

Factors Driving Rapid Photovoltaic Uptake in Rural Ugandan Households and Businesses

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The spread of grid electrical networks into rural areas of Sub-Saharan Africa has been a pernicious challenge. Rates of grid expansion have rarely matched those of population growth, with governments (and aid donors) tending to prioritise electricity access to urban areas over rural populations due to a range of economic, political and logistical factors. Uganda is a case-in-point, with the International Energy Agency (IEA) currently estimating that only 12% of country's rural population has *direct* access to electricity. Given this situation, in Uganda specifically and in Sub-Saharan Africa more broadly, there has been a growing interest over the past couple of decades in the potential of small-scale decentralized power systems, typically based on renewable energy sources, to help alleviate the dearth of rural electrical services. Among these, photovoltaics (PV) has emerged as a key technology, not least because Sub-Saharan Africa's solar energy endowment is one of the highest in the world.

The realisation of this potential for many years was far from straightforward due to a range of technical, economic and social barriers, and ultimately the dissemination of PV into rural areas until recently remained extremely limited. In this paper, however, I present how rural Sub-Saharan Africa has finally experienced a 'photovoltaic turn' with a wide range of PV products and technologies now reaching a large proportion of rural end-users. Drawing on extensive fieldwork in Uganda, conducted throughout 2018, I argue that three key factors have driven this PV revolution.

First, that the global increase in PV production, and the related drop in PV prices, has meant that the technology has become physically and financially more available to Africa's rural populace. PV modules are commonly sold in shops and markets across Uganda's regional capital cities and rural trading posts, with products ranging from pico-solar technologies for basic lighting and mobile phone recharging, to 300-watt modules for larger-scale installations. This availability has had an impact, with one recent survey indicating that one in five households in northern Uganda, the poorest region in the country, owning some kind of PV technology. Indeed, in some locations where the electrical grid is physically available, businesses and household are often opting to purchase PV modules to supply their electricity as they find it more cost-effective and reliable.

Second, there has been a rapid surge in start-up Distributed Energy Service Companies (DESCOs) focused on electricity services in rural Sub-Saharan Africa. Uganda's rural energy market has been a critical focus for many of these, including major enterprises such as Fenix International, M-Kopa, Angaza and Azuri Technologies, with the sector attracting millions of dollars in investor capital financing over the past three years. These DESCOs offer a range of electricity products, ranging from pico-solar and solar household systems (SHS), to larger-scale installations for small-to-medium enterprises (SMEs). The critical innovation for the majority of these companies has been the development of remotely enabled pay-as-you-go (PAYG) system technologies. End-users are able to initially purchase their photovoltaic systems with a deposit, paying the balance through regular fee payments via mobile money services or at kiosks. If payments stop, the PV system is shutdown using remote lockout technology until the payments resume. It is effectively modelled on the mobile phone credit

system, and provides a means for household to purchase a PV system even if they lack the capital to pay for the entire system upfront. So far, these DESCOS have sold over a quarter of a million photovoltaic systems in Uganda, reaching around 7% of the off-grid market.

Finally, the use of photovoltaic technologies has been 'mainstreamed' into development activities across Uganda and other parts of Africa. Emblematic of this, is the United Nations' Sustainable Development Goal Seven (SDG7) which includes the objective of ensuring access to electricity for all by the year 2030, as well as requiring an increase in renewable energy uptake. Photovoltaic installations have subsequently become a critical add-on to projects in areas of education (e.g., PV installations for schools), health (e.g., PV installations for health clinics) and livelihoods (e.g., PV installations in rural enterprises). Electricity is no longer a siloed concern in development framings, but rather is seen a cross-cutting requirement to ensure effective outcomes across a wide range of development indicators.

Collectively, these three trends have meant that PV in Uganda, in the space of just a few years, has gone from being a novel and sparsely used technology, to a ubiquitous feature across the country's rural landscape.