Understanding current energy needs and spending to optimise renewable energy policy and uptake in Sierra Leone

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- Unreliable grid-provided electricity, widespread in sub-Saharan Africa, creates substantial costs for SMEs and the environment. Renewable, decentralised solutions represent a key opportunity to increase the reliability and sustainability of energy supply.
- We carry out a census of 1,500 SMEs in Freetown and its outskirts to (i) characterise the demand side of decentralised solar and estimate ex-ante rates of return and (ii) create a pool of SMEs for an experimental evaluation of the determinants of adoption of renewable off-grid solutions.
- Results from the census indicate that (i) electricity reliability seems to impose substantial costs on SMEs in Freetown, (ii) current backup solutions do not allow SMEs to mitigate these costs fully, (iii) off-grid renewable energy solutions may be profitable investments for firms, and (iv) credit constraints may be binding, given the high capital intensity of such solutions.

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Policy motivations for research

Nearly three-quarters of firms in sub-Saharan Africa experience major electricity shortages (World Bank, 2022), creating substantial private and social costs. Faced with repeated blackouts, firms may self-generate electricity (Abeberese, Ackah and Assuming, 2021) through diesel or gasoline backup generators (BUGs). BUGs are ubiquitous around the developing world (20-30 million sites served). They account for most power-sector emissions of nitrogen oxides (NOx) and fine particulate matter (PM2.5), which are major threats to the ecosystem and human health (IFC, 2019). Unreliable electricity has also been shown to be a key constraint to firm productivity and profitability in both the short (Hardy and McCasland, 2021; Abeberese, Ackah and Assuming, 2021) and the long run (Fried and Lagakos, 2023).

BUGs, which are used by more than 50% of firms in sub-Saharan Africa, serve 20 to 30 million sites and represent an installed capacity of 350 to 500 GW (equivalent to 700-1000 large coal power stations); 75% of them are in grid-connected areas, suggesting high use to mitigate poor grid electricity service (IFC, 2021). BUGs account for most power-sector emissions of nitrogen oxides (NOx) and fine particulate matter (PM2.5) (IFC, 2021). Both pollutants are a major threat to the ecosystem and human health.

Renewable, decentralised solutions – and notably decentralised solar technologies – represent a key opportunity to increase the reliability and sustainability of energy supply. Several low-income countries are suitable for a large-scale expansion of clean power generation from such low-emission technologies, making it possible to preserve the benefits from increased access to reliable energy and the resultant growth whilst minimising the associated environmental costs (Burgess et al., 2023)

Multiple barriers and market failures could hold back the adoption of these solutions, including liquidity constraints (decentralised solar is typically characterised by high investment cost and high medium and long-run rates of return), market distortions (highly subsidised alternatives, for example, grid and diesel), incomplete information / non-standard beliefs (new technology), and coordination issues (for example, solar generator sharing).

In Sierra Leone, electricity production is mainly sourced from hydroelectric (mainly in the rainy season) and fossil fuel sources. Production is well below demand; low-capacity and dilapidated transmission increases the shortfall, with 66% of firms experiencing power outages and 61% owning or sharing a generator (World Bank Enterprise Surveys, 2022). Given the enormous investments made by private and public institutions in expanding energy

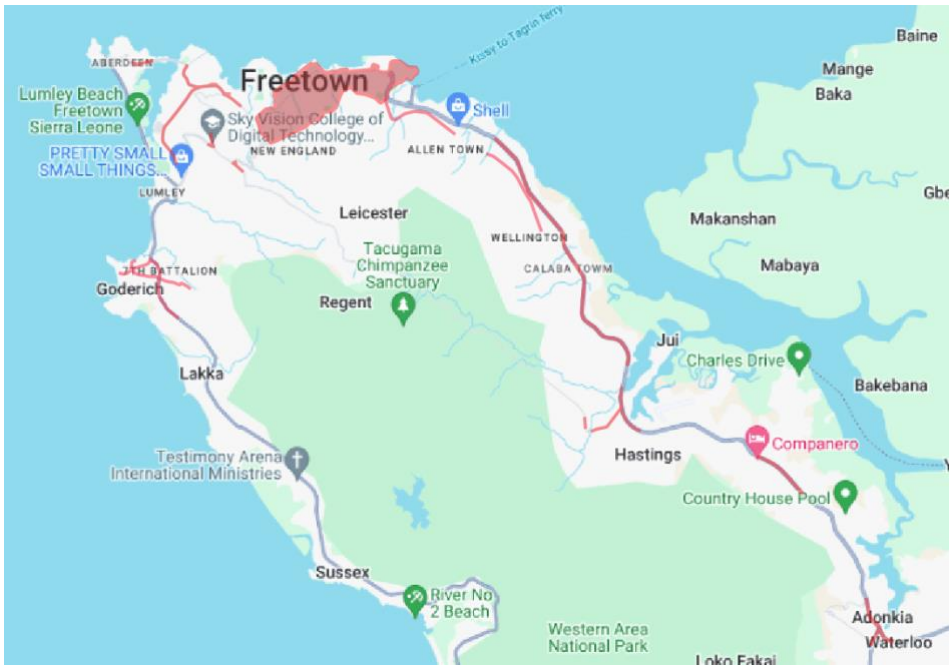
generation from decentralised solar, Sierra Leone offers a unique opportunity to understand whether and how to promote the diffusion of such technologies.

Overview of the research

This project carried out a census of SMEs in Freetown, Sierra Leone, and its outskirts (notably Waterloo, Jui and Goderich) to (i) identify the entire population of SMEs in the selected location and use it for sampling for an experimental evaluation of the determinants of adoption of renewable off-grid solutions and (ii) characterise the demand side of decentralised solar and estimate ex-ante rates of return (versus current energy spending).

Around 1,500 SMEs were identified and interviewed as part of the census.

FIGURE 1: Census areas (in red)



Summary of key findings

- SMEs that use a backup source of electricity differ significantly from those that do not—they are larger, more likely to operate in the manufacturing sector, and more likely to keep business records. They own nearly three times more electricity-using capital, spend almost three times more on grid electricity, and are more likely to own higher-capacity appliances—all statistically and economically significant differences.

- Electricity unreliability is a key issue for SMEs in Freetown – 98% of SMEs interviewed declare that poor electricity reliability is a major constraint to their business operations. 42% of SMEs declare desiring

to invest in more electricity-powered productive capital; among these, 41% of SMEs declare that grid unreliability is the main reason for not having invested in such capital, a close second to credit constraints (48%). The use of a backup source of electricity is expensive.

- Backup capital is valued, on average, at around USD 670 – nearly half of the value of all electricity-using capital. Running costs are also high - SMEs spend, on average, around 2.3 times as much to run their BUGs as they do on grid-powered electricity.

- The use of a backup source of electricity does not seem to allow SMEs to mitigate the effects of blackouts fully. Nearly 40% of SMEs declare that they are not able to power all of their appliances on their backup source of electricity due to output capacity constraints. Although they are slightly less likely than SMEs that do not own a backup source of electricity (45%) to declare that grid unreliability is the main reason for not having invested in such electric-powered productive capital, poor electricity quality seems also to be a first-order barrier to investment in such capital for SMEs that do own a backup source of electricity (36%).

- Given the high costs of backup use, renewable, off-grid technologies may be profitable investments for SMEs, for which we estimate, on average, a 2.5-year pay-back period.

- Our census results also suggest that multiple barriers – and notably the high capital intensity of such systems - may hold back SME investment. In the longer run, and similarly to what has been found for smaller solar kits, such systems may be too capital-intensive to spur meaningful firm upgrading and meaningful economic changes (notably, by stimulating firm investment in more electricity-powered productive capital).

Conclusions

Electricity unreliability imposes substantial costs on SMEs in Freetown. The capital and running costs of current backup solutions are high and do not seem to allow SMEs to fully mitigate the effects of blackouts. Electricity unreliability is one of the main constraints to investing in more electricity-powered productive capital, whether or not SMEs use a backup solution.

Renewable power backup solutions may provide an opportunity for SMEs to increase the reliability of electricity supply at a negative cost while reducing the environmental externalities of poor electricity quality. However, these solutions may be too capital-intensive for the SMEs we study; the expected price is more than seven times the average price paid for current backup solutions, and credit constraints may be binding.

In the second phase of this project, results from the census were used to design a field experiment aimed at (i) formally testing demand for these solutions among SMEs in the Freetown area and (ii) testing the effect of access to credit on demand. Although solar generators may be profitable for SMEs, the investment profile for such solutions - high capital costs and benefits spread over a long period - may hold back adoption. The results of this experiment will contribute to the ongoing debate on off-grid and on-grid electrification, which remains under-analysed in urban regions with weak grid infrastructure. Notably, if results show that demand is low and access to credit is insufficient to spur widespread adoption, investing in grid infrastructure may be desirable because of economies of scale and because such capital-intensive projects may only be carried out by institutional actors.

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