 2020 come with a warranty between six months and two years. A one-year warranty remains the most common.

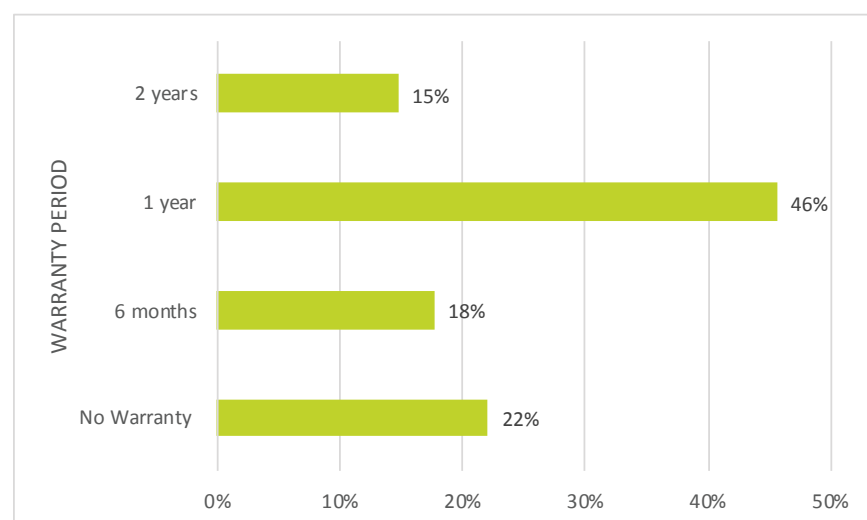
Power Consumption

Efficiency for Access procured six pedestal fans from Lagos (five identified from 2018 market surveys and one from 2020 surveys) to conduct laboratory performance testing. Similar to TVs, the team chose fans from reputable brands with low power ratings, and are not likely representative of the off-grid fan market as a whole in Nigeria. When looking at the energy efficiency value, or speed relative to power consumption, the fans sampled from Nigeria had the same average efficiency as other fans tested by VeraSol (EEI of 2.2). One fan from a local Nigerian solar brand, Cloud Energy, performed particularly well for efficiency and is in the top 15% of most efficient pedestal fans tested by VeraSol.

Table 2: Average retail prices for different fan types

FAN TYPE	FAN BLADE SIZE RANGE (MM)	AVERAGE PRICE (USD)		MEDIAN PRICE (USD)	
		2018	2020	2018	2020
Table Fan	200-400	\$24	\$29	\$26	\$29
Ceiling Fan	450 - 1570	\$25	\$44	\$20	\$34
Pedestal Fan	380 - 1150	\$46	\$46	\$42	\$56

Figure 5: Warranty period offered for fans



58. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

59. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

60. GOGLA, Global Off-Grid Solar Market Report. 2020. <https://www.gogla.org/global-off-grid-solar-market-report>

61. id.

REFRIGERATOR MARKET INSIGHTS

The off-grid refrigerator market is still nascent in Nigeria and in West Africa more generally. GOGLA affiliates reported selling just 1,100 refrigeration units in Nigeria in 2020.^{62,63} While this number may seem relatively small, it accounts for more than half of all refrigerators sold in West Africa in 2020 by GOGLA affiliates.

Field consultants gathered data on 72 unique refrigerator models from the market survey in 2018, and a further 29 unique models in 2020. However, 14 products that had capacities of 450 litres (L) and above were removed from the data set due to their large size and unlikelihood to be used off-grid. As with TVs, the consultants found that there is less variety of refrigerator brands and models in Abuja compared to Lagos.

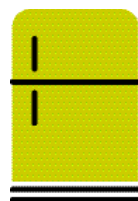
Power Type

There were no DC refrigerators identified in the market surveys during 2018 and 2020. Although one of the refrigerators selected for testing was marketed as AC/DC, testing showed that it was DC only. Although vendors are aware of the technology, they are not interested in stocking them and do not consider them valuable products to keep in stock because of low demand. AC only models still dominate the market, accounting for 87% of models surveyed in 2018 and 2020. The field consultants shared that some AC or

AC/DC models are promoted for their low overall energy consumption to make them more appealing to generator users.

Product Size

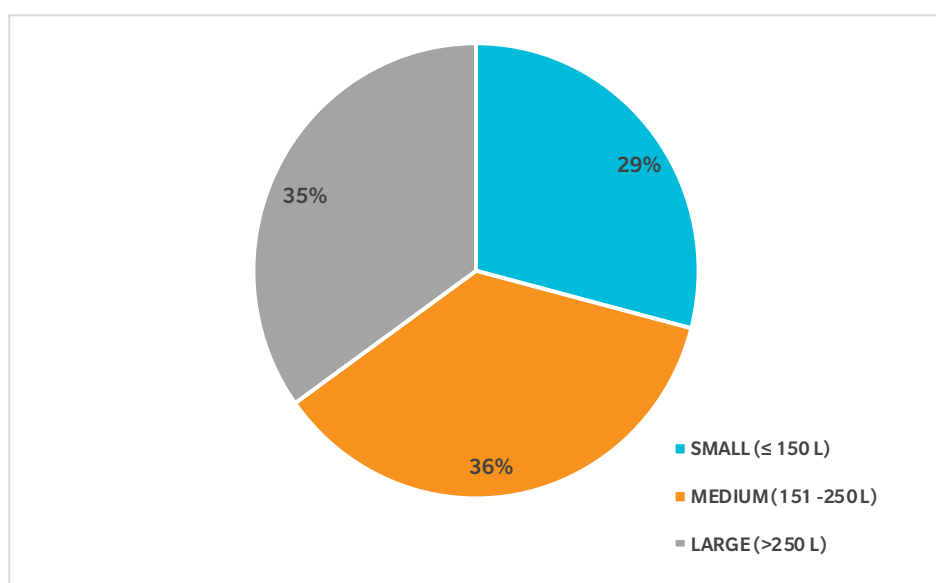
The most common size of refrigerator is medium (36%) (Figure 6). The sizes of all the surveyed products range from 35 L up to 400 L. The larger capacity models are most likely used for commercial purposes rather than for rural consumers or households. The most popular size is 200 L, with 17% of models recorded at this capacity.



101

Data were collected from 101 unique models

Figure 6: Size categories of surveyed refrigerators



62. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H1 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>

63. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

Retail Price

The prices for all surveyed refrigerators range from USD\$81 to USD\$676, with 15 models excluded since they were sold with a solar system. Freezers have the highest average price (USD\$297), and refrigerators and refrigerator-freezers have a similar average price (around USD\$234). As shown in Figure 7, the price ranges for freezers and refrigerator-freezer combination units are similar. Both the outliers for refrigerators and freezers are larger AC/DC models from local Nigerian solar brands.

Warranty

Based on the data collected by the field consultants, 81% of all refrigerators come with a warranty of one year or more. The most represented (43%) warranty period is one year (Figure 8). The products with a three-year warranty are from two well-known refrigerator brands. This is significantly different from the offering in Sierra Leone, where one year is the maximum length of warranty and it is only available with 5% of refrigerators. Still, 62% of refrigerators are sold with a warranty of one year or less. Given the high upfront costs and technical complexity of refrigerators, Efficiency for Access recommends manufacturers to offer a refrigerator warranty and after sales support for at least two years.

Figure 7: Price distributions by refrigerator types

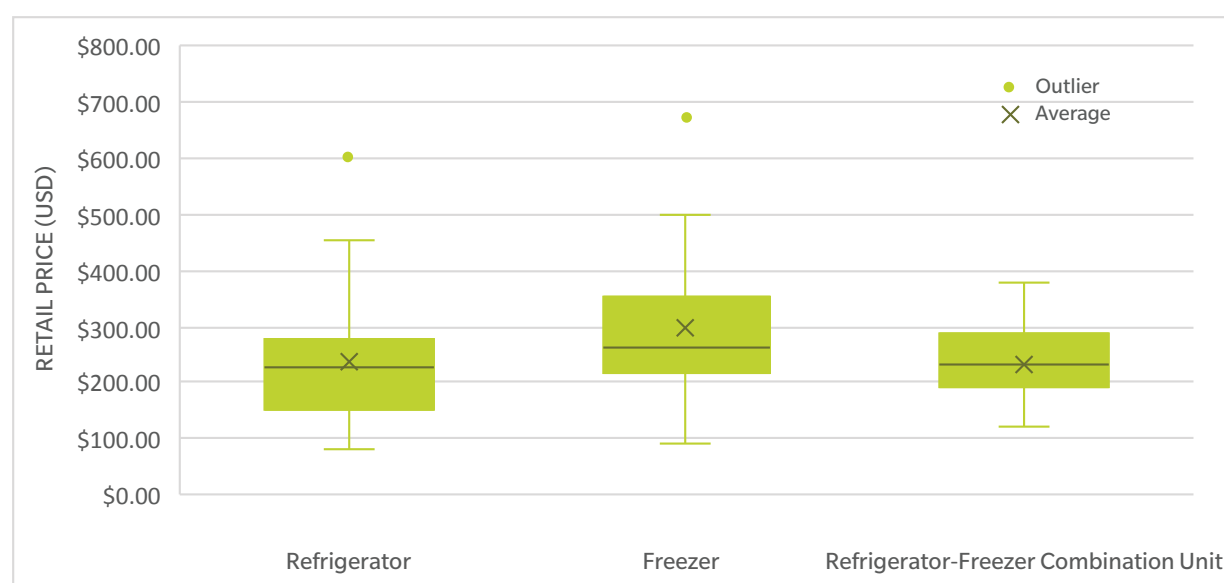
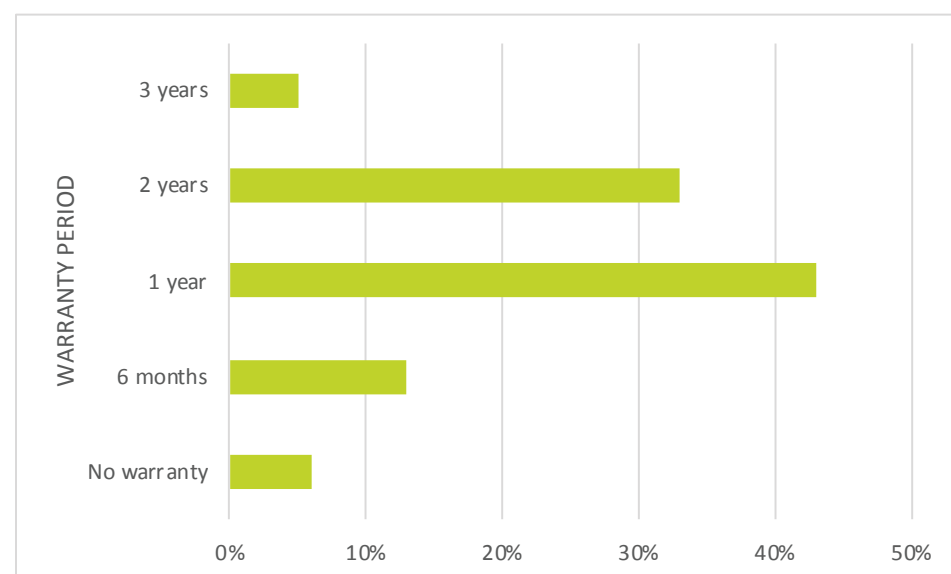


Figure 8: Warranty period offered for refrigerators for 2018 and 2020



64. One additional refrigerator and one freezer from Lagos are currently being tested at the time of this report.

65. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

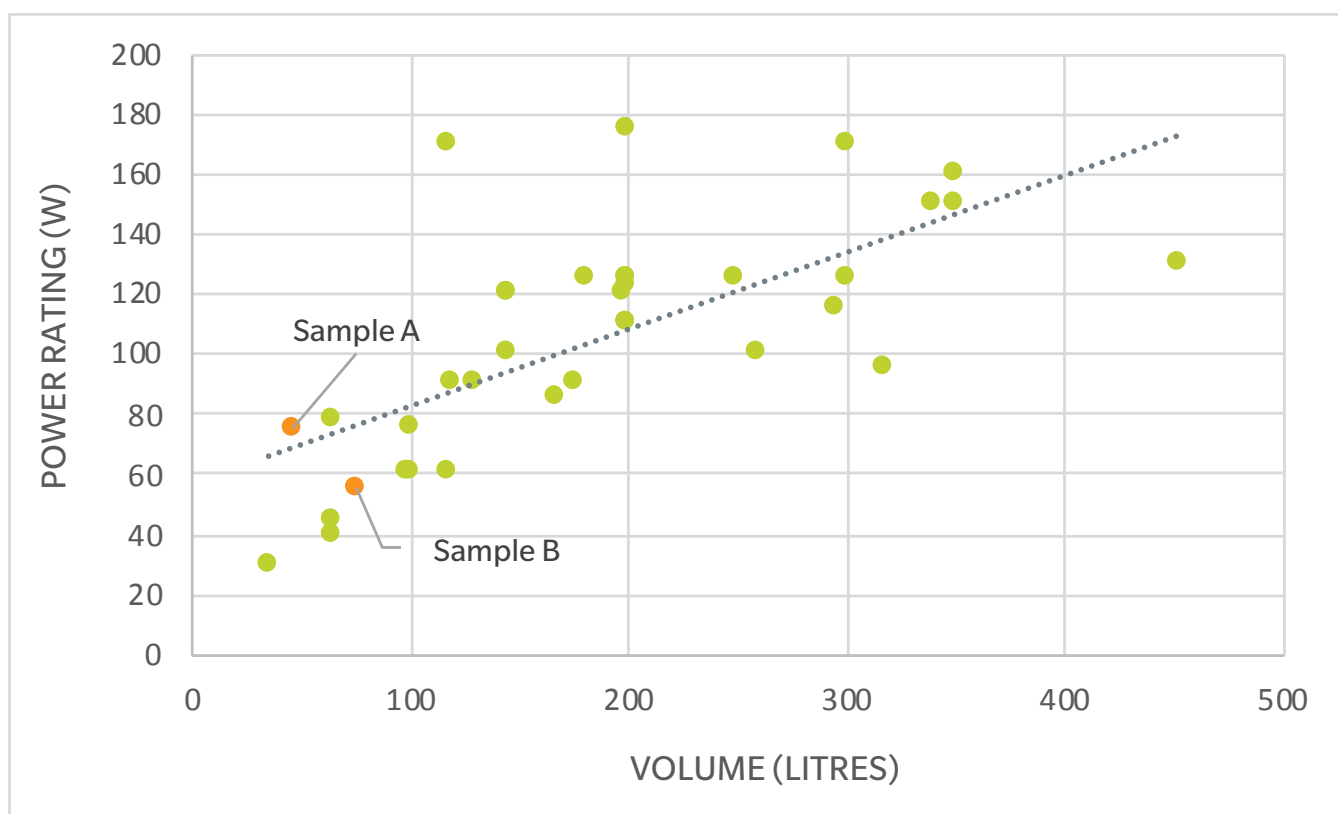
Power Consumption

Of the 101 refrigerators surveyed, Efficiency for Access selected and procured two models from Abuja for lab testing, with Sample A being an AC refrigerator-freezer combination unit, and Sample B being an unbranded, DC refrigerator.⁶⁴ Figure 9 shows the typical power rating range of the refrigerators found on the market; the two orange points are the lab-tested models. There is a weak positive correlation between the volume of the refrigerator and the power rating. This is to be expected, as larger units typically require more energy to operate.

Lab testing showed that the daily energy consumption (kWh/24h) of the two Nigerian samples was 0.538 for Sample

A, the AC refrigerator-freezer, and 0.0463 for the Sample B, the DC refrigerator. When compared to other refrigerators tested through the VeraSol Product Database, Sample A's power consumption is 10% lower than the global median and Sample B is 23% lower. When looking at the energy efficiency index (EEI), or size relative to the daily energy consumption, Sample A has an EEI of 24 and Sample B has an EEI of 39 (the higher the number, the more efficient the product). This is relatively consistent with the global market for off-grid refrigerators tested through the VeraSol Product Database, which have a median EEI of 34.⁶⁵ It's interesting to note that Sample B, the DC refrigerator, had better efficiency than both Sample A and the median.

Figure 9: Power rating and volume of refrigerator. Green points represent the models from the market survey and the orange are the lab-tested refrigerators.

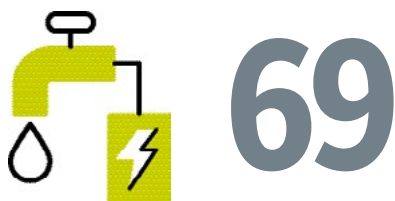


64. One additional refrigerator and one freezer from Lagos are currently being tested at the time of this report.

65. Efficiency for Access, The State of the Off-Grid Appliance Market Report. 2019. <https://efficiencyforaccess.org/publications/2019-state-of-the-off-grid-appliance-market-report>

SOLAR WATER PUMP MARKET INSIGHTS

Although there is not enough data to report on GOGLA affiliates' sales of solar water pumps in Nigeria specifically, in the second half of 2020, SWPs experienced the largest relative increase amongst all appliance types in West Africa. GOGLA affiliates reported selling 3,140 SWPs in West Africa in the second half of 2020—a 1,815% increase from the previous six months. This is likely due to established SWP companies expanding in the region. GOGLA affiliates also reported that almost all (98%) of the pumps are sold with a solar system in West Africa.⁶⁶ However, in the Nigerian market surveys, none of the pumps were sold with a solar system.



Data were collected on 69 models from 36 different brands

In 2018, field consultants gathered information on 54 models of water pumps from 26 different brands in Lagos and Abuja. In the 2020 market survey, a further 15 models from 10 different brands were collected. The consultants found that some customers are purchasing the pumps for use in the city to minimise utility bills, whereas others are using them in rural settings for domestic purposes or irrigation for farming.

Power Type

During the 2018 market survey at Coker and Alba markets in Lagos, both DC only and AC/DC water pumps were observed. A shopkeeper reported that their customers typically purchase AC/DC water pumps to allow flexibility in the use of different power sources. The majority of pumps are either DC (39%) or AC/DC compatible (26%). The remaining pumps (35%) are AC.



DEFINITIONS

SUBMERSIBLE PUMPS

Are designed for underwater installation, such as in boreholes and wells. Whilst they are generally less accessible, they do not need to be primed and are not constrained by some of the physical limitations of surface pumps, such as suction lift limits (i.e. the maximum vertical distance the pump can pull water in before pumping it out).

SURFACE PUMPS

Draw water from surface sources, such as streams and ponds. The pump itself is designed to be situated outside of the water source. The accessibility of surface pumps can present a trade-off between convenience of installation and maintenance, as well as exposure to the elements and potential theft. Some surface pumps are now designed to be mobile to address these concerns.

Product Size and Type

The pumps surveyed in Abuja and Lagos markets were predominantly submersible pumps (61%) rather than surface pumps (39%). The rated input power of pumps ranges between 0.37kW and 1.5kW. For DC pumps, the range is between 0.21kW and 4kW. For comparison, in the 2019 Solar Water Pump Global LEAP Awards Competition, the rated input power of DC SWPs ranged from 0.08 kW to 2.8kW.⁶⁷

66. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data. H2 2020. <https://www.gogla.org/resources/global-off-grid-solar-market-report-h2-2020>

Retail Price

The high upfront cost of SWPs is a barrier to wider uptake, with an average price of USD\$566 across all pump types. As shown in Figure 10, DC submersible pumps are more expensive than electric pumps or AC/DC pumps. This is likely partially due to all DC pumps being submersible, which require more complicated technology and equipment to enable the pump to be installed underwater. In addition, several of the more expensive DC pumps surveyed are from well-known SWP brands. The average price of an AC submersible pump is USD\$84 compared to USD\$1,226 for a DC submersible pump. The average price of an AC surface pump is USD\$79 compared to USD\$90 for an AC/DC surface pump.

Warranty

Compared to the other product types investigated in Nigerian markets, water pump warranties tend to be shorter, with 32% of products offering no warranty. In addition, the length of warranty is highly variable, with some pumps offering a two- or eight-month warranty. The most common (42%) length of warranty is between six months and one year (Figure 11), and only 4% have a warranty of two years.

Inadequate warranties could act as a deterrent to rural customers when considering whether to invest in these technologies. Given the high prices of these products, it's important that the consumer is protected from early product failure. Still, the provision of warranties in Nigeria is better when compared to Sierra Leone, where 86% of pumps are sold without any kind of warranty.

Figure 10: Box and whisker plot of the retail price of different pumps by power rating and type

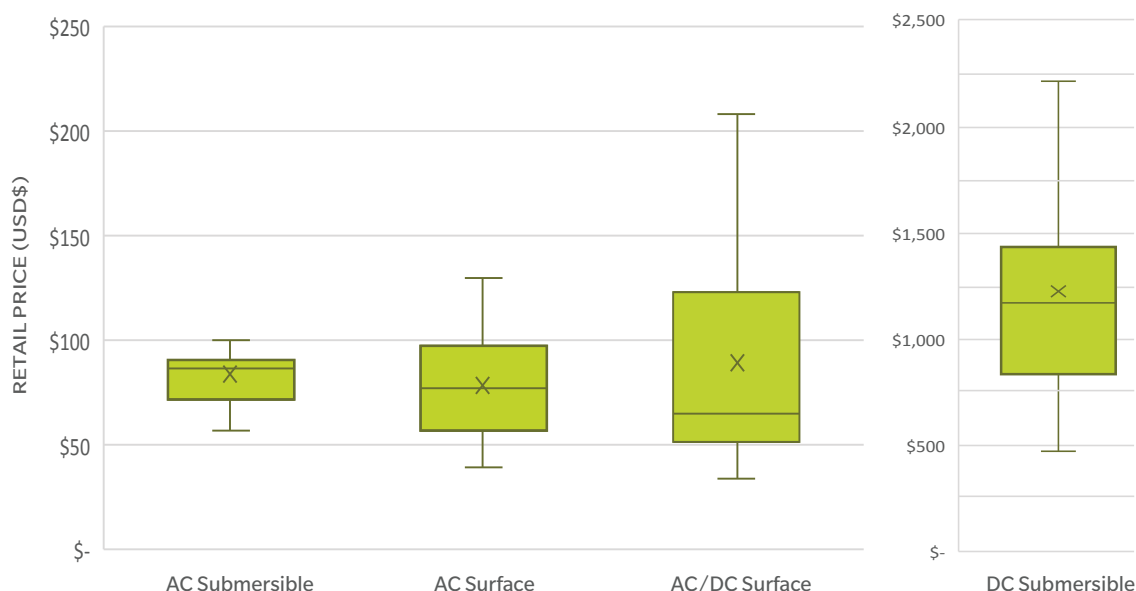
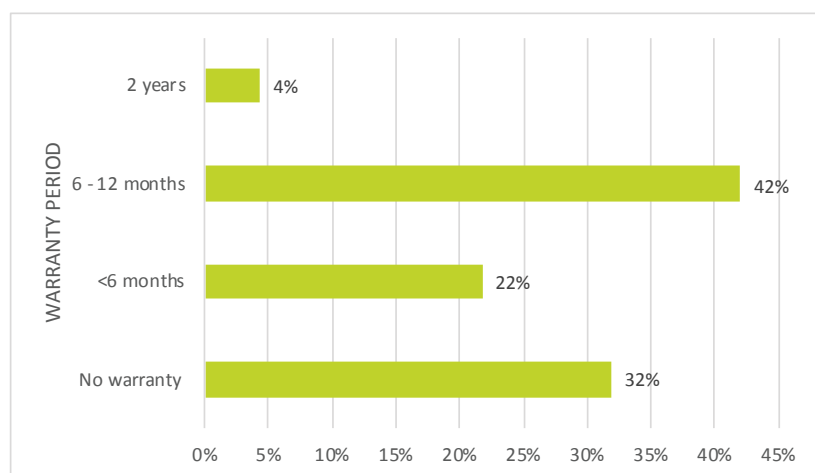


Figure 11: Warranty periods for solar water pumps



Other Appliances

During the 2020 market survey, the consultants identified and gathered information on several additional products available in surveyed shops, including hair clippers, washing machines, water dispensers, blenders, air conditioners and clothes irons.

Of the products surveyed, all have an AC power supply except for two AC/DC compatible hair clippers and an air conditioner that is DC.

The clippers all offer a one-year warranty and are priced between USD\$13 and USD\$16. The AC/DC models have a rated input power of 10 W, whereas the AC models are rated 15 W.

Of the eight air conditioners surveyed, the average retail price is USD\$320. 63% of the models surveyed offer a one-year warranty, 25% offer six months and the remaining models offer a two-year warranty.

As shown Table 3, Type B, Type D or bare plug types are commonly seen for the appliances surveyed in Nigeria. Overall, we found that the plug type is consistent for TVs and refrigerators (Type D), and pumps (bare plug), but fans are sold with both Type B and Type D plugs. The survey data also showed that there is a wide range of voltages provided for AC/DC products using a Type D plug and for SWPs. The standard plug type for electrical outlets in Nigeria is Type D or Type G, and the standard voltage is 230 V. This means that fans using a Type B plug would need some type of plug adapter to use it with the main grid.

The four different types of connectors that are provided with the appliances are displayed in Table 4. When examining the different products by input power supply (Figure 18), AC products are most commonly used with Type D connectors (although Type B and bare are also used), and AC/DC compatible products typically use alligator clips or 5.5 mm barrel connectors. DC products most commonly use bare connectors.

CONNECTORS AND PLUGS

A key challenge to growing the off-grid solar market is incompatibility between systems, which essentially locks consumers into a specific product regardless of how it performs relative to the competition. To help increase market intelligence on interoperability of appliances, Efficiency for Access collected data on the plugs and connectors that are used with off-grid appliances during the 2020 market surveys.

Table 4: Types of connectors available with appliances







ALLIGATOR CLIP CONNECTOR	TYPE D CONNECTOR	5.5 mm BARREL CONNECTOR	TYPE B CONNECTOR
			
Image Credit	Image Credit	Image Credit	Image Credit

Table 3: Count of different plugs with products by power supply type, product type and voltage

	Type B Plug  Image Credit			Type D Plug  Image Credit		Bare Plug (or no plug, just wires)	
Types of appliances and number of each that include specified plug type	Fans (29)			TVs (30), fans (6), and refrigerators (29)		Pumps (15)	
Power supply of products and number of each that include specified plug type	AC/DC (16)	AC (10)	DC (3)	AC/DC (11)	AC (54)	AC (7)	DC (8)
Voltage by power supply type	12 V ⁶⁸	230 V	12 V	Voltage range variable. Most products had an AC voltage range of 220-240V and a DC voltage of 12V, 12/24V or 12/24/36V.	230 V	230 V	Voltage range variable. Products had a rated input voltage ranging anywhere from 18V to 150V.

68. This reported information may not be accurate as AC/DC products typically come with two types of voltage, a DC voltage and an AC voltage. 12 V is typical for DC power supply.

CONCLUSIONS AND TAKEAWAYS

The off-grid appliance market in Nigeria has a high potential value, especially due to its large weak- and off-grid population and unreliable regional grid. Despite this, the solar market has not reached its full potential, mainly due to the energy shortfall largely being met by diesel and gasoline generators. Although the prevalence of SHSs is relatively low, the off-grid solar market is growing in Nigeria and will likely continue to grow as users unlock financing through PAYGO and mobile money.



Although there is reasonable rural penetration of appliances, Efficiency for Access market surveys indicate that most products used in off-grid settings are AC and powered by a generator. Field consultants noted

that the demand for DC products is so low because of several factors, including low consumer awareness and consumer preference toward AC appliances that can be powered using a combination of generators, grid electricity and solar inverters. Where DC products are available, they are often marketed to generator users as being energy efficient rather than promoting them to be compatible with an SHS kit.



The field surveys found that it is commonplace in Nigerian markets to offer a warranty with the appliances.

A duration of one year is the most typical, however, some products come with up to four-year warranty

periods. These warranty periods are relatively long, especially

when compared to other markets, such as Sierra Leone, where many products offer no type of warranty. During the field visits, customers expressed a preference for buying appliances at larger retail stores compared to open markets, mainly due to quality assurances, after-sales care and greater ease with which to claim refunds or warranties.



There is a promising shift happening in the perception of SHSs and off-grid appliances in Nigeria, which are increasingly being recognised as cost-effective alternatives to generators and unreliable grid supply.

However, this needs to be encouraged through appropriate financial mechanisms such as PAYGO or microfinancing, and renewed policy focus to create opportunities for consumers to switch from generators to SHSs. Education is also key to boosting penetration of solar devices to increase awareness. Increased customer demand for DC appliances could help to overcome the generally low availability in the market place, as retailers currently only stock items that are guaranteed to sell, or are ordered by special demand. These efforts could help build a significant SHS and off-grid appliance market in Nigeria and limit the negative impacts of diesel and gasoline generators.

If you have any insights about the appliance market in Nigeria or questions about how these surveys were conducted, which shops were visited, or which models were surveyed, please contact info@efficiencyforaccess.org.





Photo: Shell Foundation



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