Researchers release evaluation of solar pumps for irrigation and salt mining in India

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With the right business model, solar panels and pumps could be a promising sustainable irrigation approach for smallholder farmers in India. Credit: CITE at MIT

In 2014, the government of India made an ambitious goal to replace 26

million groundwater pumps run on costly diesel, for more efficient and environmentally-friendly options such as solar pumps.

Groundwater pumps are a critical technology in India, especially for small scale farmers who depend on them for irrigating crops during dry seasons. With the lack of a reliable electrical grid connection, and the high price and variable supply of diesel fuel, solar-powered pumps have great potential to meet farmers' needs while reducing costs and better preserving natural resources.

MIT researchers have just released a new report evaluating a range of solar pump technologies and business models available in India for irrigation and salt mining to better understand which technologies can best fit farmers' needs.

The report, "Solar Water Pumps: Technical, Systems, and Business Model Approaches to Evaluation," details the study design and findings of the latest experimental evaluation implemented by the Comprehensive Initiative on Technology Evaluation (CITE), a program supported by the U.S. Agency for International Development (USAID) and led by a multidisciplinary team of faculty, staff, and students at MIT.

Launched at MIT in 2012, CITE is a pioneering program dedicated to developing methods for product evaluation in global development. CITE researchers evaluate products from three perspectives, including suitability (how well a product performs its purpose), scalability (how well the product's supply chain effectively reaches consumers), and sustainability (how well the product is used correctly, consistently, and continuously by users over time).

Designing the study to fill information gaps in the market

Despite the tremendous potential for solar pumps to fill a technological need, there is little information available to consumers about what works best for their needs and a wide range of products available for selection.

"There's a lot of potential for these technologies to make a difference, but there is a large variance in the cost and performance of these pumps, and lot of confusion in finding the right-sized pump for your application," says Jennifer Green, CITE sustainability research lead and MIT Sociotechnical Systems Research Center research scientist. "In many areas, the only people to turn to for information are the people selling the pumps, so an independent evaluation of the pumps working with our partners provides a third-party, non-biased information alternative."

To conduct the evaluation, MIT researchers worked closely with the Technology Exchange Lab in Cambridge, Massachusetts, as well as the Gujarat, India-based Self Employed Women's Association, a trade union that organizes women in India's informal economy toward full employment and is currently piloting use of solar pumps in their programs.

MIT and Technology Exchange Lab researchers examine a solar pump during a field visit in Gujarat, India. Credit: CITE at MIT

Researchers tested the technical performance of small solar pump systems in the workshop at MIT D-Lab, and tested larger solar pump systems in communities in India where they were in active use. This allowed for more rigorous, controlled lab testing as well as a more real-life, grounded look at how systems operated in the environment in which they would be deployed. Researchers also used a complex systems modeling technique to examine how the pumps impacted the social, economic, and environmental conditions around them, and how different government policies might impact these conditions at a macro level.

"That was very important because although these are 'clean pumps' from the perspective of using solar, there is a concern that there is not a cost incentive to pump less and use less water," Green says. "When people are using diesel, they pay by the liter, so they use as little as possible. With solar, once people make the capital investment to purchase the equipment, they're incentivized to pump as much as possible to get a good return on investment and have potential to do serious harm to the groundwater supply."

Identifying the most appropriate, accessible technologies

In the lab, MIT researchers procured and tested five pumps—the Falcon FCM 115, the Harbor Freight, the Kirloskar SKDS116++, the Rotomag MBP30, and the Shakti SMP1200-20-30. Lab tests on flow rate, priming ease, and overall efficiency demonstrated that two of the lower-cost pumps—the Falcon and the Rotomag—performed the best, and the most expensive pump—the Shakti—performed poorly. MIT researchers also studied pump usage, installing remote sensors in panels and pumps being used in Gujarat, India to ensure that the pumps were being used consistently over the course of a day, and operating properly.

Because solar pumps are often too expensive for small-scale farmers, CITE also conducted a business case analysis to understand what financing mechanisms might make solar pump technology more affordable for these critical end users. For example, researchers looked at government policies such as subsidizing the cost of solar equipment and paying for excess electricity production as a combination that might help farmers make this transition.

"The cost of solar pumps is still prohibitively high for individual farmers to buy them straight out," Green says. "It will be critical to ensure

financing mechanisms are accessible to these users. Coupling solar pump systems with well-thought out government policies and other technologies for minimizing water use is the best approach to optimizing the food-water-energy nexus."

In addition to the evaluation, CITE created a pump sizing tool that can be used to help farmers understand what size pump they need given their particular field sizes, water requirements, and other factors.

"That gives them more knowledge and power when they go to talk to the water pump manufacturers," Green says. "If they know what they need, they're less likely to be talked into buying something too big for their needs. We don't want them to overpay."

"CITE's evaluation work has been a great value-add [for the Self Employed Women's Association] because we can better understand which pumps are most efficient," says Reema Nanavaty, director of the Self Employed Women's Association. "We're not a technical organization and we did not want to set the livelihoods of these poor salt pan workers by bringing in the wrong kind of pump or an inefficient pump."

More information: Solar Water Pumps: Technical, Systems, and Business Model Approaches yo Evaluation.
cite.mit.edu/system/files/reports/Solar%20Water%20Pumps-%20Technical%2C%20Systems%2C%20And%20Business%20Model%20Approaches%20To%20Evaluation%20.pdf

In Another World: Salt Production in the Little Rann of Kutch.
cite.mit.edu/another-world-sal … on-little-rann-kutch

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