

Solar Home Solutions Using a Pay-As-You-Go Model in Ghana: Exploring the Opportunity

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Abstract

This study offers an assessment on one specific, potential opportunity to address the issue of electricity access in the rural areas of Ghana: commercialize solar home solutions using the pay-as-you-go (PAYG) business model to facilitate electricity access to households living off-grid in rural areas. The study analyzes the market conditions and the existent policies in order to assess the feasibility of the model to the Ghanaian market.

Through the PAYG model, the population still living without electricity can lease or rent small stand-alone photovoltaic systems (a kit with a solar panel, battery and basic appliances such as lamps, a radio and a mobile charger) by paying small amounts with mobile money, usually less than their current expenditure on batteries for torches or kerosene. After a payment period that usually varies from 12 to 36 months, the client owns the solar kit. This solution provides a basic and affordable electricity service, with small upfront costs, an easy and quick installment, and a convenient and flexible payment system.

Although Ghana is one of the countries with the highest electrification rate in Sub-Saharan Africa (84.3%), approximately 4.5 million people are still lacking access to electricity. This translates to an estimated total of 1 to 1.2 million households without electricity, of which between 391 and 511 thousand households could be marketed for solar home systems, resulting in a potential market of USD 70-92 million.



There are, however, challenging conditions to the setup of this particular model:

- Due to Ghana's high electricity access rate, the market for standalone solar home solutions is more limited than most other Sub-Saharan Africa countries.
- The government has been leading the programs to extend electricity access to remote localities, offering, in many cases, subsidized solutions.
- The high interest rates, the devaluation of the local currency and limited funding in the local markets imposes financial constraints for companies.

However, the combination of a limited but still considerable market and the current administration's pursuit of enhanced electricity access through public-led initiatives creates an interesting opportunity to design a program based on a public-private partnership to implement PAYG solar solutions on a national scale. Such approach could bring the following advantages:

- Creation of economies of scale and the consequent reduction of the monthly prices paid by the households.
- Accelerate the electrification of remote communities, without incurring in high investment costs.
- Put in place the conditions for the local manufacturing of solar panels and to raise funds to finance the company's operations.
- Including such solutions as part of the centrally planned energy roadmap will allow better resource allocation.
- The model allows for better protection of the customers' interests.

Keywords: Ghana; Electricity access; Energy poverty; Africa; power; solar; pay-as-you-go business model.



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1. Introduction

The objective of this study is to offer a brief assessment on one specific, potential opportunity to address the issue of electricity access in the rural areas of Ghana: offer solar home solutions using the pay-as-you-go (PAYG) business model to facilitate electricity access to households living off-grid in rural areas.

Through this model, the population still living without electricity can lease or rent small stand-alone photovoltaic (PV) systems (a kit with a solar panel, battery and basic appliances such as lamps, a radio and a mobile charger) by paying small amounts with mobile money—usually less than their current expenditure on batteries for torches, diesel generators or kerosene. After a payment period that usually varies from 12 to 36 months, the client owns the solar kit.¹

Size of the Problem the PAYG Model Solves

Although Ghana is one of the countries with the highest electrification rates in sub-Saharan Africa (84.3%), approximately 4.5 million people are still lacking access to electricity.

Value Proposition Elements

The value proposition includes:

- electricity for areas that are not covered by the national grid
- more affordable than current off-grid alternatives (kerosene)
- better quality than current alternatives: 220 lumens versus 96 lumens (kerosene lamps)
- small up-front costs
- easy and quick to install: takes a few days
- convenient and flexible payment system, through mobile money
- lease-to-own scheme: client owns the kit after completing the payment term.

2. Market

What Is the Market Size?

The total number of households without electricity is estimated at between 1 million and 1.2 million (2018). Most of these not-yet-connected households are expected to get connected to the grid in the near future. In fact, the government aims for universal energy access by 2020 with a 92% grid connection rate (National Renewable Energy Action Plans, 2015).

¹ For a better, more comprehensive understanding of the PAYG solar business model, we recommend reading the following article: Paola Giordano, Leticia Pelizan, and Ahmad Rahnema Alavi, "Pay-As-You-Go: Unlocking Access to Energy Services in Sub-Saharan Africa: A Disruptive Business Model Leveraging Mobile Technology to Finance Energy Services for the Bottom of the Pyramid," IESE, OP-303-E, 07/2018, <https://ieseinisight.com/fichaMaterial.aspx?pk=150265&idi=2&origen=3>.



The remaining 8% may be targeted by off-grid solutions, which corresponds to a market for mini-grids or solar home solutions of approximately 2.38 million people, or 541,000 households. Mini-grids are the preferred solutions for villages with more than 500 households, whereas the smaller localities could be targeted by solar home systems.

Taking into consideration the government's plans to build 300 mini-grids, and assuming a range of 100 to 500 households per mini-grid, the market for solar home systems would be further reduced to between 391,000 and 511,000 households (see **Table 1**).

Table 1
Off-Grid and Solar Home Solutions Market

Population in 2018	29,767,148
Population to be connected off-grid (8%)	2,381,372
Households to be connected off-grid (8%), of which:	541,221
households to be connected with a mini-grid	30,000–150,000
households to be connected with solar home solutions	391,211–511,221

Source: Estimated by the authors based on the following data and assumptions:

1. Population in 2018: World Bank database.
2. Households to be connected off-grid = population to be connected off-grid divided by average household size (4.4 people per household, based on the 2010 census (Ghana Statistical Service 2012)).
3. Households to be connected with a mini-grid: 300 mini-grids, with a number of households per mini-grid of between 100 and 500. Households to be connected with solar home solutions = (2) minus (3).

For example, if solar kits were to be leased for \$10/month for an average period of 18 months, the total size of this potential market would be around \$70 million to \$92 million.²

What Is the Solar Home Solutions Market Situation in the Country? Are There Companies Already Using the PAYG Model in the Country?

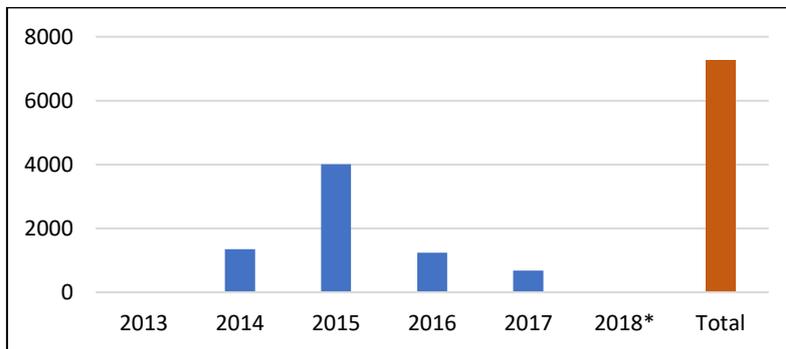
Solar stand-alone solutions, without the use of the PAYG model, are currently part of the power generation mix, especially in remote areas around Lake Volta. In this overall market of solar off-grid solutions, installations peaked in 2015—coinciding with the power crisis—as shown in **Figure 1**. At the end of 2018, solar off-grid accounted for 7,272 kW of accumulated installed capacity.

No information about the share of final usage of these systems was found—either for commercial, industrial or residential activities, or about system types (direct current [DC] or alternating current [AC]). According to our estimation, PAYG solar home systems could represent approximately 880 kW³; 12% of the solar off-grid installations.

² Maximum value, considering that all potential customers could afford such an alternative.

³ Based on an estimated 44,000 solar home systems installed, each of 20 W.

Figure 1
Solar Off-Grid, Installed Capacity (kW), 2013–2018



Source: Prepared by the authors based on data from Table 3.1 of “National Energy Statistics 2009–2018” (Energy Commission of Ghana 2019).

Currently, there are 158 companies that are generally licensed for installment and maintenance of renewable energy systems in Ghana. Most of these companies provide solar systems for commercial /agricultural / industrial activities. Only a few of these are actually offering to specifically install solar home solutions (residential) and even fewer are offering the PAYG model.

Indeed, the authors found only three companies operating through the PAYG model. Together, they are already serving approximately 44,000 households:

- PEG Africa, the biggest player, serving approximately 40,000 households
- Zoola, serving approximately 2,500 households
- Burro Brand, serving approximately 1,400 households.

However, Burro Brand—which also used to sell other innovative products to rural communities—left the market recently, an indication of the complexity and risks of such a market.

These companies offer a range of different solar home products, from basic kits with three lamps, a radio and a mobile charger, to versions including a television. The authors did not find official information about the prices applied, but stakeholders indicate that the monthly fees are usually from 100 Ghanaian cedis to 300 Ghanaian cedis (\$20 to \$60)⁴, with payment plans that vary from 12 months to 36 months.

How Competitive Can the Proposed Solution Be? Comparison With Substitutes

One of the main drivers for the success of the solar PAYG model in other countries has been the capacity to offer a monthly service fee, or a monthly installment, equal or inferior to the current household expenditure on other inferior lighting sources, such as kerosene or batteries for torches.

⁴ Exchange rate used 1\$ = 5 cedis.



In **Table 2**, we compare the cost of some common lighting alternatives (kerosene and electricity from the grid) in Ghana with the PAYG solar home solution to serve basic electricity needs (lighting, a radio and a phone charger) for an average of four to five hours per day. For the PAYG model, we used two references: one of the cheapest pricing plans found in Africa and a reference of PAYG prices in Ghana (however, the range of prices and payment periods in the PAYG African market is much broader).

Table 2
Comparison of Electricity Access Alternatives

Technology	Up-front cost	Monthly cost (\$)	Payment period ¹	Lumen	NPV (\$) ²
Kerosene	-	11–17	Continuous	98	367–567
Grid connection	0 GHS to 410 GHS = \$0 to \$82	0.9	Continuous	500–700	111–192 ³
PAYG solar home system (cheapest reference in other African markets)	\$10	10	18 months	200–300	168
PAYG solar system (local reference) ⁴	100 GHS = \$20	100 GHS = \$20	18 months	200–300	315

Source: Prepared by the authors.

Notes: GHS = Ghanaian cedis

1. Net present values (NPVs) have been calculated over a time frame of five years (60 months); the life span of a high-quality solar kit—although the periods of payment considered are 60 months for kerosene and grid (continuous payment) and 18 months for PAYG (the payment period for PAYG solar systems in this example, although the terms vary from company to company, is generally between 12 and 36 months. After this period, the client usually owns the solar kit).
2. We are assuming an annual interest rate of 26% (2.17 % per month) in all the NPV calculations. It is the lending average interest rate for 2018, according to the Bank of Ghana. However, the rate varied considerably, from 13% to 40%. As another reference, in February 2018 the credit to households was, on average, 30.8%. Bank of Ghana, “Annual Percentage Rates (APR) and Average Interest (AI) Paid on Deposits,” February 28, 2018, <https://www.sikasem.org/wp-content/uploads/2018/03/Banks-APR-and-Average-Interest-Rates-on-Deposits-February-2018.pdf>.
3. Lowest value applies if there is no up-front cost that has to be carried by the households. When including up-front cost the NPV is US\$192.
4. Based on information provided by stakeholders.

According to our estimations, PAYG is considerably cheaper than kerosene and, generally, more expensive than the grid. However, PAYG could be cheaper than the grid in a scenario where the client has to pay up-front costs (such as an access fee and internal wiring) to be granted a grid connection.

3. Business Environment and Policies

What Is the Government’s Position Regarding This Solution/Opportunity?

Currently there is no specific regulation/policy regarding the PAYG model. Companies operate on a market-based approach or engage with the government to participate in specific public-private-driven programs.



The government has, however, a clear target in terms of off-grid solutions:

- The government is aiming for universal energy access by 2020, with a 92% connection rate to the grid (National Renewable Energy Action Plans, 2015). The remaining 8% may be targeted by off-grid solutions. This indicates that, although there is a clear 8% market for mini-grids and solar home solutions, it will be publicly driven.
- The recently published Renewable Energy Master Plan (REMP) (Ministry of Energy, 2019) foresees the installation of 18 MW of stand-alone solar PV from 2019 to 2030. However, the plan does not specify how much of this capacity is intended to be delivered with the installation of small solar kits, typically supplied by the PAYG solar model (DC), or bigger solar panels with inverters to support standard appliances (AC), typically supported by the government in recent programs—such as the Solar Rooftop Project. One of the main strategies of the plan is to create manufacturing capacities. See **Exhibit 1** for more details on the strategy for solar home systems in the REMP.

Although we did not find evidence of direct support for the PAYG solar model, we did find several examples of support for the implementation of stand-alone solar home solutions. Incentives are mainly based on government or development agency programs, which normally include subsidies and are donor-funded. There are several examples of massive, at-scale programs implemented; however, it is difficult to assess the actual outcomes of such programs. Some examples are:

- The Solar Rooftop Program to provide 20,000 households with PV systems (of a maximum of 500 watts each). The households can be connected to the grid or not. Part of the cost is subsidized. The main objective of the program was to lower the peak load on the national grid by 200 MW (Energy Commission n.d.). It is important to note that this program subsidizes solar panels with inverters—therefore, not the same kind of kits offered by the PAYG solar companies. In contrast to the solar kits, these more sophisticated panels can supply electricity to standard AC appliances and eventually be connected to the main grid (ongoing program).
- The Solar Lanterns Program, which subsidizes solar lanterns by 70% in off-grid communities to replace 200,000 kerosene lanterns (Ghana Business News 2013). In the future, this program is supposed to scale up to reach 2,000,000 distributed solar lanterns by 2030 (Kwabena 2018) (ongoing program).
- The Scaling-up Renewable Energy Program (SREP) plans (among other ambitious goals) to implement 20,500⁵ stand-alone PV systems for households, using public-private partnerships (PPPs) to scale up “the successful, private-sector-led, stand-alone PV deployment approaches” (SREP Investment Plan for Ghana, 2015) (ongoing program).

The strong government/agency intervention is a threat as the companies would not be able to operate in a pure free-market approach. However, such government/donor initiatives have the power to either jeopardize or develop the PAYG market, depending on the role assigned to the private companies in such programs.

⁵ REMP mentions that this plan aims to install 33,000 stand-alone solar home systems.

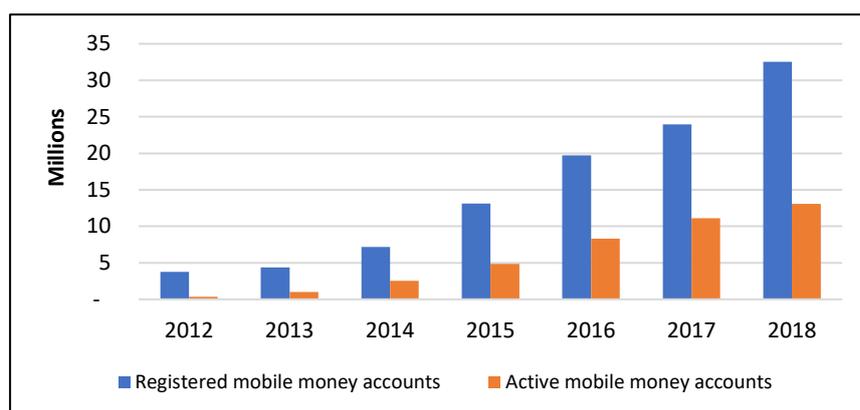


Mobile Money Penetration in Ghana

Mobile money is a fundamental piece of this business model, used to collect the payments made by customers. In Ghana, mobile money usage is high, with 29.5 million mobile accounts registered, of which 12.7 million are active—equivalent to a penetration rate of 69% (of the adult population). There are three mobile money operators: MTN, AirtelTigo and Vodafone. In addition to the growth of mobile money accounts, the number of transactions per active user has increased from 52 in 2012 to 111 transactions in 2018.

Figure 2

Registered and Active Mobile Money Accounts (Cumulative), 2012–2018



Source: Prepared by the authors using data from “Payment System Statistics” (Bank of Ghana 2019).

Note: Active mobile money accounts refer to the number of accounts that transacted at least once in the 90 days prior to reporting.

However, the mobile network coverage in remote rural areas can be a challenge. In fact, some PAYG companies are assessing different payment alternatives, such as scratch cards, to be able to serve customers living in such areas.

4. Barriers

What Are the Barriers to Entry? What Are the Main Challenges to Overcome?

The main barriers and challenges are:

- Government intervention in the market—as electricity is considered a public service—in several areas of scope:
 - Residential tariffs are cross-subsidized
 - Grid connection costs are subsidized
 - The government develops or supports donor-based solar-stand-alone programs, providing subsidies for solar home systems.



- Uncertainty about future government support to PAYG companies—grid extensions and mini-grids are, apparently, the preferred solutions promoted by the government. Solar stand-alone solutions could be seen as a second-class solution and therefore be rejected by the population or receive little support from public institutions.
- No clear information about the potential market—although the government runs a website (Ghana Energy Access Project n.d.) to provide information about electrified and non-electrified villages/communities, there is no detailed and updated information about where the households without electricity are concentrated, nor which communities will be electrified by a grid extension or a mini-grid, nor when.
- Logistical challenges to serve disperse, remotely located clients—although the population density in Ghana is high if compared with other countries in the region, clients without electricity access are usually in remote rural localities. Reaching the last mile in a cost-effective way is a difficult task that requires a studied operational and commercial strategy.
- Financing—the model demands high working capital, as the company must finance imported solar systems for several months (from procurement to the moment the client pays back). Under the current scenarios of high interest rates and the devaluation of the cedi, finding the right financing strategy for the PAYG model remains a key challenge. In addition, local solar companies report facing difficulties to raise funds, as the model is relatively new for local financing institutions.
- Entrepreneurs should be aware of the 2017 Local Participation and Local Content Regulation for the Electricity Supply Industry (LI 2354) (Energy Commission 2017), whose objective is “to achieve a minimum of fifty-one percent (51%) equity participation in wholesale supply and distribution in the electricity supply industry (ESI) in Ghana and 60% local content and also develop capacity in the manufacturing industry for electrical cables, solar cells, conductors, accessories, etc.”

5. Conclusions

Due to the high electricity access rate, the market for stand-alone solar home solutions, specifically for the PAYG solution, is more limited than most other countries in sub-Saharan Africa. In addition, the government—with the support of development agencies and donor-based initiatives—has been leading the programs to extend electricity access to remote localities, through grid extension, mini-grids, solar stand-alone systems and distribution of lanterns—in many cases subsidized. Furthermore, the high interest rate, the devaluation of the local currency against the US dollar and limited funding in the local markets impose financial constraints on the PAYG business model. These are, therefore, challenging conditions to the setup of the PAYG model. Indeed, apparently there are just two companies actively working in this segment.

However, the combination of a limited, but still considerable, number of households without electricity and the vocation of the current administration to enhance electricity access through public-led initiatives creates a good opportunity for the development of a PPP to develop a PAYG program on a national scale, introducing and incentivizing the PAYG model from a central planning perspective—where the government acts as an enabler for market development.



Ignite Power, for example, developed a collaborative approach with the Rwandan government and is now developing a similar approach in Mozambique and Sierra Leone. In Rwanda, Ignite and the government worked together developing a national plan, suitable for the country's population needs. In the implementation phase, the government gave support in three main ways:

- endorsing marketing efforts and raising the population's awareness of the new plan
- supporting the credit given to the poorest population, granting their monthly payments
- supplying Ignite with thorough information about the target market

Ignite, on the other hand, was responsible for raising the funds, bringing high-quality technology, realizing the installations and providing customer support—developing a whole ecosystem to enhance the model.

Thanks to the government's support, Ignite Power was able to raise funds to finance massive operations and reduce the prices of the solar systems offered to the clients to \$4 per month, doubling the market in the first year and reaching more than 100,000 families in four years.

Although the terms and scope of such PPPs have to be carefully studied and discussed between the government and local companies, recognizing a solar stand-alone home solution with the PAYG model as part of the official electricity solutions—and supporting this market through PPPs—could bring the following advantages:

- Creation of economies of scale in the local PAYG market and the consequent reduction of the monthly prices/fees paid by households.
- Acceleration of the electrification of remote communities, without incurring infrastructure or high investment costs, alleviating the financial deficit situation of the power sector.
- Development of a stable market that will put in place the conditions for (i) the local manufacturing of solar panels and accessories and (ii) to raise funds to finance the company's operations.
- Including such solutions in the centrally planned energy mix will allow better resource allocation.
- The model allows for greater government control over the quality of services provided, guidance in terms of priorities and better protection of the customers' interests.



Exhibit 1

Extract From REMP: Strategy Regarding Solar Home Systems

Solar home systems (SHS) (stand-alone and grid interactive)

Challenges in the adoption of SHS

The principal challenges encountered in the SHS market are:

- The high cost of inverters and batteries, making systems expensive.
- Households with seasonal income have difficulty making payment for fee-for-service installations.
- The difficulty in finding the perfect business model to implement SHS in rural communities.

Strategies to promote SHS already receive a lot of government support. The government sees this sector as a strategic sector in which Ghana could develop competitive advantage and provide a manufacturing service to its neighbors. To further promote the sector, the following strategies will be adopted:

- Continue providing incentives through the energy levy.
- Intensify awareness creation and capacity development for stakeholders.
- Provide focused training for technicians in the maintenance of systems.
- Continue to develop and implement innovative, market-driven policy instruments; for example, matching grants, subsidies, revenue generation models, etc.
- Support the implementation of the 200,000 rooftop solar program
- Support the private sector to facilitate the establishment and growth of a local solar components manufacturing industry).
- Encourage local assembling/manufacturers to supply solar systems and components for government-funded projects in line with the Local Content and Local Participation Policy.
- Remove import duty and taxes on raw materials and components for the production of renewable energy.



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