GOGLA

The Voice of the Off-Grid Solar Energy Industry

Powering Opportunity in West Africa

Improving Lives, Powering Livelihoods with Off-Grid Solar

altai consulting

UKaid from the British people

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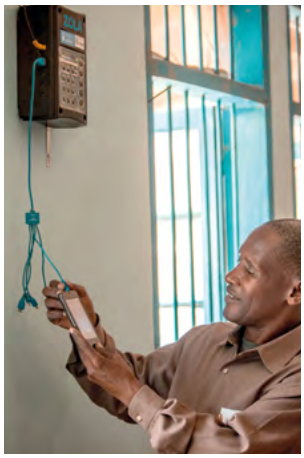

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About

GOGLA
GOGLA is the global association for the off-grid solar energy industry. Established in 2012, GOGLA now represents over 160 members as a neutral, independent, not-for-profit industry association. Its mission is to help its members build sustainable markets, delivering quality, affordable products and services to as many households, businesses and communities as possible across the developing world. The products and solutions that GOGLA members sell transform lives. They improve health and education, create jobs and income opportunities and help consumers save money.

To find out more, go to www.gogla.org

Altai Consulting
Altai Consulting provides strategy consulting & research services to private companies, governments and public institutions in developing countries. Our teams operate in over 50 developing countries in Africa, the Middle East and South Asia.

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Foreword

As the world is running out of time to reach the Sustainable Development Goals (SDGs), off-grid solar is emerging as a power tool for change. Through technology and business innovation, our industry is working hard to develop products and services that bring light and energy services to households living beyond the reach of the grid. Every day we see the positive impact that solar home systems have, and the ways in which they are providing customers with new opportunities to generate income, unlock more working hours and create jobs.

Following the first groundbreaking 'Powering Opportunity' report in 2018, this latest round of research draws a detailed portrait of the social and economic impact that is a direct result of increased demand for and uptake of solar home systems across four countries in West Africa. The findings confirm what more than 280 million people already know: off-grid solar powers opportunity.

As the industry celebrates the significant number of households reached across the globe, this impact also reaffirms our belief that off-grid solar will be crucial for reaching Sustainable Development Goal 7 (SDG 7) - access to affordable, reliable, sustainable and modern energy for all by 2030. The extent of the challenge can sometimes seem daunting: in West Africa alone more than 180 million people remain without access to energy. Only fast and proven solutions will make a difference, and off-grid solar is able to provide clean energy services quickly and at scale.

Further to this, it becomes increasingly clear that off-grid solar also plays a vital role in accelerating progress towards realizing other SDGs, as it is tackling climate change and improving people's quality of life in many ways. Households using off-grid solar products consistently report that their health improves, that they feel safer and that their children have more time to study.

While the evidence is growing, it is important to recognize that the full potential of off-grid solar can only be achieved with concerted and collaborative action from all stakeholders across the public and private sector. The off-grid solar sector is still relatively young, and companies often operate in challenging and dynamic environments. This is why continued support for the sector is crucial.

We thus call on industry, decision-makers, investors, and development partners across West Africa to come and work together to create a strong, sustainable off-grid solar sector. Only together, can we go further, faster to bring the positive economic, social and environmental impact to millions of additional people in the region and around the world.

Namory Doumbia, West Africa Representative

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Acknowledgments

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Executive Summary

'Powering Opportunity in West Africa: Improving Lives, Powering Livelihoods with Off-Grid Solar' provides new data and insights into the social and economic impact of off-grid solar in West Africa. It follows two previous reports published by GOGLA which focused specifically on East Africa, 'Powering Opportunity: The Economic Impact of Off-Grid Solar' (2018) and 'Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool for Change' (2019). This report explores how solar home systems (SHS) enable households in West Africa to undertake more economic activity, generate income and improve their quality of life. The research took place in Ghana, Côte d'Ivoire, Nigeria and Togo with customers of four leading Pay-As-You-Go (PAYGo) companies: PEG, ZOLA Electric, Greenlight Planet and BBOXX.

Thanks to funding from the UK's Department for International Development (DFID), researchers were able to collect and analyse data from 1,678 customers who purchased their SHS in the first half of 2019, and were interviewed both at the time of purchase (baseline) and three months later (follow-up).

SHS bring clean, sustainable energy into homes.

For 51% of households, SHS replace torches[1] or kerosene lamps as a primary source of light. For these households, using the SHS means that, for the first time, they have access to quality lighting and additional energy services within their home.

26% of households previously relied on the grid and/or generators as their main source of light. For these customers, SHS provides a back-up for unreliable electricity access. In some cases, the SHS replaces polluting generators used as a back-up to the grid. In other cases, the SHS becomes the primary source of lighting ahead of the grid or generators.

20% of customers already had access to solar products. In their case, purchasing a SHS from one of the participating companies is often akin to moving up an energy staircase[2] from smaller products or low-quality generic solar products available in the market to high quality SHS[3] giving them access to broader energy services such as phone charging and powering appliances.

More work hours unlocked and jobs created.

By extending business opening hours or giving customers more time in their day for economic activity, the SHS helps them work more hours or even start new income-generating activities. 19% of households report undertaking more economic activity since purchasing the SHS. Overall, the sum of this additional work enabled is equal to creating 8 new full-time equivalent positions for every 100 SHS sold. Job creation unlocks improved income prospects and by extension better quality of life for the (informal) workforce, especially in rural areas.

Customers generate more income.

Among the 19% of households that undertake more economic activity, 74% report generating additional income. In total, 14% of all households report an income increase as a result of the SHS. The average reported additional income is $31 per month or $372 per year. The amount generated by each household is equivalent to, on average, 8.5% of their country's national monthly income per household[4].

Significant improvement in quality of life.

97% of households report an improvement in their quality of life as a direct result of using the SHS. People report that their health improved, that they feel safer, and that children have more time to do their homework.

1 A portable battery-powered electric lamp.
2 Previous discourse suggested the emergence of an 'energy ladder', where off-grid customers move from a solar lantern to a small solar home system and then on to larger products and more appliances. However, a more recent narrative has emerged that additionally recognizes that many customers do not move in a linear fashion from one product to another but may stack products (e.g. they may own several solar lights, or a solar home system as well as solar lanterns). The energy ladder concept is now often replaced by reference to the 'energy staircase', to allow for this stacking whilst maintaining the upward energy access trajectory and allowing for product to product movement.
3 All participating companies are Lighting Global compliant. For more information, please see the Lighting Global Compliance Guide.
4 Based on gross national income (GNI), ratio of additional income/GNI calculated for each household using country data before computing the average. World Bank (2018), GNI per capita: Côte d'Ivoire $1,610, Ghana $2,130, Nigeria $1,960, Togo $650.

Introduction

> **Solar lighting enables me to provide health assistance day and night**
>
> ZOLA Electric Customer
> Kumasi, Ghana

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Key Findings

86% report their health has improved buying the SHS

19% of households undertake more economic activities thanks to their SHS

91% of customers say children have more time to do their homework

14% of households generate additional income once they purchase an SHS

Households create an additional $31 per month on average

Among households generating income

98% of customers report they feel safer with off-grid solar

SHS help households to work more hours or start new activities. Overall, this additional work translates into 8 FTE jobs per 100 SHS sold

In total 38% of these FTEs are undertaken by women and 69% are in rural areas

Introduction

1.1. Context and objective

There are little more than 10 years left to realise Sustainable Development Goal 7 (SDG 7): access to affordable, reliable, sustainable and modern energy for all. The number of people without access to electricity fell to 840 million in 2017[5], yet meeting SDG 7 remains challenging. At the current pace of electrification, 650 million people are likely to remain without access to electricity in 2030, and 9 out of 10 of these people will live in Sub-Saharan Africa[6]. Decentralised systems led by solar off-grid and mini-grid are the most efficient solution to provide the technologies needed to reach at least 220 million people[7]. The off-grid solar share could be even larger if grid and mini-grid solutions do not develop at the pace required to fulfil their anticipated contribution to the electricity access goal by 2030.

The off-grid solar sector has considerably expanded over the last nine years. The compounded annual growth rate between 2010 and 2017 was close to 60%[8]. Similarly, investment in the sector has grown considerably from 10 investors and $21 million in 2012, to 43 investors and over $350 million in 2018[9].

Off-grid solar solutions are transforming lives across developing countries. Impact research on solar lanterns shows benefits in terms of savings, health improvements (when switching from kerosene) and additional study hours for children (SolarAid[10], Harrison et al[11], Aevarsdottir[12], Hassan and Lucchino[13]). Limited data on the impact of Solar Home Systems (SHS) led the United Kingdom's Department for International Development (DFID), GOGLA, the global association for the off-grid solar energy industry, and Altai Consulting to launch the Powering Opportunity series, which collects evidence on the socio-economic impact of solar home systems, most of which are sold through the Pay-As-You-Go (PAYGo) business model.

The first Powering Opportunity report was published in 2018 based on data collected in East Africa in 2017-2018, looking at the impact of SHS on households three months after the purchase and installation of their product. This initial study illustrated that SHS greatly improve the well-being of those who used them in their homes and businesses by replacing dangerous kerosene lamps and candles, improving safety and giving them life-changing services such as phone charging. The research also showed that a significant share of households was able to undertake more economic activity and generate additional income thanks to the SHS. The report was an ambitious collaborative effort and the first of its kind to bring off-grid solar companies across a number of countries together to focus on the economic activity and income generation unlocked by SHS.

In September 2019, a second report was published, 'Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool For Change', in which results were shared from a follow-up study at the 15-month mark, revisiting the same East Africa customers featured in the initial research. This latest report confirms the impact SHS are creating and showcases how impact evolves over time in the East African region. Additionally, the report provides valuable insights into job creation in terms of FTEs.

The East African market has been one of the key markets for the off-grid solar sector, containing some of the more mature country markets for the SHS and PAYGo segment. This made it the ideal candidate location to conduct the first study. In the meantime, the off-grid solar sector has been rapidly expanding to other geographies, and markets in the West African region have shown significant growth. Between 2016 and 2018, GOGLA estimates over 1.7 million products were sold[14] by GOGLA members and Lighting Global affiliates in West Africa.

5 ESMAP (2019), 2019 Tracking SDG7 The Energy Progress Report.
6 ESMAP (2019), 2019 Tracking SDG7 The Energy Progress Report.
7 IEA (2017), Energy Access Outlook 2017.
8 Dalberg Advisors and Lighting Global (2018), Off-Grid Solar Market Report 2018.
9 GOGLA (2019), Investing in the Off-Grid Solar Sector: What You Need to Know.
10 SolarAid (2015), Impact Report 2015.
11 Harrison et al (2016), Accelerating Access to Electricity in Africa with Off-Grid Solar.
12 Aevarsdottir et al (2017), The Impacts of Rural Electrification on Labor Supply, Income and Health: Experimental Evidence with Solar Lamps In Tanzania.
13 Hassan and Lucchino (2016), Powering Education 2, Enel Report.
14 GOGLA/Lighting Global Sales Data.

Introduction

While the market in West Africa has grown, it is a relatively under-researched area in terms of the impact of off-grid solar products on households. This research, which follows the same approach as the original East Africa research, provides insight into what impact SHS have on households in relation to access to clean, renewable energy, and how SHS are contributing to increased productivity, income generation and quality of life in West Africa.

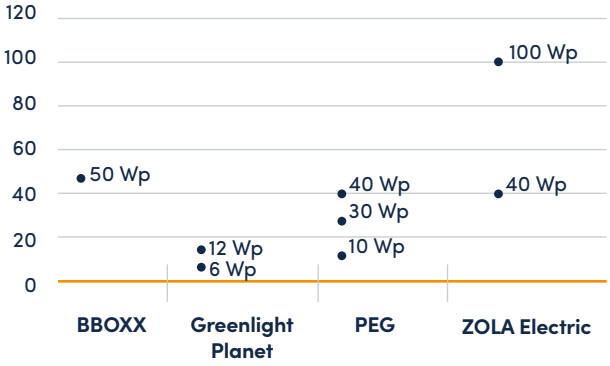
1.2. Methodology and limitations

Four PAYGo solar home system providers[15], operating in four countries joined the West African research effort: BBOXX (Togo), Greenlight Planet (Nigeria), PEG (Ghana and Côte d'Ivoire) and ZOLA Electric (Côte d'Ivoire).

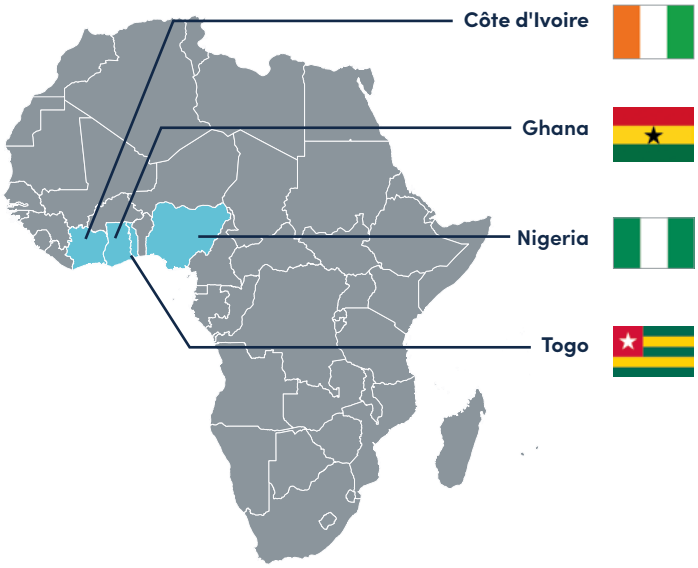
SHS sold by participating companies range from 6 Wp to 100 Wp[16]. The difference in size represents a difference in the cost to the customer but also in the level of power the user has access to.

Exact system sizes are shown in the chart below (Figure 1). In this research, system sizes below 30 Wp typically include two or three lights, phone charging capacity and sometimes a radio. From 30 Wp onwards, systems include at least three lights, phone charging capacity and a TV, with larger systems including larger TVs. Finally, many 100 Wp products include pedestal fans, in addition to the previously mentioned appliances.

Figure 1: System sizes



Country



Service

ZOLA

PEG

BBOXX

sunking from Greenlight Planet

15 Although all four companies operate using the PAYGo business model, it should be noted that Greenlight Planet, PEG and ZOLA Electric's products are sold on a rent-to-own model, while BBOXX products are sold on an energy-as-a-service model and are subsidised by the Government of Togo under the CIZO program.

16 Watt-peak.

Introduction

SHS are first and foremost designed to meet household level needs in terms of access to electricity. Therefore, the research uses the household rather than the individual as the primary unit for impact measurement. However, for specific metrics, efforts have been made to understand the profile of the individuals benefitting from the impact within the household, especially in terms of gender.

Data collection for this study took place in two rounds:

- Baseline data collection: participating companies interviewed new customers joining their customer base between February and April 2019. This approach enabled the research to leverage interactions between companies and their customers and minimise disruptions to operations.
- Follow-up data collection: three months after the baseline survey, customers were interviewed by phone by a third-party research company (Sagaci Research).

The target population is customers that purchased a SHS from the four participating companies in the designated countries between January and June 2019. Although the sampling methodology constitutes a convenience sampling, discussions between Altai, GOGLA and participating companies indicate that there are no significant differences between interviewees and the target population. Therefore, the assumption that the customers can be considered as having been selected randomly from the target population likely holds true.

The sample size of the baseline data collection was 2,375. Attrition linked to refusal to participate in the survey, phone number change, unavailability of respondent at the time of the survey, poor mobile coverage or invalid or incomplete interviews led the sample size of the follow-up research to 1,678. The sample size enables a margin of error of maximum 4.1% at 95% confidence level, guaranteeing the statistical significance of the analysis.

Three-data point rule

GOGLA respects a three-data point rule when using its Member companies' data. Therefore, analyses presented in this document rely on data from at least three companies. This allows for greater reliability in the results as it means that each data point presented includes data from customers of different companies. However, it also means that certain insights cannot be shared publicly, and analyses cannot be conducted by country or company. Unlike the previous Powering Opportunity reports, the West Africa publication does not contain analysis by system size due to this rule. However, GOGLA and companies have agreed to the publication of case studies that provide company-level insights.

Definitions

Full Time Equivalent (FTE): Unit of measurement of the workload of an employed person. It is calculated as the total hours worked divided by the legal maximum week full-time jobs within each economic territory[17] (i.e. 1 FTE is equivalent to 1 full-time worker).

Pay-As-You-Go (PAYGo): Refers to a business model that allows users to pay for their product via consumer financing over time. A PAYGo company will typically offer a solar product for which a customer makes a down payment, followed by regular payments for a term ranging from 6 months to 8 years[18]. In most cases, the repayment period is close to 24 months.

Solar Home System (SHS): The SHS included in this study refer to kits of solar technologies that consist of a solar PV panel, battery pack and LED lights which provide light and power to a household or business. These products are sold in many countries that have large populations living off-grid. The size of SHS can vary, as can the appliances they are sold with, although all are sold as 'plug and play' kits. SHS are often defined as 11 Wp and larger, while systems between 3-10 Wp are referred to as 'multi light and phone charging kits'. In this report, the term 'SHS' refers to the whole range of systems included in the research (6-200 Wp).

17 Commission of the European Communities, International Monetary Funds, Organisation for Economic Co-operation and Development, United Nations and World Bank (1993), System of National Accounts.
18 Details provided in Methodology Annex.

Introduction

Limitations and risk mitigation

- Data was collected at specific points in time and may have been affected by seasonal factors such as the agricultural calendar, political events, currency variations, diesel price variations, etc. Through consultation with participating companies at the time of initial data collection, it seems no specific conditions apply to new customers joining the four companies' customer bases during the survey period.
- Due to the multi-country aspect of the research, cultural understanding and interpretation of certain questions may have differed. To mitigate this effect, all translations were conducted by Sagaci Research, a market research firm with extensive experience in conducting surveys in multiple African countries, including all countries covered in this research. All translations were reviewed by local staff of the participating companies to ensure the questions were clear and understandable for by their customers.
- For many questions requiring customers to quantify their answer, ranges were provided. Metrics based on these ranges were computed by using the median value of each range, the upper limit of the bottom range and the lower limit of the top range. (For example: if the range is 'Between 10 and 20', the value will be 15 and if the range is 'More than 50', the value will be 50).
- Data on income and expenses is reported by customers. This includes overall household income and expenses and income generated from additional economic activity.

© PEG

© PEG

“

The Solar Home System Customer

”

© BBOXX

The Solar Home System Customer

2.1. Socio-demographics

The typical user-household lives in a rural area and is composed, on average, of 7 members[19]. It is noteworthy that this household size is significantly larger[20] than the national averages of the countries in which the research was conducted, which ranges from 3.5 to 5.4[21].

Type of location

The majority (70%) of households in this research are rural households. 30% of households are classified as urban, which includes both urban and peri-urban households[22] (Figure 2).

Household size and composition

While the average household size is 7 across the research, urban households tend to be closer to 6 members while rural households are closer to 8 members. 48% of household members, and therefore beneficiaries, are female (adult women and female children) and 51% are children (26% in urban areas and 70% in rural areas).

Income level

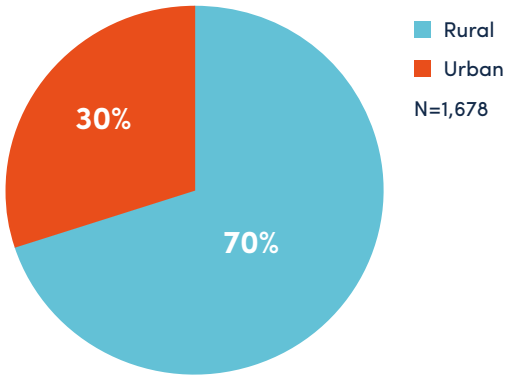
In order to better understand the income-levels of households using the SHS, customers were asked to report their income and expenses. Overall, 25% of customers report an income below $1.90[23] per day and 59% report an income below $5.50 per day (Figure 3). This indicates that the SHS in this research are to a large extent reaching low income households. Reported expenses also tend to confirm this, although it should be noted that respondents may exclude major irregular or infrequent expenses such as school fees or agricultural inputs from their reported weekly expenses.

The significant disparity of reported incomes can be linked to fundamental financial and geographical differences between interviewees. The countries in the research have very different levels of wealth with GDPs per capita ranging from $672 in Togo to $2,028 in Nigeria[24]. Additionally, the data collection reached a significant share of urban customers who were more likely to report higher income-levels: 29% of rural customers and 10% of urban customers reported an income below $1.90 per day, while 34% of rural customers and 65% of urban customers reported an income above $5.50 per day.

Gender and age of purchaser

In most cases, the interviewees were the purchasers of the product as their contact information was available to companies. Although they are not the only beneficiaries of the system and may not even be the main users, they are often the one responsible for the decision to purchase the SHS. The average purchaser of the SHS is a 39-year-old man (Figure 4 and 5).

Figure 2: Households by type of location



19 Household size and composition data was not collected in Ghana, due to the fact that asking for this information can be perceived as intrusive by respondents. It was decided to remove these questions from the survey in consultation with the company and the research partner.

20 This can be partly explained by the fact that the majority of households in this research are rural.

21 United Nations (2017), Household Size and Composition Around the World (Data Booklet). Average household size Côte d'Ivoire 5.4, Ghana 3.5, Nigeria 4.9 and Togo 4.6

22 Location types were defined by population. Urban designates a population above 5,000. Peri-urban a population between 2,000 and 5,000 and rural a population below 2,000. These definitions were respected on a best effort basis.

23 International Poverty Line has a value of US$1.90 PPP. Lower Middle-Income Class Poverty Line has a value of US$3.20 PPP. Upper Middle-Income Class Poverty Line has a value of US$5.50 PPP.

24 World Bank (2018), please see https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=NG-TG

Figure 3: Distribution of households by reported daily income and expenses

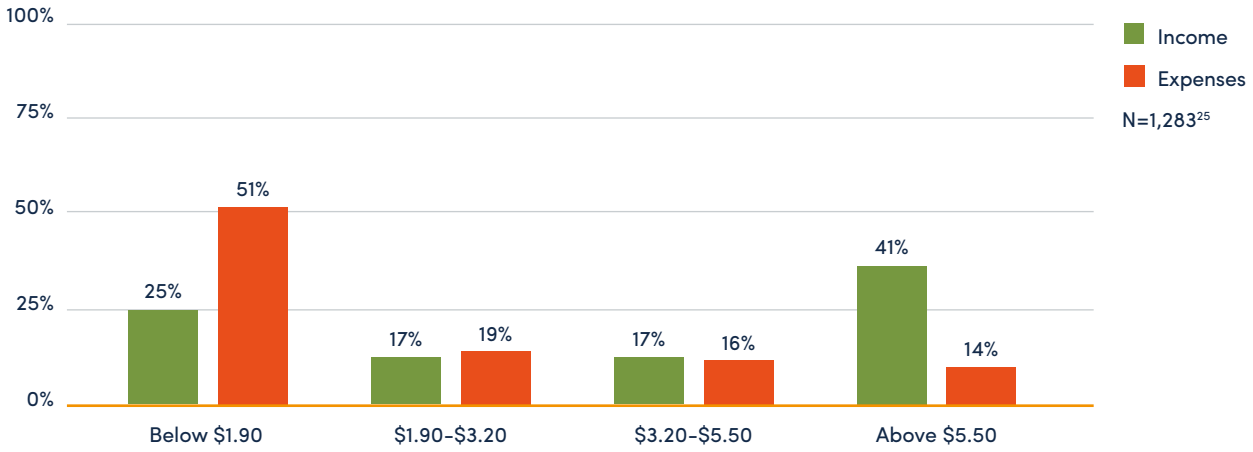


Figure 4: Gender of purchaser

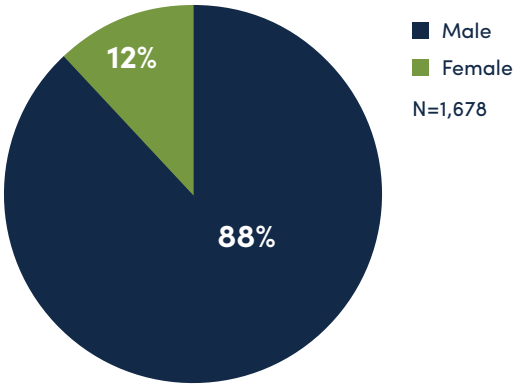
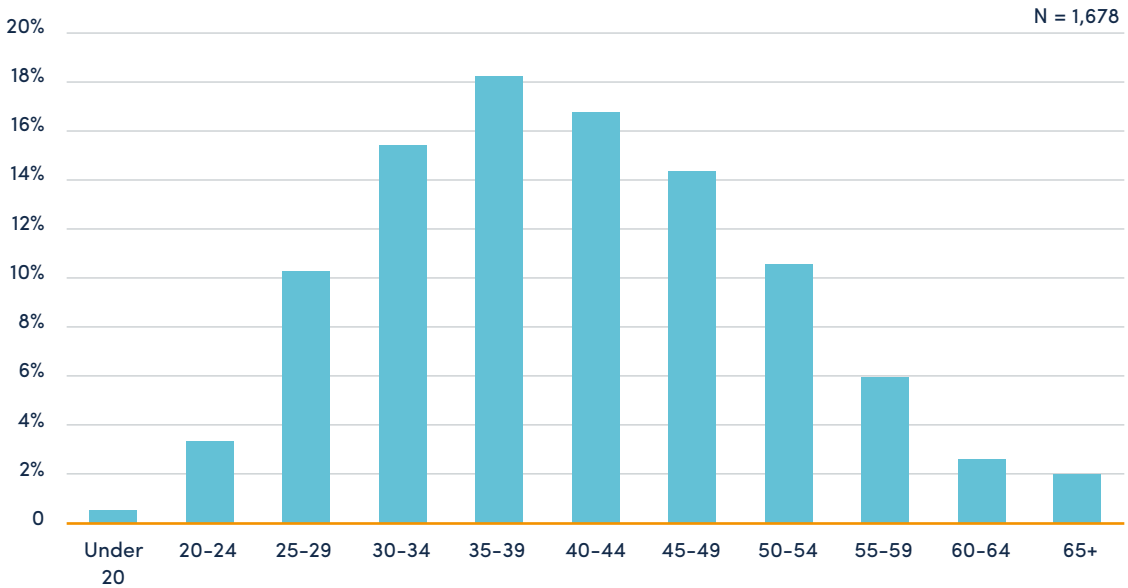


Figure 5: Age of purchaser



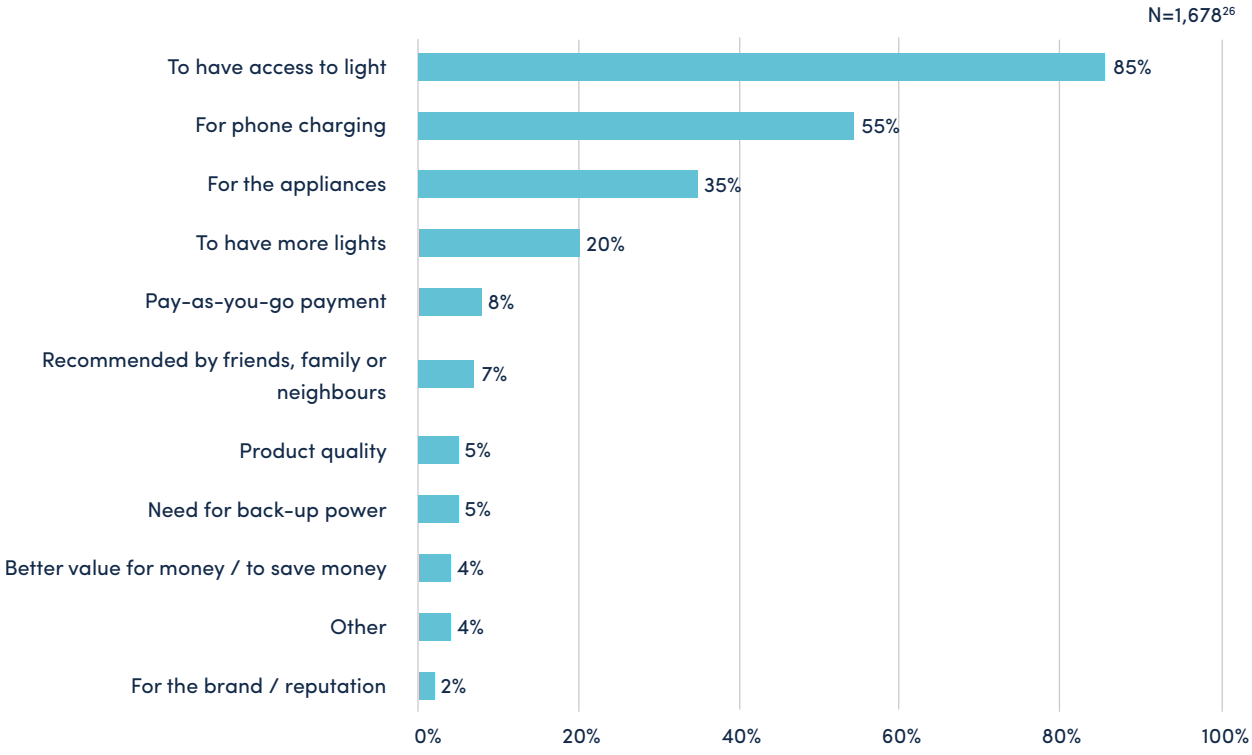
25 Excluding customers responding 'do not know' or 'do not wish to answer'.

2.2. Customer experience

Reason for purchasing the system

The most common motivation to purchase a SHS is to have access to light, cited by 85% of respondents. Phone charging (55%) and appliances (35%) are also mentioned by a significant share of customers. Beyond the system's features, the PAYGo payment model is mentioned as a reason for purchasing the product by 8% of customers.

Figure 6: Reasons to purchase the SHS (% of customers mentioning each reason)[26]



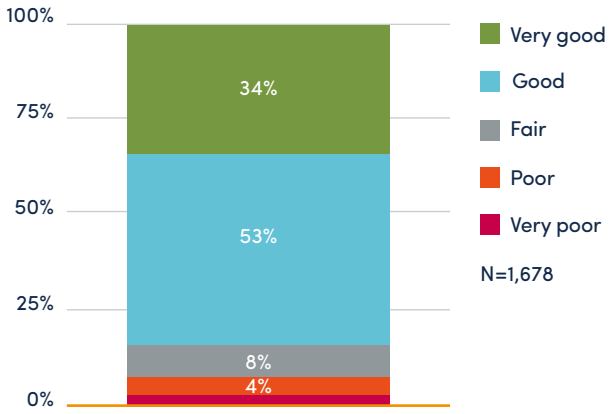
26 Responses were not prompted, and customers could provide multiple answers.

The Solar Home System Customer

Value for money

Three months after purchasing the solar home system, most customers are (very) satisfied with the products they have purchased. 87% of customers rate the value for money of their product as either 'good' or 'very good'.

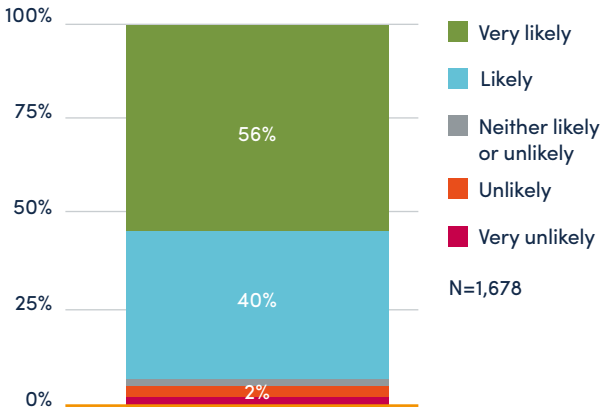
Figure 7: Value for money



Likelihood to recommend

The results for the likelihood to recommend the SHS to family, friends or neighbours are very encouraging as well, with 96% of households either 'likely' or 'very likely' to recommend their product (Figure 8).

Figure 8: Recommending the product



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The research identified a number of 'main reasons' for customers to purchase the SHS. For some customers, purchasing a SHS enables them to use bright lights in their home for the first time. Others benefit from an increased reliability in energy access, or access to services beyond lighting that they didn't have before such as phone charging capacity or the ability to power appliances such as radios, TVs and fans.

3.1. Improved access to light

Previous sources of light

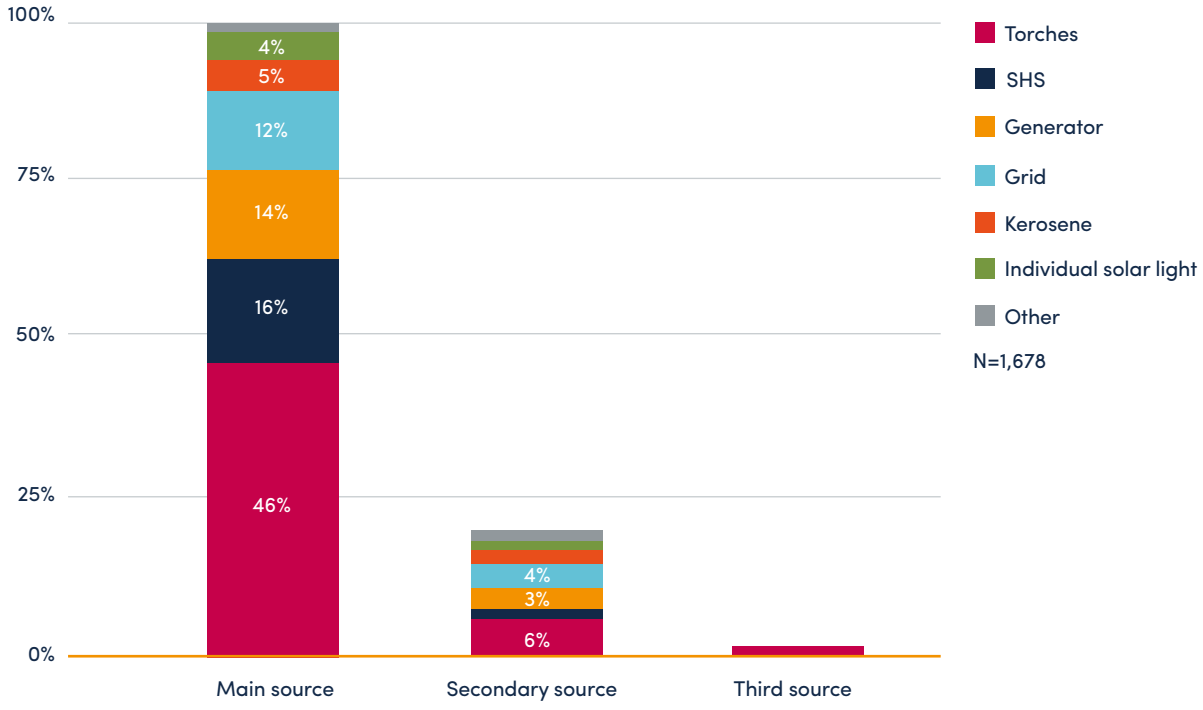
To understand how the SHS affected customers' access to light, customers were asked to provide up to three sources of light they used prior to purchasing the SHS (Figure 9). Overall, torches were the most common main[27] source of light (46%) prior to purchasing the SHS. In addition to torches, 5% of households relied on kerosene as their primary light-source. This means that for half of customers, purchasing a SHS provides them access to high quality, sustainable lighting inside their home for the first time.

Type of location and sources of light

The results in this research include data from companies and countries with very different customer profiles. However, to protect the proprietary interests of the companies who are involved in the research, data cannot be disaggregated by country or by company due to the three-data point rule.

It is important to note that a large share of urban households in this research are based in Nigeria where many customers are connected to an often unreliable grid and where generator usage is high[28]. Most rural customers are based in Côte d'Ivoire - where many interviewees already used solar products, and in Togo, where the access to energy rate in rural areas is 19.5% according to the World Bank[29].

Figure 9: Previous sources of light



27 Customers were asked to rank their main source of light from most to least used source of light.
28 Please see 'Off-grid solar solutions can play a key role in unreliable grid areas' box below.
29 World Bank (2017), please see https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=TG

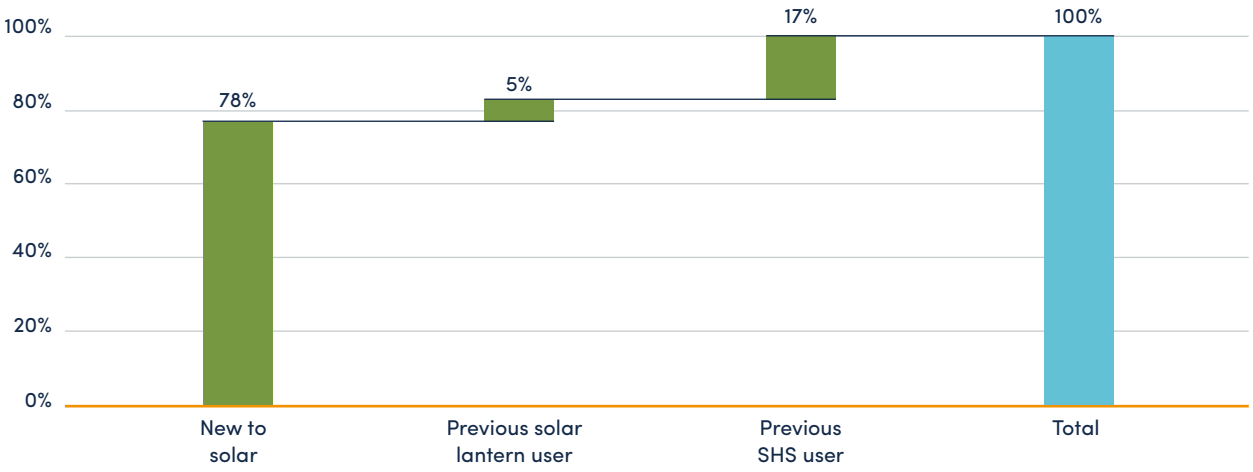
The Power Of Off-Grid Solar

Solar products were already relatively common. 20% of households already relied on solar energy as their main source of light, including 16% that already had a SHS. In this context, SHS do not only include the kits sold by companies like those participating in the research but also component based 'home-made' systems put together using a solar panel and battery. For these customers, purchasing a SHS will likely be an upgrade from a less performing product, or an addition to a smaller product.

This data reflects the customer journey along the energy staircase[30] as they upgrade their energy service or stack energy solutions (e.g. combining the use of both solar lanterns and SHS). Overall, 78% of households are new to solar, 5% are moving up from a lantern to an SHS and 17% already had an SHS (Figure 10).

Figure 10: Energy staircase

N=1,678



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30 Previous discourse suggested the emergence of an 'energy ladder', where off-grid customers move from a solar lantern to a small solar home system and then on to larger products and more appliances. However, a more recent narrative has emerged that additionally recognises that many customers do not move in a linear fashion from one product to another but may stack products (e.g. they may own several solar lights, or a solar home system as well as solar lanterns). The energy ladder concept is now often replaced by reference to the 'energy staircase', to allow for this stacking whilst maintaining the upward energy access trajectory and allowing for product to product movement.

The Power Of Off-Grid Solar

Off-grid solar solutions can play a key role in unreliable grid areas

More than two billion people worldwide live with over 100 hours of blackouts per year and one billion live with over 1,000 hours[31]. In many cases, this implies the need for back-up solutions. Off-grid solar products, especially SHS, provide a clean and quality back-up solution. However, most grid back-up solutions to date are generators powered by fossil fuels.

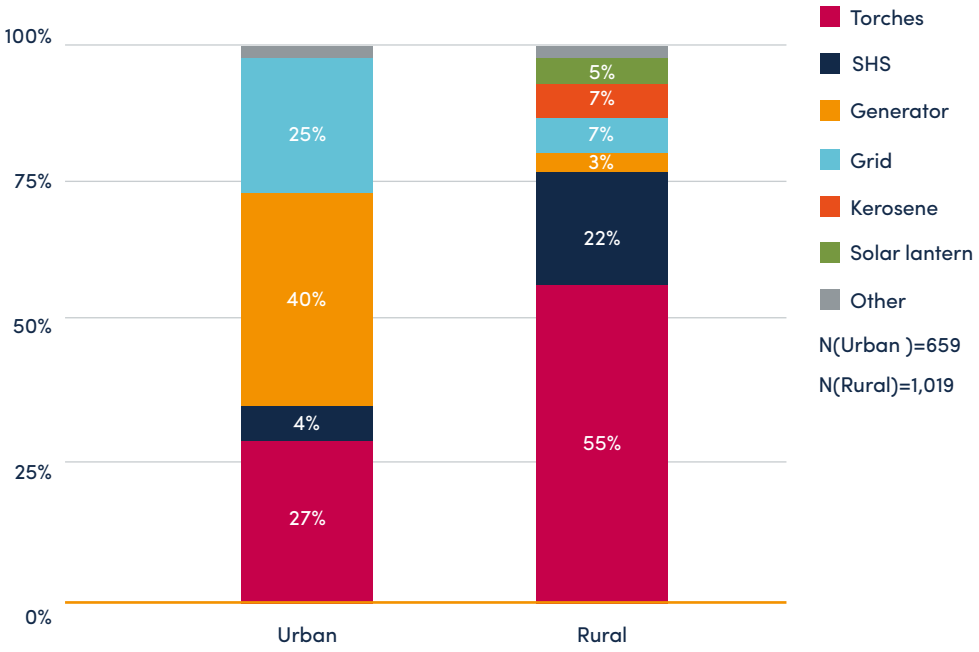
A recent study by the IFC[32], showed that 75% of locations where generators were deployed were actually connected to the grid. Sub-Saharan Africa represents the largest share of the fleet ahead of the MENA and South Asia regions. In West Africa, 40% of annual electricity consumption comes from generators[33].

Reliance on fossil fuel generators has several negative impacts on the region. These solutions are expensive for users and end-up requiring huge expenditure on fuel. In West Africa, the IFC estimates that total expenditure on generator fuel reaches $7 billion, a billion more than for the grid. Additionally, generators are a source of pollutant emissions with negative impacts on health and the environment.

Among the countries in this study, Nigeria is a particular point of interest with an estimated 22 million small gasoline generators[34] totalling an installed capacity of approximately 42GW while the grid's peak capacity is 5.4GW[35].

In cases where they can provide a similar capacity or meet a similar level of energy need, SHS offer a clean alternative to generators and can play a key role in reducing or eliminating their usage in the same way off-grid products can reduce the usage of kerosene[36]. In this research, this is especially the case in urban areas, where households often mainly use generators in conjunction with the grid. Rural households rely mostly on torches and, to a lesser extent, solar products (Figure 11).

Figure 11: Previous main source of light used by type of location



31 IFC (2019), The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries.
32 Ibid.
33 Ibid.
34 0-4 kVA capacity.
35 A2EI (2019), Putting an End to Nigeria's Generator Crisis: The Path Forward.
36 GOGLA (2018), Powering Opportunity: The Economic Impact of Off-Grid Solar.

Current sources of light

Three months after their purchase, 86% of customers are using the SHS as their main source of light. Most customers using a different main source of light are using the grid or a generator (Figure 12). However, SHS are also replacing generators and, to a lesser extent, the grid as a main source of light[37].

The analysis of secondary sources of lighting highlights three main profiles. The first profile is customers using torches as a secondary source of light to complement their SHS when portable lights are needed (13%, Figure 13). The second profile is customers using their SHS (13%) as a secondary source of light, in most cases to back-up the grid or a generator. The third profile provides a particularly noteworthy insight, which is customers using the grid (7%) or a generator (9%) as a secondary source after the SHS.

Figure 12: Evolution of main sources of light over time

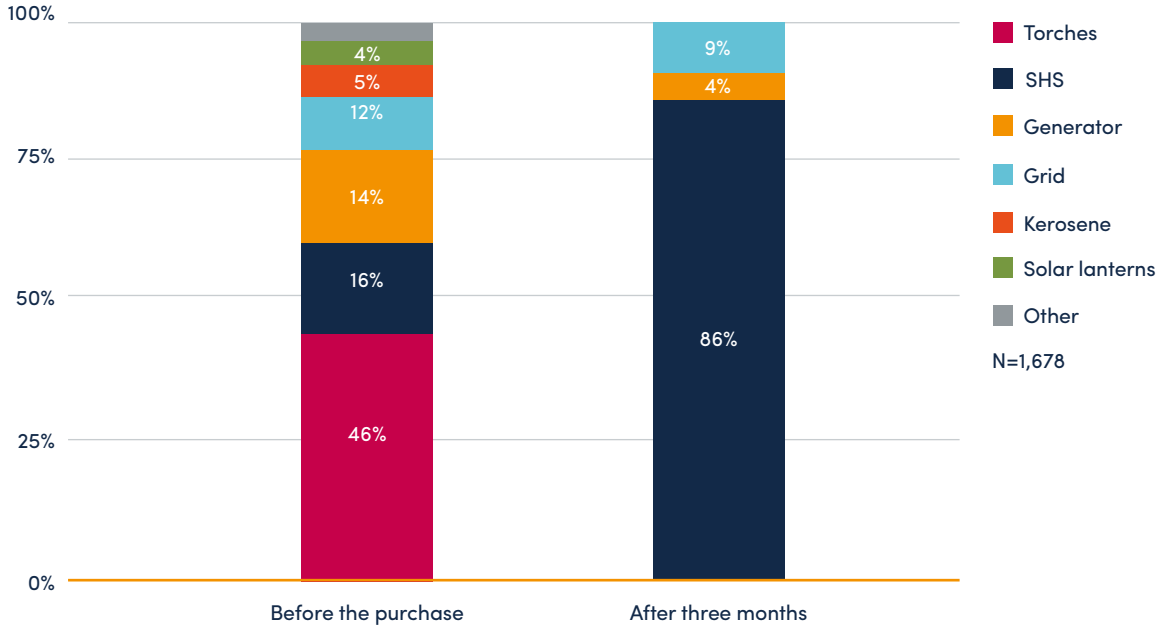
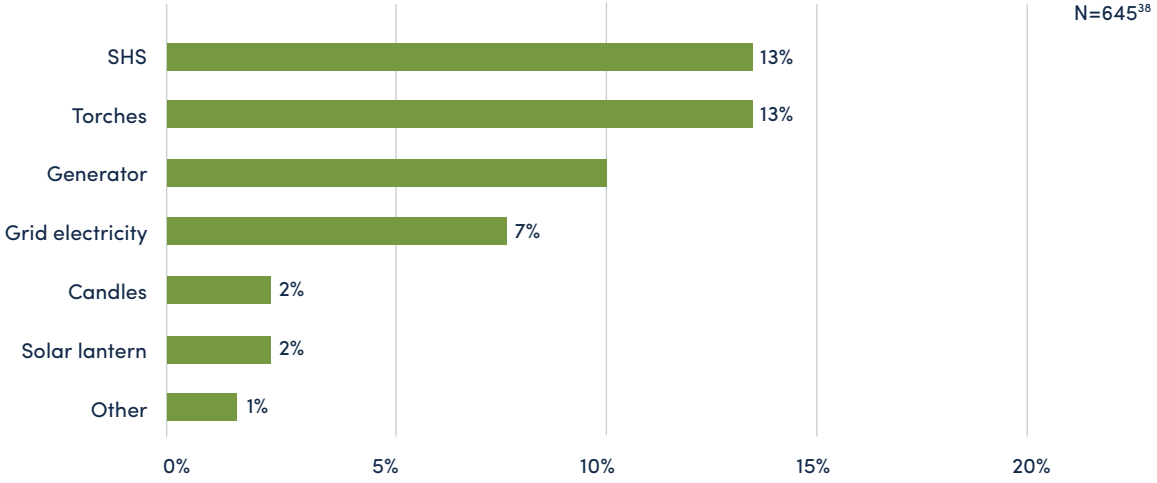


Figure 13: Current secondary sources of light used



37 This is particularly the case in Nigeria.
38 Among customers mentioning at least one secondary source.

The Power Of Off-Grid Solar

Greenlight Planet SHS enable a hospital in Nigeria to operate despite grid unreliability

More than 30 expecting mothers are admitted to Mother and Child Hospital, a small maternity clinic in Ado Ekiti located in southwest Nigeria, every day. The hospital specialises in maternity services, ranging from antenatal to postnatal care; services that are often unscheduled and required at all hours of the night.

However, the power supply at the hospital is erratic. Dr. Oria Adebose, a medical officer at Mother & Child Hospital explains: *"In 24 hours, we may have 16 hours of light, at the most. We have power cuts from 6 am to 1 pm. It runs for about four hours, till 5 pm, switches off and comes back at midnight. On some days, it does not even last up to 16 hours."*

When facilities like Mother and Child Hospital lose power, their clinicians have to figure out how to accommodate unexpected, long gaps in service without jeopardising patient care. In July 2017, the hospital, which already used generators, decided to purchase solar lighting to help cope with these frequent power cuts and to enable more continuous care.

The risks of childbirth can be exacerbated by a lack of access to electricity. Even if a hospital has the expertise and equipment to provide necessary care for a patient, it might not have the electricity to use that equipment or properly see a patient in the dark. Unexpected gaps in electricity access and the ensuing inability to provide care when needed can introduce risks that are less common in facilities that do not face electricity challenges.

During power cuts, generators and the solar lamps are immediately switched on. Generators power the equipment and solar systems provide the light enabling most of the clinic's basic care services to continue, uninterrupted. Thanks to the additional light provided by the new solar lamps, night-time check-ups happen faster, and both clinicians and patients can move around the hospital with greater speed and safety.

"Even when the generator shuts down, we are not caught unaware because the Sun King lamps are on standby", adds Adebose.

Hours of light

One of the primary benefits of using the SHS is an approximate 50% increase in hours of light available to the household on a daily basis (on average, Figure 14). Prior to purchasing the SHS, almost half of the households had less than five hours of light per day. Three months after the purchase, more than half of customers report over 10 hours of light per day. Overall, the average number of hours of light per day for customers increased from just over six hours to nine hours.

On average, households experienced a 2 hour and 46 minutes increase in lighting hours per day (Figure 15). The increase in hours of light is quite similar in rural (2:41) and urban (2:59) areas. Looking at previous sources of light, the households that felt the biggest increase are those that relied on generators and torches as their main sources of light, with an increase of close to 4 hours. Households that used the grid as their main source of light before purchasing their SHS report a stable number of hours of lighting. This is likely in part due to the fact that the SHS is often used as a back-up source for customers connected to the grid.

Figure 14: Evolution of the number of daily hours of light available

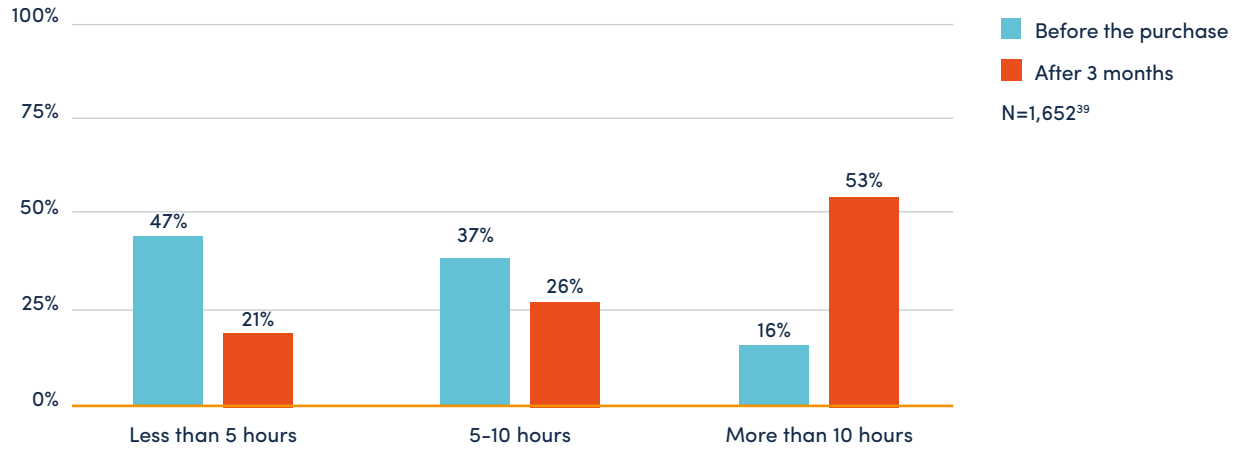
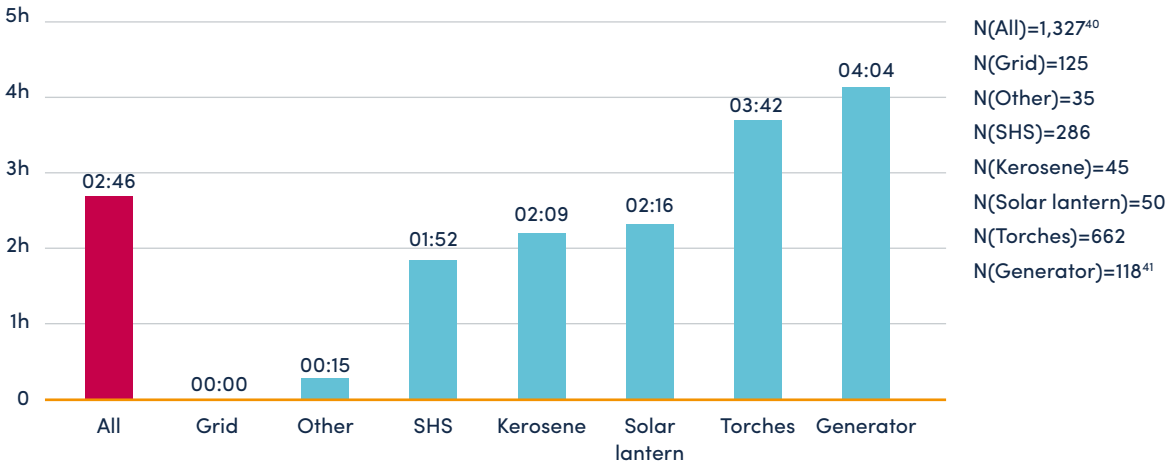


Figure 15: Increase in hours of light per day by previous main source of light



39 Excluding customers responding 'do not know'.
40 Among customers currently using the SHS as a main source of light.
41 Candles excluded from chart due to small sample size.

3.2 Appliances

While lighting is the central feature of these systems, they also provide other services, and households can access a variety of appliances with their SHS depending on the power capacity and size. All systems considered in this research include phone charging capacity, 55% include radios, 31% include a TV and 8% include a fan. 40 to 50% of customers who have either a radio, TV or fan included in their system mention the appliance as one of their main reasons for purchasing the SHS.

Mobile phones

Prior to their purchase, most customers paid for phone charging. This meant that charging a phone required time and came at an additional cost, potentially including transport fees.

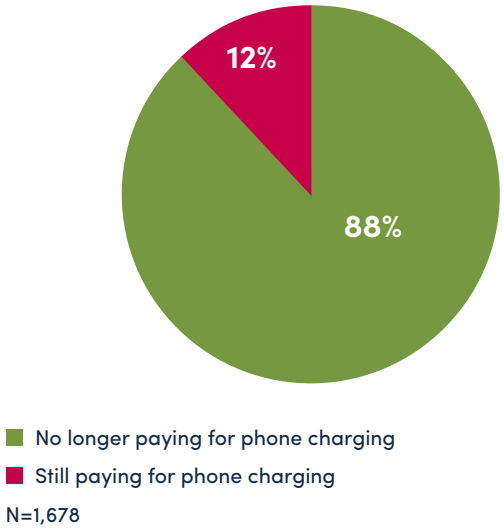
Since purchasing the SHS, 88% of customers no longer pay for phone charging (Figure 16). With close to three phones per household, this can result in significant savings for families (see sub-section 3.3 Energy Expenditure).

For the vast majority of customers, the ability to charge their phone more easily also helps them to improve their connectivity and 93% of users report using their phone more since purchasing the SHS (Figure 17). This in turn can help users improve their economic activity (see section 4. Economic Opportunity) as well as less tangible but highly valuable benefits such as improving cohesion within dispersed families and increasing users broader sense of inclusivity[42].

Televisions and Radios

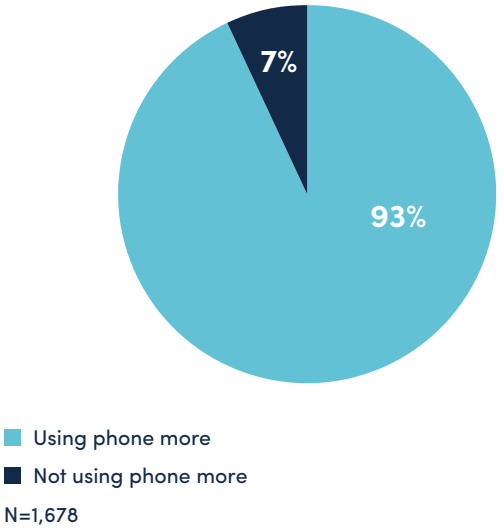
Radios are the appliances most commonly included with the SHS and therefore the most commonly used appliance. However, when looking at the utilisation rate of appliances, TVs are the most popular, 92% of customers who have a TV included in their SHS report using them (Figure 18). This shows the popularity of TVs, and in the past, other research also highlighted the strong links between TV use and solar sales[43]. There is currently not much research available around the impact of TVs, either negative or positive, although it was found that televisions have the potential to increase political awareness and disseminate best practices on topics such as health or financial inclusion[44].

Figure 16: Share of customers no longer paying for phone charging



N=1,678

Figure 17: Share of users using their phone more since purchasing the SHS



N=1,678

42 See GSMA (2006), The Economic and Social Benefits of Mobile Services in Bangladesh and Goodman (2005), Linking Mobile Phone Ownership and Use to Social Capital in Rural South Africa and Tanzania.
43 Jacobson (2007), Connective Power: Solar Electrification and Social Change in Kenya.
44 See M-KOPA (2017), Tuned In, Television and Civic Engagement in Off-Grid Society and Global LEAP (2016), The State of the Off-Grid Appliance Market.

Customer aspirations

The vast majority of households (83%) report wanting more appliances or services from their SHS. Unsurprisingly, TV's are the most popular sought-after appliance (Figure 19). Among households that currently do not have a TV, 65% indicate they would like to own one. Second and third on the customers' wish list are fans and fridges.

Figure 18: Share of households using each appliance included in their SHS

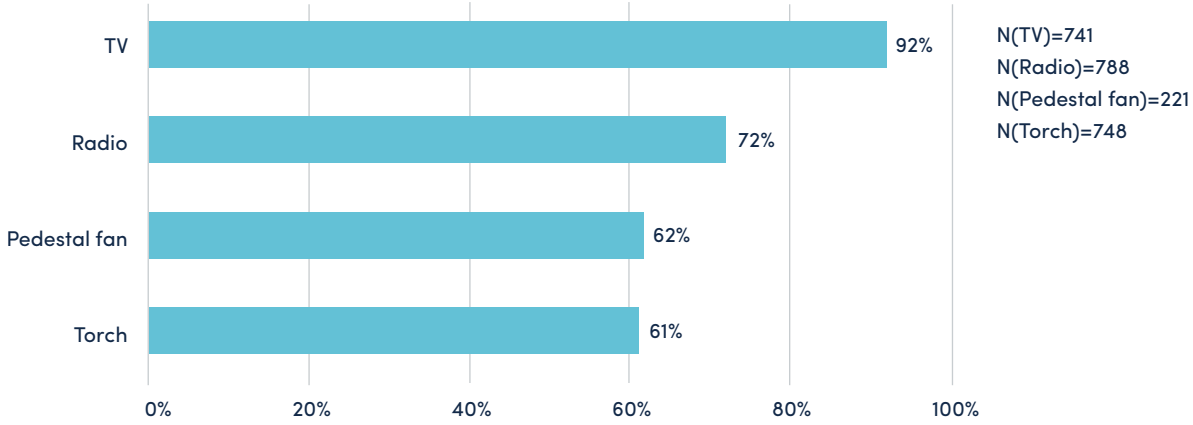
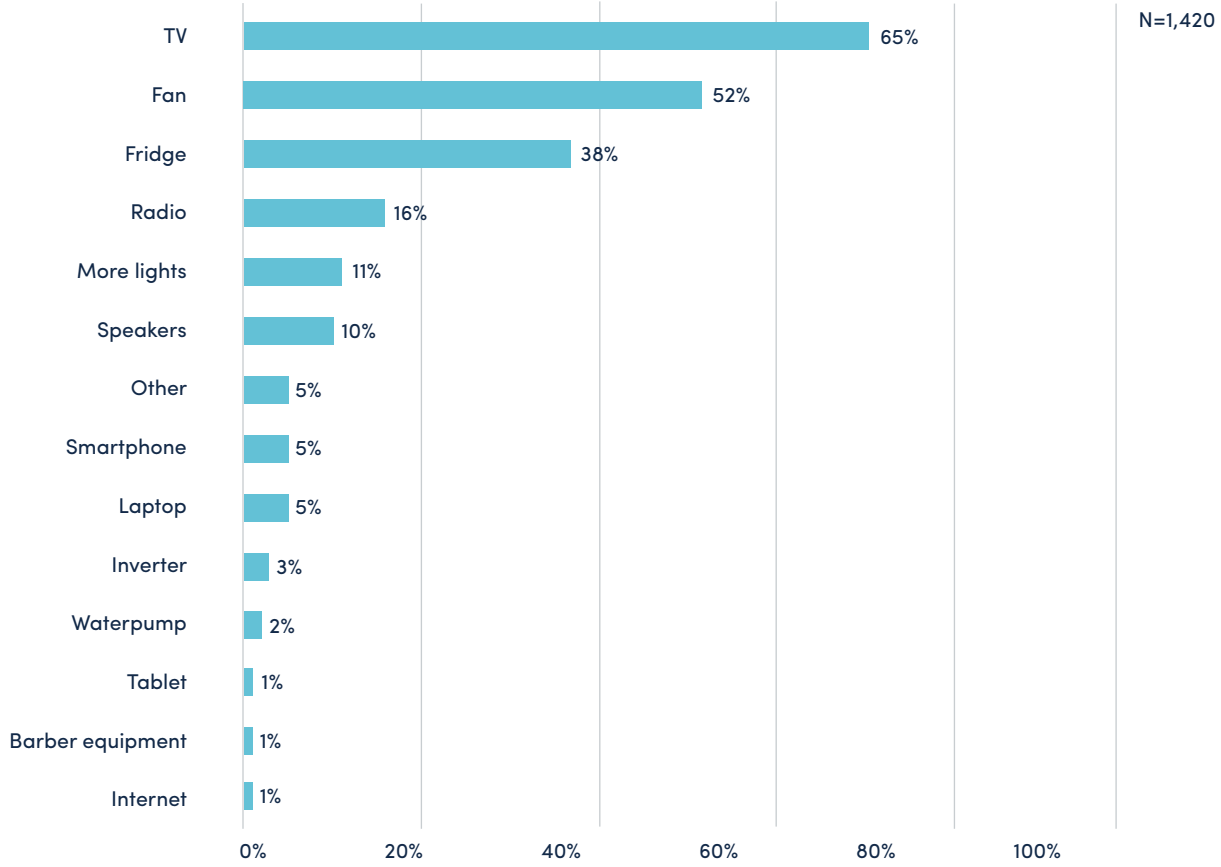


Figure 19: Appliances wanted by share of households



West Africa: State of the Market

Approximately 208 million people in West Africa, including the Sahel, do not have access to electricity. Electrification rates in the region vary drastically, from 79% in Ghana to 20% in Niger[45&46]. In many countries, access to electricity is location dependent, with urban areas seeing much higher rates of electrification than rural areas. In Niger, for example, the urban electrification rate surpasses 65%, while rural areas are mostly not electrified[47]. Although the off-grid solar market in West Africa is still relatively nascent, these numbers indicate there is a huge market opportunity for off-grid solar solutions. This is evidenced by a GreenMax market assessment as part of the Regional Off-Grid Electrification Project (ROGEP). The research identified around 31 million households that could be electrified using solar home systems in West Africa and the Sahel, with the potential value of the household solar market estimated to be about USD $6.6 billion[48].

In recent years, PAYGo sales in the Sub-Saharan region have been strongest in East Africa. In Kenya, the largest market in the region, 518,821 products were sold in 2018. Nigeria is the dominant market in West Africa with 135,232 PAYGo products sold in the same year, followed by Côte d'Ivoire, with 38,531 product sales[49]. One important reason why sales in West Africa trail behind East Africa is that the region has not attracted the level of investment required to build a strong market. The West African market is fragmented and consists of many countries with small, dispersed populations. Both investors and companies are facing barriers such as lack of appropriate policy and regulatory environments, a lack of supporting ecosystems for the solar industry, poor access to finance and lack of clear information on demand and customer segments, which hampers investment and market growth[50].

However, companies and investors increasingly recognise the potential for off-grid solar in West Africa. Barriers that are specific to the PAYGo model, such as the adoption of mobile money, will likely dissipate in several markets over the coming years. Ghana is the fastest growing market for mobile money in Africa[51], and in Nigeria the government recently passed regulation that will allow mobile network operators to offer banking services, allowing PAYGo companies to streamline their payment platform[52]. These measures create an enabling environment that fosters market growth, and by learning from countries in East Africa and South Asia, West Africa could bypass its development phase to attract investment and rapidly improve uptake of off-grid solar products.

3.3 Energy expenditure

Understanding how the purchase of the SHS affects a household's expenditure is complex. This report looks at lighting and phone charging expenses to provide insights as to how energy expenditure evolves with the purchase of the SHS in the short-run and over the product's expected lifetime[53].

It is important to note that this study is not a fully detailed cost-benefit analysis. Many costs in-

45 World Bank (2019), Press Release.
46 World Bank (2017), please see https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=GH
47 World Bank (2017), please see https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NE
48 World Bank (2019), Regional Off-Grid Electrification Project.
49 GOGLA (2018), Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data January – June 2018 and GOGLA (2019), Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data July – December 2018. Sales refer to all off-grid solar lighting product sales reported by participating affiliates in the period between July 1st-December 31st, 2018. Affiliates include GOGLA members, companies selling Lighting Global quality-verified products, and appliance companies that participated in the Global LEAP Energy Efficient Appliance Awards or are engaging with the Low Energy Inclusive Appliances (LEIA) programme.
50 World Bank (2019), Regional Off-Grid Electrification Project.
51 USAID (2019), Off-Grid Solar Market Assessment Ghana.
52 GOGLA (2019), Investing in the Off-Grid Solar Sector: What You Need to Know.
53 Expected product lifetime is computed using the warranty period and a standard multiplier: Warranty * 1.5. For more information please see GOGLA (2018), Standardized Impact Metrics for the Off-Grid Solar Energy Sector.

curred by off-grid customers when accessing energy-based services are not included (transport costs to purchase energy sources or charge phones, paying to watch TV, etc.) and the acquisition of additional products such as radios, multiple lights or televisions are not directly comparable to prior costs.

Additionally, sample sizes for this section are significantly smaller[54] than for the overall research due to cases where customers were unable or unwilling to share their energy expenses with the researchers[55]. Nonetheless, the analysis provides reliable insights into the evolution of customers' energy expenditure which are laid out in this section.

It was found that 25% of customers experience an immediate reduction of expenses on light and phone charging and 49% of customers will save on energy expenditure over their product's lifetime. Additionally, the SHS brings significant added value to customers which is not captured in the analysis of energy expenses.

Evolution of household weekly energy expenses

Before buying the SHS, households spent an average $2.5 per week on lighting. Households that were reliant on solar products as a main source of lighting spent an average $1.3, while households that mainly used a generator were spending over $6 each week (Figure 20).

Before purchasing the SHS, households spent an average $3.4 per week on phone charging, with urban households spending on average $4.5 and rural households $3.2. After their purchase, 88% of households no longer pay for phone charging, which results in a decrease to $0.4 per week on average in both cases (Figure 21).

Figure 20: Weekly lighting expenses of households by main source of light before purchasing the SHS (USD)[56]

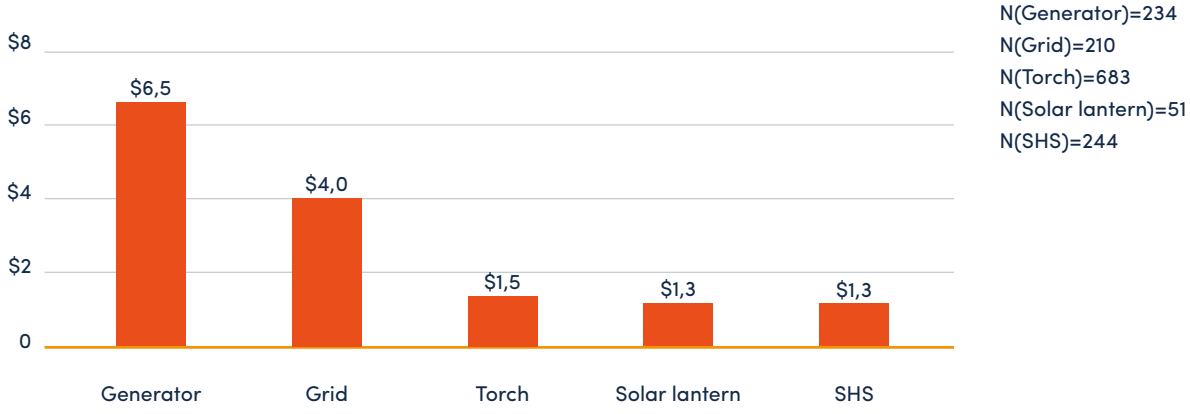
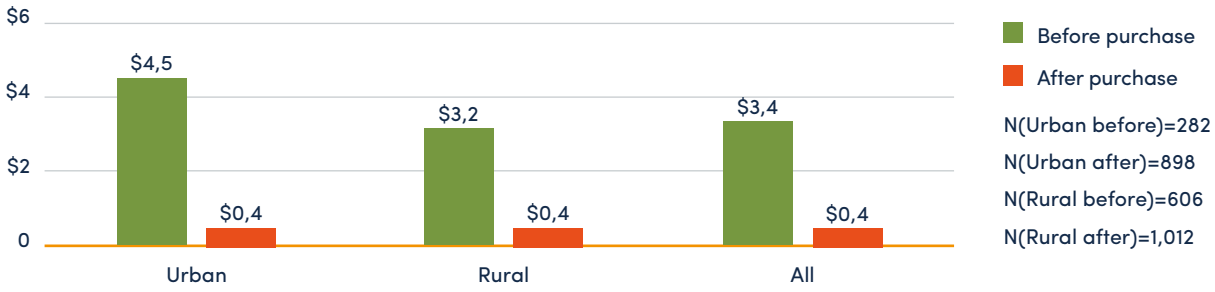


Figure 21: Evolution of weekly phone charging expenses by type of location (USD)



54 Sample size for this section is 722 or 43% of the overall sample.
55 See Methodology Annex.
56 Grid costs vary from country to country. Cost of grid access in this research is mostly reported by customers in Nigeria.

Overall, before purchasing the SHS, households spent an average of $5.6[57] per week on energy (lighting and phone charging), or $292 per year. After their purchase, the average weekly energy expenditure of households increases as the average amount paid per week to the SHS provider is $5.1, which is added to residual expenses on other lighting sources. Therefore, in the short term, most customers pay more for energy on a weekly basis with expenditure increasing from $5.6 to $7.3 (Figure 22). However, this analysis does not take into account other costs (such as transport) that are eliminated or reduced by the SHS and does not acknowledge that for many households the SHS provides access to a dramatically greater and more reliable range of services.

The average also hides a critical insight which is that among households that provided answers for all relevant questions, 25% report immediate weekly energy savings – meaning their current weekly expenses are lower than before purchasing the SHS.

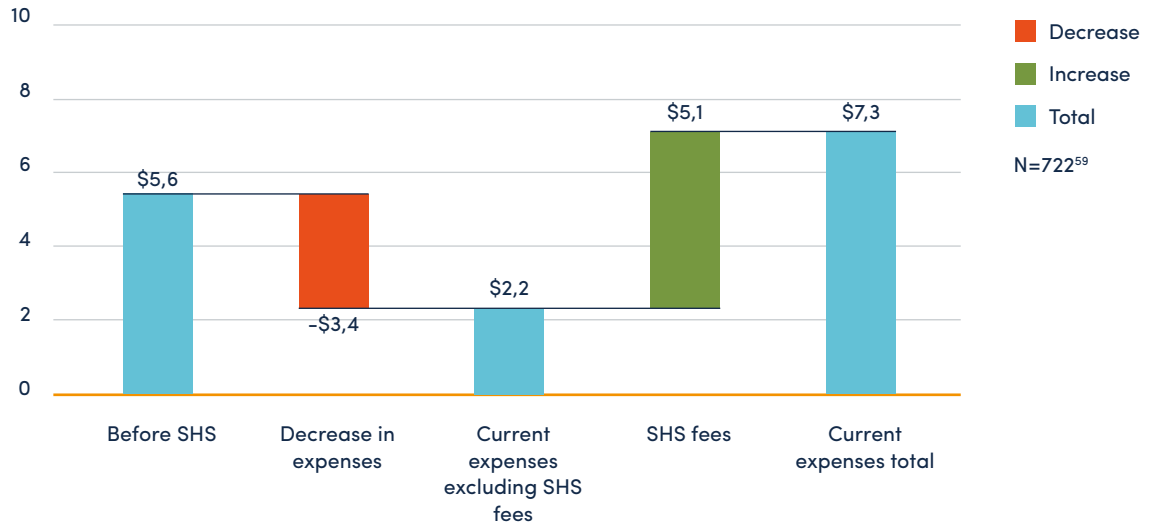
Evolution of household weekly energy expenses over the SHS expected lifetime

On a weekly basis, the SHS does not lead to reduced energy expenditure (lighting and phone charging) for most households. However, this snapshot does not reveal the full financial value of the product to the customer. Looking at the energy spending over the product's expected lifetime[58] shows that 49% of households make savings compared to their previous energy expenditure. This increase is in large part due to the fact that the product lifetime is equal or longer than the repayment period.

Households that purchase the SHS will benefit from average savings of $265 over the products' expected lifetime. Among the 49% of customers that will experience reduced energy expenses, the average amount saved is $1,269. For the 51% of customers with increased energy expenditure, the additional expenses sum up to an average additional $697. This projection does not consider possible changes in behaviour or economic activity over the three-to-ten-year period of product expected lifetimes.

It should be noted again that analysing expenses on lighting and phone charging does not provide the full picture. Customers may well be reducing other expenses by acquiring the SHS such as travel costs or paying a fee to watch TV. This hypothesis seems to be supported by a more qualitative approach: three months after purchasing the SHS, 75% of customers report they feel as though they have more money available than before (Figure 23).

Figure 22: Evolution of weekly energy expenses since purchasing the SHS (USD)



57 Pleaste note that this figure only includes households for which all energy expenditure data points from both the baseline and follow-up are known. This is why the average is $5.6 and not $5.9 as indicated in the paragraphs above.

58 For rent-to-own models, expected product lifetime is defined as Warranty period * 1 .5. Please see GOGLA (2018), Standardized Impact Metrics for the Off-Grid Solar Energy Sector for more information. For energy-as-a-service models, expected product lifetime is the duration of the servicing contract. Product expected lifetime may extend beyond the repayment period.

59 Only includes households for which all energy expenditure data points from both the baseline and follow-up are known.

PEG SHS save their customers time and help children study

By accessing additional hours of light in their home, or by reducing the time they spend travelling to access energy services such as phone charging, customers report having more free time after purchasing their SHS. This is the case for Kwesi Amoah Nti from Kintampo in Ghana.

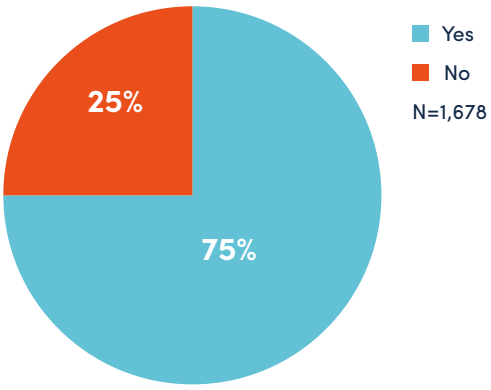
"I was introduced to PEG solar products by a close friend who was one of the first people to buy a SHS in my village.

Before I bought the SHS, I used to charge my phone at my friend's house. Over time, I got tired of having to walk long hours to and from his house just to do that. This pushed me to get my own.

I am now able to sit at home and charge my phone while having the added benefit of light at night and a TV to watch. My wife uses the lights to sell her 'hausa koko'[60] in the evening and my children now have a well-lit house to study after dark."

Kwesi Amoah Nti speaking at a public gathering

Figure 23: Share of households reporting they have more money available to spend since purchasing the SHS



60 Spicy millet porridge. A Ghanaian street food commonly eaten as breakfast.

Economic Opportunities

© Greenlight Planet

Economic Opportunities

In addition to access to light and phone charging, SHS have the ability to help households seize economic opportunities and increase their income. Although not all households experience this, it can have a significant impact for those that do.

This section showcases the key focus of this research: overall economic impact figures that are derived from either using the SHS in a business or being able to work more hours with the extra time unlocked by the SHS.

This section is structured around three key impact measures:

- **Section 1: Undertaking more economic activities**, the share of households who report that the SHS has helped them undertake additional economic activity.
- **Section 2: Income generation**, customers who report generating additional income from new or extended economic activity.
- **Section 3: Job creation**, FTE employment created through new or extended economic activity.

4.1. Undertaking more economic activities

In this research, additional economic activity encompasses customers using the SHS in a business and customers working more hours thanks to the SHS. This section explores the prevalence of this impact in West Africa and the specific role of the SHS.

Overall, 19% or 1 out of 5 households report undertaking additional economic activity thanks to the SHS, either by using the system to support a business or by undertaking more work (Figure 24).

Among the 19%[61] of households undertaking more economic activity:

- 9% have done so through unlocking additional working hours thanks to the SHS
- 7% have done so by using the SHS to support a business
- 2% have done so by undertaking both activities (thus working additional hours[62] and using the SHS in a business)

Figure 24: Share of households undertaking additional economic activity

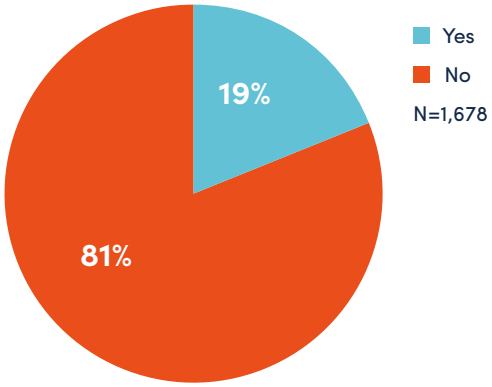
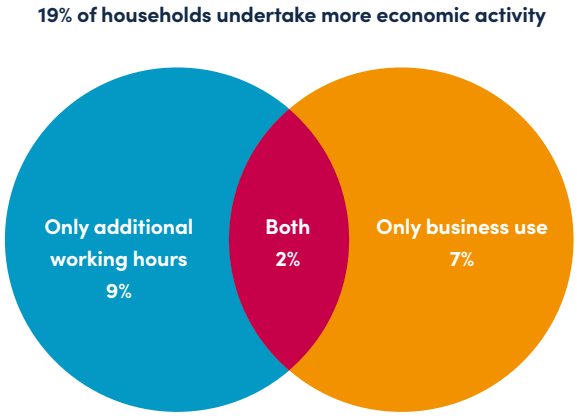


Figure 25: Type of additional activity undertaken

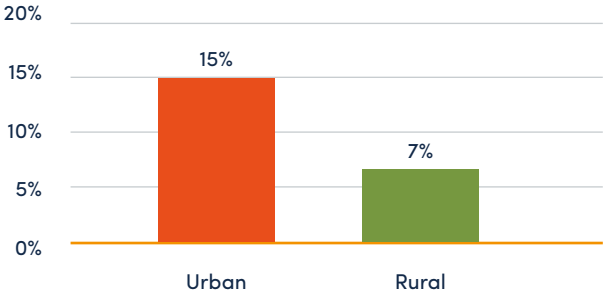


N=1,678

Focus on business use of the SHS

Overall, 9% of households use the SHS for business purposes. Urban households (15%) appear more likely to do so than households in rural areas (7%, Figure 26).

Figure 26: Share of households using the system for business by type of location



N(Urban)=659 N(Rural)=1,019

61 Total is 18.7% with 9.2% of customers working more hours, 7.4% using the SHS in a business and 2.1% doing both.
62 To avoid double counting, the additional working hours in the business where the SHS is used are not included.

Economic Opportunities

91% of businesses that use SHS were in operation prior to the purchase whilst 9% are new businesses. The most common type of business is a shop or stall, followed by bars and restaurants and phone charging (Figure 27). 'Other' includes a broad set of activities including mobile money or airtime agents, small businesses showing TV for a fee and pharmacies.

Predictably, the SHS primary use is for lighting businesses (Figure 28). 68% mention indoor lighting, and 53% mention outdoor lighting. Beyond lighting, 18% mention phone charging for a fee as a way to improve their business, while only 14% indicate that their business activity is phone charging for a fee. This indicates some customers are using the SHS to both improve an existing business and charge phones for a fee as a secondary activity.

Figure 27: Types of businesses the SHS are used in

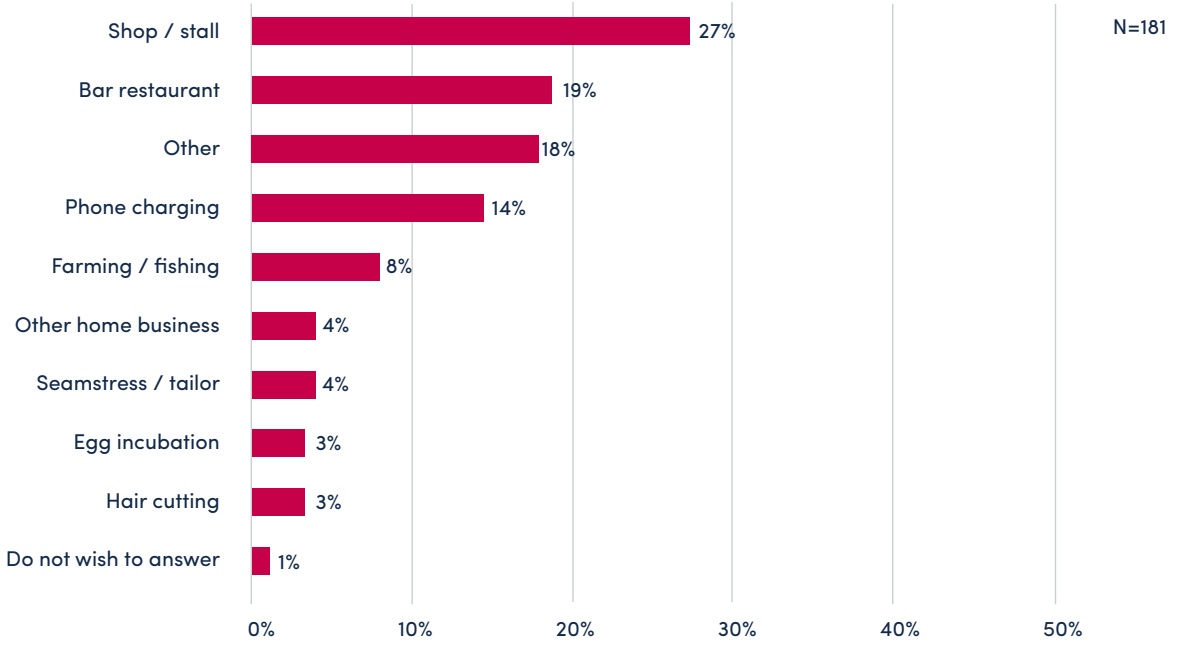
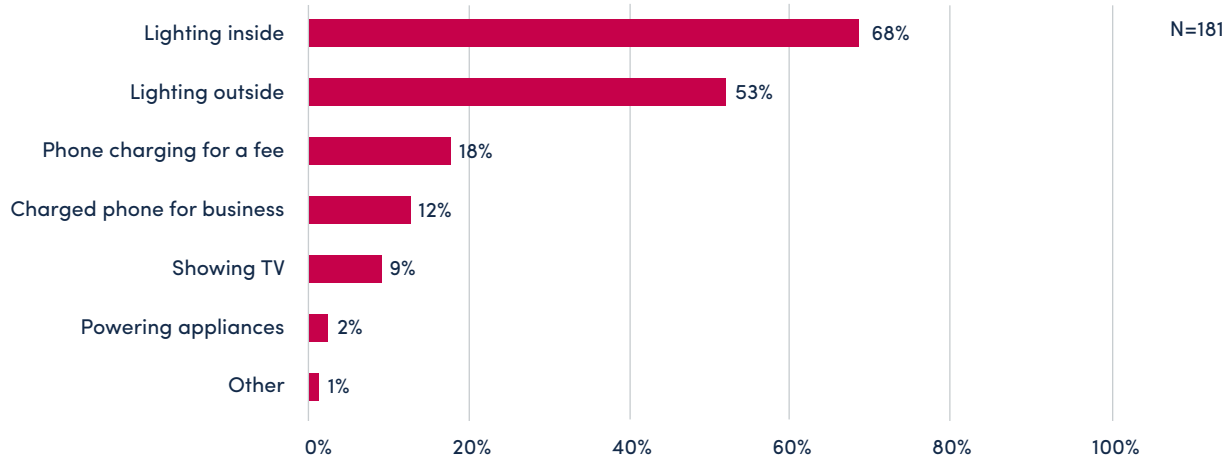


Figure 28: Ways the system is used in businesses



Economic Opportunities

BBOXX SHS empower entrepreneurs

In Togo, BBOXX's SHS are used by many entrepreneurs to improve their business or start new ventures. Below are the stories of two of these entrepreneurs.

Lighting a tailor-shop

Yavo Nsougan is a tailor located in Zooti, Aneho. He owns a SHS which helps him to light his sewing shop and work in the evening.

"It was hard for us to work in the dark using a petrol lamp; if you don't burn your client's clothes, it's snakes that will come and bite you. The SHS helped me to deliver my clients on time and work safely. Not only do I have more clients but I was also able to hire more apprentices."

Opening a video club

Tonou Komi is a young man living in Kévé. Thanks to the SHS, he has opened a video club. Films are downloaded on a USB device and broadcasted to his customers. He charges 25 FCFA ($0.4) for each session and earns up to 500 FCFA ($8.4) per day. He also provides people the opportunity to charge their mobile phones.

"It's hard to earn a living here as it's a poor community but I never thought a TV could help me this much."

Economic Opportunities

Focus on more work hours unlocked by the SHS

In addition to using the system for business activities, the SHS can also enable household members to spend more time working. Having more light hours at home allows customers to reorganise their activities in the evening to increase their time at work. Customers often do not need to travel anymore to buy energy sources or charge phones, which frees up time for productive work. Improved connectivity also means people are easier to reach, enabling them to seize more opportunities[63].

As can be seen in Figure 26, 11% of households report members are able to work more hours. Among them, two-thirds are able to do so because the SHS provides them additional hours of light in the evening at home which enables them to reorganise their activities and spend more time at work (Figure 29).

Among households reporting additional working hours, the most common activities undertaken are farming and selling products (Figure 30). The broad 'Other' category includes a wide array of jobs from fishermen and craftsmen to teachers and civil servants. A few respondents also mention working as solar panel or SHS installers.

Figure 29: Ways the SHS enables household members to work more hours

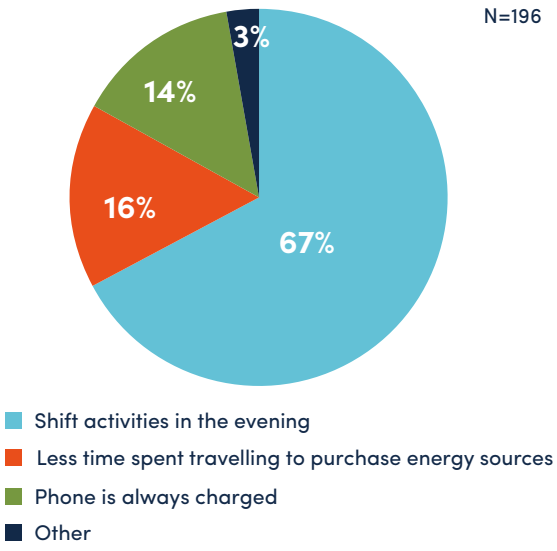
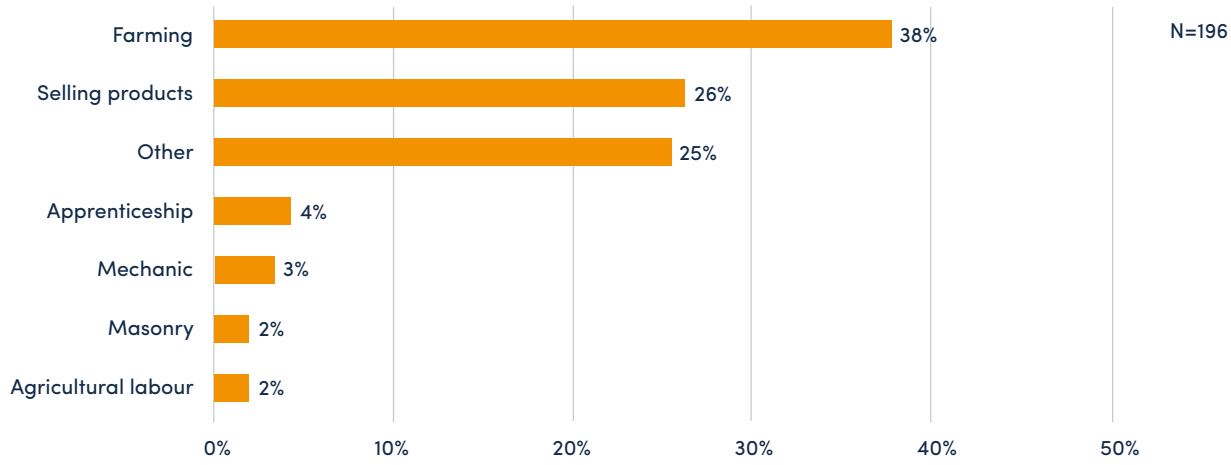


Figure 30: Main types of activities conducted through more work hours



63 See Bloomberg (2018), Powering Last Mile Connectivity and GSMA (2006), The Economic and Social Benefits of Mobile Services in Bangladesh.

4.2 Income generation

74% of households undertaking more economic activity report that they generate additional income from this activity. Overall, this means 14% of households generate more income by using the SHS.

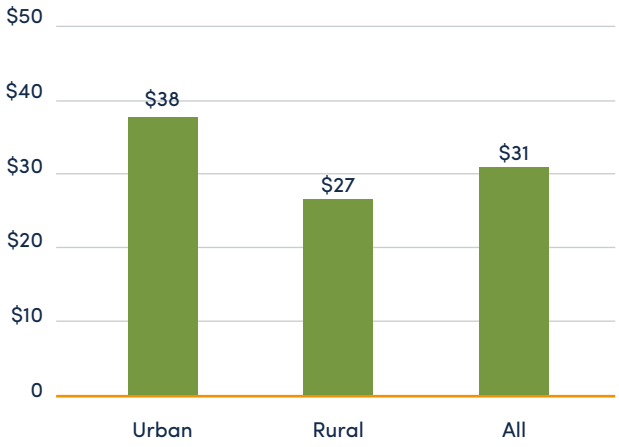
The additional income generated adds up to an average of $31 per month, or $372 per year. Households that generated income, generated an amount equivalent to 8.5% of the average household monthly income in their country[64].

On average, urban customers report earning an additional $38 a month, while rural customers increase their income with $27 a month (Figure 31).

Focus on business use of the SHS

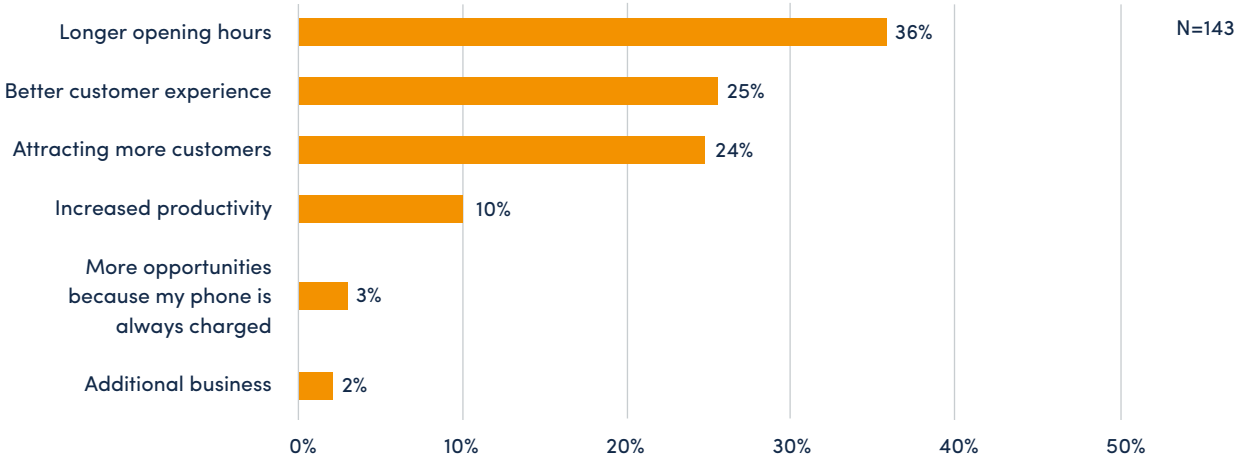
Among pre-existing business (91% of businesses), 79% report that the SHS helped them improve their income. The main mechanism through which additional income is being generated is through longer opening hours (36%). Better customer experience (25%) and attracting additional customers (24%) are also mentioned by many businesses (Figure 32). All new businesses (9% of businesses) report being able to generate income from their activity. On average, businesses using the SHS report an additional monthly income of $31. Among the main types of businesses, shops are the most profitable with an average additional income or $43. Bars and restaurants report an average of $21 and phone charging as a fee $8 (Figure 33).

Figure 31: Average additional monthly income generated by type of location (USD)



N(Urban)=122
N(Rural)=128
N(All)=250

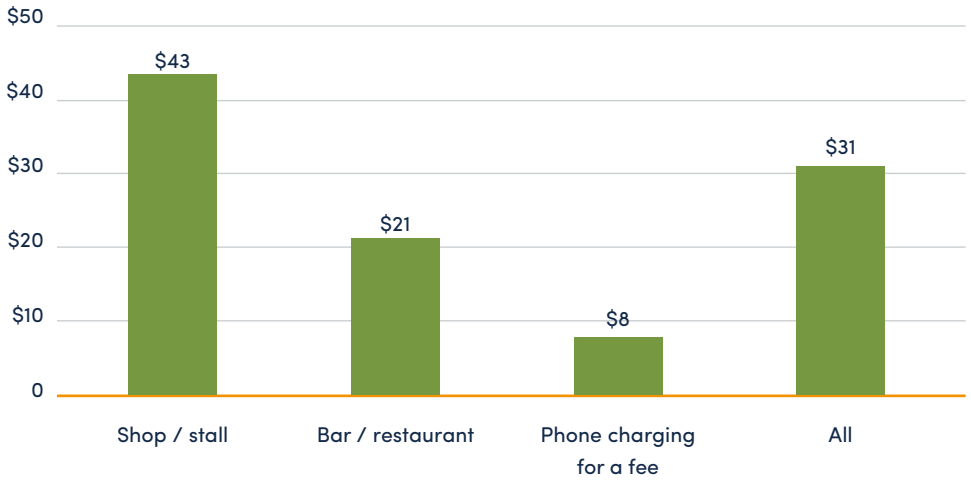
Figure 32: Ways the SHS improves the income of pre-existing businesses



64 Based on gross national income (GNI), % of monthly income per household calculated for each household and averaged. World Bank (2018), GNI per capita: Côte d'Ivoire $1,610, Ghana $2,130, Nigeria $1,960, Togo $650.

Economic Opportunities

Figure 33: Average additional monthly income reported by type of business (USD)



N(Shop/stall)=52
N(Bar/restaurant)=26
N(Phone charging)=26
N(All)=181[65]

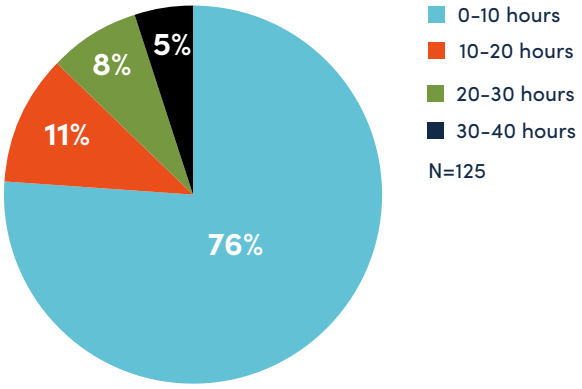
Focus on more work hours unlocked by the SHS

Among the 11% of households reporting being able to work more hours since purchasing the SHS, two-thirds also report this additional work has enabled additional income generation. Overall, this means 7% of households report generating income from additional work hours.

On average, these households report generating an additional $31 per month.

Among them, three-quarters work up to 10 additional hours a week (Figure 34) or a maximum of 40 additional hours a month. The working week for most formally employed workers from the countries of this research is 40 hours per week.

Figure 34: Additional hours worked per week among customers generating income from additional working hours



N=125

65 The chart does not include business types for which the sample size is too small.

4.3 Job creation

Additional questions were asked to households that reported undertaking more economic activity, in order to understand how many household members were working more and whether they were male or female. It was found that often more than one household member was able to work more hours or find new employment. For example, in several cases, both a female and a male adult are able to work for longer, or to take on new employment.

To more clearly demonstrate the impact of this increase in economic activity, this research uses a calculation of FTEs, based on the number of extra hours worked thanks to the SHS. This FTE calculation includes the additional time that is spent working via all of the mechanisms highlighted earlier in this research: more time working due to extended business hours and more time spent working due to increased hours of light, less time spent travelling and better connectivity. The term 'job creation' refers to the creation of FTEs. The vast majority of FTEs in this research are enabled through additional work hours rather than new employment.

Using the same approach as for economic activity and income generation, FTEs can be attributed to business usage or work hours unlocked by the SHS[66]. Overall, the additional economic activity undertaken by household members adds up to 8 FTEs created for each 100 SHS sold. Of these, three come from business usage while five come from additional work hours in other activities (Figure 35). Almost 70% of these FTEs are created in rural areas (Figure 36) and 38% of these jobs are undertaken by women (Figure 37).

Figure 35: FTEs created for 100 SHS sold by type of economic activity undertaken

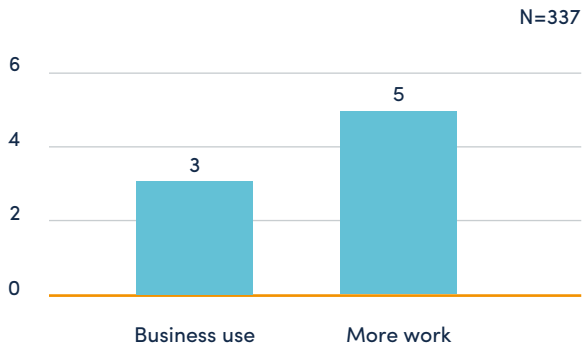


Figure 36: Distribution of FTEs created by type of location

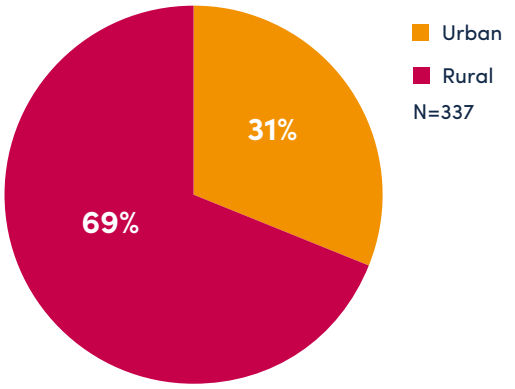
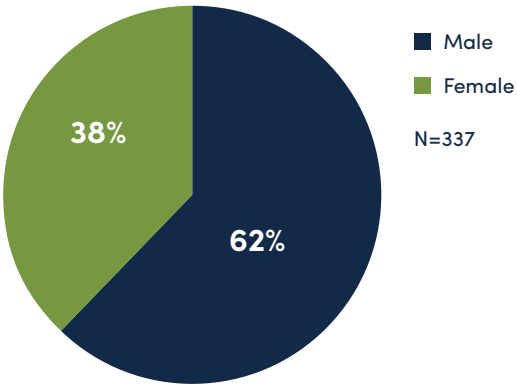


Figure 37: Share of FTEs created by gender



While this additional activity is extremely significant in demonstrating the opportunities created by the simple addition of light and power into a home or business, it should be noted that new jobs or work hours created due to the SHS are likely to be informal e.g. where additional hours are spent working in a small shop, or a household member is able to take on more part-time work, and may not be as secure as more formal activities. However, improving the lives of the informal workforce is an important part of economic development[67], especially in Africa where the informal sector accounts for around 40% of GDP[68].

66 The survey questionnaire was designed so as to avoid double-counting with additional hours counted separately for both activities, and specific indications to not count hours spent working in the aforementioned business for customers who reported business usage.
67 ILO (2018), Women and Men in the Informal Economy: A Statistical Picture.
68 ODI (2018), Informal is the New Normal – Improving the Lives of Workers at Risk of Being Left Behind.

Economic Opportunities

FTE Methodology

Full Time Equivalent (FTE): Unit of measurement of the workload of an employed person. It is calculated as the total hours worked divided by the legal maximum week full-time jobs within each economic territory[69] (i.e. 1 FTE is equivalent to 1 full-time worker).

Within this research, FTE jobs were calculated relative to the 40-hour-long legal working week in participating countries[70].

Customers reporting an existing business were asked to report the increased number of opening hours per week. The number of hours was attributed to only one household member and compared to a full week as described above.

Customers reporting a new business were asked how many household members worked in the business and how many hours they worked in the business. FTEs were calculated for each individual and summed at the household level.

Customers reporting working more hours were asked how many household members worked in the business and how many hours they worked in the business. FTEs were calculated for each individual and summed at the household level.

FTEs were only calculated when additional economic activity translated into additional income.

Although several businesses reported gaining new employees, this data was not used within the FTE job calculation, as data was not obtained on the number of additional hours worked by these employees.

Please note that the FTEs within this research are only calculated for the increased time spent working by off-grid solar customers and does not include any hours worked by the staff or agents of off-grid solar companies themselves. Furthermore, that a majority of jobs within off-grid solar companies, such as those for sales staff, technicians and management, are formal and full time. More details on 'sector level', rather than 'household level' jobs can be found in the report 'Off-Grid Solar. A Growth Engine for Jobs'[71].

Focus on business use of the SHS

On average, the businesses surveyed in this research operated for 33 hours a week, with the SHS being used an average of 28 hours a week. It is important to note that this hides several realities. In some businesses, the SHS is only used a few hours a day to light a store after dark while others may leave the SHS on all night for safety, and therefore use the SHS in the business beyond opening hours.

Looking more specifically at businesses created since purchasing the SHS, the average number of household members working in each business is 1.7. Among them, 38% are women. Unsurprisingly, many (48%) of these household members report working full-time in their new business.

Taking into account both jobs created by new businesses and extended working hours from pre-existing business, each business generates 0.3 FTEs. In a broader perspective, this means that for 100 SHS sold, the use of SHS in business creates 3 FTEs.

Additionally, businesses were asked if they had been able to hire new employees from outside their households. 24% of businesses report doing so and on average they report hiring two employees. However, the research did not include any time spent or activity undertaken to gain further qualification for these jobs or assessment of the time these employees spent at work. Therefore, although a significant finding, these additional hires were not counted towards the measurement of job creation in terms of FTEs.

69 Commission of the European Communities, International Monetary Funds, Organisation for Economic Co-operation and Development, United Nations and World Bank (1993), System of National Accounts.

70 The standard legal work week is 40 hours in Côte d'Ivoire, Ghana and Togo. In Nigeria, the general work week is 40 hours. Nigerian law does not set a maximum working week, and working hours are usually set by mutual agreement, or through collective bargaining and industrial wages boards.

71 GOGLA (2019), Off-Grid Solar. A Growth Engine for Jobs.

Economic Opportunities

Focus on more work hours unlocked by the SHS

In households reporting additional hours of work, the average additional time spent working is 9.5 hours per week. This amounts to just over an hour and a half per day for a six-day work week[72]. Overall, these additional work hours add up to 5 FTEs for every 100 SHS sold.

Among the customers reporting these results, most have simply increased their working hours, but a few have started new jobs. This explains why, although most household members spend less than 10 additional hours per week at work, a few report full work weeks.

58% of these households report that the system has enabled more than one member of the household to spend more time working or get a new job: on average, 2.5 members. Among the beneficiaries, 39% are women.

Job Creation in the Off-Grid Solar Industry[73]

The off-grid solar industry is generating thousands of employment opportunities in emerging markets. These opportunities have crucial impacts on individual livelihoods, on rural and urban development, and on other sectors in the economy. Across East, West and Central Africa, and across South Asia, it is estimated that the off-grid sector currently supports 370,000 full time equivalent (FTE) jobs. South Asia accounts for around 260,000 of these jobs, representing the largest market for employment amongst the four regions.

By 2022, the off-grid solar sector could support up to 1.3 million FTE jobs by 2022 across these four regions. South Asia will remain the largest market for employment, accounting for 740,000 FTE jobs, followed by East Africa with 350,000 jobs and West Africa with 150,000 jobs. Over half of the jobs created in West Africa will be in sales and distribution and almost a fifth in installation and maintenance of solar products.

As with FTEs created at the customer level, the majority of jobs created within the industry will be in rural areas, supporting job creation and diversification among often economically disadvantaged and vulnerable communities. There is also a strong representation of women among workers in the off-grid solar sector, which is expected to rise. Wages in the industry are in line with, or higher than, average national wages and many companies are also supporting the expansion of skills and capacity of their staff through training and development programs.

72 Many respondents are likely to be working in the informal economy where there is no standard work week.
73 For more information, please see GOGLA (2019), Off-Grid Solar. A Growth Engine for Jobs.

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Impact on Quality of Life

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Impact on Quality of Life

While not all users benefit economically from the system, the SHS itself does a lot more to improve households' quality of life. Access to lighting, phone charging and appliances offer many immediate benefits, and enables customers to feel safer, healthier and better connected.

97% of households report they feel their quality of life has improved since purchasing the SHS. The primary reasons cited for the improvement of quality of life are access to more light, improved safety, having a phone which is always charged and children having more time to do homework (Figure 38).

Among the 3% of customers that did not report an improvement in quality of life, the main reasons mentioned are that their system cannot power the appliances they want, that they are experiencing technical issues or that the product is too expensive.

In addition to these quality of life improvements, three-quarters of households report they feel they have more money available to spend since purchasing the SHS. Many households mention spending this additional budget on food (28%), which indicates that these households are likely low-income households.

Saving money (13%) and repaying debt (10%) are also mentioned by households, as is investing in a farm (8%) or business (8%). Education is also an important area of expenditure with school fees (10%) and school materials (2%, see Figure 39) adding to the impact of additional time for homework enabled by solar lighting.

Figure 39: Main area of expenditure mentioned by households reporting additional money available to spend since purchasing the SHS[75]

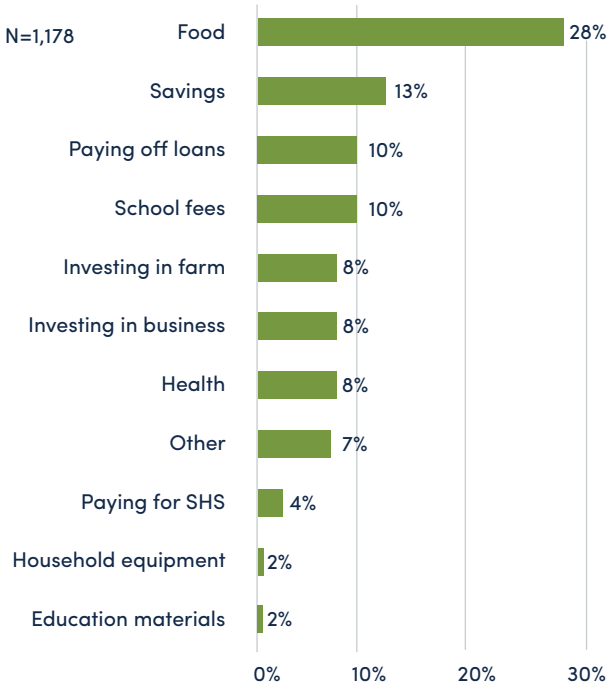
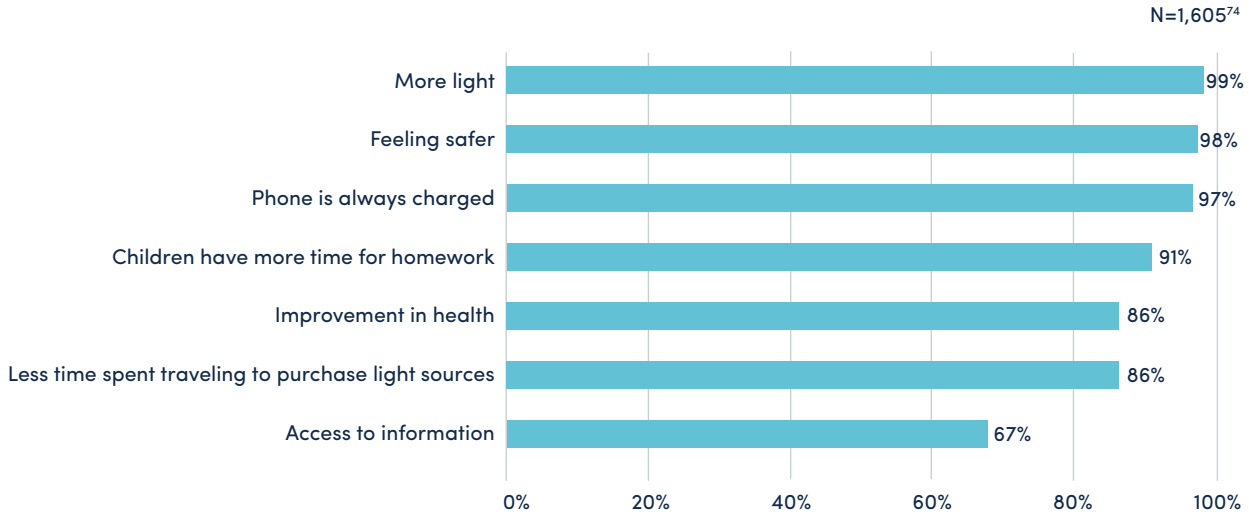


Figure 38: Reasons for quality of life improvement



74 Among customers reporting a quality of life improvement.
75 'Other' category includes a broad set of expenses including building a house, vehicle expenses, clothes and entertainment.

Impact on Quality of Life

ZOLA Electric's SHS improve quality of life and power business

ZOLA Electric's SHS are used both by households and businesses in Côte d'Ivoire and their impact is felt in terms of quality of life for families and operating conditions for businesses as illustrated by the cases of Kouassi Dilami and Badimi Drissa.

Kouassi Dilami, Father of two

"In the past, I was using a generic solar panel and I was spending a lot of money on renewing batteries, almost every three months. I wanted my children to be able to study more in the evening but they could not really do so.

Today with the SHS, my children can study better and until late, like 9 pm. I also worry less about the safety of my family, when I go on a trip for example. On top of it, I managed to save money because of the SHS and I have invested the money in a new business project."

Badimi Drissa, Shopkeeper in the Tonkpi region

"Before purchasing my SHS, I was using a solar panel and batteries at my store. The product was not reliable and the expenses were weighing my business down.

With my new SHS my business is doing better. I am open longer hours, usually until midnight. The lights protect my produce; snakes and mice do not eat my goods anymore. I use a safety light for the store which also benefits my neighbours and this has created a sense of solidarity between us."

Conclusion

This study is part of the Powering Opportunity series around the socio-economic impacts of SHS. The first two reports, Powering Opportunity: The Economic Impact of Off-Grid Solar and Powering Opportunity in East Africa: Proving Off-Grid Solar is a Power Tool For Change, provide clear, evidence-based insights into how solar home systems are improving the lives of people living in low-income households in East Africa, currently the core market for PAYGo SHS. This report shows that SHS have similar significant social and economic impacts in West Africa as they have in East Africa.

The majority of customers in this research are rural and low-income households, but also urban and often wealthier customers are purchasing the same products to meet their needs. For 51% of households, SHS enable them to switch from torches or kerosene fuelled lights and provide them with access to quality lighting for the first time. For 30% of customers, especially in urban areas, SHS are used to increase their access to reliable and clean electricity, replacing or complementing the grid and in many cases eliminating or reducing the use of polluting generators.

Almost all customers (96%) would recommend their product to a friend or relative, and an overwhelming 97% report that their quality of life improved after their purchase. They report that they feel healthier (86%), safer (98%) or that their children have more time to study (91%).

The research also highlights the economic impact of SHS in West Africa. Overall, 19% of households report undertaking more economic activity since purchasing the SHS. In most cases where a household is able to undertake more economic activity, more than one household member is doing so, earning additional income. To more clearly demonstrate the impact of this increased economic activity, this research calculated the number of unlocked FTEs, based on the number of extra hours worked thanks to SHS ownership. Overall, the additional hours customers were able to work translate to a significant 8 FTE jobs created for every 100 solar home systems used. In total, 38% of these jobs are undertaken by women and 69% are in rural areas.

For 14% of customers, the system has proven to be a sustainable source of income generation. The average additional monthly income reported by these households is $31 per month, or $372 per year. This is considerable, seeing that 25% of customers report an income below $1.90 per day and 59% report an income below $5.50 per day.

The findings in this report show that SHS have an untapped, transformative power. Off-grid solar is reaching low-income households in both rural and urban communities in West Africa, providing households with new opportunities for profound social and economic change. We hope that the Powering Opportunity series will help investors, decision-makers and those looking to support the industry to better understand how off-grid solar can impact the lives of households and can be a power tool for change.

Additional research could further support this effort:

- How does the impact observed in this study evolve over time?
- What is the impact of SHS over the product's expected lifetime among customers who have paid for their system in full?
- How do SHS integrate with the grid?
- What is the net cost of SHS over their product lifetime?
- How can off-grid solutions improve productivity, resilience, and incomes for smallholder farmers?
- What is the impact of off-grid products on education and health facilities in West Africa?

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Annex

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Annex

Product Annex

BBOXX - Home System – 50 Wp

Greenlight Planet - Sun King Home 60 – 6 Wp

Greenlight Planet – Sun King Home 120 – 12 Wp

PEG – d.light D30 – 10 Wp

PEG – d.light X740 – 30 Wp

PEG – d.light X850 – 40 Wp

ZOLA Electric - Flex 19" TV - 40 Wp

ZOLA Electric - Flex Plus 24" TV + FAN - 100 Wp

Annex

Methodology Annex

Baseline data collection

Baseline data was collected by participating companies themselves using a questionnaire designed by Altai Consulting and after receiving training from Altai Consulting. This approach enabled the study to leverage points of contact between the company and customers while minimising the impact on operations. The survey was conducted at the moment of purchase or soon after. This avoided relying on customers' memories for information about their prior situation.

The final sample size was 2,375.

Follow-up data collection

Data collection was conducted by Sagaci Research, an experienced pan-African market research firm. The questionnaire and training for the data collection were provided by Altai Consulting.

Sagaci Research conducted the data collection using tablets with an adapted software to ensure traceability and enable extensive monitoring. Monitoring was continuously conducted by both Altai Consulting and Sagaci Research to address all potential issues. Any irregularities or inconsistencies in interviews led to their dismissal.

Sagaci Research attempted to interview all baseline interviewees. However, attrition was expected (refusal to participate in the survey, phone number change, unavailability of respondent at the time of the survey, poor mobile coverage) and the final sample size is 1,678.

Incomplete data

For the baseline data collection, flexibility was given to the participating companies as to how to collect the data. Some data was gathered from data previously collected by the company rather than asked to customers and in some cases questions were excluded all together because companies feared they might be perceived as too intrusive. This is reflected in smaller sample sizes for certain analyses.

Data cleaning

To ensure the robustness of the data, additional cleaning and recoding was conducted by Altai Consulting.

This was particularly the case for questions where 'Other, please specify' was a possible answer as this enabled to create new codes when a specific answer was given by a sufficient number of respondents.

Recoding was also used to eliminate inconsistencies when they could be verified with Sagaci Research.

Weighting

Weighting for the analysis was based on the panel survey design[76] used for the East Africa research which has been reviewed by a statistical expert[77]. The sampling methodology consists in selecting a base sample from the target population from which data was collected at an initial point in time and then collecting similar measurements on the same sample at a later date.

The original sample was comprised of new customers joining the companies' customer bases between January and June 2019 (target population). This methodology was used to enable the research to coexist with the participating companies' operations and constitutes a convenience sampling. The total number of new buyers of SHS during the period of interest were provided for all companies in all participating countries. This stratified information (by countries and by companies) on the target population, under the assumption that the convenience sampling could be considered as a clear random sampling, allowed to produce estimators with statistical precision and develop a weighting methodology[78] to address the unequal selection of respondents and to address the non-response due to the respondents' attrition across the consulting waves.

Aware that the sampling is subject to assumptions on the probabilistic design of the base sample, limitations exist to extrapolate the findings. For this study to be representative of a larger population, the assumption that needs to hold true is that the surveyed/sampled customers are selected randomly with known probability from the target population: new customers who bought an SHS between January and June 2019.

76 Kasprzyk et al (1989), Panel Surveys, Volume 227 of Wiley Series in Probability and Mathematical Statistics.
77 Khalil El-Gazri, an experienced statistician who designed many statistical projects for the UN, World Bank, USAID and French Ministry of Foreign Affairs
78 Chen et al (2012), Weighting Adjustments for Panel Nonresponse.

Annex

Weighting has been used to balance the quota effect and adjust the data collected to better represent the population from which the sample was drawn. The weighting methodology developed addresses the unequal selection of respondents.

$$\text{Weighting factor} = \frac{\text{Number of occurences in population}}{\text{Number of occurences in sample}}$$

Margin of error

The sample size provides a margin of error of 4.1% at 95% confidence level.

Analysis

Methodological rules were defined for certain analyses.

Energy expenditure

Baseline energy expenditure is calculated by adding previous weekly household lighting expenditure and previous individual phone charging expenses multiplied by the number of phones in the household.

Follow-up energy expenditure includes fees for the SHS and, if relevant, remaining expenses on light and phone charging from other sources than the SHS.

Comparisons over-time only include households having provided data for all questions on energy expenses in both the baseline and follow-up survey. Therefore, if a customer answered a question with 'do not know' or 'do not wish to answer', his answers are discarded from the analysis of the evolution of lighting expenditure.

Full-Time Equivalents (FTEs)

FTE jobs were calculated relatively to the legal working week in participating countries: Côte d'Ivoire 40[79] hours, Ghana 40[80] hours, Nigeria 40[81] hours and Togo 40[82] hours.

Customers reporting an existing business were asked to report the increased number of opening hours per week. The number of hours was attributed to only one household member and compared to a full week as described above.

Customers reporting a new business were asked how many household members worked in the business and how many hours they worked in the business. FTEs were calculated for each individual and summed at the household level.

Customers reporting new jobs or additional time at work were asked how many household members worked in the business and how many hours they worked in the business. FTEs were calculated for each individual and summed at the household level.

Although several businesses reporting gaining new employees, this data was not used within the FTE job calculation as data was not obtained on the number of additional hours worked by these employees.

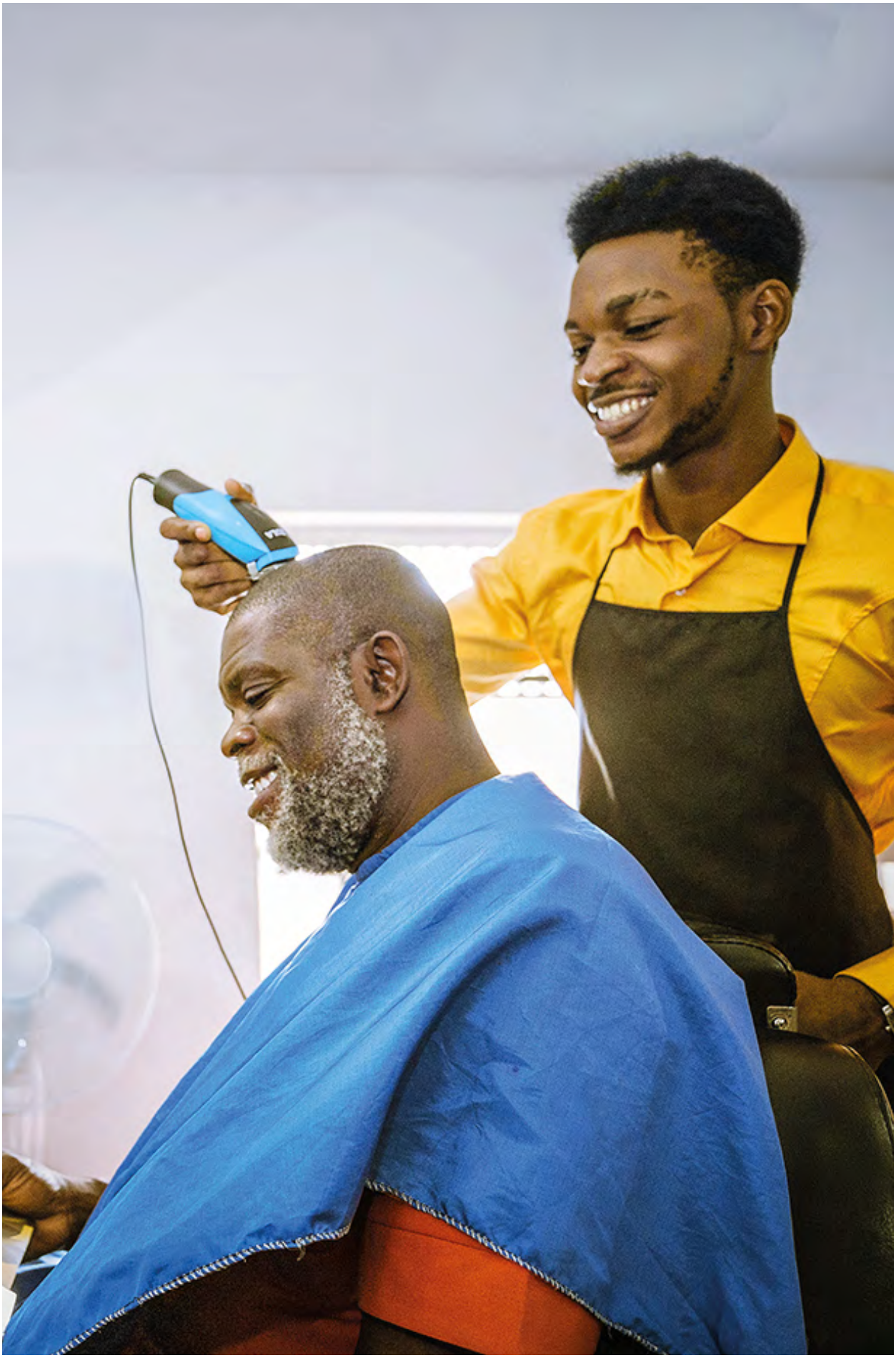
Eliminating outliers

- Income generation: to eliminate extreme values from average calculations a minimum ($0.5) and maximum ($200) amount were defined.
- Full-Time Equivalents: to eliminate extreme values in the number of working hours, a maximum of 12 hours a day was considered for businesses and the legal working week for each country was defined as the upper-limit for additional time spent working (see above).

Three-data point rule

This rule followed by GOGLA dictates that data can only be published if at least three separate companies have reported data for any single data point. When there are less than three responses, no results are shown. This protects the proprietary interests of the companies who have supplied data in support of this report and reduces the influence of any one company's data.

79 40 hours a week maximum for non-agricultural companies. For more information please see Décret no 96-203 du 7 mars 1996, relatif à la durée du travail.
80 40 hours a week maximum except cases expressly provided for in the Labour Act (2003).
81 The general work week is 40 hours. Nigerian law does not set a maximum working week, working hours are set by mutual agreement, collective bargaining or industrial wages boards. For more information please see the Labour Act Chapter 198.
82 40 hours a week maximum for non-agricultural companies. For more information please see Loi n° 2006 Portant Code du Travail.



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