

The economics of rural electrification

Evidence from Kenya



In brief

- In sub-Saharan Africa, nearly 600 million people - or 70% of the population - live without electricity. As a result, universal access to energy has emerged as a top priority for policymakers.
- However, there is limited empirical evidence on the demand, supply, and economic and social impacts of infrastructure investments.
- This study analyses the economics of rural electrification through a randomised field experiment that connected hundreds of rural households to the national electrical grid in Kenya.
- The experiment reveals low demand for grid connections, high costs of construction, and limited economic and social impacts of rural household electrification, roughly 18 months after connection.
- Some of these results may be attributed to excess costs due to leakage, and low demand due to bureaucratic red tape, low reliability, and credit constraints.

*This project was funded
by IGC Kenya*

Policy and research context

In sub-Saharan Africa, nearly 600 million people - or 70% of the population - live without electricity. Universal access to modern energy has emerged as a top priority for policymakers, non-governmental organisations, and international donors. While development economists have recently begun to measure the economic impacts of various types of infrastructure, there remains limited empirical evidence that links the demand-side and supply-side economics of infrastructure investments.

In Kenya, the past decade was characterised by a dramatic increase in the number of public facilities connected to the national electricity grid. The driving force behind the expansion in grid coverage - which mainly targeted markets, schools, and health clinics - was the creation of the Rural Electrification Authority (REA), a government agency established in 2007 to accelerate the pace of rural electrification.

Despite this expansion in grid coverage, the national electrification rate in 2012 was estimated to be less than 25%. Kenyan policymakers were in the process of discussing a major national programme to subsidise grid connections in rural areas. These discussions, however, were being held with very limited evidence on even the most basic patterns of energy demand, as well as the potential costs and benefits of rural electrification.

The study

The study presents experimental evidence on the demand, supply, and economic and social impacts of electrification, specifically, household connections to the electric grid. The setting is 150 rural communities in Kenya, a country where grid coverage is rapidly expanding. In partnership with Kenya's REA, randomly selected clusters of households were provided with an opportunity to connect to the grid at subsidised prices.

The intervention introduced changes both in the price of a grid connection, and in the scale of each local construction project. As a result, it is possible to estimate the demand for grid connections, the average and marginal cost associated with grid connection projects of varying sizes, and the economic and social impacts of providing households with access to electricity for the first time.

The study focuses on answering four questions that are relevant to policymakers in developing countries that are weighing the costs and benefits of implementing government-subsidised mass electrification programmes:

1. What is the opportunity for “last mile” electrification in rural areas?
2. What is the demand for grid connections in “under grid” communities?
3. What are the economies of scale in costs associated with a mass connection programme?
4. What are the economic and social impacts of household electrification?

Key findings

The key findings from this research are summarised as follows:

Key research questions	Key findings
What is the opportunity for “last mile” electrification in rural areas?	In a sample of over 20,000 geo-tagged structures located across 150 rural communities in Western Kenya, we find that half of the unconnected households are “under grid,” or clustered within just 200m of a low-voltage power line. If governments wish to leverage existing grid infrastructure, subsidies and new approaches to financing are necessary.
What is the demand for grid connections in “under grid” communities?	In rural Western Kenya, household demand for grid connections is lower than predicted, even at high subsidy rates. For example, lowering the connection price by 57% (relative to the prevailing price) increases demand by less than 25 percentage points.
What are the economies of scale in costs associated with a mass connection programme?	Experimental variation in the number of connections combined with administrative cost data reveals considerable scale economies, as hypothesised. However, consumer surplus is far less than total costs at all price levels, suggesting that residential electrification may reduce social welfare.
What are the economic and social impacts of household electrification?	In an analysis of ten pre-specified economic and social outcomes - including household energy consumption, wealth, employment, health, education, political awareness, and others - we find minimal positive impacts of grid electrification, roughly 18 months after connection. This result is consistent with the demand results. In general, electricity consumption is extremely low for connected households, at under \$2 per month, and there is low take-up of the electrical appliances that enable electricity-consuming activities.

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Policy recommendations

In our setting, the net benefits of a large, government-funded rural household electrification programme may be limited. There are a variety of potential explanations for this finding. Each of the issues listed below points to a specific area that policymakers can focus on improving in order to maximise the welfare gains from rural electrification.

- **Leakage:** In a comparison of budgeted and invoiced construction costs, we find evidence of excess costs from leakage. The number of installed poles, for example, was 21.3% less than the number of budgeted poles. This finding points to the importance of improved monitoring of contractors in a mass electrification programme.
- **Bureaucratic red tape:** It took a staggering 212 days on average to complete each electrification project. Low demand may be due in part to households' expectations that they would encounter lengthy delays.
- **Reliability:** Electricity shortages and other forms of low grid reliability are well documented in less developed countries. During the study period, 19% of transformers experienced at least one long term blackout.
- **Credit constraints:** Low demand may be driven in part by household credit constraints, which are well documented in developing countries. Stated willingness to pay is much higher than revealed demand, suggesting that take up of grid connections will be higher if financing is offered.
- **Low usage:** Low electricity consumption amongst connected households points to several areas where further research is necessary. For example, providing households with subsidies to acquire electrical appliances may lead to greater usage of electricity and greater impacts.