IGC

Expanding electricity access through solar home systems in Zambia

POLICY NOTE

This policy note explores the role of solar home systems (SHS) in tackling Zambia's electricity access challenge.

- Electricity access in Zambia stands at 80.3% among urban households but only 34% among rural households.
- SHS offer a relatively low-cost lighting source for isolated rural households, but typically lack capacity for high-energy uses like cooking.
- Despite the potential benefits of SHS, only 11.4% of rural and 5.5% of urban households report using them.
- To increase SHS adoption, Zambian policymakers should focus on three primary areas:
    1. **Affordability** – Suspending customs duty and zero-rating value added tax are positive developments, but the government can take further steps with innovative financing, with Namibia as a potential case study.
    2. **Information** – The government can complement existing information campaigns with credible information on performance, quality, and price.
    3. **Peer Effects** – Speeding up government solar adoption is a promising development and should be implemented widely, signalling the reliability of solar technology.

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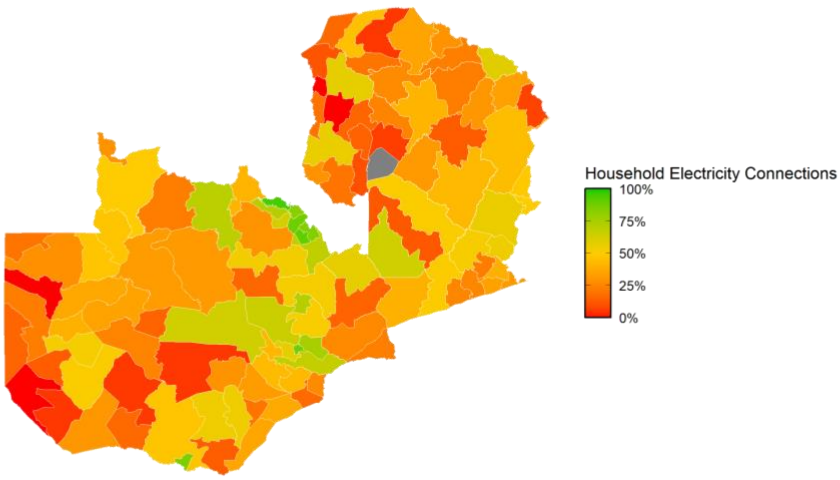
This note proceeds with the following structure: I. Zambia's electricity access challenge, II. Mapping Zambia's SHS, III. Strengths and limitations of SHS, IV. Policy discussion, and V. Conclusion.

Zambia's electricity access challenge

Electricity access is at the heart of the international development agenda. Without electricity, health clinics cannot store vaccines, children struggle to study at night, businesses face major production constraints, and communities remain isolated (UN, 2025). In light of this reality, the primary objective of Zambia's National Energy Policy (2019) is to achieve universal access by 2030.

To track progress towards this goal, Zambia's 2023 National Energy Access Survey (NEAS) offers insights into household electricity usage. **Figure 1** maps electricity access across Zambia's 116 districts.

FIGURE 1: Household electricity connections in Zambia



Data Source: National Energy Access Survey (2023). Grey shading indicates no data available.

The map shows that electricity access varies substantially across Zambia's districts but is concentrated in urban centres. The overall statistics are as follows:

- **National electricity access** – 53.6% of households have access to electricity.
- **Rural and urban electricity access** – electricity access is 80.3% among urban households but only 34% among rural households.

To address these access gaps, the Zambian government is increasingly focused on solar power (Presidential Delivery Unit, 2025). Located in the heart of southern Africa, Zambia's sunlight offers impressive energy generation potential. With an average Global Horizontal Irradiance[1] of 5.88 kWh/m²/day (ESMAP 2020), Zambia's shortwave solar radiation (the input used to generate solar power) ranks 24th globally and 3rd in the Southern African Development Community (SADC).

Promisingly, innovations in producing cheap solar technology have made low-emissions electricity access possible and cost-effective (Burgess et al., 2023). Equally, because solar technology can be scaled up or down by adding or removing standardised components, its modular design has made it a practical tool for off-grid electrification (Balboni et al., 2024).

The government plans to harness Zambia's solar potential through three primary mechanisms:

1. **Solar power plants** – large-scale solar installations that generate electricity and often feed into the national grid.
2. **Solar mini-grids** – small, localised power grids that provide electricity to entire communities that are not connected to the national grid.
3. **Solar home systems** – individual solar units installed within households to power lights, mobile phones, and small appliances.

As outlined in Zambia's 2023 Integrated Resource Plan (IRP), the government plans to add 1,960 MW of solar capacity by 2030, a massive increase from the existing 123 MW of installed solar capacity. While this capacity addition will be generated through power plants and mini-grids, the role of solar home systems (SHS) in serving isolated rural communities should not be overlooked.

In 2022, 34% of new household electricity connections in sub-Saharan Africa used a SHS (Balboni et al., 2024). Indeed, SHS are often cited as the ideal solution to SSA's energy poverty, especially in locations where grid connections are unreliable or unavailable (Ngonda, 2022). Zambia's IRP echoes this sentiment, stating that SHS are the cleanest and most cost-effective energy source for Zambian households where grid connection cannot be delivered by 2030.

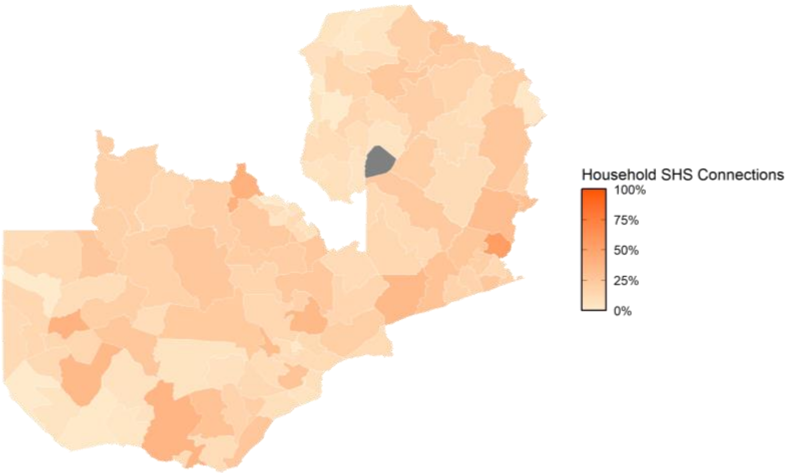
Therefore, this policy note seeks to answer the question: ***What is the role of solar home systems in tackling Zambia's electricity access challenge?***

Mapping Zambia's SHS

It is critical to map out the existing landscape to understand the role of SHS in Zambia's electricity access strategy. **Figure 2** shows the percentage of households using SHS across districts in Zambia.

[1] Global Horizontal Irradiance (GHI) is the total amount of shortwave radiation received from above by a surface horizontal to the ground. It includes direct sunlight and diffuse sky radiation and is measured in kilowatt-hours per square meter per day (kWh/m²/day).

FIGURE 2: Household solar home system (SHS) connections in Zambia



Data Source: National Energy Access Survey (2023). Grey shading indicates no data available.

For those familiar with Zambia's population geography, **Figure 2** shows that solar home systems are much more prevalent in rural areas where off-grid solutions are desirable. The overall statistics confirm this picture:

- **National SHS adoption** – 8.9% of households use SHS.
- **Rural and urban SHS adoption** – 11.4% of rural and 5.5% of urban households use SHS.

Similarly, rural households are more likely to report using batteries[2] (lithium-ion or lead-acid) and inverters[3] to store energy and power appliances.

With inverters, the statistics are:

- **National inverter adoption** – 8.8% of households *using SHS* use inverters.
- **Rural and urban inverter adoption** – 9.6% of rural and 6.4% urban households *using SHS* use inverters.

With batteries, the statistics are:

- **National battery adoption** – 13.6% of households *using SHS* use batteries.
- **Rural and urban battery adoption** – 14.8% of rural and 10% urban households *using SHS* use batteries.

[2] Lithium-ion and lead-acid batteries both store energy for nighttime power and cloudy days. Lithium-ion batteries are more expensive upfront, but are more energy efficient and typically last longer.
[3] Inverters convert power from direct current (DC), used for basic appliances including lights and phone chargers, into alternating current (AC) power for refrigerators, televisions, large fans, etc.

In all cases, limited adoption of inverters and batteries indicates that most SHS are small-scale. Nationally, self-reported data from SHS users suggests a weighted *mean* wattage of SHS is 165.76 watts (164.50 in rural areas and 169.64 in urban areas). Self-reported *median* wattage is 30 watts, comparable to a small incandescent lightbulb. These statistics are consistent with findings that most SHS sold in sub-Saharan Africa are between six and 100 watts (Mukisa et al., 2022).

Collectively, these statistics suggest that most SHS in Zambia are low capacity, while a share of households operate large SHS with inverters, batteries, and higher energy output.

Strengths and limitations of SHS

In this section, we highlight three strengths of SHS: rural lighting, urban backup power, and low relative cost. However, we also identify cooking capacity as an important limitation which merits a separate policy response.

Rural lighting

Lighting is cited as the primary motivation for rural electricity access in many contexts. Economic research in rural parts of India's Uttar Pradesh found that the primary motivation behind rural power subscriptions was lighting and that willingness to pay for additional services, such as a fan or television, was low (Urpelainen, 2015).

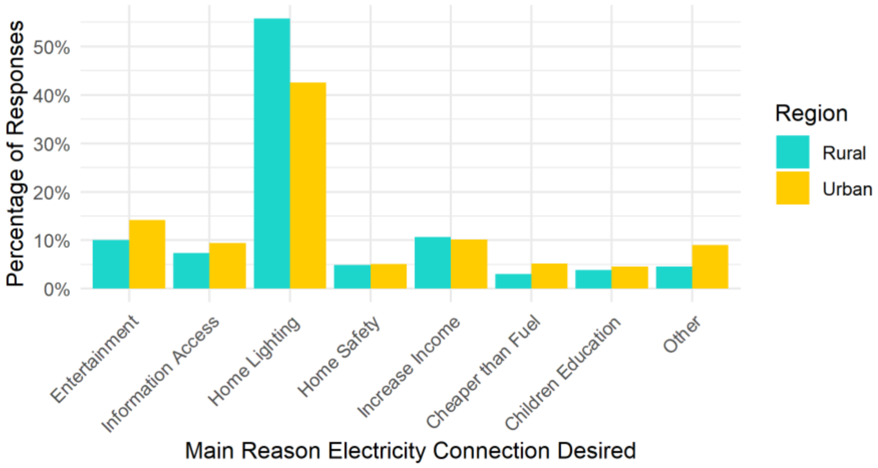
Solar lighting offers transformative benefits (Kizilcec et al., 2022; Balboni et al., 2024; Wallach et al., 2022), which include:

- **Safety** – reduces risks of theft and violence, especially for women and children.
- **Work** – extends productive hours, supporting rural livelihoods and increasing women’s labour force participation.
- **Education** – enables evening study, improving children’s homework completion and educational outcomes.
- **Pollution** – displaces high-polluting, fuel-based lighting devices such as kerosene lamps, reducing indoor air pollution.

Because of these benefits, households in even the poorest rural areas express willingness to invest in lighting (Urpelainen, 2015).

Survey data confirms that lighting drives adoption of SHS in Zambia. When asked about their main reason for desiring electricity connection, over 50% of unconnected households cite lighting, far exceeding any other reason (NEAS, 2023). **Figure 3** shows that this phenomenon is more pronounced in rural areas.

FIGURE 3: Reasons for desiring electricity connection in Zambia



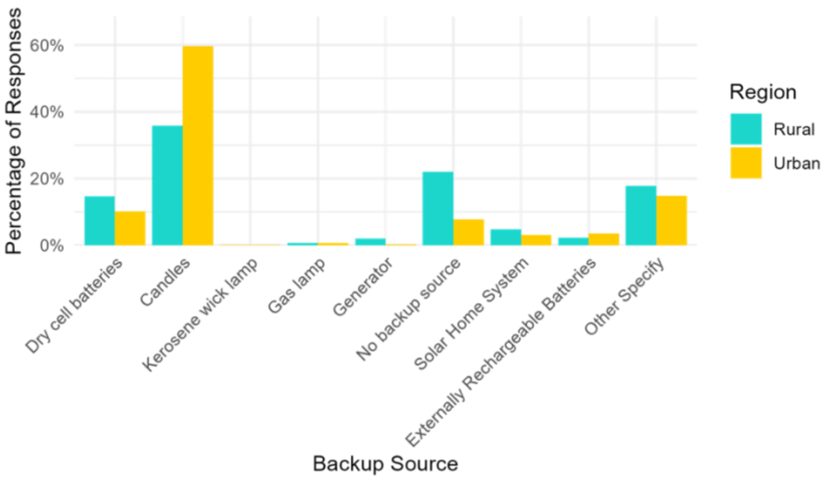
Data Source: National Energy Access Survey (2023). All percentages are computed using survey weights.

Urban backup power

In urban areas, solar represents an important source of potential backup power for grid-connected households.

As seen in **Figure 4**, most urban households state that they use candles as a backup lighting source in case of grid failure.

FIGURE 4: Urban backup power sources



Data Source: National Energy Access Survey (2023). All percentages are computed using survey weights.

Compared to candles, SHS reduce fire hazards and increase lighting potential, offering the advantages described in the preceding section.

Aside from candles, consistent loadshedding has led many middle-class households in sub-Saharan Africa to invest in diesel generators for backup power supply (Ngonda, 2022). Compared to SHS, diesel exhaust from generators releases substances dangerous to human and environmental health, including (Awofeso, 2011):

- **Carcinogens** – known or suspected carcinogens, including benzene, arsenic, and formaldehyde.
- **Pollutants** – nitrogen oxide, the most important substance for ozone depletion.

Although diesel generators provide a reliable power supply, policymakers should consider how much their long-term human and environmental costs might offset these benefits.

Relative cost

Since 2000, the price of solar panels has fallen by over 95%, from USD 6.41/watt to USD 0.31/watt in 2023 (Our World in Data). Solar energy is one of the most competitive renewable sources globally in terms of levelised cost of energy (LCOE), which considers lifetime costs including capital costs, maintenance, fuel, and financing.

Table 1 presents estimated LCOEs for power sources in Zambia and reveals that solar power is among the most competitive. However, please note that these estimates are for large-scale power plants.

TABLE 1: Levelised cost of energy (LCOE) by energy source

Energy Source	LCOE
Hydropower (projected)	$0.05-0.10/kWh
Solar Photovoltaic (PV)	$0.06-0.08/kWh, can be as low as $0.044/kWh (IEA, 2024)
Coal	$0.10-0.15/kWh
Onshore Wind	$0.18-0.24/kWh

The cost of SHS installations varies widely across Africa. As noted in IRENA's 2016 report, SHS installation costs in Africa are highly dependent on the margins taken by the manufacturer, distributor, and retailers. The quality of the system specifications also creates wide disparities in price.

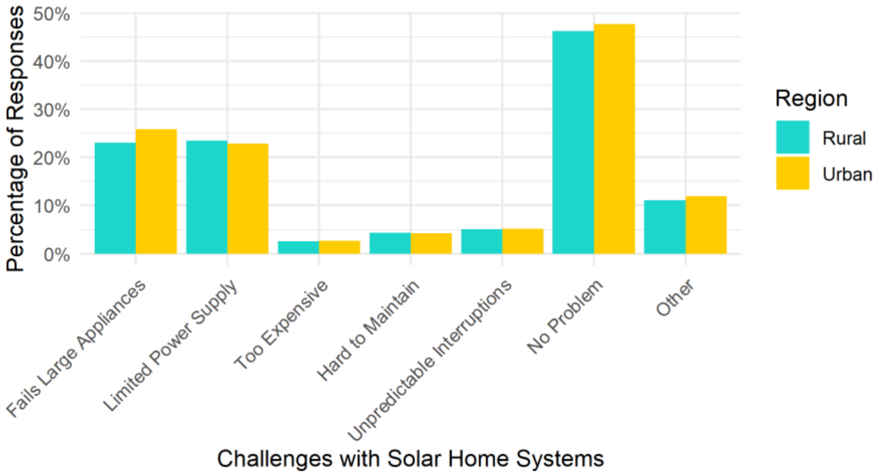
While there is a lack of comprehensive data for Zambia, online prices provide a rough gauge for the low relative cost of components of SHS. For example, one online retailer[4] quotes the cost of 30 W solar panels at ZMW 575 (USD 22.04)[5]. More broadly, the absence of comprehensive data highlights the importance of transparent pricing information, as highlighted in the policy discussion.

Cooking

While SHS are a promising lighting option, the low-wattage SHS primarily being adopted in Zambia do not possess sufficient power for cooking. For instance, powering an electric stove, which typically uses 1,000 to 3,000 watts of electricity (Marsh, 2024), is far beyond the capacity of most SHS in Zambia.

In the 2023 NEAS (**Figure 5**), the primary problems expressed by households with their SHS are that it fails large appliances and offers a limited power supply.

FIGURE 5: Challenges with SHS



Data Source: National Energy Access Survey (2023). All percentages are computed using survey weights

With SHS insufficient for cooking, nearly 83% of households state that charcoal is their primary source of cooking and heating in case of grid failure. Just 1%[6] of households report that they are using liquefied petroleum gas (LPG) for cooking.

While the use of cooking fuel in Zambia raises separate policy questions, charcoal use is frequently linked to lung disease (Idowu et al., 2023) and is a significant contributor to deforestation in Zambia, degrading 190,000 hectares each year (World Bank, 2019). As SHS are insufficient to promote clean

[4] Products can be viewed at: https://www.radianonline.co.zm/lighting-solar-energy/solar-panels.html.
[5] Calculations are performed using the average ZMW to USD exchange rate for 2024: https://www.exchange-rates.org/exchange-rate-history/zmw-usd-2024.
[6] With LPG consumption increasing by 51.8% from 2023 to 2024, per the ERB's 2024 *Annual Statistical Bulletin*, this number may have increased greatly since the 2023 NEAS was conducted.

cooking, the Ministry of Energy (2022) has outlined a separate set of LPG policies in its *Energy Efficiency Strategy and Action Plan*.

Policy discussion

Below, we outline three potential policy levers for the Zambian government to scale SHS adoption.

Affordability

Despite decreasing solar costs, high installation and maintenance costs remain the most significant barrier to solar adoption (Balboni et al., 2024; Ngonda, 2022). Because access to capital is highly limited in Zambia, households unable to finance installation costs in one payment will struggle to afford solar power.

The Zambian government has taken proactive steps to address affordability concerns, including suspending customs duty and zero-rating value added tax (VAT) on solar equipment (Kemp, 2024; Ministry of Energy, 2024).

To further address affordability challenges, Zambian policymakers might explore:

- **Pay-as-you-go (PAYG)** – Under PAYG, customers pay for SHS in instalments via mobile money platforms until they achieve ownership (Angaza, 2019). Should they fail to make a payment during the prescribed period, then the SHS will remain locked (Angaza, 2019). In Zambia, PAYG solar has been expanding through private sector social impact firms. For instance, in 2022, the UN Capital Development Fund awarded a private firm a two-year loan facility worth ZMW 4,600,000 (USD 250,000) to purchase inventory for their PAYG business (Kambandu, 2022). During a period of constrained donor financing, the Zambian government might consider co-financing[7] projects with the private sector and donors to stimulate donor appetite and maximise collective resources.
- **Results-based financing (RBF)** – Under RBF, governments and donors give grants to SHS project developers *after* they have successfully delivered SHS connections (SEforALL, 2025). For example, the Universal Energy Facility's (UEF)[8] Stand-Alone Solar for Productive Use (SSPU) programme offers RBF to solar companies based on verified end-user connections (UEF, 2024). While the focus of this programme is on productive uses, there could be room to explore RBF targeted at low-income residential connections. When implemented effectively, RBF can

[7] For a broader discussion of government financing of solar in sub-Saharan Africa, please see Box 1 on Namibia.
[8] UEF is a multi-donor fund providing results-based grants to renewable energy companies to develop projects in Africa.

incentivise companies to innovate in last-mile delivery and consumer financing, especially for underserved households.

BOX 1 - Namibia's solar success

Namibia's success with solar energy adoption may offer a case study for Zambia. Sharing a border, the two countries have many similar characteristics: a rural-urban divide, an economy highly reliant on mining, and low solar costs. Despite these similarities, Namibia has experienced far more success[9] than Zambia in increasing solar generation, including through SHS.

While both countries have solicited aid and exempted solar products from import duties, Namibia's Solar Revolving Fund stands out as a notable difference between the two. Since 1996, individuals (end users) and sellers have been eligible to apply for subsidised loans, currently between USD 327 and USD 1,910[10], to purchase solar home systems. If approved by the Ministry of Industries, Mines and Energy, the loan recipient must deposit 5% and is then expected to repay the loan at an annual interest rate of 5% over a 5-year payback period. Successful applicants must meet the stated requirements, including restrictions on age, employment or pension status, credit history, and income, and repayment is made via debit order or payroll deduction.

For Zambian policymakers interested in expanding SHS access, it is worth conducting detailed research on Namibia's Solar Revolving Fund, including its effect on adoption, the demographics of adopters, repayment rates, and potential differences in country context.

	Namibia	**Zambia**
Rural Population	45%	54%
Mining Share of GDP	14.0%	13.7%
Electricity Access (Rural)	56.0% (34.1% in Rural Areas)	53.6% (34.0% in Rural Areas)
Solar PV Costs (LCOE)	USD $0.043/kWh	USD $0.044/kWh
Solar Irradiance	6.405 kWh/m^2/day (2nd Globally)	5.883 kWh/m^2/day (24th Globally)
Solar Capacity Per Capita	75.26 watts	5.94 watts
Generation Capacity	47% Hydropower, 32% Solar	83% Hydropower, 3% Solar

Information

As part of Zambia's Renewable Energy and Strategy Action Plan (2022), disseminating information and knowledge is critical to the government's solar energy policy. The Ministry of Energy (2024) has implemented this pillar via

[9] Watts per capita calculations are determined by dividing installed solar capacity by reported populations for 2023, 2.963 million for Namibia and 20.72 million for Zambia.
[10] Exchange rate calculations are computed using the average Namibian dollar (NAD) to USD exchange rate for 2024: https://www.exchange-rates.org/exchange-rate-history/nad-usd-2024.

platforms such as Energy Week, dissemination of the Customs Handbook for Solar PV Products in Zambia, and other interventions as needed.

The focus of these programmes – creating awareness on solar energy sources and policy developments (Ministry of Energy, 2024) – is crucial for solar adoption across Zambia. In developing countries, information is often a key driver for low penetration of solar technology (Burgess et al., 2023), which manifests in two ways:

1. **Lack of information** – many households lack reliable or sufficient information on SHS and are sceptical of potential benefits (Ngonda, 2022; Balboni et al., 2024). Equally, lack of awareness of the technology can also lead to misinformation being disseminated among potential adopters (Qureshi et al., 2017).
2. **Information asymmetries** – even in cases where the household is interested in solar power, there is incomplete information where the seller possesses more knowledge than the buyer about the capacity and quality of a particular solar product (Mahadevan et al., 2023).

Further public advocacy campaigns will be critical to address lack of information. Through collaboration between the government, SHS experts, and the private sector (Ngonda, 2022), households can receive reliable information about the potential benefits of SHS.

As for information asymmetries, impartial and trustworthy technical and financial information is needed on the viability of various SHS products (Ngonda, 2022). To increase trust in SHS products, information about such products should ideally come from the government or peers (Ngonda, 2022). In Zambia's context, the government might provide detailed information on SHS standards, including:

- **Performance** – daily output under typical solar conditions, estimated lifespan of batteries, panels, and inverters, as well as what common household devices would be powered under different wattages.
- **Quality** – a publicly accessible list of registered suppliers and red flags on products regularly reported to be of low quality.
- **Price** – information on existing solar products, including payment schedules for PAYG options.

Peer effects

Peer effects, where a neighbour's experience influences one's decisions, are important for solar power adoption. Because reliable information on solar power is often unavailable, personal experiences frequently drive adoption patterns. In the academic literature, direct contact with a neighbour using SHS has been shown to speed up decision times by up to 4.6 months (Ngonda, 2022).

Admittedly, peer effects can be a difficult policy lever for governments to use because they are primarily driven by interactions with close contacts. In the solar power context, the Zambian government can play an additive role by demonstrating solar power's potential in government facilities. When Zambia's load-shedding crisis began, the government initially responded by installing generators across government buildings (Kemp, 2024). To citizens, the government's response may have left the impression that generators were the most reliable backup technology during the power crisis.

More recently, the Zambian government has instructed all public institutions to fast-track the adoption of solar energy (Presidential Delivery Unit, 2025), sending a positive signal about the quality of solar power products.

In a separate context (agriculture), research in Tanzania has found that demonstration plots of agricultural inputs increased purchase rates by as much as 17% (Sseguya et al., 2021). Similarly, using government facilities for solar power demonstration may spur increased trust and user adoption, especially in rural areas where solar power is not widespread.

Conclusion

With benefits for health, education, business, and more, Zambian policymakers are well-justified in their aim to systematically electrify rural areas by 2030. To achieve that aim, policymakers will need creativity and flexibility. In this policy note, we identify solar home systems as a crucial element of rural electrification efforts. Offering lighting at relatively low cost, SHS can be a viable option for low-income rural areas unlikely to receive grid access soon.

As the grid expands, SHS can offer an important backup power source, preferable to candles and diesel generators and comparable to the role they already play in urban areas. However, their power generation will likely remain insufficient for cooking, suggesting complementary LPG policies are needed.

To increase SHS adoption, the primary barriers to overcome are limited affordability and a lack of credible information (Ngonda, 2022). While SHS are frequently supported based on social and environmental objectives, policymakers promoting these objectives must ultimately convince households that SHS are in their economic self-interest and design mechanisms to make this so.

Therefore, we identify three primary areas for Zambian policymakers to focus on:

1. **Affordability** – Suspending customs duty and zero-rating VAT are excellent first steps. However, the government can take further action with innovative financing, including pay-as-you-go and results-based financing.

2. **Information** – Further information campaigns can build trust by providing performance, quality, and price information.
3. **Peer Effects** – Speeding up government solar adoption signals the quality of solar technology, similar to the role played by agricultural demonstration plots.

Of course, policies around small-scale solar generation must be considered alongside broader questions of grid expansion and planning (Balboni et al., 2024). While these questions are beyond the scope of this policy brief, one crucial principle is that targeting of SHS adoption should be aligned with the Rural Electrification Master Plan (REMP) developed by the Rural Electrification Authority. As the REMP aims to increase rural electrification from a baseline of 3% to 51% by 2030, a significant share of rural areas will not receive grid expansion by 2030. These areas, often low-density, can be an appropriate target for SHS expansion as an intermediary energy access step until they become connected to the national grid.

Ultimately, amidst the current loadshedding crisis, the Zambian government has pursued encouraging steps to hasten SHS adoption. By adopting the measures outlined in this policy brief, we hope that SHS growth can increase further to ensure sustainable electricity access for all.

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