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Solar Power and the Struggle for Electrification in Africa

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This comment by a resident of Accra, Ghana, in an interview with me and my research team, encapsulates the complexity of electrification in Africa: “The national grid isn’t completely reliable . . . we’ve experienced widespread power outages in the past. To prevent my refrigerator’s contents from spoiling and to enhance my safety during periods of darkness, which tend to embolden armed robbers, I now use a generator to ensure continuous power and lighting.”

Based on estimates provided by the International Energy Agency, 600 million people in sub-Saharan Africa do not have access to electricity. Over 50 million people in Nigeria lack electricity, and less than 15 percent of Malawians are connected to the national grid. In such underserved countries, even the privileged few with access to the grid encounter regular power outages. The situation in Zimbabwe is particularly dire: people there may experience power cuts lasting up to 20 hours each day.

According to the African Development Bank, power shortages in Africa result in a roughly 12.5 percent loss in production time, in contrast to a 7 percent loss in South Asia. In 2022, *The Economist* published a piece entitled, “Africa will remain poor unless it uses more energy.” Indeed, the continent cannot simultaneously tackle poverty and leapfrog the stages of economic development without a significant increase in reliable electric power. It is no secret that lack of energy access slows economic growth and increases the cost of doing business. Companies must either stop work during power outages or use alternative

sources of energy such as diesel generators, which tend to increase production costs.

In June 2023, the International Monetary Fund noted that South Africa’s economy was losing “momentum amid record power cuts.” According to the World Bank, businesses in Nigeria incur annual collective losses of \$29 billion due to unreliable electricity. South Africa and Nigeria are the two largest economies in the region—and if they are held back by electricity shortages, other African countries are even more vulnerable.

The costly consequences of lack of energy access also include a negative effect on job creation. For instance, a World Bank Policy Research Working Paper published in 2018, “Jobs! Electricity Shortages and Unemployment in Africa,” notes that power outages resulted in an approximately 13.5 percentage point decrease in employment in the region.

HOW SHORTAGES AFFECT EVERYDAY LIFE

For individuals, lack of electricity imposes restrictions on the hours in which they can work or run a business. Without lighting, markets and shops must close at sunset, foregoing potential income and limiting access to goods and services. In rural areas, the absence of power means that activities such as grinding grain or pumping water for irrigation are done manually or not at all, severely reducing productivity and the potential for agricultural development.

Lack of access to electricity also has dire health implications. In Africa, many medical facilities, including hospitals and clinics, lack reliable electricity supply; most do not even have backup generators. The severe consequences include spoilage of medicines and an inability to use critical medical and diagnostic equipment. Additionally, the absence of basic lighting and communications

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capabilities can hinder treatment processes, particularly in emergencies. There have been instances when power outages occurred during surgical operations and doctors and nurses were required to continue the procedures using the flashlights of their mobile phones. For some people in the global North, such a scenario might seem exceptional, but it is part of the everyday life of people in most African countries.

At the household level, lack of access to electric lighting creates dangers, especially for children and women. There have been multiple cases of fires in various African countries due to the use of candles or kerosene lamps for lighting. Such fire hazards can lead to potentially fatal burns. In areas lacking electric lighting, the risk of assault or rape increases significantly for women who must use toilets or other outdoor facilities after dark.

Asked whether they use candles for lighting, an Accra resident whom we interviewed said, “A candle caused a fire at my parents’ home, which is why I avoid using them. My safety is a priority for me.” People in rural Ghana told us of similar experiences. “My child nearly caused a house fire with a candle while I was away, so I have vowed never to use it again,” said one. Another said, “My son burned down my shed with a candle in 2020, so I stopped using them.”

Furthermore, the use of open-wick kerosene lamps contributes to indoor air pollution. Kerosene lamps produce smoke and soot that can lead to respiratory problems and other health issues. According to a study published in *The Lancet Planetary Health* in 2021, household air pollution accounted for almost 700,000 deaths across Africa in 2019.

In many African countries, education is impeded by the lack of reliable sources of electricity. In an era when educational frameworks increasingly leverage technology, the erratic provision or absence of electricity means a failure to deliver on the necessities of modern learning environments.

Power shortages limit the potential benefits of information and communication technologies, such as computers and the Internet, in African schools. And without reliable electricity supplies, numerous vocational schools that offer classes in welding, carpentry, engineering, and metalworking cannot match the education provided

elsewhere, especially with respect to the use of electric appliances and tools.

THE PROMISE OF OFF-GRID SOLAR POWER

Renewable energy, especially solar power, is increasingly being used to address low electrification rates and unreliable grids across Africa. There are various reasons for the increase in uptake of solar power, starting with the abundance of sunshine in the region. Unlike nonrenewable sources, solar energy is essentially infinite. As long as the sun keeps shining, electricity generation can continue. Also, off-grid solar solutions such as mini-grids, solar home systems (SHSs), and solar lanterns are particularly suited for dispersed or remote areas where connecting to the grid is a challenge. Although there are environmental benefits to the use of off-grid solar products, this is not among the principal reasons cited by most users in Africa for adopting the technology.

Evidence of the growing popularity of off-grid solar products is not difficult to find. According to a report published in 2017 by the African Progress

Panel, sales of single-light lanterns and small SHSs of 10 watts or less surged from fewer than 500,000 in 2011 to 11.3 million in 2015. The *Off-Grid Solar Market Trends Report 2022* notes that 1.87 million pay-as-you-go solar

lanterns and multi-light systems were sold in Eastern Africa in 2021; in Central Africa, sales of solar home systems (which consist of solar panels, a battery, and a charge controller) grew by 450 percent between 2018 and 2021. It is worth noting that these statistics exclude the thousands of “generic” off-grid solar products sold by companies not affiliated with the Global Off-Grid Lighting Association.

As I have found in my interviews, this exponential increase in sales of off-grid solar products over the past decade speaks to the benefits they bring to the everyday lives of people across the continent, especially those without access to the grid. For example, Gichinga (all names here are pseudonyms), who lives in rural Kenya, said, “I can only thank them”—the provider of solar home systems in her area—“because they brought me out of darkness, and now I have light.” A counterpart in Tanzania attested that “the solar home system has been helpful; without it, we’d still be relying on candles and kerosene,” adding, “Since we

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poverty without reliable
electric power.*

started using solar, I've never had to suffer through darkness or miss a meal due to lack of light. Despite not having access to the national grid, it hardly feels like we're without it."

Tumo, in rural Tanzania, also expressed a clear preference for SHSS: "I like using solar because it's a source of electricity with no complications at all. It's better compared to the kerosene we used to use before." Gathe, in rural Kenya, remarked, "Previously, when we used traditional kerosene lamps, the smoke from the lamps would cause health problems for the children. So, solar is good because it produces no smoke, thus it's free from causing diseases."

These comments underscore the ease of use associated with SHSS, which do not require constant fuel purchases and extensive maintenance, or emit harmful fumes. The comparisons with kerosene, a commonly used fuel source in many African households before the adoption of solar energy, highlight the health benefits of SHSS. The spreading preference for solar reflects an awareness of the fire and pollution hazards posed by kerosene lamps and an appreciation for the safer alternative provided by solar energy.

Some users of solar home systems have also noted economic benefits. Mwamba, in Tanzania, said, "I am happy about the arrival of solar home systems because I have saved more money on expenses than before when I used to buy battery cell torches." The economic incentives for choosing solar technology are particularly clear to residents of regions plagued by unreliable electricity supplies and high energy costs. Prior to the advent of SHSS, Mwamba, like many others, relied on battery-powered flashlights for illumination. This not only caused recurrent expenses for battery purchases but also contributed to environmental degradation through the disposal of used cells. The transition to solar energy represented a major shift in his household's energy consumption pattern, marked by a notable reduction in out-of-pocket expenses for lighting needs.

The financial savings cited by Mwamba are multifaceted. The initial investment in a solar home system, while substantial, is offset by the elimination of ongoing costs associated with the purchase of batteries. Over time, this results in net savings, making a solar home system a cost-effective solution for lighting and energy needs. For those on a tight budget, the savings can be used to meet other household needs in the education and health spheres.

BUSINESS OPPORTUNITIES

Other African users' narratives also offer evidence of how solar home systems are fueling entrepreneurial ventures and income generation. The experiences of Chikondi and Chakufwa in Malawi and Afaafa in Tanzania provide tangible examples of this trend.

Chikondi's business involves a novel use of solar power: leveraging the energy source to run a television for public viewings in his rural community. This enterprise generates approximately 12,000 Malawian kwacha (MKW) for Chikondi (about \$7) when a football (soccer) game is broadcast. Hosting viewings of television shows, particularly in areas where access to electricity is limited, presents a lucrative opportunity. It not only brings communities together; it also fills a gap in entertainment, thereby creating a modest yet steady income stream for those offering such services, at least until the market becomes saturated.

In Tanzania, Afaafa's venture capitalizes on the appeal of both football and movies in Africa. By charging a modest fee for viewership—500 Tanzanian shillings (TZS), about 20 US cents, for football matches, and 200TZS for movies—Afaafa has created a popular and profitable entertainment hub in his rural neighborhood. The audience size fluctuates, with up to 30 attendees for football matches. There is potential for a relatively good income stream, especially during sporting events that draw large crowds. Through such ventures, an SHS can transform a simple space into a vibrant social and commercial gathering point, leveraging the communal aspect of sports and entertainment.

Similarly, Chakufwa's initiative in rural Malawi taps into a basic need within his community: facilities for charging mobile phones. Given the pervasive use of mobile phones across Africa and the challenge of keeping them powered in off-grid areas, Chakufwa's service, offered at his house, meets a critical demand. Although the daily earnings fluctuate, the constant need for phone-charging ensures a regular income, demonstrating the versatility of solar systems in supporting small-scale businesses. "People pay me 50MKW" to charge their phones, Chakufwa said. Due to his SHS's limited capacity, only one person can use the service at a time.

EDUCATIONAL BENEFITS

The adoption of SHSS in Africa has reconfigured the economic realities of numerous households. It

has also had an impact on the educational opportunities available to children in these families, as can be seen in the experiences of Magreth and Mansa, parents of school-age children in Tanzania. Magreth highlighted the transformative impact of solar power on her children's education: they "now have what can help them in their studies, which is what I had been thinking about for a long time."

Such experiences bring to the fore the value of high-quality lighting, which SHSS provide, in enhancing the learning environment for children. Before this technology became available, many children in rural and off-grid communities either had to halt their studies at sunset or were forced to use low-quality lighting sources, limiting their potential for academic achievement. With the advent of SHSS, Magreth's children, like many others, now have the means to extend their study hours into the evening.

Mansa likewise reported that solar-generated electricity has had a direct impact on his family's life, particularly in terms of educational benefits for the children: "Because I have light throughout the night, my kids are able to study well, which makes me happier than anything else." Again, Mansa's comments reflect the crucial role that access to lighting plays in facilitating effective study habits. The ability to study at night in a well-lit environment can dramatically increase the quality of education that children receive, directly influencing their academic performance and future opportunities.

These experiences in Tanzania echo a common theme observed across Africa: SHSS play a vital role in unlocking the potential of young learners. By alleviating the constraints imposed by a lack of electricity, SHSS act as catalysts for educational development. In assuring adequate lighting, they enable a conducive learning environment that allows students to complete homework, engage with educational materials, and prepare for examinations. Arguably, their adoption might also help reduce educational inequalities within countries.

ENHANCING QUALITY OF LIFE

Beyond the educational sphere, SHSS enhance people's quality of life in multifaceted ways. Comments from Tanzanian residents Neema, Saida, Akida, Tumpe, and Abasi offer insights into the

practical and lifestyle improvements that solar energy has facilitated.

The experience of Neema, a 30-year-old mother of four who resides in a rural community, encapsulates the broad utility of solar power. As she stated, "We get light, watch the news, and use a blender." This comment emphasizes how SHSS not only address the basic need for illumination, but also provide people with the ability to stay informed and perform household tasks with ease. These energy technologies offer multifunctionality in supporting daily activities.

Saida's perspective sheds light on the convenience and autonomy solar power brings: "We can now charge our phones at home, which is different from before when we had to take our phones to be charged somewhere else. Also, we watch television." The ability to charge mobile devices at home instead of relying on external charging services is another tangible example of solar energy's role in enhancing personal independence and access to information and entertainment.

Akida contrasted their current situation with their daily life before solar power, noting the enhanced entertainment options now available to them: "Being able to charge the phone and listen to music

through my radio is better than the battery-powered radio I used to have." Along similar lines, Tumpe said: "We can watch television now and charge our phones." Such comments indicate the importance of solar energy in bridging the digital divide, providing access to global media, and enabling communication.

Abasi welcomed the broader lifestyle enhancements afforded by solar power: "The fact that we get light during the night and also listen to different music and songs most of the time is a benefit for us." The additional hours of light improve safety and extend productivity and leisure time into the evening hours, enriching the cultural and social life of the community.

These accounts illustrate the impact of solar home systems on everyday life in Africa. By providing reliable, high-quality lighting, enhancing access to information and entertainment, and fostering greater independence, off-grid solar technologies—more precisely, SHSS—have fundamentally improved the living standards of individuals and communities in Africa.

Solar home systems are fueling entrepreneurial ventures.

SOLAR SHORTCOMINGS

Though SHSS have made substantial contributions toward tackling Africa's electrification crisis, they are not without flaws. There are problems related to the durability and authenticity of solar components that can undermine the effectiveness and reliability of these technologies.

For instance, Mkandawire in Malawi voices a common concern regarding the lifespan of solar batteries: "The only challenge is the durability of the battery. From my experience, I have noticed that most batteries only work for a year, and some are not original." This affects the reliability of SHSS. The need for frequent battery replacement results in additional costs and interrupts the continuous supply of solar power.

The issue with battery life is not unique to Malawi, as Andwele in Tanzania attested: "Solar is good. The only problem we encounter is with the battery. . . . We change the battery every six months." This hints at the frustration that comes with the high maintenance demands of SHSS, particularly the need for frequent battery replacement, which can erode the initial economic benefits.

In Kenya, Gitonga noted declining SHS performance over time: "When I got the solar home system, it was very bright . . . but now it's dim; not as bright as it used to be. Also, its battery's power is drained quickly." The deterioration in both the lighting quality and battery efficiency of their SHS leads to inconveniences such as the system occasionally shutting down as early as 11 p.m., and sometimes even before the family has finished their dinner.

In Malawi, Yatuta raised another issue, pointing out inconsistencies in the quality of solar panels: "There are some solar panels that are original, while others are not." He observed that original panels lasted longer, whereas counterfeit panels or batteries did not last more than a year. He was frustrated because he could not distinguish between authentic and counterfeit products. Most often, users realize the difference once the system ceases to function shortly after purchase. The infiltration of the market by suppliers of counterfeit or substandard SHS components poses a serious problem. Reduced efficiency and longevity of solar installations could lead to higher long-term costs and lower trust in solar technology.

Besides affecting the daily lives of users, the flaws related to battery durability, the presence of counterfeit components, and the declining

performance of SHSS over time also pose broader questions about the quality control and regulation of off-grid solar products on the market. Addressing these concerns is essential for ensuring that the use of these technologies remains a viable and reliable option across the continent.

Capacity is another common concern. People in various African countries often purchase smaller SHSS that prove unable to meet their energy demands. Even larger SHSS have limitations when it comes to meeting the energy needs of some households. The limited capacity of these systems leads to practical challenges and familial tensions.

Hashiki, in Kenya, pointed out a fundamental flaw in the capacity of solar batteries to meet energy demands, especially for larger appliances included in solar packages: "In my view, the battery is not compatible with the TV, since the TV is large . . . when we watch TV during the day, we can't watch it at night because the battery is low, and it goes off." Although Hashiki focuses on the battery, it is worth noting that a larger solar panel would also be required to capture sufficient energy. That said, this limitation, which was experienced by several users, not only restricts entertainment options, but also reflects broader concerns about the adequacy of SHSS to power essential devices consistently.

In Malawi, family dynamics and the equitable distribution of solar energy emerge as sources of contention, as highlighted by Hetherwick: "There was a time when some relatives wanted us to connect some bulbs in their house using our solar home system, which caused some disagreements." Similarly, Cecilia told us that energy scarcity had led to family disputes: "It has happened several times because there is not enough solar energy to support the household's needs." In addition to interpersonal conflicts within households, the technical limitations and system capacity issues linked to SHSS can lead to tensions between users and other members of the community, weakening social cohesion.

Solar power insufficiency was also a problem in Kenya. Gitonga noted the issue of power management within households: "Sometimes you find that it has been used during the day . . . and when you get home in the evening, there is no power." The inadvertent consumption of energy, particularly by lighting left on during the day, leads to frustrations and disputes over energy usage priorities.

In Tanzania, Erevu's experience introduces another dimension of difficulty, particularly with

charging modern devices: this occurs “mostly with my daughter because she has a smartphone, so it takes a very long time to charge. That’s why sometimes we tell her that she should wait for our phones to get charged first, or we remove it before it’s fully charged.” This situation encapsulates the tensions between the need for connectivity and the limitations of SHSS in providing sufficient power for all household devices.

There are also problems relating to the environmental sustainability of SHSS. Besides undermining the economic benefits of solar energy, batteries that only last a year contribute to increased waste and pollution. The disposal of solar batteries—especially in areas without proper recycling facilities—can lead to the leakage of hazardous materials into the environment. Even as SHSS are often celebrated for their role in producing “clean” energy, their environmental benefits are compromised by the negative impacts of disposing of short-lived batteries, panels, and other components. Although the continued demand is beneficial to businesses and providers of SHSS, it is detrimental to the environment in another way, since more resources are needed to produce more of these products. As long as this issue goes unaddressed, any claim that SHSS

contribute to environmental sustainability will be highly problematic.

NO MAGIC BULLET

The limitations of SHSS underscore the fact that there is no magic bullet for Africa’s electrification crisis. Although solar energy systems, along with other renewable sources, play a crucial role in Africa’s energy mix, the continent cannot depend solely on these sources for its immediate electrification needs. African countries are not experimental subjects and should not strive to achieve what even the global North has not fully accomplished—a complete transition to renewable energy sources. Any attempt to lead such a transition prematurely could prove detrimental to African economies and populations.

The challenges associated with electrical grids and solar power across the continent raise more questions than answers. Addressing the electrification crisis in Africa therefore requires collective efforts by academics, policymakers, energy companies, and local communities. No single party can resolve this issue alone; collaborative approaches and a sense of humility on the part of all stakeholders will be essential. ■