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INTERNATIONAL POLICY
RESEARCH AND EVALUATION

IssueBRIEF

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The Kigoma Solar Activity in Tanzania: Evaluation Findings

School solar system

The $11 million Kigoma solar activity was one component of a $199.5 million energy sector project in Tanzania funded by the Millennium Challenge Corporation (MCC). The solar activity was designed to provide photovoltaic (PV) systems in the Kigoma region of Tanzania to schools, health centers, markets, businesses, fishermen, and households. Mathematica's performance evaluation found that two years after the activity, use of solar PV systems increased both among those targeted to participate in the program and those who were not targeted, which may reflect a growing interest in solar energy in the region. Recipients of the PV systems were using their systems regularly but reported some issues with the systems' capacity and performance. Liquid fuel use was lower among those targeted for the systems than among those not targeted, suggesting that solar PV systems may serve some of the same energy needs as liquid fuels, such as providing light and powering appliances. There was limited evidence of an association between the Kigoma solar activity and other key outcomes such as investments, economic activity, or human capital accumulation.

The activity was designed to provide solar photovoltaic (PV) systems for schools, health centers, and village markets, and support the sale of systems to fishers, households, and individual businesses, with financing through local credit institutions.

THE KIGOMA SOLAR ACTIVITY

Improving access to high quality electricity can be a key driver of economic growth and household well-being. In an effort to promote economic growth and reduce poverty in Tanzania, the Millennium Challenge Corporation (MCC) funded an energy sector project to increase the availability of reliable, high quality electricity to people in Tanzania. The Kigoma solar activity, one component of the energy sector project, was designed to promote solar power systems in the Kigoma region of western Tanzania. The activity was designed to provide solar photovoltaic (PV) systems for schools, health centers, and village markets, and support the sale of systems to fishers, households, and individual businesses, with financing through local credit institutions. Supporting components included marketing of the solar systems and information on their benefits; training of installers, vendors, and end users; and maintenance and post-sale services, all aimed at developing a market for solar PV systems in the Kigoma region. The activity was expected to affect key outputs and outcomes and to reduce poverty through economic growth, as described in the logic model below.

The Kigoma solar activity is well aligned with the Tanzanian government's interest in expanding access to electricity to promote

APRIL 2017

Activity logic for the Kigoma solar activity

PROCESS

- Conduct feasibility study
- Implement activity
- Distribute PV systems to beneficiaries
- Develop market for PV systems

OUTPUTS

- Increased access to electricity
- Increased technical/ maintenance capacity of end users

OUTCOMES

- Improved electricity coverage
- Improved quality of service
- Increased electricity consumption

OBJECTIVES

- Increased investment and economic activities
- Improved human capital accumulation

COMPACT GOAL

- Poverty reduction and economic growth

economic growth. Tanzania's National Electrification Program Prospectus includes plans to increase electrification rates to 50 percent by 2020, and solar-installed capacity to 100 megawatts by 2025 (Harrison et al. 2016; Ministry of Energy and Minerals 2014). Thus, solar power is expected to make an important contribution to increasing access to energy in Tanzania, especially in rural areas. In recent years, the development of off-grid solar power services in Africa has also received increasing support from the international community through initiatives such as the Power Africa initiative by the U.S. government, the Lighting Africa initiative by the World Bank Group, and the Energy Africa campaign by the U.K. Because of the increased focus on solar power in Tanzania and across Africa, findings from the Kigoma solar activity provide some useful insights into the implementation of solar programs and their ability to expand access to electricity and reduce poverty.

Mathematica Policy Research recently completed a performance evaluation of the Kigoma solar activity. The specific questions this evaluation sought to answer were:

1. How was the Kigoma solar activity implemented?
2. How did outcomes differ at follow-up and change over time for the targeted group selected to receive the Kigoma solar activity versus the nontargeted group?

We addressed these questions by comparing outcomes among survey respondents who were targeted for the Kigoma solar activity and a set of nontargeted comparison respondents at two separate time points: shortly after the activity had been implemented (referred to as the "interim survey"), and two years later (the "follow-up survey").

FINDINGS

Implementation generally occurred according to plan. The seven types of individuals and institutions targeted by the Kigoma solar activity are summarized in Table 1. At follow-up, we found that implementation was generally successful, with most targeted institutions receiving solar PV systems funded by the Millennium Challenge Account-Tanzania (MCA-T) as expected. Schools, health facilities (dispensaries and health centers), and businesses in village markets generally received access to solar PV systems according to plan, and individual households and businesses purchased systems through Savings and Credit Cooperative Organizations (SACCOs).

However, the activity faced some key implementation challenges, some of which limited our ability to evaluate certain components of the activity. For example, during the marketing phase, short message service (SMS) messages were intended to provide an important way to disseminate information about the activity to large audiences, but in the follow-up survey, we found that no respondents had received these messages. This may be the result of a translation issue in the survey, but it may also be that these messages were not appropriately targeted, or there may have been other reasons why they were unpopular among respondents. There also appears to have been very limited uptake of solar PV systems among fishers because no fishers in our study sample reported having participated in the activity, though the interim report did find some use among fishers (Busalama 2013). Because of this, we were unable to assess how the activity affected fishers' operations in these communities and we omit fishers from most of our analyses unless noted otherwise.

Solar PV use was common among those who received MCC-funded systems. All targeted health centers and dispensaries, and 80 percent of targeted schools, were using their MCC-provided solar PV systems at the time of the follow-up survey. Use of MCC-funded PV systems was lower among market businesses, individual businesses, and households (Table 2).

As use of solar PV systems grows, so do expectations for their performance and capacity. Our implementation findings indicate that solar PV systems are being used and are helping to meet the energy needs of most respondents in the targeted communities. The use of solar PV systems increased slightly over time among both targeted and nontargeted respondents, which suggests that the systems are growing in popularity. However, the percentage of MCA-T system users who reported that their solar PV systems met their energy needs fell over time, from 42 percent in the interim survey to 31 percent in the follow-up. This

Table 1. Key components of the Kigoma solar activity

Respondent type	PV system and purpose	PV system capacity	Number targeted to receive systems
1. Schools	Metered AC electrical system for lighting classrooms and offices, computer/TV use, and cell phone charging	3 kilowatt hours (kWh) per day	45 schools
2. Dispensaries; 3. Health centers	Metered AC electrical system for lighting and media services, and cell phone charging; Vaccine refrigerator system for storing BCG, measles, and polio vaccines, as well as other vaccines as needed	1 kWh per day	116 dispensaries; 14 health centers
4. Fishers	Encouraged to purchase systems through beach management units (BMUs)	0.45 kWh per day (powering 5 LED lamps for 9 hours)	38 BMUs
5. Businesses in village markets	Utilized power from village market systems. Village markets received electrical systems to provide general lighting in the market and lighting for individual businesses.	2.6 kWh per day	25 village markets
6. SACCO businesses; 7. SACCO households	Encouraged to purchase unmetered Pico Solar PV systems and Solar Home Systems through SACCOs that could be used for a variety of home and small business needs.	20–50 Watt peak	N/A

Source: Kigoma solar baseline and interim performance evaluation report (Busalama 2013).

As the demand for solar PV systems grows, it will be important for providers to ensure that the systems available to users are of high quality and remain functional.

suggests that as solar PV systems become more common and as electricity becomes cheaper and more efficient, community members' needs and expectations regarding the availability of electricity may be growing and/or that the systems may be degrading over time.

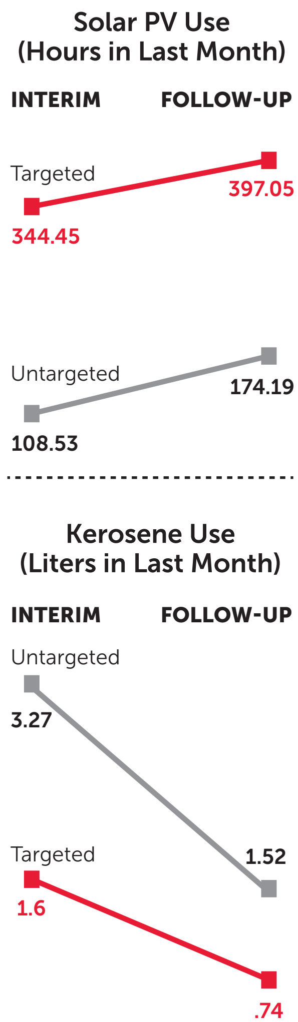
Solar PV systems face quality issues, and a lack of maintenance and repair training may limit their utility and popularity. As the demand for solar PV systems grows, it will be important for providers to ensure that the systems available to users are of high quality and remain functional. Our implementation findings suggest that although MCA-T-funded systems may have performed better than other systems, all systems experienced problems fairly frequently, and only a small proportion of targeted respondents received the maintenance and repair training that was designed to be a component of the Kigoma solar activity.

Table 2. Installation of MCA-T solar systems among targeted respondents

Respondent type	Number of targeted respondents	Received MCA-T PV system	Currently using MCA-T PV system
Schools	10	100%	80%
Health centers	6	100%	100%
Dispensaries	14	100%	100%
Village market businesses	12	92%	67%
SACCO businesses;	14	71%	57%
SACCO households	15	93%	53%
Fishers	8	0%	0%

Source: Kigoma solar interim survey (2013) and follow-up survey (2015).
Notes: Targeted respondent sample size = 71. Sample sizes for some variables may be smaller due to nonresponse.

Solar PV and kerosene consumption



Source: Kigoma solar interim survey (2013) and follow-up survey (2015).

The use of solar PV systems increased over time, among both targeted and nontargeted respondents, and was consistently high in the targeted group at interim and follow-up. The growing amount of solar PV use in the nontargeted group may reflect the fact that other donors and implementers were working on solar programs in the Kigoma region at the same time, and may also point to the fact that the demand for these systems are growing in the study area.

Liquid fuel use was lower among targeted respondents than nontargeted respondents both at interim and at follow-up, which is consistent with the hypothesis that solar PV systems could help to meet many of the same energy needs that liquid fuel sources typically meet, such as providing light and powering appliances.

Findings from the performance domains provide limited evidence of association between the Kigoma solar activity and improvements in outcomes related to investments, economic activities, and human capital accumulation for specific respondent types. Note that our small sample sizes limit our ability to assess these outcomes deeply. After controlling for respondent type, we found no statistically significant differences between targeted and nontargeted respondents in the number of staff or hours of operation of schools, health facilities, or businesses; per capita household income; or the availability of vaccine refrigerators at health facilities. We found that although most targeted and nontargeted health facilities had vaccine refrigerators available, key vaccines were more commonly found in targeted health facilities than in nontargeted facilities.

CONCLUSIONS

The growing focus on improving access to electricity in sub-Saharan Africa, and in Tanzania in particular, has provided the political will necessary to test and develop programs to deliver electricity to rural and other hard-to-reach populations. Given the high costs associated with expanding access to grid electricity and the falling cost of solar energy worldwide, programs such as the Kigoma solar activity may offer a relatively low-cost and effective way to bring electric energy to many rural Tanzanians. Such efforts could help change how people and institutions use energy sources, reduce energy costs for individual households and businesses, enable schools and health facilities to serve people better, and ultimately reduce poverty.

Our findings suggest that the Kigoma solar activity has achieved some of these expected outcomes. Specifically, the overall high use of and satisfaction with solar PV systems, coupled with some changes in the consumption of liquid fuels, suggest that the activity may have helped to encourage solar energy use. Although there is some evidence to support the hypothesis that increased solar energy consumption could help lead to longer-term outcomes, such as improved facility operations and increased income and revenues, our results in this area were generally very imprecise.

Our study provides useful information on solar energy use, and although our evaluation was not a rigorous assessment of the Kigoma solar activity's impacts, it provides a basis for evaluations of future efforts to expand access to solar energy. Future evaluations that allow for longer-term assessments and more rigorous methods could help to produce more rigorous evidence on how expansion efforts work and to what extent they can be used to meet the energy needs of sub-Saharan Africa.

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