



## Leaping or creeping up the energy ladder? Technology adoption in rural African households

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- This brief explores findings from a study of electric appliance adoption after the arrival of grid connections in a rural, low-income area of north-east South Africa. The study seeks to understand how many years it takes for a majority of households to start using electrical appliances after connecting to the grid and what barriers they may face.
- The evidence suggests that it takes between four and fourteen years after the arrival of free electricity in an area for at least 50% of households to adopt electrical appliances like stoves, televisions, and refrigerators.
- Increasing the speed of adoption could be very costly. In the rural area in question, even increasing household incomes to the level of public-sector earnings (nearly seven times the average household income) would not significantly speed up adoption.
- The source of income may have a more important impact on adoption speed than the level of income. The study finds that households containing a public-sector worker adopt technologies much more quickly than those with similar income levels from different sources (remittances or private-sector jobs). Reliable public-sector wages may speed up adoption because they provide better access to credit.
- A key takeaway from this research is that short-term studies are not indicative of the long-term impacts of electricity access for local economies and households.

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## Policy motivation

In 2024, approximately one billion people, half of them living in Africa, still have no access to electricity. Despite the rapid growth in electricity grid access since the early 2000s (The World Bank, 2023; Blimpo and Cosgrove-Davies, 2019), most rural areas in Africa do not yet have grid infrastructure. Future expansions of grid electricity have great potential for addressing economic poverty in these areas. However, there is considerable uncertainty regarding how quickly households and firms will adapt to this new technology and how quickly new electrification could translate into impacts on household livelihoods, small businesses, and the environment in sub-Saharan Africa.

The transformative impact of electricity on the economy depends on adoption dynamics for complementary inputs. Households must purchase and use electrical appliances, and firms must invest in capital goods that use electricity. In the United States, this adoption process spanned decades. Households transitioned to electric lighting over 60 years, while refrigerator adoption took about 50 years (see, for example, Lebergott (1976) and Greenwood and Yorukoglu (2005)). While adoption of these now-mature technologies may turn out to be faster in low- and middle-income countries (Comin and Hobijn, 2010), high financial and other frictions could still slow this process down (Mobarak and Saldanha, 2022). There is compelling evidence that shows negligible impacts of electricity at the household level in the short-term of one to two years (Lee et al., 2020) or even three to five years (Burlig and Preonas, 2024). How do we reconcile the long-term transformative impacts of electrification with these negligible shorter-term effects?

In this paper, we ask: What is the best estimate of how long it could take for a rural household in Africa to adopt appliances and start using electricity productively after the arrival of new grid electricity? With these estimates in hand, we then ask: Can we quantify the cost of speeding up these adoption dynamics and, in so doing, learn more about some of the frictions that might slow down adoption in other similar rural settings?

## Research overview

We explore the timing and determinants of electrical appliance adoption following rural electrification in South Africa, using a unique 15-year panel dataset from the Agincourt Health and Demographic Surveillance Survey (HDSS). This region is in the rural northeast of South Africa, close to the border with Mozambique. The HDSS covers 36 villages and over 234,000 people, where the median household income in 2001 was only USD 150 per month. The HDSS has been running since 1992 and continues today.

In a mass electrification project funded by the national utility, household electrical connections in South Africa rose from below 10% in the 1980s to over 90% in 2017. Once a village was targeted for connection to the grid, the utility went in and electrified all existing households. Households could opt for a low-level free electricity connection (20 Amp) or get a 60 Amp connection for a fee. Most rural households chose the free connection. This 20 Amp connection is sufficient to support lighting, an electric kettle, a TV and radio, an electric hotplate, and a modest refrigerator, but not all at the same time.

Because the HDSS surveys the same households every year through this period of mass electrification, we can measure household assets, including appliances, over time. In this way, we can measure how long it takes households in Agincourt rural villages to buy electric stoves, for example, from the time their villages are connected to the national grid.

Our study addresses the broader challenge of understanding technology adoption in resource-constrained settings. By identifying key frictions, such as income instability and credit access, the research sheds light on why technology adoption often lags in such settings, despite the transformative potential of electrification. This research contributes to the literature on rural electrification and technology diffusion by providing the first estimates on time-to-adoption for sub-Saharan Africa. We also highlight how income composition may affect adoption dynamics. The findings of this research emphasise the need for policymakers to temper expectations about the pace of rural electrification's impacts and to consider reducing credit and financial barriers to expedite appliance adoption. These insights are vital for designing effective interventions to maximise the socio-economic benefits of electrification in low- and middle-income countries.

## Summary of key findings

We find that it takes between 4-14 years after the electricity grid arrives for a majority (more than 50%) of households to adopt appliances such as stoves, refrigerators, and televisions. The study highlights that while baseline income moderately speeds up adoption time, having a stable and reliable income stream—particularly the type of income earned in public-sector jobs—may be critical in improving access to credit, which is essential for purchasing costly appliances.

The gradual diffusion of electrical technology in the home that we document limits the immediate and short-run economic benefits of electrification in rural communities.

## Recommendations for policy

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- Short-term studies of the impacts of electrification at the household level are unlikely to be good guides for the long-term transformation of local economies and households.
- Policy-makers and development practitioners should temper their expectations for how quickly rural electrification can transform communities.
- Even under some of the most favourable conditions, such as those observed in South Africa (free connections and free basic electricity), the diffusion of electrical appliances in rural Africa will likely be gradual.
- Promoting access to credit for appliance purchases may be very important in low-income settings in order to maximise the economic benefits of new access to grid infrastructure.

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