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Solar Off-Grid Markets in Africa – Recent Dynamics and the Role of Branded Products

Abstract

Solar off-grid technologies have become a lower-cost alternative to grid-based electrification in rural Africa. As a contribution to the United Nations' electricity for all goals, policy currently promotes branded solar products based on the assumption that high-quality standards are necessary. We provide evidence suggesting that non-branded technologies have already made widespread inroads to rural households. Quality is not necessarily worse, in particular if the considerably lower end-user prices are accounted for. A justification of branded solar promotion programs can thus not only be based on energy access arguments, but rather on environmental concerns related to electronic waste. Moreover, we show that if poorer strata are to be reached, end-user subsidies are required.

JEL Classification: O13, O33, Q41

Keywords: Rural electrification; energy access; energy poverty; technology adoption

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1. Introduction

Spearheaded by the United Nations' Sustainable Energy for All (SE4All) initiative, the international community is striving to provide electricity to all non-electrified households around the world by 2030. Achieving this by extending national electricity grids would require enormous investments. Solar off-grid technologies such as solar home systems (SHSs), solar lanterns, and Pico-PV kits are a lower-cost alternative. Production costs for these technologies have decreased sharply in recent years and various branded and non-branded products have become available all over Africa. Under the auspices of the *Lighting Global* program, donor organizations and some African governments currently promote branded solar products arguing that high quality standards are necessary to establish self-sustaining markets. Lighting Global endorses a market-based dissemination approach that requires end users to pay cost-covering prices (see Lighting Global 2016).

The present note challenges this policy and the role of branded solar products in meeting the SE4All goals. We provide evidence that the vast majority of the rural poor will not be able to bring up the required investment costs, even if the devices can be purchased with credit. We call attention to the lighting transition in rural Africa that is already ongoing before branded products might reach a certain area: dry-cell battery driven LED lamps and non-branded solar products are replacing kerosene and candles as dominating lighting sources. We show that the somewhat better off strata obtain non-branded solar products on local markets, while the poorer strata use LED torches that can be easily scaled from one diode hand-crafted lamps to larger sizes. Durability of non-branded products is likely to be shorter than for branded products, but this is overcompensated by the lower upfront costs. Given the availability of these alternative technologies, branded products are not necessarily the most rational choice from the poor's perspective.

In the following, we first present the data underlying our assessment, second we provide evidence on the lighting transition to LED and non-branded solar products, and third we carve out the affordability problems of the majority of rural households.

2. Data sources

The data we use in this note was collected in various household surveys that we conducted between December 2006 and December 2014 in Benin, Burkina Faso, Mozambique, Rwanda, Senegal, Tanzania, and Zambia. The studies were commissioned by development agencies such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Netherlands Ministry of Foreign Affairs to evaluate the effects of their electricity access interventions. All surveys were designed to collect detailed information on energy consumption and lighting usage, which is not available in secondary data sets like the Demographic and Health Surveys (DHS) or the Living Standard Measurement Surveys (LSMS). More details on the surveys and their representativeness as well as the underlying evaluations can be found in Bensch et al. (2015) and Peters and Sievert (2016).

3. The lighting transition: non-branded solar products and dry-cell batteries

Table 1 shows adoption rates for off-grid electricity sources in the absence of governmental programs or promotion activities by branded solar product companies. The surveyed areas are representative for the rural population in the respective countries. They are not particularly well-off. It can be seen that – with the exception of Rwanda – solar technologies are already used by considerable parts of the rural population. It is important to emphasize that the products found in such non-program areas are virtually only non-branded ones. Non-branded products are not quality verified and are sold by non-licensed vendors on local markets or in local shops.[1]

To the extent that these observations can be transferred to other African countries the message that can be taken away from Table 1 is that households in rural areas do have access to solar technologies, also without any promotion of branded products. It is sometimes argued that these non-branded products are of an inferior quality, since they are not quality verified and marketed via licensed vendors (see GOGLA 2016). Bensch et al. (2016) examine the difference in lighting performance, user satisfaction, and durability between informally obtained SHS and high-quality SHS promoted by an international NGO. No sizeable differences were found. To the contrary, the available evidence suggests that these non-branded SHS meet expectations in terms of durability and lighting quality.

Table 1: Electricity sources in off-grid regions (in percent of surveyed households)

		solar panel	pico-solar lamp	other
Burkina Faso	2010	26	-	7
	2012*	34	-	7
Rwanda	2011	1	-	2
	2013*	2	4	2.3
Senegal[1]	2011	18	-	5
Senegal[2]	2014	16	2	5
Tanzania	2014	15	16	10
Zambia	2011	34	-	17

Note: Senegal[1] refers to surveys in the Bassin Arachidier and Casamance region, Senegal[2] to surveys in the Thiès region. Other sources include car batteries and generators. *refers to surveys that were conducted after an electrification intervention. Numbers reported in this table are based on the control group part of the sample, i.e. households that were not served by the electrification program.

Bensch et al. (2015) show that lighting consumption patterns in Africa have also changed in off-grid households that do not possess a solar home system or a solar kit. Off-grid households are increasingly using dry-cell battery LED lamps. As can be seen in Table 2, in particular in West Africa kerosene and candles have almost vanished completely. But also in countries in which we encountered lower dry-cell battery LED

[1] See also Lighting Global (2016).

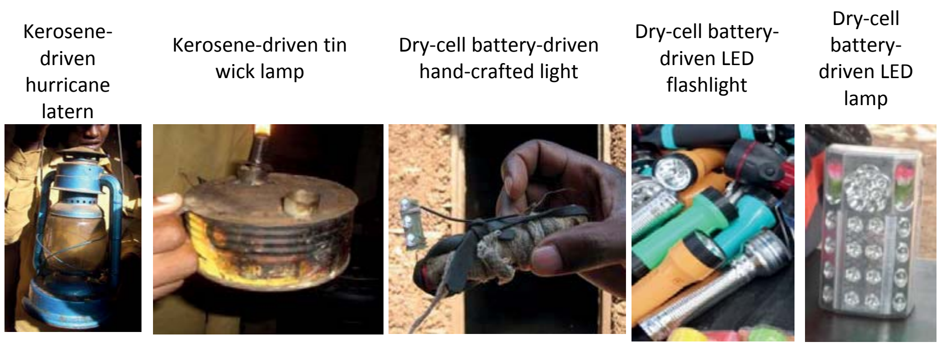
usage rates some years ago, they have gone through double-digit annual growth rates since then.

Table 2: Lighting sources of non-electrified population in our survey samples

		Lighting usage rates among non-electrified households, in %		
		candles	kerosene	Dry-cell batteries
Burkina Faso	2010	0	29	100
	2012*	0	10	99
Rwanda	2011	26	65	24
	2013*	32	36	47
Senegal[1]	2011	21	9	97
Senegal[2]	2014	0	1	97
Tanzania	2014	9	61	68
Zambia	2011	69	17	85

Note: Senegal[1] refers to surveys in the Bassin Arachidier and Casamance region, Senegal[2] to surveys in the Thiès region. * refers to surveys that were conducted after an electrification intervention. Numbers reported in this table are based on the control group part of the sample, i.e. households that were not served by the electrification program.

Figure 1: Lighting sources of non-electrified populations

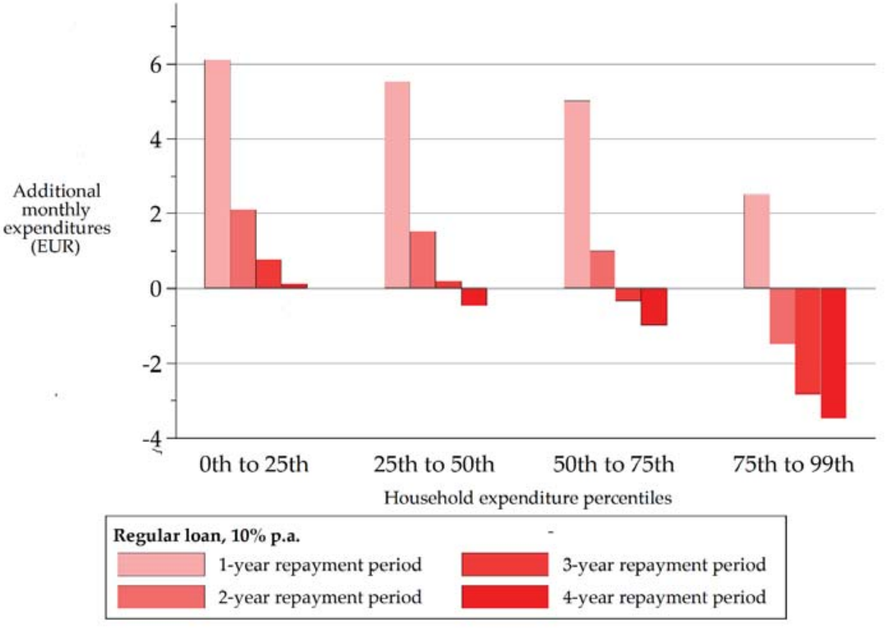


This transition from kerosene and candles to dry-cell battery LED has been largely unnoticed, one reason being that official censuses do not account for dry-cell battery LED lights as a lighting option. The lighting quality of these lamps is comparable to small solar devices, depending on the number of diodes. The poorest households use hand-crafted LED lamps; the cheapest options are made of one or two diodes, wired to a set of dry-cell batteries. Components are obtained in rural shops for less than 1 EUR. Multi-diode lamps are available at between 2 and 5 EUR and can be as bright as regular energy saver lamps. Figure 1 shows some pictures of kerosene lamps as well as hand-crafted and ready-made LED lamps.

4. The affordability problem

The last section has argued that solar markets in rural Africa are taking off already without external support and presence of licensed vendors of branded products. This section argues that the challenge is indeed not to sell solar products per se in Africa: the better off stratum is ready and able to pay cost covering prices, some of them even for more expensive branded products. But to increase coverage rates considerably and to iterate towards the SE4All goals, the poorer strata have to be reached. Using our data sets from rural Burkina Faso we show that the rural poor can hardly be expected to make the upfront investment that is required if cost-covering prices are charged for solar products. For this purpose, we take the perspective of a rural Burkinabè household that hitherto does not possess a solar product and that ponders the investment decision for a solar home system. Since it is often argued that financing schemes will help the poor to overcome the investment burden, we assume availability of a credit scheme at a modest 10 percent interest rate. The average price for a non-branded 40-50 Watt SHS bought on the local market is at 100 EUR. Figure 2 shows the cash flow that results from this investment for different repayment periods (1-6 years). An important parameter are the savings potentials on the household's current energy expenditures for energy services to be replaced by the SHS. Since wealthier households have higher ex-ante energy expenditures and have thus higher savings potentials Figure 2 shows cash flows by expenditure quartiles.

Figure 2: Expenditure effects of SHS adoption under different credit repayment periods



It can be seen that for the most likely scenario of a one-year repayment period the investment into an SHS entails an additional burden for the monthly cash-flow of all expenditure strata. For the poorer 50% of the population this burden weighs heavily: servicing the loan creates additional costs of around 6 EUR per month. For comparison, the poorest stratum has monthly total expenditures of 25 EUR per month, the second poorest around 58 EUR, so the monthly installment payment would consume a considerable share of total expenditures (between 10 and 24 percent).[2] The monthly burden obviously decreases for longer repayment periods. Moreover, the figure also shows that affordability is much less of an issue for the upper stratum. For a one year repayment period additional expenditures are at slightly more than 2 EUR, which corresponds to only 1 percent of their total monthly expenditures.

[2] A more profound analysis of this case can be found in Bensch et al. (2016).

It is worth noting that all parameters in this hypothetical calculation are set in a very conservative way and hence the factual cash-flow can be expected to be more onerous. Among others, optimistically, we assume all kerosene, candles, and dry-cell battery expenditures to be replaced, which is typically not the case, since some traditional lighting is used complementarily. While we use data from Burkina Faso in this example, these calculations can be replicated in all of the other countries we collected such data without significant changes in the findings.[3]

5. Conclusion

What are the implications of the above observations for public policies in general and the branded solar sector and promotion programs like Lighting Global in particular? For starters, it raises the question whether there is a target group at all for branded solar providers given the market-based paradigm that is prevailing. One part of the rural population does already have access to non-branded solar products. These devices might be of lower quality in terms of durability, but not necessarily in terms of service levels. In addition, the shorter durability is also compensated by considerably lower market prices, so non-branded products in fact seem in many cases to be worthwhile investments from the customers' perspective. Those households who do not use a non-branded solar product are much more difficult to reach, because they are already using electric light powered by dry-cell batteries and, more importantly, because they will not be able to afford the required up-front investment. Financing schemes might help to reach more customers, but considerable parts will remain to be excluded. In this situation, the role of branded solar products in achieving the SE4ALL goals is particularly unclear, at least if the current SE4ALL-paradigm of no-end-user-subsidies is maintained. If a political decision is taken that access to electricity is defined as access to high-quality solar energy, more direct promotion schemes like

[3] In Rwanda, for example, the amortization period of a 1-Watt branded solar kit is around 18 months given the real-world lighting expenditures of rural households (Grimm et al. 2015).

end-user subsidies are required. In fact, branded solar products might justify public support not by an energy access argument but by a life-cycle management argument: the shorter durability of non-branded products and the surging consumption of dry-cell batteries in rural Africa is leading to more and more electronic waste, which is becoming a growing environmental burden. It might indeed be possible to implement a reasonable waste management system through licensed vendors, but probably not through non-licensed vendors on local markets or in local shops.

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