

Are mini-grids still relevant in India?

What is a mini-grid?

Mini-grids are not a new phenomenon. Nearly all current centralized electricity grids started with isolated mini-grids, which gradually expanded and got interconnected over the years. In the next

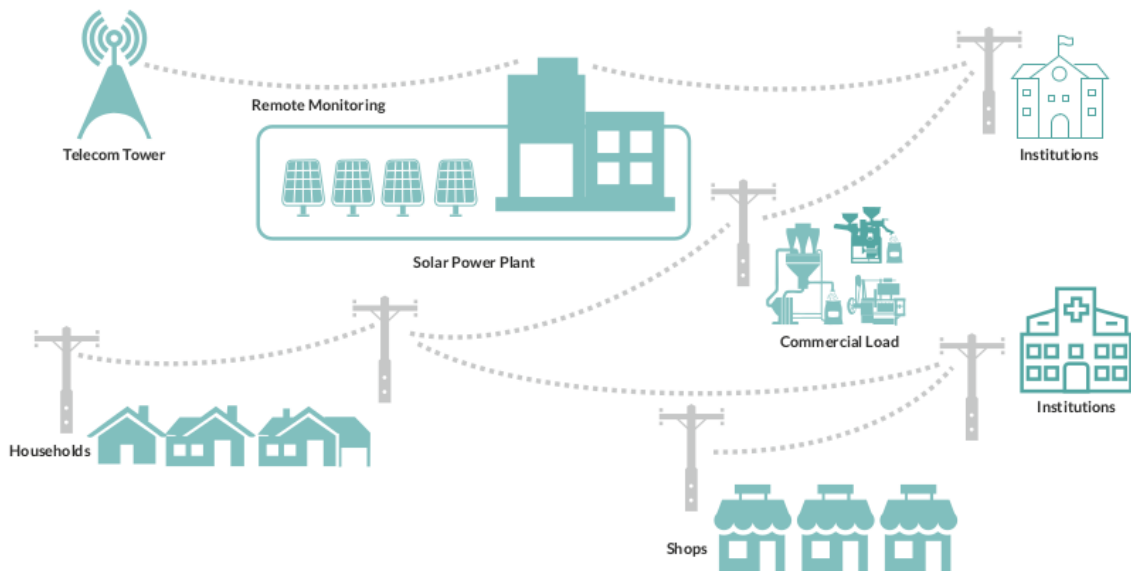


Figure 1: A typical schematic of a mini-grid in rural India

generation, which is typically called the second generation of mini-grids, systems set up are typically small and isolated, powered by diesel and in some cases hydro, and built by local communities or entrepreneurs to provide access to electricity to households, primarily in rural areas that were yet to be connected to the centralized grid. These mini-grids also yielded lessons on technical design, productive uses, economies of scale, financial viability, and regulatory frameworks under which such projects can operate and the fine-tuning of regulations that are required for the joint operation of mini-grids with the centralized or main grid. They also underlined the importance of productive uses for the financial viability of mini-grids and the need to reduce the risk of stranded assets once the main grid arrives in areas hitherto not connected to the main grid.

Over the past few years, the third generation of mini-grids have emerged. Dominated by solar PV and battery storage technologies, these mini-grids are owned and operated by private companies that leverage transformative technologies and innovative strategies to build portfolios of mini-grids instead of one-off projects. The project developers use remote management systems, prepay smart meters, and the latest solar-hybrid technologies; and incorporate energy-efficient appliances for productive uses of electricity into its business model. These mini-grids are generally grid-interconnection ready and await the appropriate regulatory framework to be put in place for the same (Meier, 2017).

India has made significant progress in the development of mini-grids in recent years. According to a report by the International Energy Agency, as of 2021, there were over 5,800 mini-grids operating in India, providing electricity to more than 300,000 households and businesses. Most of these mini-grids are powered by solar energy. The Government of India (GoI) has been actively promoting the development of mini-grids as a way to increase access to electricity in rural areas. In 2016, the Ministry of New and Renewable Energy launched the Deen Dayal Upadhyaya Gram Jyoti Yojana, a scheme aimed at electrifying rural areas through a combination of grid and off-grid solutions, including mini-grids. In addition, the government has set a target of installing 10,000 renewable energy-based mini-grids in remote and inaccessible areas by 2021. The mini-grid sector in India is also supported

by various organizations and initiatives, including the Rockefeller Foundation's Smart Power for Rural Development program, which aims to promote the development of mini-grids in India and other countries.

All villages are electrified; are mini-grids still relevant?

However, there are also challenges facing the mini-grid sector in India, including regulatory barriers, financing constraints, and limited demand in some areas. Despite these challenges, the mini-grid sector is expected to continue to grow in India in the coming years as the government and private sector continue to invest in the development of off-grid renewable energy solutions.

In the context of 100% village and household electrification, it might seem that mini-grids have lost their relevance. This, however, is not true. While grid extension has provided the rural population with basic electricity services, the grid is not suitable for stimulating local economic development. The relevance of mini-grids in India can be summarised as follows:

- **Addressing energy access challenges:** Despite significant progress in recent years, a significant proportion of the Indian population still lacks access to reliable electricity. Mini-grids can help to address this challenge by providing clean and affordable electricity to remote and underserved communities.
- **Decentralized power generation:** Mini-grids offer a decentralized approach to power generation, which can reduce transmission and distribution losses and improve energy efficiency. This can also help to reduce the burden on the national power grid and enhance energy security.
- **Supporting renewable energy deployment:** Mini-grids are ideally suited for the deployment of renewable energy sources, such as solar, wind, and biomass, which can help to reduce greenhouse gas emissions and mitigate climate change impacts.
- **Promoting local economic development:** Mini-grids can support local economic development by creating job opportunities, promoting entrepreneurship, and facilitating the growth of small and medium-sized enterprises.
- **Enhancing resilience:** Mini-grids can help to enhance resilience to natural disasters and other shocks, by providing a reliable source of electricity even in the face of disruptions to the national power grid.

Overall, mini-grids have significant potential to contribute to India's sustainable development goals, including the provision of universal energy access, reducing greenhouse gas emissions, promoting economic development, and enhancing resilience to climate change and other shocks.