SOUTH ASIA
INNOVATION
PROJECT BRIEF

ADB

**High-voltage distribution system.** The Maharashtra Rural High Voltage Distribution System Expansion Program, supported by ADB, is working to enhance the efficiency of the electricity value chain.

AUGUST 2023 | No. 5

# Maharashtra Rural High Voltage Distribution System Expansion Program

## Setting the Scene: The Innovation Opportunity

Poverty is a major challenge in the state of Maharashtra, India. About 20 million people, or 17% of its population, are poor and more than half work in the agriculture sector and related fields. In rural areas, as much as 24% of the population are poor; however, in some districts, the poverty rate reaches 40%.[1]

Unreliable power supply contributes indirectly to the state's high rural poverty rate. Frequent power outages and poor quality of high- and low-voltage electricity supply often damage agricultural motor pumps. Farmers are forced to rely on diesel pumps for water supply, incurring additional equipment costs as well as high operational costs. They must deal with high diesel prices,[2] which have risen by 29% in the last 4 years,[3] in addition to repairing or purchasing increasingly costly diesel pumps to replace damaged motor pumps. Farmers who cannot afford these must make do with poor-quality electricity supply, which impedes efficient crop irrigation and agricultural productivity. Increased diesel prices as a result of the recent energy crisis are also causing food prices to rise, exacerbating poverty.

Maharashtra State Electricity Distribution Company Limited (MSEDCL) is India's largest electricity distribution company. It serves over 25.4 million customers across the state.[4] It has over 4.2 million agriculture customers in rural areas, accounting for an estimated 30% of its total electricity sales volume (footnote 4).

MSEDCL's losses in its rural segments are very high, even with recent improvements in the company's aggregate technical and commercial loss levels. Low metering rates, irregular billing, nonpayment of electricity bills, and delays in the receipt of electricity subsidy from the state government make it difficult for MSEDCL to provide quality and reliable power to rural

[1] Asian Development Bank (ADB). 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to India for the Maharashtra Rural Connectivity Improvement Project*. Summary Poverty Reduction and Social Strategy (accessible from the list of linked documents in Appendix 2). Manila.
[2] ADB. 2022. *Asian Development Outlook 2022: Mobilizing Taxes for Development*. Manila.
[3] Petroldieselprice.com. Monthly Historical Diesel Prices in Maharashtra (accessed 28 April 2023).
[4] ADB. 2020. *Report and Recommendation of the President to the Board of Directors: Proposed Results-Based Loan and Technical Assistance Grant to India for the Maharashtra Rural High Voltage Distribution System Expansion Program*. Manila.

**Site visit.** The project team, with ADB Executive Directors Chantale Wong and Sameer Kumar Khare, inspect one of the low-capacity distribution transformers installed by the project in Maharashtra.

consumers and to reduce its mounting financial losses. Based on a soundness assessment,[5] if these issues were addressed, MSEDCL could secure additional revenues amounting to approximately ₹2,756 million ($38,473,360 ), which it could reinvest in the electricity transmission and distribution system.

The state has been looking for a solution to this perennial problem. With the introduction of the Maharashtra Rural High Voltage Distribution System Expansion Program,[6] it is now looking forward to affordable, high-quality, efficient, and dependable electricity for its agriculture customers.

## What ADB Did: Innovation in Action

In 2016, the state government of Maharashtra set an ambitious goal of 100% electrification through its 24x7 Power for All Program.[7] It aims to provide customers with continuous and reliable power by using clean energy sources, improving energy efficiency, providing better power supply quality, and enhancing facilities and services. While the said program made significant progress in the electrification of rural households, it did not make much progress in the agriculture sector. A large portion of the state's agriculture sector still lacks access to reliable electricity. This prompted the state government of Maharashtra to review the requirements for a reliable rural power supply. It decided to provide agriculture electricity connection applicants with a metered high voltage distribution system (HVDS).[8] With HVDS, power is supplied to consumers at a higher voltage level and with an extensive network, reaching almost all customers' doorsteps.[9] This supply configuration helps reduce distribution losses and ensures effective metering and billing (footnote 9).

The Maharashtra Rural High Voltage Distribution System Expansion Program, the first results-based lending program[10] financed by the Asian Development Bank (ADB) in South Asia's energy sector, began to support the state in this endeavor in 2020. The program includes innovative components designed to make the energy supply in the state more efficient and reliable.

5 Footnote 4. Program Soundness Assessment (accessible from the list of linked documents in Appendix 2).
6 ADB. India: Maharashtra Rural High Voltage Distribution System Expansion Program.
7 Footnote 4. Program Implementation Document (accessible from the list of linked documents in Appendix 2).
8 HVDS is an electricity distribution system that has longer high voltage lines, more transformers and shorter low voltage lines.
9 Footnote 4. High Voltage Distribution Systems Experience and Technical Study (accessible from the list of linked documents in Appendix 2).
10 ADB. 2020. ADB Provides $346 Million Loan for Rural Electricity in Maharashtra, India. News release. 29 April.

## Key Innovations

### Using a more efficient energy distribution system

In India, power is traditionally distributed via low-voltage distribution system (LVDS). Technically and commercially, this is better suited to areas with a high concentration of customers, such as cities. Multiple customers are clustered together in a service area in this scheme, and power is distributed to them from a single shared transformer. This may appear to be cost-efficient, but LVDS has technical issues such as transformer and voltage line overloading when energy demand increases, resulting in brownouts and energy losses. Customers' electrical appliances may be damaged if power outages happen frequently.

LVDS is also prone to commercial losses. Under this system, there have been numerous reports of meter tampering and electricity theft in Maharashtra. Customers in rural areas also tend to overuse electricity since most of the supply is unmetered. Moreover, agriculture customers are hampered by very high voltage drops caused by long low tension lines that cross large fields in rural areas. This inefficient energy distribution causes frequent power outages and high technical losses, which negatively impact agricultural production. It leads to suboptimal pump performance as well as frequent transformer and motor pump damages.

By replacing LVDS with HVDS, the program aims to eliminate all these issues. Meter tampering is reduced with this new system because meters may be located on distribution poles that are difficult to reach. Electricity theft can also be avoided because HVDS reduces the length and cost of low-voltage lines. These lines also cater to previously identified customers.

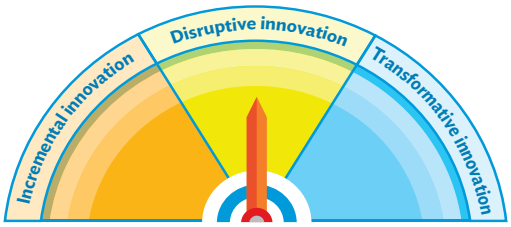
Economic analysis shows that the adoption of HVDS will reduce distribution losses, improve energy supply, and reduce damages to agricultural pumps and distribution transformers (footnote 4). In addition, an earlier pilot done by ADB in Madhya Pradesh on the adoption of HVDS for rural feeders significantly reduced overall losses from 35.0%–41.6% to 22.5%–25.1% in three different regions of the state.[11]

To replace the LVDS scheme in rural Maharashtra and to connect about 156,000 new agriculture consumers to HVDS, the program installed 132,600 customized low-capacity distribution transformers, with an efficiency of more than 99%. It built 46,800 kilometers of 11-kilovolt (kV) high-voltage line extensions to connect new customers to the existing distribution grid. In addition, 129 units of 33/11 kV distribution substations were upgraded to increase the upstream distribution network capacity for HVDS to supply power to new customers.

### Putting people and the environment first

The program prioritized the people and the environment to ensure long-term development. It was designed as a demand-driven intervention. Consultation with the local farmers was an integral component of the program. While the program provides power supply to agriculture consumers, all connections are voluntary.

**LEVELS OF INNOVATION**
RURAL HIGH VOLTAGE DISTRIBUTION SYSTEM EXPANSION PROGRAM




- **Incremental innovation** improving on existing products, services, approaches, or processes, i.e., doing what is already done, but better
- **Disruptive innovation** "shakes things up" or subverts previous approaches. Instead, using approaches that are new in the country context or are a demonstration project.
- **Transformative innovation** shifts the whole system over time to new viable approaches by scaling disruptions, new approaches, and pilots.

Source: Asian Development Bank.

The program made sure there were no adverse impacts on indigenous peoples or vulnerable groups. There was no compulsory land acquisition nor was there any involuntary resettlement. It built the infrastructure through mutual negotiation and a participatory approach. The vulnerable groups were the program's partners and beneficiaries.

It also protected key biodiversity areas or national protected areas, such as wildlife sanctuaries or reserves, forests, and cultural heritage sites. Activities in, or directly adjacent to, these sites were avoided, and where this was not possible, a proper mitigation plan was prepared, or some of the components of the program were excluded. The program had no significant, irreversible, diverse, or unprecedented negative environmental and social impacts because safeguard screening guidance was used, and relevant national regulations and practices were implemented. An accompanying technical assistance has also demonstrated ways to conserve energy and water as well as how to use drip irrigation to save even more water.

### Training for new technology

The program aided in the development of MSEDCL's institutional capacity. It trained approximately 1,000 MSEDCL staff in HVDS capital investments, operation, maintenance, monitoring, and safeguards, as well as on agricultural metering systems, including billing, collection, and enforcement. The program also offered staff training on systems for physically verifying HVDS assets. In addition, the program conducted periodic awareness-raising activities to familiarize farmers on HVDS and the efficient use of water and electricity. The Maharashtra Energy Development Agency, in collaboration with the Energy Efficiency Services Limited, also provided farmers with a training program on energy and water conservation.

[11] Footnote 4. Sector Assessment (Summary): Energy (accessible from the list of linked documents in Appendix 2).

These interventions assisted Maharashtra in increasing electrical agricultural connections to metered HVDS by 156,000 in 2021, roughly a year after the program began. It also increased the number of commissioned HVDS distribution transformers by 132,600. All of these changes, aside from making power supply reliable and cheaper for farmers, helped reduce carbon emissions by 2.5 million tons.

## Innovation Takeaways

### Readiness for change

Progress requires change. In Maharashtra, changing the traditional electricity distribution system was not easy because only a few people were aware of the benefits of HVDS. Even though the state had already studied the feasibility of such change, adoption was slow because of a lack of awareness of energy efficiency, high upfront costs, frequent pump burnout due to poor voltage regulation, and unmetered power supply. To become ready for change, Maharashtra studied a new technology, reviewed existing business models, and learned the steps that will bring them closer to its goal of power for all. The eventual adoption of HVDS in Maharashtra allowed the state to provide farmers with quality and reliable electricity, enabling them to increase their incomes and productivity.

### Prioritizing the marginalized

One of the program's defining characteristics is its emphasis on the agriculture sector, which comprises much of the state's poor. The program was designed to specifically improve the lives of farmers who needed dependable power supply. By providing this, the program supported Maharashtra in increasing agricultural productivity, farmers' incomes, and the sector's growth to 5% per year.

**INNOVATION AREAS**
RURAL HIGH VOLTAGE DISTRIBUTION SYSTEM EXPANSION PROGRAM

| AREA | INNOVATION | THIS PROJECT |
|---|---|---|
| FINANCING | Innovative financial products that help developing member countries finance complex projects and programs | |
| TECHNICAL DESIGN | Innovative technical solutions that improve sustainability, efficiency, and effectiveness | ✓ |
| IMPLEMENTATION | Innovative implementation design that helps to overcome bottlenecks in institutional capacity or governance | ✓ |
| PARTNERSHIPS | Value-adding partnerships and collaborations that bring enhanced knowledge and skills | ✓ |
| ADB'S INTERNAL PROCESS | Innovative processes that make ADB more efficient and effective | |

ADB = Asian Development Bank.
Source: Asian Development Bank.

### New technology can reduce poverty

The program areas covered the regions of Konkan, Marathwada, Northern Maharashtra Vidharbha, and Western Maharashtra. The power supply from the newly built substations under the HVDS scheme has begun to provide farmers with uninterrupted power.[12] The farmers shared that instead of 5-horsepower (HP) diesel pumps, they now mostly use 3 HP and 5 HP electric pumps for agriculture, while a few use 7.5 HP electric pumps (footnote 12). These electric pumps are comparatively cheaper.

Farmers shared during consultations that agriculture yield has increased in some areas, and is expected to increase by 25%–50% (footnote 12). In some cases, the yield has even doubled. Sugarcane output increased by 50% in Aral village where farmers grow sugarcane, cotton, arhar (pigeon pea), chana, turmeric, and watermelons. Soya bean is expected to increase by 100% with the HVDS supply. Rice production is expected to increase from 14 quintals per acre to 20 quintals under the new system, while vegetable production is expected to increase by 20%. Farmers practicing monocropping are now optimistic that they will be able to grow double crops such as rabi crops and even introduce new ones. Some farmers have also begun to introduce commercial crops like sugarcane, grapes, and many horticultural crops, which they could not grow before because of poor water supply and unreliable electricity (footnote 12).

The program is now playing an important role in reducing outward migration. Because of lack of work during the off seasons, families used to migrate to other areas for sugarcane cutting. Now, with the availability of water—thanks to the program—outward migration has decreased by 70% (footnote 12). Farmers are also optimistic that the reliable electricity supply will jumpstart poultry and dairy projects; small ancillary units like rice mills, flour mills, livestock feeding mills, and welding shops; and small home-based industries. All these create better livelihood opportunities for the people.

## Faces of Impact: Jyotirmoy Banerjee, senior project officer (energy), ADB

**Q: How did the new system reach the farmers and their fields, which are vast and sometimes hard to reach?**

**A:** Small capacity transformers with an average of 10 kilovolt-amperes (kVA), 16 kVA, and 25 KVA made up the new power supply system. The program built these transformers close to the water sources used by the farmers. It also installed an 11 kV high-tension (HT) line at the HT tapping of each transformer. To calculate the average HT line length, technologies such as the mobile app Mahavitaran were used to map the geographical coordinates of HT tapping and consumer endpoints for each connection. The program used both full turnkey and partial turnkey contracts to speed up the construction,

[12] MSEDCL. 2021. Environmental and Social Monitoring Report: India—Maharashtra Rural High Voltage Distribution System Expansion Program (prepared for ADB)

## Voices from the Field

*"After the individual transformers were installed under the high voltage distribution system (HVDS) scheme, water extraction was optimized to our needs. My pump and wires used to burn out frequently because the voltage used to be very low. The new system eradicated these issues. I now have more water available for irrigation."*

**Yuvraj Ankushrao Dhavile**
HVDS project beneficiary
Nalegaon Village, Latur

with nearly 648 agencies awarded contracts throughout the state to complete this system on schedule.

**Q: What were the challenges in implementing this new electricity distribution system?**

**A:** Since HVDS was a new concept for the state of Maharashtra, it began with time-consuming HVDS transformer designs, approvals, and type tests. Various factors delayed its installation, which included a temporary lag in the supply of transformers because manufacturers lacked the necessary production capacity for small-capacity transformers. The need for physical inspection before the state's approval also delayed the installation. This restriction was later relaxed by the state government. The coronavirus disease (COVID-19) pandemic, heavy rains, and standing crops in the field significantly slowed down the installation of the HVDS.

**Q: What makes this program a success?**

**A:** Since the program is based on a results-based loan, it was able to progress based on incremental and accumulated achievements validated against success indicators. Some of its most notable gains include improving voltage regulation at the consumer's end from a baseline of <+/–15% to <+/–6% and reducing the transformer failure rate from 12% to 2.6%. Additionally, more than 95% of agriculture consumers energized under HVDS are now billed using a usage-based energy charge. These achievements have resulted in the reliable and high-quality rural power supply to the agriculture consumers of Maharashtra.

## Learn More

**Project documents:** ADB. India: Maharashtra Rural High Voltage Distribution System Expansion Program.

**News release:** ADB. 2020. ADB Provides $346 Million Loan for Rural Electricity in Maharashtra, India. News release. 29 April.

***South Asia Innovation Project Brief Series*** captures and disseminates knowledge on innovation embedded in ADB's operations in South Asia. This series promotes cross-project learning, improves project design and implementation, strengthens the understanding of innovation needs and trends, and enhances development effectiveness of ongoing and future projects and south-south knowledge cooperation. The South Asia Department administers the series.
Please contact SARDKM@adb.org.

This issue is supported by the Republic of Korea e-Asia Knowledge and Partnership Fund.

https://www.adb.org/publications/series/south-asia-innovationproject-briefs



**About the Asian Development Bank**
ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members—49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
Tel +63 2 8632 4444
Fax +63 2 8636 2444



ISBN 978-92-9270-258-8 (print); 978-92-9270-259-5 (electronic)
Publication Stock No. BRF230283-2
DOI: http://dx.doi.org/10.22617/BRF230283-2