Inclusive Digital Economy Kit

Switch your economy on for all

India: Increasing electricity coverage with off-grid solar power

Infrastructure

In 2014, 137 million Indians didn't have access to electricity. Of those that did, around half faced black-outs and high electricity costs. Expanding the grid to rural and remote areas was expensive for the government, meaning a shift in approach was needed. Indian Institute of Technology Madras (IITM) started engaging with private energy start-ups and various government departments to develop a modern energy technology called Solar-DC and brought rooftop solar energy to off-grid communities across 12 different states of the country. Solar-DC technology now provides quality and affordable electricity to about 50,000 households in remote regions of India.

The problem

In 2014, 237 million Indians out of a population of 1.3 billion didn't have access to electricity.[1] Of those connected to the grid, around half of households faced black-outs and high electricity costs.[2] Poor communities living in the rural and semi-urban areas and mountainous regions were the most affected, which in turn restricted health and education services and economic growth.

Electricity provision in India has historically been the responsibility of the public-owned and run companies for power generation, transmission and distribution. While the government succeded in providing electricity infrastructure to most urban areas, many rural and remote areas remained off-grid. This was mainly because grid extensions to these areas were expensive and viewed as commercially unviable. To address this, the government launched the *Deendayal Upadhyaya Gram Jyoti Yojana* scheme in 2015 and the *Pradhan Mantri Sahaj Bijli Har Ghar Yojana* scheme in 2017 – both aimed to provide universal electricity access with an increased emphasis on off-grid renewable energy projects.[3,4] However, the Indian market lacked renewable energy products that were affordable, easy to install and efficient in providing good-quality electricity.

Solution

An example of an initiative which disrupted this situation is a rooftop-solar power technology developed by the Indian Institute of Technology Madras (IITM, an engineering university). Aided by the recent technological advancements in power electronics, IITM designed and built *Solar-DC* technology. *Solar-DC* system is designed to take in the direct current (DC) generated by a rooftop-solar panel and give a DC output – instead of the more common alternate current (AC) output – to power DC appliances at home. Since most of the appliances (like LEDs and ceiling fans) and electronics (like laptops, mobile phones and TVs) used in a typical Indian home are

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already DC-based, this avoids the need for any DC-AC and AC-DC conversions during power distribution. About 45% of the electricity gets lost in these conversions when more common AC solar power solutions are used for DC appliances. *Solar-DC*, therefore, is more efficient and this efficiency also helps make Solar-DC around 40% cheaper than AC alternatives.[5]

IITM researched, designed and developed Solar-DC. It then partnered with private energy start-ups to build DC-appliances and test prototypes. With the success of early trials, the Ministry of Power provided a grant funding to IITM to run a larger pilot. IITM, through a collaboration with Rural Electrification Corporation (REC) (a public infrastructure finance company) ran a pilot covering 4000 off-grid homes in Rajasthan, India. The pilot used 125 Watt panels with 1kWh battery version of *Solar-DC* which powered 1 DC tube light, 1 DC ceiling fan, 2 LED bulbs and a mobile phone charger. An AC-powered solution would have needed 500Wp panels and 5kWh batteries to power the same set of appliances resulting in much higher costs. The pilot also used GPRS technology to remotely monitor the systems over cellular network which helped to further reduce maintenance costs. Professor Jhunjhunwala, who spearheaded the initiative, commented: "This sent a strong message that Solar-DC worked in remote and rural areas where the government was struggling to find good solutions."

Seeing its potential, the Ministry of Power gave further grant funding to the IITM to roll-out Solar-DC on a larger scale. At the same time the IITM partnered with various appliance manufacturers to develop more DC-based products such as coolers, ceiling fans, mixers, grinders, air-conditioners and induction stoves to help create demand for Solar-DC. It also worked with the Bureau of Indian Standards to develop standards for DC appliances.

Impact

After six years of development and testing, Solar-DC technology is now deployed in more than 50,000 homes across twelve states in India – including in 4000 homes in desert regions in Rajasthan, 10,000 homes in the Himalayan state of Jammu & Kashmir, and 27,000 and 3,200 homes in remote regions of Assam and Manipur, all of which were formerly off-grid. [6,7] The Solar-DC initiative became a part of a broader set of government electrification projects that reportedly provided 99.99% of households in India with access to electricity infrastructure by 2019.[8] And while there are few studies on the link between electricity access, internet usage and broader health, education and economic outcomes, off-grid renewable solutions like Solar-DC will certainly have played a positive role.[9]

Risks:

Of course, it wasn't all plain sailing. IITM had to withstand pressure from groups and individuals in government to work with firms importing lower-quality solar panels and DC appliances. Professor Jhunjhunwala explained: "We couldn't push low-quality products on low-income households as some aid agencies do. People from low-income homes have high aspirations too. So, we developed solutions I would find acceptable in my own house. Transforming lives

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requires a certain level of quality electricity and that is where the countries looking to invest in electricity infrastructure should focus."

IITM also had to pivot its approach during the roll-out. In some places people didn't use the full amount of solar electricity captured by the *Solar-DC* technology, which led to wastage. So IITM established a network of homes on one *Solar-DC* system and created a microgrid. But this was not perfect as people didn't want to share electricity. The high usage of mainstream AC-based appliances was also a problem as these are incompatible with *Solar-DC*, so IITM is now working on developing an AC output for the product.

The Lesson

The case of Solar-DC roll-out gives an example of government, academia and private firms coming together to deliver a new technology to the poor in a way which Is economically viable. The collaboration between academia, industry and government worked well during this time and was critical for the scale that Solar-DC technology achieved. The then Minister of Power called it a 'Public-Private-Professor-Partnership.' IITM is now working with private firms to make Solar-DC a commercial product available for both on and off-grid customers."

This case benefitted from inputs from Dr. Ashok Jhunjhunwala and Dr. Prabhjot Kaur.

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Endnotes:

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