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Random Access

By: Jessica Pothering

Most development experts believe that energy access improves living standards. But gathering proof is a challenging proposition.

Kenya's vast rural landscape tells a misleading story about energy access across the country. Power transmission towers can be spotted in even the most remote areas and found within one kilometer of 70 percent of Kenyan households. Yet only five percent of rural residents—who constitute the majority of Kenya's 44 million people—have electricity. This is likely because the cost of a household power connection is prohibitively high for most rural families: about US$400 per home. As a result, most village homes go dark once the sun goes down.

Alleviation of so-called "energy poverty" is a key focus in the field of international development. But while it is generally accepted that access to power yields positive social and economic results, concrete evidence is sparse.

"We actually know very little about the impacts of energy access, and whether there are in fact large welfare gains from these versus other types of community investments," says Ken Lee, a graduate researcher with the University of California, Berkeley's Center for Effective Global Action (CEGA).

Few studies have sought to examine the relationship between infrastructure development and social and economic wellbeing. This is surprising, given the enormous public and private investment in infrastructure. For example, in 2014, the World Bank spent $24.2 billion on infrastructure, which typically accounts for 30 to 40 percent of its total commitments.

For the last three years, a team of researchers from Berkeley's Development Impact Lab have been working to shed light on that question. The Lab, which is funded by USAID, develops multidisciplinary projects to improve development impact. Its team in Kenya, which includes Lee, has partnered with a Kenyan government agency on a large randomized study to determine the costs and benefits of expanding energy services to remote areas.

"We hope to show, with rigorous impact evaluation, whether there are quantifiable positive effects of connecting people to the electricity grid," explains Matt Podolsky, an engineer who serves as a technical expert on the project from Berkeley's Technology and Infrastructure for Emerging Regions (TIER) group. "It's not necessarily a unique idea, but having this kind of evidence would be useful for influencing public investments."

It may not be a new idea, but it is a relatively untested one: Berkeley's so-called "Rural Electric Power Project" in Kenya is one of a very small number of randomized studies on infrastructure development.

The Research Challenge

Randomized controlled trials—commonly called RCTs—set the gold standard for empirical analysis because of their rigor and objectivity. But while they have become the norm in fields like drug and medical device testing, experts acknowledge that it is difficult to execute RCTs for infrastructure because of the difficulty identifying counterfactuals. In the scope of electricity projects, this means trying to estimate how households with electricity would have fared if they did not have electricity.

"One way to deal with this counterfactual is to make electricity available in a randomized fashion and then observe how households similar in all characteristics except electricity compare with one another," notes a 2009 World Bank study on rural electrification in Bangladesh.

This is not how grid expansion projects are typically planned, however. "In order to be financially viable, electricity [projects] generally follow a plan to reach more developed and densely populated communities before more remote areas," the report explains. This highlights why in Kenya, for example, urban electrification (65 percent) far outpaces rural electrification (5 percent), even when a larger share of the population lives in rural areas.

Other experts note that there are also ethical considerations to randomly assigning infrastructure access to members within the same community.

The approach the REPP team is testing effectively allows for electricity connectivity to be randomized, while avoiding potential allegations of unfairness or favoritism. This is because the study merely encourages access by offering some households a discount for a power line connection.

The REPP team selected 150 villages in western Kenya that are within a mile (1.6 km) of a power transformer. In half of those villages, about 1,100

households were offered the discount; the other villages were not. Hundreds of the "treatment group" households responded to the incentive.

At the time of writing, the REPP team had begun analyzing information about the households that responded to the voucher. Over the next year, they will also review household energy usage and social and economic impacts between the study's connected and unconnected households.

Two other experts in the field, Maximo Torero and Tanguy Bernard from the International Food Policy Research Institute, used this approach in a smaller randomized study in Ethiopia. So far, these appear to be the only studies to attempt randomized impact evaluation on infrastructure development with this tactic. Torero and Bernard's work in Ethiopia exposed another possible reason why: researchers have little to no control over infrastructure delivery.

"The main problem we faced [in Ethiopia] was that, due to technical reasons, 10 of the 20 planned villages could not be electrified during the course of the study, affecting the study's overall statistical power," the authors note in one of their early reports.

This has not been an issue for the Kenya REPP so far, but Podolsky says it is nevertheless a logistically and financially intensive study that has exposed the challenges of research on this scale in remote places. Podolsky reflects that had they not been working in direct partnership with the Kenyan government, the project would have been unfeasible.

"Even if this was not an infrastructure project where you need the support of government, these interventions are not easily done. It is a very pricey proposition to set everything up, gather the surveys and analyze the data," he says.

Changing Course

When the Berkeley REPP team began laying the groundwork for the Kenya study in 2012, they had no intention of partnering with the government—nor were they interested in studying grid infrastructure at a national level. Instead, the RCT was meant to focus on another type of technology: microgrids.

Microgrids—or small, decentralized power systems—have been gaining traction as a way to improve power access to the world's energy poor, particularly as more infrastructure is being privately financed. The team initially wanted to work with a private sector partner to set up and record the

impacts of 40 village microgrids. Six months into their field assessment, however, they realized the project would not be feasible.

"The microgrids we wanted to install were best suited for communities with high population densities," Lee explains. But density is sparse in rural Kenya. The team then found that there were few truly off-grid villages; rather, villagers were not connected to the many power lines nearby.

The team's discovery of what they call the "under-grid" population compelled them to reframe their problem statement. "The problem isn't a dichotomy between on-grid and off-grid; there are also people living 'under-grid'," Lee says. "We hope to change the [way] we view the energy poverty problem because the policy implications for [these] communities are different."

By drawing from the limited research available, including the Ethiopia study, the REPP team re-spun their project to better understand what prevented rural Kenyans from requesting an electricity connection. Hypothesizing that cost was a critical barrier, the Berkeley researchers adopted the voucher incentive approach with the intention of analyzing cost-demand curves of connectivity.

"What started as an impact study on rural electrification shifted to a project about cost and demand economics for supplying access to energy," Lee says.

A Case for Grid Investment?

This kind of rigorous analysis and insight could have a significant impact on the world's least electrified continent and beyond, particularly as population growth intensifies the need for infrastructure development.

In Kenya, for example, the government announced a mass electrification program to connect every household within 600 meters of a transformer by 2020. Its strategy will look to replicate the REPP team's model by connecting groups of households at a discounted rate, which is more cost-effective than line-by-line extension, Podolsky notes.

"Grid technology is not the most exciting, but it may well be the most effective way to get power to people," he says. The REPP team hopes to be able to advise the government on the best price point to do that.

Findings from this study could also affect other countries in Africa, which view Kenya as a regional leader. Seeing whether Kenya's initiative achieves positive economic benefits could motivate more informed (and speedier) investment elsewhere.

In a 2014 report on the impact of rural electrification, Torero identifies “profit maximization” as one important area where research could support infrastructure development. “That is, taking into account that more remote areas might have high productive potential that would be realized by electrification,” he writes, ultimately making investments profitable.

Podolsky says that being able to present a clear picture of the grid’s value proposition is exactly what the REPP team hopes to achieve.

“It might prove that grid connectivity requires large investments, but if the benefits are there, it would be a net-positive endeavor,” he says. “Or we may find that those impacts aren’t there—that information is just as valuable.”

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