Sierra Leone Opportunities for Business Action
SOBA 2
Small Solar Market Analysis

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SOBA SIERRA LEONE OPPORTUNITIES FOR BUSINESS ACTION

UKaid from the British people

Table of Contents

1. Executive Summary

Levels of access to energy in Sierra Leone are among the lowest in Africa, and the World. The country lacks energy generation capacity and the reach of energy transmission networks is limited. The national grid only reaches parts of the capital, Freetown, and a few larger towns in other parts of the country. Grid access is practically non-existent in rural areas where most of the population of Sierra Leone resides. The little electricity that is available is expensive with electricity tariffs twice as high as the continent's average.

Small scale solar systems present an opportunity to bridge the energy gap in Sierra Leone. Solar home systems and pico solar can offer lighting, charging and some other energy options for the majority of the population not covered by the national grid which would be relatively costly to extent to rural areas of the country. The cost of these solar products has fallen dramatically in recent years, making them a feasible alternative to traditional sources of energy.

Challenges

Sierra Leone's solar market, however, is still in its infancy. There are a few solar distributors based in the country who import certified solar products such as solar lanterns, solar home systems (including with plug and play devices/appliances) and larger off-grid household systems. The channel to market for these distributors is mainly through numerous NGOs based in Sierra Leone, who purchase solar devices and distribute them to their beneficiaries. The market is also filled with solar products of low or unknown quality which undermines consumer confidence in solar products more broadly.

Many other constraints prevent the solar market from developing and achieving impact for low income households across the country. These challenges include:

- **Transportation and skills.** High per product transportation costs for small volumes of inventory is one of the main challenges. Transport by container would reduce the costs dramatically, however it requires purchases in bulk, which local solar distributors aren't able to make without financing. Additionally, the market in Sierra Leone lacks skilled labour required to install, repair and maintain solar products.

- **Sales and performance history.** On the financial side, solar distributors in Sierra Leone require significant working capital. There is a lack of investment into this sector due to the perceived high risks resulting primarily from lack of track record of sales. Solar distributors have limited alternative financing options. Solar suppliers are unwilling to provide trade financing while commercial financiers in Sierra Leone, including banks and MFIs, are currently not positioned to service the financing requirements of solar distributors.

- **Consumer financing.** Consumers, particularly low-income households, also face finance constraints. Many are not able to afford upfront payments for solar products and there is currently no consumer credit for solar products available on the market. Pay-as-You-Go (PAYG) payment schemes provide a realistic payment alternative allowing more rapid access to solar energy.

- **Business enabling environment:** A number of barriers discourage investment and increase the unit price of solar products. These include duty and taxation costs that add 55 percent to the cost of solar units. Further, unclear registration and investment processes often delay access to imports and result in stiff holding penalties that render the country a high risk operating and investment climate.

Opportunities

There are however, significant opportunities for the solar market in Sierra Leone to build upon. These include:

- **Strong demand.** The acute shortage of energy and limited grid outreach is one of the main opportunities.
- **Engaged private sector.** The solar private sector, though limited in size and experience and poorly capitalised, is highly engaged. Businesses are leading policy dialogue, willing to trial new strategies and to make internal performance improvements that are necessary to attract outside capital.
- **Experienced suppliers.** Suppliers are now well-experienced in developing best-fit solar products and targeting the bottom of the pyramid consumer uptake. This expertise can be leveraged to enter Sierra Leone cost effectively.
- **Active and reform-minded community.** The Government of Sierra Leone (GoSL) and development partners are focused on and investing in off-grid solar energy as a way of increasing access to energy across the country. This has translated into substantial policy action with the GoSL introducing an import duty waiver for certified solar products. If this initiative is implemented successfully it will aid the development of the solar market reducing the costs of solar products.

Recommendations

Based on the findings of the market analysis, a number of opportunities to improve the performance of the small solar market standout and will be the focus of the SOBA programme. These include:

1. Improving local solar distributor performance
2. Unlocking working capital constraints for local distributors
3. Developing local PAYG opportunities
4. Solidifying the duty waiver and streamlined registration process for solar products
5. Trialling new route-to-market strategies that reduce customer acquisition costs
6. Proving and marketing sales potential to investors, distributors and solar suppliers

Purpose of the Market Systems Analysis

This document analyses Sierra Leone's pico and solar home system market, outlining both critical limitations to its performance as well as opportunities for performance improvement. The analysis was completed by SOBA for the purpose of determining interventions and investments that the programme will undertake to improve pro-poor solar market performance.

This analysis is a research document that compiles available information from relevant secondary sources and fills the remaining gap through primary data collection. It includes information such as:

- how the energy sector in Sierra Leone is operating;
- what are the sustainable and renewable energy options suitable for the country, focusing on small scale solar;
- which market players are involved;
- what are the major constraints and opportunities in the sector; and
- how SOBA can contribute to improve sector performance toward increased energy access for low-income groups.

2. Background

The Context of Sierra Leone

Sierra Leone has boasted sustained post-conflict recovery since the end of its civil war in 2002. Rates of economic growth have been high on the whole. This resulted in Sierra Leone making significant progress in its aim of reaching middle income country status.

The economy stalled during the recent Ebola virus outbreak between 2014 and 2015, with the Ebola response taking priority over other development programmes. Rural areas of Sierra Leone were hit particularly hard due to quarantines. Additionally, the crash in the global price of iron ore, one of the main exports of the country, further added to the economic pressure. Together with the Ebola outbreak this created a 'twin shock' resulting in GDP in 2015 projected to decline by over 20 percent (World Bank, 2016). With the Ebola outbreak behind Sierra Leone, the economy is expected to return to high rates of growth, with forecasts predicting a return to double digit growth rates by 2020 (Trading Economics, 2016).

Despite this significant progress, Sierra Leone is still one of the poorest countries in the World. In 2014 it was ranked 181th out of 188 countries according to the UN Human Development Index with an estimated GNI per capita of $693 in 2015 (current international USD, World Bank, 2016). The largest segment of the population of 6.5 million is located around Freetown. The levels of poverty are high across the country with an estimated 53 percent of the population living below the national poverty line (as of 2013, World Bank). Poverty is even more severe and widespread in rural areas.

Current Energy Situation in Sierra Leone

Electrification & Power Generation

Only four countries across sub-Saharan Africa have the same or lower national electrification rates when compared to Sierra Leone, namely Burundi, Chad, Central African Republic and South Sudan. Access to electricity in Sierra Leone is among the lowest in Sub-Saharan Africa. Estimations vary by source, however the IEA puts the national electrification rate at 5 percent with 11 percent among the urban population and 1 percent among the rural.

Sierra Leone lacks adequate power generation, transmission and distribution infrastructure. **This is a major constraint in expanding on-grid electricity access, particularly across rural areas.**

- The national distribution network covers Freetown the capital city, the Western Area, reaching about 40 percent of the 1.5 million residents of the area. Two isolated systems in Bo-Kenema and Makeni provide some limited coverage in the south-eastern and northern regions. Electricity access is practically non-existent in rural areas where around 60 percent of the population of the country resides (World Bank, 2016).
- Sierra Leone's government-owned installed capacity was around 100MW in 2013 including the 50MW Bumbuna hydroelectric power plant and two thermal power plants at Kingtom (10MW) and Blackhall Road (16.5MW) that serve the Freetown Capital Western area. Power from the Bumbuna hydroelectric plant is seasonal averaging only 20MW during the dry season. Industry, predominately mining companies, owns captive thermal power generation plants which is estimated at 90MW.
- The majority of electricity consumption takes place in Freetown and in parts of the south-east of the country. The current transmission systems are not adequate to reach populations in other parts of the country. This poses a serious challenge to adding generation capacity to the national grid.

Where electricity is available, access to it is exceptionally challenging and costly.

- Sierra Leone ranks 178th out of 189 countries in the 'Getting Electricity' rank of the World Bank's Doing Business 2016 report. The rank measures the number of procedures required for a business to obtain a permanent electricity connection and supply for a standardised warehouse as well as the time required to do so and cost as a share of per capita income.
- In Sierra Leone there are 8 procedures involved in 'getting electricity' which take 82 days and cost 4,066 percent of average per capita income to access electricity. Sierra Leone scores 0 on the 0 to 8 scale of reliability of supply and transparency of tariff index. This is compared to 5.4 procedures on average across sub-Saharan Africa taking 130.1 days and costing 4,071 percent of average per capita income and an average score of 0.9 on the reliability and transparency index.

Sierra Leone's electricity tariff is US 28 cents/kWh, twice as much as the average across the continent.

- The current electricity tariff regime is not cost recovering; it relies on subsidies by the Government of Sierra Leone.
- High generation costs increase tariffs. This results from expensive and unreliable imported diesel or HFO that powers thermal power plants.
- High transmission and distribution losses also increase tariffs. The transmission system consists of one radial 161 kV transmission line extending 205km between Bumbuna and Freetown. Due to poor infrastructure and maintenance losses at the transmission and distribution stage are estimated at around 38 percent.

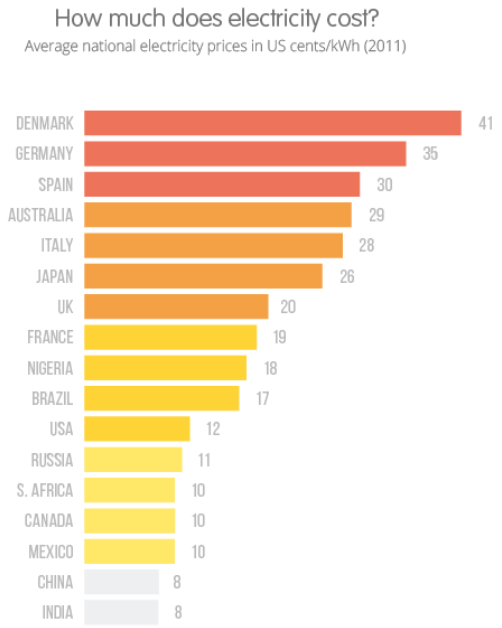

Figure 1: Average national electricity price in countries across the world (US cents/kWh, Source: Ovoenergy.com 2011)

The Off-Grid & Renewable Energy Imperative

Electricity represents only 7 percent of total energy consumption in Sierra Leone. Increased power generation capacity, expanded distribution and lower tariffs, however, will take decades to deliver. In the interim, Sierra Leoneans are leveraging energy alternatives – albeit costly and inefficient ones such as diesel, fuel wood, charcoal, and battery-powered lamps.

- There are an estimated 35,000 generators being used across the country providing an installed capacity of 180MW.
- About 96 percent of households use battery-powered lights commonly known as 'Chinese Lights.' These are low-cost, often low-quality lighting alternatives.
  Less than 2 percent of households use kerosene[1]

The absence of cost-effective energy alternatives weighs on household and business budgets, limits productive potential and hampers overall economic growth. Access to electricity can provide substantial income and welfare benefits to households.

[1] These statistics are derived from research recently carried out by 'Promoting Renewable Energy Services for Social Development in Sierra Leone (PRESSD-SL), which is funded by the European Union (EU) and implemented by Welthungerhilfe (WHH) in partnership with Energy for Opportunity (ENFO), IBIS and COOPI. It has long been assumed that the rural population in Sierra Leone uses kerosene as the main source of lighting thus spending significant part of their income on this polluting fuel source. This misunderstanding of the market misinforms policy design assuming health and cost implication of kerosene use.

- With 96 mobile phone subscriptions per 100 inhabitants in Sierra Leone (CIA World Factbook, 2015) the rates of mobile phone ownership are far higher than rates of access to electricity in the country. This illustrates how despite the lack of access to electricity households across Sierra Leone still purchase energy services such as mobile phone charging. Furthermore, a customer survey conducted by Solar Era, one of the distributors of solar products in Sierra Leone, found that 88 out of 94 households surveyed charge their mobile phones in a shop rather than at home.
- Households without access to electricity also spend part of their income on lighting, through buying 'Chinese lanterns' and batteries required to power them as well as, to a smaller extent, kerosene. The households surveyed by Solar Era, a solar distributor, spent on average SLL 15,524 (USD 2.73) per week on 'Chinese lanterns' and batteries. Together with mobile phone charging this amounted to an expenditure of SLL 1,064,691 (USD 187) per household per year. In comparison a Lighting Global/ IEC-certified small solar home system (SHS) with LED lights and a mobile phone charging capabilities, can be purchased in Sierra Leone for between USD 20 and USD 50. Given the inelastic demand for services such as mobile phone charging and lighting, increasing access to electricity through solar home systems can provide substantial savings to households.
- Aside from monetary savings access to electricity can also provide saving in terms of time, as charging a phone in a shop uses up time. The time and monetary resources saved through gaining access to electricity can be spent in more productive areas, potentially increasing the incomes of households. This can have a disproportionate effect on women, given that access to electricity can give them the flexibility to perform household chores after dark. Reallocation of resources towards more productive uses can, in aggregate, stimulate economic growth.

Aside from these income effects, access to electricity is also associated with direct welfare benefits.

- The World Bank (2008) reviewed nine rural electrification programmes and found that increased access to TV and radio increases knowledge about health and contraception. This in turn led to improved health outcomes and reduced fertility rates. Access to electricity was associated with a reduction in fertility rates by 2.00 children in Senegal and 1.06 in Ghana (cited in ODI, 2015).
- The World Bank (2008) also found an association between electricity access and the number of years spent by children in school. Lights at home can allow children to study at home while electricity at school can attract higher quality teachers and improve the learning experience.
- Electricity access in healthcare facilities can be linked to poverty reduction. Electrified healthcare facilities provide better services and attract higher quality staff.

Small Scale Solar Opportunity

Solar home systems and pico solar lanterns offer a high-quality, low-cost, customisable, adaptable and renewable alternative for many homes and businesses. This technology has not yet reached Sierra Leone en masse. However, these products exist today as part of a growing and thriving marketplace in a number of other African countries.

- Sales of solar lanterns have increased by nearly 100 percent every year since 2009, growing 300 percent in 3 years (in Africa). The World Bank estimates that the African market for off-grid renewable lighting alone will quadruple by 2015.
- By the first half of 2015 the estimated cumulative sales of pico-solar lighting products in sub-Saharan Africa and Asia has reached 44.2m units (Bloomberg New Energy Finance, Lighting Global, GOGLA,2016)
- One solar supplier, d.light, has sold over 6 million products – servicing an estimated 30 million people – providing energy access to more customers than many large electrical utility companies in the world (based on the number of unique connection points) (Power for All: The Energy Access Imperative, 2014)

Solar home systems and pico solar products also offer the potential for a speedier route to energy for Sierra Leone.

- A number of distributors and suppliers have proven commercial potential in other, similar countries. Their models can be scaled to Sierra Leone.
- Moreover, because these products are low-cost consumer goods, they bypass many of the challenging regulatory and policy complexities and financing/development issues that limit large-scale energy infrastructure.
- Perhaps most importantly, distributed energy options – led by low-cost solar – are far more likely to bridge the energy gap and to create new opportunities for the vast majority of rural Sierra Leoneans than any other energy alternative in the near future.

Solar home systems and pico solar options do not replace electricity. There is a lot of work to be done to unlock grid-connected, commercial alternatives and there is a role for this facilitation in Sierra Leone, such as:

- Sierra Leone's power purchase agreement (PPA) process and framework is not standardised, resulting in notable uncertainty and risk. Developers and financiers require certainty to invest.
- Mini-grids have not yet proven their commercial viability. Subsidies are paramount, even in more advanced economies with higher demand and certainty.
- Sierra Leone's grid is crippled, unable to manage additional power generation without upgrade.

These issues may be resolved over the long-term. Meanwhile, **solar home systems and pico solar offer a more immediate and proven inroad to energy access for many Sierra Leoneans. For this reason, SOBA has chosen to prioritise its renewable energy investments in this sector.**

3. Solar Market System

The next section describes the consumer base and business, financial, and regulatory climate surrounding the solar home system and pico solar market.

Sierra Leone Market & Consumer Groups

Electricity is a commodity that will be used by both domestic (individual households) and commercial users (businesses and industries). Community service points (schools, hospitals etc.) will also demand electricity.

End Users:

- **Small Shops**

Sierra Leone has many small to medium size retailers with over 100 retailers within Freetown alone. Many of these are a key access point for basic household items. Retailers sell a range of lighting goods including bulbs, batteries and torches. Some retailers sell, non-IEC compliant solar pico systems, and electrical lanterns. This would make shops a valuable distribution channel for pico systems.

- **Middle / High income customers**

The middle-income customers are often university educated men and women. This group has many sources of income, from their salaried work and assets, which generate income (Sloane, 2012). Many own several electrical appliances, including televisions, refrigerators and often employ people with low education levels for domestic staff. These households are predominantly located in urban areas, and are connected to the national grid. They receive frequent electricity during the rainy season as the Bumbuna plant benefits from higher amounts of rainfall.

During the dry season when electricity from the grid is scarce, over 42 percent of middle-income households use diesel as their main energy substitute. Middle-income households spend around SLL 50,000 a week on diesel for generators (BBOXX data, 2016). Households, which currently have solar home systems, use them in addition to the national grid and generators.

- **Urban low-income groups**

Sierra Leone's urban population accounts for 39.6 percent of the country's total population. Urban areas have the highest rates of electricity, especially Freetown, where 57.7 percent of households use electricity as their main lighting source (Statistics Sierra Leone, 2016). Low-income groups living in urban areas have limited job opportunities and work as manual labourers, domestic and security workers or small-scale petty traders (Sloane, 2012). Many of these people live in zinc, cement or mud houses, and own radios and mobile phones.

- **Rural low-income groups**

Around 60 percent of Sierra Leone's population live in rural areas (World Bank, 2016). Rural areas have the lowest rates of electrification in the country, with less than 1 percent of households having access to electricity (Statistics Sierra Leone, 2016). The main source of lighting for these households are battery powered lights, with an estimated 96.8 percent of rural households using this as their main lighting source. The second source of lighting are generators, followed by kerosene lamps. Lighting costs for rural households accounts for 12.7 percent of their overall income.[2]

The main source of income for rural households is agriculture including crops such as rice, cassava, maize and palm oil. Some rural households produce cash crops, such as tobacco, coffee, cocoa and sugar cane. Households dependent on

[2] Extracted from PREESD baseline research conducted across six districts, excluding major town centers, in Sierra Leone in 2015

agriculture face seasonal income generation, with the period between June and August commonly named the 'hunger season', due to the lack of produce and resulting lack of income for farmers. This negatively affects rural households' ability to spend, as this also coincides with the start of the new school year, which can be a significant financial drain on household savings/income.

Channels

- **NGO's**

Since the end of the Civil War and with the outbreak of Ebola, Sierra Leone has had a significant NGO presence. There is a lack of accurate data, however there are online directories with over 170 large NGOs based in Sierra Leone. NGOs address a broad range of initiatives from health, education to energy access. NGO's often buy large quantities of solar products and distribute them to the local population free of charge. NGO's therefore have the potential to be a viable route to market strategy for a solar distributor based in Sierra Leone, if the company can provide the solar units in country. NGO's often purchase and distribute small solar systems such as solar lanterns and small solar home systems rather than larger solar systems, which require installation and technical assistance.

- **Aggregators**

Households in rural areas of Sierra Leone are often constrained in terms of cash. Many operate on a barter system, where they swap agricultural produce for other goods and services. Using aggregators can therefore be a way for solar distributors to capitalise on these practices. For example, a farming aggregator (or other agri-business) could buy solar systems from a solar distributor at a wholesale price and then sell to farmers, who in turn would pay for these goods with agricultural produce (for example cocoa). This could be an effective route to market strategy reaching the most remote areas in Sierra Leone, while tackling affordability issues on the demand side.

- **Retailers**

Retailers in Sierra Leone are mainly located in cities and large towns, such as Freetown, Bo and Kenema. They already sell lighting/ electrical products, including solar, pico systems and large panels. Although large retailers import their products themselves, small to medium sized retailers do not, making them a potentially effective channel for solar distributors. Solar distributors can sell to small to medium retailers at wholesale prices, making it an attractive distribution channel.

Distribution & Business Skills Constraints

High transportation and order volume barriers limit inventory/product availability.

- Sierra Leone is a small market with limited attractiveness, boasting just under seven million people. It is also among the poorest countries in the world. At present, only a handful of certified solar home systems and other small scale solar products are available in Sierra Leone. Distributors find it particularly challenging to bring in new inventory. High costs associated with small orders/transport are a key factor: air freight, associated with smaller order sizes, is prohibitively expensive. Margins can only be made when products are shipped via container in higher volumes. However, poor business performance and limited capital mean investment is unlikely for most distributors.

Solar distributors are plagued by limited experience, capital and capacity.

- **There is no track record of sales of quality-certified solar products in the country.** Quality, low-cost small scale solar distributors do not have a strong track record of sales in Sierra Leone to date. Most are small in size and with only a handful of sales in the previous years. One of the distributor, established in 2012, has sold under 5,000 low-cost products in four years – and mostly through larger, intermittent NGO orders. Given the attention given to the energy sector in 2016 by both the government and donors, an increasing number of start-ups are entering the market. Many misconceive this opportunity as a quick win – fast sales, good margin.

- **Poor financial and business management capacity.** Financial and business management performance is lacking for many distributors in Sierra Leone. Most acute, however, is the financing gap. All distributors are capital-challenged and targeting a product and market that requires significant, patient capital. In absence of a track record for sales or well-managed books, it's unlikely that local distributors will be positioned to access capital in the near future. Without capital, none are likely to bring in inventory.

- **Suppliers perceive high risk and underperformance.** Prior to the Ebola outbreak, some solar companies such as did establish a sales footprint within Sierra Leone. However, the crisis exacerbated poor repayment rates for PAYG products and scared away investment from suppliers who now perceive the country as an exceptionally high risk market.

High costs associated with establishing distribution channels, educating consumers and offering financing.

- Poorly capitalised distributors with limited experience and skills to distribute find it difficult to push slow-moving solar products in Sierra Leone, a country with limited supporting infrastructure. In absence of a strong supporting ecosystem, solar distributors must internally manage a range of costly tasks to sell products. These include:
  - Establishing distribution channels
  - Educating consumers
  - Training resellers/agents on product, marketing, sales and general management
  - Offering financing

Shortage of skills necessary for the solar market.

- Sierra Leone generally suffers from a chronic shortage of skillset in almost all sectors and solar energy is no exception. Shortage of skills in this sector can be seen in all levels from business owners right down to technicians who deliver solar systems. Skills-gaps also exist in peripheral industries such as communications, marketing and administration. SHS and SHS with plug and play devices require a great deal of customer engagement and support infrastructure in order to ensure payment collection, installation training and maintenance. PAYG by its nature guarantees that a system is fully supported throughout the life of the contract, which is typically 24 months. Although this is an important financing mechanism, which improves the sale of these kits, it also means that greater investment is needed to support the customers during this contract period. Lack of availability of appropriately skilled rural agents would mean that the franchise company is not able to penetrate certain parts of the country.

Information & Awareness Constraints

The solar sector in Sierra Leone is challenged by both the lack of awareness about the benefits of solar use on the consumer side and the lack of information about demand on the supplier side.

Product awareness/value

Consumers have limited knowledge of the benefits of solar product uptake as well as poor brand and product awareness. There is, however, widespread skepticism for low quality brands and products.

As a precursor to the Energy Revolution, many newspapers and media outlets reported heavily on the sector, increasing overall awareness of solar energy. With the launch of the Energy Revolution and associated product exhibits, many Paramount Chiefs are more aware of solar products generally. There remains a significant marketing gap, to provide consumers with information such as the importance of IEC/Lighting Global certified products, how to dispose of batteries properly and how to solve any issues arising during use of products. As well, distributors and suppliers aiming to increase product purchase will need to address brand awareness gaps.

Marketing gap

To date, there has been little marketing done. This reflects the nascent stage that the industry is in in Sierra Leone. Prior to launching marketing campaigns for specific solar products, solar distributors must first secure inventory. Marketing activity with SOBA's partners is expected to increase, as solar distributors begin to import larger quantities of solar products. Alongside company-specific efforts, a larger advocacy discussion is underway for the sector as a whole. This is likely to be led by Power for All and REASL, with some SOBA support.

Challenges of absent demand data

The urban demand for energy is high as only 17 percent of Sierra Leoneans are connected to the national grid. Rural areas have little to no electrification, and are reliant on battery powered torchlights and Chinese lights to meet their lighting needs. Sierra Leone has no baseline data on energy access and usage except those for, the amount of people connected to the national grid. As a result, demand data collection has been conducted privately by various solar companies, but has primarily focused on the affordability of products, rather than the willingness to pay – which requires time and sales data to better decipher. The main challenge for commercial entities will be translating perceived demand for energy into solar sales.

Finance Constraints

The availability of financing is particularly important for the small scale solar market in Sierra Leone. Current business models rely on distributors to finance their own inventory requirements as well as to manage consumer financing needs. In absence of consumer financing, solar products sell slowly, limiting commercial viability. In absence of working capital to finance inventory and operations, distributors are unable to bring the product into Sierra Leone cost-effectively, limiting commercial viability. In other words, financing could unlock the market – if businesses were investment ready.

The Sierra Leone market is considered a high risk investment climate.

- Sierra Leone is a small market with limited attractiveness, boasting just under seven million people. It is also among the poorest countries in the world.
- The country is experiencing significant inflation which has challenged USD-lending. With the recent hyper inflated exchange rate of the SLL to the USD, banks are even more reluctant to lend in foreign currencies. Sierra Leone's diminished foreign exchange reserves add further concerns to the willingness to lend. The President has

also decreed that businesses should conduct business in the local currency, which has only heightened inflation – and exasperated currency exposure – rather than stabilising the currency as intended.
- The recent Ebola Virus Disease shock has sullied the country's reputation and raised its risk profile.

Distributors of solar household systems require significant working capital.
- High transport costs: Air freight, associated with smaller order sizes, is prohibitively expensive. Margins can only be made when products are shipped via container in higher volumes.
- PAYG: Long-term customer payment options boost sales significantly. The closer solar product payments are to current energy outlays, the greater the uptake. Often, repayment periods are stretched across many years for even those products that are relatively low in cost.

Distributors of solar household systems in Sierra Leone are high risk investments.
- Most businesses in Sierra Leone are small, poorly capitalised and limited in capacity. This is particularly true of solar distributors. None have established distribution channels or sales teams. Many are start-ups with no track record of sales at all.
- To date, solar sales are limited. Most sales are ad hoc in nature or reliant on intermittent NGO purchases.
- In more established solar markets, the sale of small scale solar products such as SHS and solar lanterns have yielded small margins while demanding significant capital outlay to prime the market and to establish distribution channels.

Solar distributors have limited alternative financing options.
- Solar suppliers are unwilling to provide trade financing. At best, they may offer a percentage payment on an order and a final payment on arrival in port.
- Commercial financiers, including banks and MFIs, are not positioned to service solar distributor financing requirements.
  - Banks: currently, many banks offer highly collateralised loans for short periods or larger capital outlays that are well-above distributor capital requirements. They also necessitate strong and repeat performance track record; start-ups do not qualify.
  - MFIs: may be positioned to meet consumer financing requirements in the future. Currently however, the terms are ill-fit for solar products. Furthermore, solar products are perceived as too high risk due to factors such as limited quality controls/assurances and poor technicians.
- Sierra Leone is a high risk market and solar distribution is a high risk venture. Risk tolerant capital, more characteristic of impact investment funds than other financing options, is needed.

Impact investment options are limited in Sierra Leone.
- Access to debt financing for just a few key solar distribution players will open up product availability and distribution in the short-term, helping to prove market viability and reduce risk that will attract more financiers and distributors in the future. Distributors that are more structured, with better financial management and some track record of sales are best-placed to attract financing. The current limited spectrum of investment funds will need to broaden to enable growth of the solar market.

Blended financing options emerging as a new, high potential alternative to standard commercial options.
- One solar company has indicated it will employ an energy project financing approach to small scale solar product financing in Sierra Leone. Here, it will manage the product financing and tender out the distribution and after sales service requirements. This approach has quickly shifted the status quo. Other solar distributors have already suggested that they may employ similar strategies, focusing on finance as opposed to the usual approach of finance, distribution, marketing, and after sales functions together that is typically required of solar home system distributors. These financiers have also suggested they'll accept blended payment options, including shared margin, which may attract many more candidates for distribution. It will remain to be seen, however, whether this will open up the market. The margins for solar products are low. Limited consumer awareness also limits sales. For this to be attractive to local distributors, margins must still be substantial and combined with scaled demand.

Consumers in the solar market also face financial constraints.

- Solar lanterns are the most affordable solar power system in the market. Though the upfront cost is higher than for 'Chinese Lights' that are commonly used across Sierra Leone, most households could potentially afford these if they're informed about the benefits of reduced operating cost compare to 'Chinese Lights' which are associated with high and regular costs of battery replacement. Some companies may also offer Pay-As-You-Go (PAYG) options for qualified customers.
- SHS and SHS with plug and play devices are much more expensive than lanterns and in most cases are well over what households expect to pay for access to lighting. This category cannot compete with Chinese Lights and it is very difficult to justify the cost to many households. The most effective sale model for these systems has been PAYG as this is the only way that low-income rural households can assign portion of their weekly budget aside for access to lighting. Most rural households do not have the saving and are not credit-worthy enough to access their own funding to purchase these kits upfront. PAYG provides a realistic payment alternative allowing a more rapid way of access to lighting.

Regulatory Landscape and Constraints

Regulatory background of the Energy Sector in Sierra Leone

Institutional and regulatory frameworks of the energy sector are at an early stage of development. Oversight of the sector falls under the Ministry of Energy (MoE). Unbundling of the sector has recently taken place but it is yet mature to its full working capacity. The National Electricity Act, 2011 (the Electricity Act) repealed the National Power Authority Act, 1982 and established two state owned enterprises (SOEs) the Electricity Generation and Transmission Company (EGTC) and the Electricity Distribution and Supply Authority (EDSA). Most of the background work for the appropriate functioning of the newly created entities as a result of unbundling has already been carried out with the support of DFID and the World Bank.

An economic regulator for both water and electricity supply is essential for attracting the needed investments in both sectors. However, the Electricity and Water Regulatory Commission (EWRC) Act adopted in 2011 does not adequately enshrine the independence of the regulator. The EWRC is at a fledgling stage, and seeking to assert itself with the electricity utilities and sector generally. Pricing and service delivery in both electricity and water sectors are contentious in Sierra Leone, and this allied to the technical complexities of the regulator's mandate mean that it will need considerable donor assistance and support if it is to carry out its role effectively.

Currently there are no clear policies supporting the deployment of renewable energy technologies under a single national strategy, although the motivation and the intent seem to exist at present within the relevant government authorities. From the policy makers' point of view is seen as a national power generation and distribution matter with the ambitions to create a national grid and supporting generation capacity. Various ministries seem to act independently of each other in relation to energy projects where all matters relating to energy generation has always been viewed as the MoE issue. As a result of this disconnect, an enabling environment to facilitate the growth of the sector does not exist. Even when a clear policy does exist, the respect and adherence to the policy is often overlooked and traditional transaction mechanisms take over.

Focus on Solar Technology

In the autumn of 2013 the Government of Sierra Leone issued a National Energy Policy and a Strategic Energy Plan for the coming years. Although fossil fuels will stay the main energy source for the country in the short-term, renewable energy sources will become more important in the future. Solar PV will be essential for street and security lighting, telecommunications, hospitals, clinics and households in rural areas. The government has explicitly stated that it will introduce legislation to attract private sector interest in renewables as well as power generation more broadly. Besides

this government initiative other development agencies and investors are also willing to invest in solar more than any other energy generation technologies. For example, the Abu Dhabi Fund for Development loan programme provided Sierra Leone with USD 8.9 million, to construct a new solar power plant near Freetown. Further, Access Power and the Dutch Development Bank invested USD 100,000 on solar projects. DFID has also taken a keen interest, establishing the Africa Clean Energy business case.

Centralised power is only part of the story. For the 99 percent of rural Sierra Leoneans who lack access to the grid, off-grid individual solar home systems and decentralised generators offer a critical energy lifeline.

Regulatory constraints facing the solar market

A conductive policy environment is an important driver of the development of the small scale solar market in Sierra Leone.

There is no consumer protection.

- There is no licensing or standards in place that preclude any brand or model from the solar market. Sale and installation of solar equipment does not require any particular licensing either.
    - SHS can apply for certification through the World Bank-sponsored Lighting Global initiative. Government and donor support for SHS will usually only be directed to products certified by Lighting Global.
    - For SHS the same standardisation and quality assurance protocol apply if the kits are purchased from as PAYG option through the franchises and agents.

Import duties and taxation for solar products are high.

- Reducing or removing taxes associated with the importation and sale of quality solar equipment (40 percent duty) will improve the retail pricing and increase profit margins for the SMEs who are active in the market.

The GoSL has committed to policy reforms through signing the Sierra Leone Energy Africa Compact.

- In May 2016, Sierra Leone's Ministry of Energy and DFID organised the Sierra Leone Energy Revolution with support from Adam Smith International, SOBA and Power for All. The event was part of the UK's Energy Africa campaign which aims to help the continent achieve universal energy access by 2030.
- During the event the Minister of Energy signed the Energy Africa Compact, effectively outlining a pathway for reform and investment aimed at catalysing solar home system/lantern market performance. The Compact is part of the UK's Energy Africa campaign which seeks to accelerate the expansion of the household solar market across Africa, and help achieve universal energy access across the continent. Commitments in the Compact include:
    - Power for all by 2025 (five years ahead of Sustainable Development Goal 7 and Energy Africa Access campaign target of 2030)
    - Modern power to one million people by 2020
- Through signing the Compact the GoSL committed to the following:
    - Permanent elimination of import duties for qualifying solar equipment (in line with IEC standards) and implementation of tax-free status with customs and port officials to enable expedited 'green lane' importation for qualifying products.
    - Elimination of GST sales taxes on sale of quality certified solar products.
    - Establishment and maintenance of a list of solar products qualifying for GST and duty exemption.
    - Establishment of a National Renewable Energy Policy of Sierra Leone.
    - Standardisation and simplification of utility-scale on-grid Power Purchase Agreements (PPAs), mini-grid concession terms for mini-grids, and other enabling actions.

4. Solar Market Actors

The following section outlines key actors in Sierra Leone's solar market. With peaked interest in the sector, more and more actors are coming onto the scene with high frequency. Accordingly, the review is by no means exhaustive. Groups discussed include:

- Solar distributors
- Financial service providers, including banks, MFIs and investment funds
- Telecoms and mobile payment platforms
- Associations and advocacy groups
- Government of Sierra Leone and regulatory bodies
- Development and donor community

Solar Distributors

Sierra Leone does not manufacture any solar products. The primary way that certified small scale solar products can reach the market in Sierra Leone is through country-specific distributors which have established relationships with international suppliers.

Certified supply options are typically plug and play. Some companies in Sierra Leone also distribute a large range of solar products of variable quality and lacking certification. However, there are also a number of Sierra Leone distributors that are collaborating with suppliers of Lighting Africa and IEC-standard products. Distributors on the other hand operate independently, with distribution agreements that may or may not be exclusive and include basic trade finance and marketing support options. These options however are typically limited.

Suppliers certified with Lighting Africa with distributor relationships in Sierra Leone include: Greenlight Planet, d.light, Fosera, BBOXX, and Azuri. Additional relationships are emerging quickly. Most products boast pay-as-you-go (PAYG) option. Many suppliers are all now well-experienced in the East African and Asian markets and bring their learning and expertise to the market in Sierra Leone.

Financial Service Providers

Commercial Banks/ MFIs

Taken as a whole, Sierra Leone commercial banking sector has proven exceptionally risk adverse. Most financial institutions rely on fees and foreign exchange to yield returns.

Overall, banks may be positioned to offer debt financing for solar distributors. However, banks have also outlined their inability to assess risks associated with solar lending. This, combined with poorly-aligned management and oversight structures required to manage loans of smaller sizes, mean that banks perceive solar lending risk as high.

Perceived risk, as opposed to actual risk, may be managed with education and loan management restructuring. While this may be possible for larger distributor loans, it's highly unlikely for consumer finance lending for purchases of solar products.

Investment Funds

Solar home systems and lanterns are a market with limited attractiveness when compared with other lower risk and higher return investments. Yet, impact investment, which typically affords greater risk tolerance and longer repayment periods when compared to other commercial financing options, may be a good fit for solar distributors who target raises

between USD 100,000 and 300,000 to bring in larger volumes of products and to manage long-term customer repayment offers.

There are few investment funds targeting Sierra Leone specifically. Cordaid, ManoCap and West Africa Venture Fund are three with operations in country. Cordaid and ManoCap have expressed interest in the energy sector specifically. Debt financing, particularly raised from impact investing funds, can therefore be appropriate capital for solar distributors.

Telecoms & Mobile Payments Platforms

Sierra Leone has five main telecom operators, with Africell and Airtel being the most dominant. Telecom companies are some of the biggest energy consumers in Sierra Leone. They require constant energy to power their masts and towers. The existence of money transfer schemes in Sierra Leone offers the potential for innovative consumer payment mechanisms. Mobile money payments reduce payment collection costs while helping to manage for delinquency.

Associations & Advocacy Groups

Collective action and advocacy has emerged as important way of addressing some of the seemingly intractable challenges hampering renewable energy and solar home system/lantern market specifically. Many of these challenges are related to policy and regulation, port operation, registration, taxes, and standards – they limit the capacity of businesses to operate cost-effectively and efficiently as well as the Government of Sierra Leone's expressed recovery agenda of bringing energy at scale to Sierra Leone.

Government of Sierra Leone & Regulatory Bodies

The Government of Sierra Leone has taken a keen interest in the performance, availability and access to energy as a post-Ebola recovery era pillar of its delivery and performance. GoSL is targeting increased large scale energy generation alongside improved performance of the solar home system energy market. At the start of 2016, the Ministry of Energy launched the Sierra Leone Energy Revolution and with support from DFID. As part of this activity, the Minister of Energy signed UK Energy Africa Compact, effectively agreeing to a number of reforms aimed at unlocking performance in the solar home system/lantern market. Among these are duty waivers and adoption of universal standards. The public sector energy actors' act as key stakeholders in ensuring they waiver process is streamlined and ensuring quality is maintained within the market. Due to the overlapping mandates in Sierra Leone, there are many public sector actors within the energy space. This means implementing decisions involves engaging many players separately and together.

Development & Donor Community

There is a large number of donors in Sierra Leone with many funding programmes and initiatives aiming to increase access to energy across the country. Means of reaching this goal vary greatly with some donors focusing on policy reform of the energy sector, some on supporting large scale energy infrastructure projects, while others focus on off-grid renewable energy. The programming approaches also vary with for example some donors focusing on direct delivery of solar systems to low income households, while other take a systemic approach of trying to develop a sustainable market for solar products by addressing multiple constraints simultaneously.

Donor coordination is crucial to enable the development of synergies between programmes and leverage the impact of donor funding. Donor coordination can also ensure that efforts aren't duplicated, or at worst, don't undermine each other. In Sierra Leone data relating to the energy sector and the renewable energy sector more specifically is limited. Sharing data and research can therefore be an effective form of donor collaboration, instrumental to the success of many energy initiatives. Some collaborative measures to achieve access to energy are now within the implementation stage. A number of donors are working closely together to tackle fundamental policy and financial barriers for low-income households to access energy.

5. Recommendations

The solar market in Sierra Leone is still unproven, with few solar sales and limited turnover. A number of key questions remain, including: Is the solar technology that is available the right fit for Sierra Leone market? Is the solar market attractive enough to invest in? The only way to answer these questions is to demonstrate market potential for solar products through sales.

The following early performance improvements are key to unlocking the long-term solar market potential and should be a focus of the SOBA programme early on:

1. Improving local solar distributor performance
2. Unlocking working capital constraints for local distributors
3. Developing local PAYG opportunities
4. Solidifying the duty waiver and streamlined registration process for solar products
5. Trialling new route-to-market strategies that reduce customer acquisition costs
6. Proving and marketing sales potential to investors, distributors and solar suppliers

With these foundational changes completed, the larger external investment and solar supplier attention required to scale product access is likely.

Sierra Leone Solar Market Advantages

A number of opportunities are afforded to the Sierra Leone solar market. These should be leveraged to accelerate performance and change. Specifically:

1) **Acute energy challenge.** Energy is more expensive and more challenging to acquire in Sierra Leone than most other sub-Saharan African countries. This is an acute, daily challenge for businesses and households alike. Significant challenges often beget opportunities. In this case, Sierra Leoneans are highly aware of the costs associated with energy access and consumption and are very willing to take on quality, cost-effective alternatives.

2) **Engaged and open-minded private sector.** There are a number of local solar distributors that though small and poorly capitalised, are willing to challenge norms, lead discussions on policy reform, trial new distribution and marketing strategies, and make internal performance improvements that are required to attract outside financing. High momentum and energy amongst private sector positions the solar market for change at scale.

3) **Attentive and keen Government of Sierra Leone.** In its post-Ebola recovery period, the Government of Sierra Leone has recognised the importance of improved energy sector performance – specifically calling out the solar home system opportunity. To date, key Ministries have proven willing to entertain complex and challenging reforms as well as to collaborate closely with the private and civil society sectors to facilitate this. Forward-leaning and action-oriented GoSL has generated momentum and positive attention for the solar sector that will hopefully translate into meaningful reforms that pave the way for substantial and sustained energy investment.

4) **Strong donor (DFID) engagement.** In support of GoSL energy sector momentum, a number of high profile donors have lined up to support change – these include DFID and Millennium Challenge Fund, that are explicitly

supporting energy and with a private sector-led approach in mind. Early, subsidised capital may be the fuel required to propel the momentum for actionable change.

5) **Strong learning and technological improvements gleaned in other contexts and applied in Sierra Leone.** Sierra Leone is a late adopter. Solar technology and BoP business models have been on the scene for a decade. Many of the kinks have been worked out in East Africa and Asia. Though improvements are still to be had, many of the suppliers that are offering product to Sierra Leone offer not only a superior product but consumer uptake expertise that was hard-won in other regions. This is an advantage to distributors and consumers in Sierra Leone.

Potential Partnerships

To facilitate the growth of renewable energy in Sierra Leone through the private sector, a number of early potential partnerships have been identified:

- **Solar Distributors**
  First on the market and willing to take the risk – however poorly capitalised and limited in skill and experience. SOBA must work with these actors to prove market potential.
  - Improve health of solar distribution businesses, positioning them to be able to manage distribution, long-term credit lines and capital infusions.
  - Trial new sales and distribution strategies for Sierra Leone's solar market that increase sales at minimum cost.
  - Prove solar market potential, ultimately attracting a strong group of competing players that scale up solar product access.

- **Telco/Commercial Finance**
  Telcos and commercial financiers are key to unlocking working capital and consumer finance and enabling the market by providing both the funds and means of transferring these funds. SOBA's activity in this space can take place in the following ways:
  - Bringing together finance companies, telcos and solar supplier/distributor companies to deliver Pay-As-You-Go systems
  - Valuing the solar distributor opportunity, offering commercial financing for working capital needs (investment funds)
  - Developing and trialling a finance product for both distributors and Solar Home System consumers
  - Encouraging Telco partners to distribute Solar Home Systems though their existing network of agents.

- **Business/Retail Sector**
  There are networks of retail stores that cover the entire country. These stores provide all types of domestic and agriculture goods for the rural community. SOBA will facilitate the growth of the renewable energy industry sector through this channel by:
  - Coupling specialised solar companies to these networks so as to facilitate the increase of the distribution network at a lowest cost possible
  - Provide promotional tools for local retailers to allow them to promote solar products to household
  - Facilitate microfinancing for the domestic market through these networks
  - Partner with existing solar companies and support them in creating business plans and growth strategies

- **Advocacy Bodies.**
  REASL and the GoSL/MoE Task Force have proven open to change, facilitating interagency dialogue and overseeing policy proposals. Their support and willingness to bring down major roadblocks – including 40% duty tax – are critical to the sector's overall performance.

Solar Distributors: Key Actions

Power for All: The Energy Access Imperative, June 2014 describes several action points for each group of stakeholders to accelerate uptake of solar technology for power generation. The following section highlights actions that are relevant for SOBA's potential intervention partners in the private sector.

- **Ensure quality**
  While meeting quality standards such as those supported by Lighting Africa are voluntary, active pursuit of improved standards for products as a whole is essential.

- **Build customer trust**
  Closely related to quality, consumer trust is a prerequisite to facilitating wider adoption of solar goods and long-term, permanent displacement of fossil fuels. For first-time customers moving from kerosene to renewables, a positive initial experience is critical to drive future decisions to purchase solar light and power products.

- **Make energy access more affordable**
  Beyond the obvious of lowering costs and expanding the range of product choices, the solar light and power industry can do a great deal to increase affordability through innovative payment solutions, which will reduce up-front costs. In particular, micro-loans, micro-payments, mobile money, and 'scratch' or 'top-up' cards can enable people to access a basic energy system that is often described as a critical 'first rung on the energy ladder'.

- **Collaborate in market-building**
  It is essential that the industry works together, through trade groups such as the Global Off-Grid Lighting Association (GOGLA), to share insights, best practices, lessons learned, and other areas of mutual interest. In particular, the dearth of clear, consistent, and trusted market intelligence to support the growth of the industry can be addressed through trade groups and partners dedicated to building the off-grid sector for the developing world.

- **Financing for consumer payments**
  Financeable solar light and power products generate reliably predictable consumer payment streams while enabling access through small, affordable purchases of energy. When companies have enough resources to finance consumer purchase of baseline solar energy systems (paid for over time, leading to system ownership) or provide energy as a service (e.g., PAYGO), consumers can pay for their power as they use it and secure immediate access to energy on their own terms. To support growth of these activities, the sector needs specific facilities to advance financing for consumer payments.

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Annex 1: Solar Technology Spectrum

The solar market in Sierra Leone can be divided into the following segments.

Small Scale Solar	**Large Off-grid Systems**	**On-grid Systems**
1. Solar Lanterns 2. Solar Home Systems 3. Solar Home Systems with greater capacity	4. Micro-grids 5. Mini-grids 6. Commercial off grid 7. Domestic off-grid	8. Domestic on-grids 9. Commercial on-site on-grid 10. Ground mounted on-grid

The above segments require the support of different type of regulatory mechanism, financial instruments and business skillset. These constraints lead to a lack clarity in the 'development path' as business do not know how to articulate each step of their business. Before addressing the development path, a more detailed explanation of each market segment is necessary.

Lighting Global is the World Bank's programme to aid the international off-grid lighting industry. Lighting Africa aims to develop the off grid market within Africa, to ensure it is affordable and off high quality.

Through the Lighting Global programme the World Bank/ IFC has created a quality testing methodology in collaboration with the International Electrotechnical Commission (IEC). The IEC/Lighting Global standard ensures that internationally, there are uniform qualities, which can be applied to pico solar products. Lighting Global has quality standard laboratories in Africa, Asia, Europe and the United States. By endorsing high standards, Lighting Global and Lighting Africa ensure consumers are protected from low or unknown quality products.

Global Off-Grid Lighting Association, GOGLA, was founded in 2012 out of the IFC/World Bank Lighting Global programme, to assist in fast-tracking global access to energy. GOGLA represents over 75 companies and organisations within the off-grid industry. GOGLA aligns its objectives with Lighting Global and focuses on three key areas namely mobilising investment, creating an enabling environment, and quality assurance and consumer protection.

GOGLA has contracted Berenschot Consultancy to collect the sales data of GOGLA members. But, not all GOGLA members submitted their data. The data presented by GOGLA, highlights worldwide sales, regional sales and country-to-country sales. By the end of 2015 GOGLA members sold 16,277 solar units in Sierra Leone (GOGLA, 2015).

Small Solar Products

Solar Lanterns

Solar Lanterns are simple systems usually consisting of a single panel, LED light and sometimes a USB port for mobile phone charging. They are available through various retailers and are the simplest type of system available in the market and most affordable for the BOP customer segment. These systems can be part of a certified global programme such as the Global Lighting Standards where the quality and support structure is reflected in the cost, or they can be mass produced units typically imported from Asia with little to no quality-warrantee and obviously significantly cheaper than the higher quality equipment. The high quality equipment that belong to these global lighting programme are available to the market both as a one-time purchase or are supported by Pay-As-You-Go payment models.

1) **Solar Home Systems**

Solar Home Systems (SHS) are similar to Solar Lanterns but slightly larger typically comprising of more than one LED light and more USB ports. These systems are very easy to install, providing a more suitable home lighting system than a single lantern. Majority of these systems are part of the Lighting Global programme where equipment is specifically certified in order to benefit from this global standard recognition and some associated funding. There is however non-certified equipment in the market as well often cheaper but of sub-standard quality.

2) **Solar Home Systems with greater capacity allowing for use of plug and play equipment (e.g. TV and fans)**

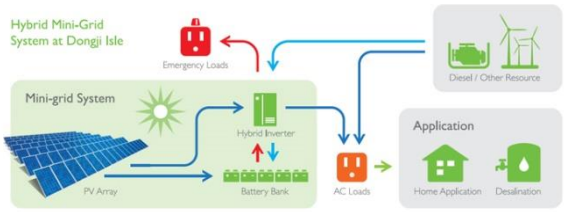
These systems are similar to the standard Solar Home Systems but have a much larger solar panel and battery pack. The systems start to appear more like real home energy systems. They can be supplied with DC fan, radio and TV as well as variety of lighting options. These systems are available in Sierra Leone in small numbers through companies like Solar Era/Fosera and BBOXX.

Large off grid

3) **Micro-grids**

Micro-grid and its defection is often misunderstood. This is a relatively new terminology and may be adopted to better describe an electrification concept. However in the context of rural electrification and in particular where it fits to Sierra Leone, a micro-grid is a small system no greater than 5kW (although it may be as large as 20kW) where it is owned by a handful of households or a community cooperative. In most cases it is unlikely that these very small installation can be operated commercially. The most viable model for operation of such systems is in situations where a extend family occupies multiple dwellings, very close to each other. These installations may be AD or DC.

4) Mini-girds (hybrid)

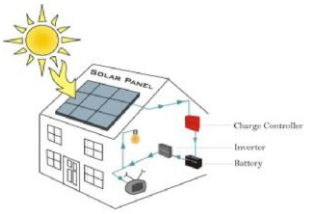


Mini-grids are by far the most effective way of providing real power to rural and remote regions. In fact in countries such as Sierra Leone where the grid is limited, mini-grids are the only logical and cost effective way to electrify the nation. Mini-girds mimic the characteristics of large national grids by providing high quality power suitable for any form of domestic and some industrial/commercial applications. In most cases these installations are composed of more than one technology so as to ensure reliable supply. Implementation of mini-grids have proved to have a positive social impact by fostering and improving the local governance structure through the involvement of the community in the decision making process linked with the energy system. There are hundreds of diesel-based isolated grids worldwide which lend themselves to be retrofitted with renewable energy technologies. Sharing limited resources and power among users in a mini-grid requires rules and a tariff structure that ensures sustainability in the operation. In general, mini-grids involve intense preparation to ensure the systems operation and maintenance will be sustainable. In Sierra Leone several mini-girds exists one in particular that has been successful on some modest measures, is the Yele project which is a hydro power based mini-grid.

5) Commercial off grid

Such systems do not exist in Sierra Leone but opportunities are vast. There are many agricultural and farming practices such as rice, maize and poultry businesses that depend on energy in order to conduct their business. These are energy intensive operations that heavily depend on diesel generators and firewood to conduct operations such as drying, milling, cooking and so on. This segment presents an untapped opportunity. The reduced environmental impact alone which will be achieved by reducing the use of firewood is significant. Interventions in this segment could be an opportunity for delivering economically viable renewable energy solutions and build capacity of local actors. It could make other rural energy programmes more financially viable due to the 'anchor' effect of this segment. The commercial off grid segment of the solar market has largely been untouched by almost all donor programmes.

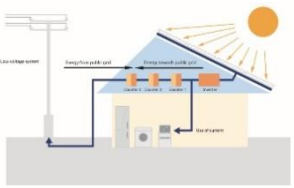
6) Domestic off-grid



Some larger homes have the resources to have a solar power system which has been specifically designed to meet their demand. These systems may be installed in larger rural homes that have no access to any other form of power or in urban setting when the homeowners chooses to discount themselves from the grid which is available to them. Given the intermittent nature and the high cost of the grid power in Sierra Leone, coupled with the need to run expensive diesel generators, the opportunity to disconnect from the grid presents a viable solution for many homes and small businesses. The real cost of diesel is often misunderstood as most generators are oversized and poorly maintained. Larger urban and per-urban houses often are occupied by large and extended families. The density of such dwellings around major populations centres such as Freetown, Bo and Kenema offer a captive market which remains to be exploited. Most of these properties use electric water-heating which can easily be replaced by Solar Thermal systems removing a large portion of electrical demand out of the equation.

On-grind installations

7) Domestic on-gird



These are systems that are commonly found in the more developed parts of the world which have a more advanced electricity infrastructure. For the most part these systems are the same as off-gird domestic solar installation but instead of having a battery-bank, the system is connected to the national grid using it as reserve. The system generates power during the day with the surplus energy then injected into the gird. When the household needs power at night or more than what system can generate during the day, the grid power is used and the net effect is metred.

8) Commercial on-grid

Same as commercial off-grid, commercial on-grid solar power installations have the potential to contribute largely to the nation's energy ecosystems. These are facilities that use vast amount of energy during the day which puts the national electrical network under strain. Utilities must have enough power in reserve in order to meet the demand of these large users, therefore self-generation relives the pressure on the system to some extent. Much like the domestic on-grid segment, it is unlikely that such installations will be relevant for Sierra Leone in the foreseeable future.

9) Ground mounted on-grid

These are typically utility scale installations which are connected to the main grid and work in unison with other generation technology-mix. Technically there is very little difference between these large systems and small domestic installations. Global installed capacity has now reached more than 200 Gigawatts. Sierra Lone currently has no such plants in operation although there plans afoot for number of grid connected solar farms.

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