USAID
FROM THE AMERICAN PEOPLE

ENERGIZING SOUTH ASIA

IMPACT STORIES ON CLEAN ENERGY TRANSITION

ACKNOWLEDGEMENT

This publication is made possible by the contributions and dedicated efforts of numerous partners, both individuals and institutions, who generously contributed their time and insights during the identification, collation, and development of the impact stories and case studies, as well as throughout the review process.

We are deeply grateful to the government agencies across South Asia that have not only shared their valuable experiences but have also been pivotal champions and enablers of these clean energy initiatives, ensuring their success and impact throughout the region. We would like to acknowledge and thank:

- Ministry of Power, Government of India (GoI)
- Ministry of New and Renewable Energy (MNRE), GoI
- Ministry of Heavy Industries (MHI), GoI
- Ministry of Housing and Urban Affairs (MoHUA), GoI
- Ministry of Railways, GoI
- Energy Efficiency Services Limited (EESL)
- Convergence Energy Services Limited (CESL)
- Department of Energy, Ministry of Energy and Natural Resources (MoENR), Royal Government of Bhutan
- Ministry of Power, Energy and Mineral Resources, Government of Bangladesh
- Ministry of Climate Change, Environment, and Energy (MoCCEE), Government of Maldives
- Ministry of Energy, Water Resources and Irrigation (MoEWRI), Government of Nepal
- Electricity Regulatory Commission, Government of Nepal
- Ministry of Power and Energy, Government of Sri Lanka
- Lanka Electricity Supply Company (LECO), Sri Lanka

We are also thankful to our colleagues from USAID Missions and their implementing partners i.e Bangladesh Advancing Development and Growth through Energy (BADGE), Urja Nepal, and Sri Lanka Energy Program (SLEP) in Bangladesh, Nepal, and Sri Lanka for their support in coordinating with their country governments and other agencies for information collation for these impact stories:

- Development of a PBS-based Distribution System in Bangladesh
- Identification of Wind Potential in Bangladesh
- Accelerating Clean Cooking Access in Bhutan
- Strategic Hydropower Development in Bhutan - the 18MW Suchhu Project
- Renewable Energy Access for Bhutan's Remote Communities
- Transforming power distribution in Sri Lanka: Case of Lanka Electricity Company (LECO)
- Supporting Clean Energy Transition in Small Island Developing States
- Mobilizing USD 7.5 Billion for Nepal's Clean Energy Future
- Pioneering Competitive Power Markets in Nepal Through Open Access
- Evolution of CBET Policies and Regulatory Instruments
- Market-Based CBET in South Asia

ABOUT THIS PUBLICATION

"Energizing South Asia – Impact Stories on Clean Energy Transition" is a collection of impact stories on clean energy transition from South Asia. It celebrates the achievements of diverse partners, including governments, communities, the private sector, and development agencies in advancing sustainable energy solutions across the region, with a focus on Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka. The publication aims to share tangible examples of how collaborative efforts are driving transformative change in the clean energy transition journey across South Asia. Each story is a testament to enduring partnerships, shared goals, and innovative approaches that are shaping the clean energy landscape, driving economic opportunities, empowering communities, and addressing the pressing challenges of climate change.

CONCEPTUALIZED AND EDITED BY

Apurva Chaturvedi, Senior Regional Clean Energy Specialist, Indo-Pacific Office, USAID/India

AUTHORS

USAID's South Asia Regional Energy Partnership (SAREP) Program

- Ajay Rawat
- Atul Dhir
- Avik Roy
- Bidur Gautam
- Marc Eliemel Tagub
- Mayank Bhardwaj
- Mohamed Inaz
- Namrata Mukherjee
- Nidhi Gupta
- Nishant Goel
- Rajiv Ratna Panda
- Rohit Pathania
- Ruchika Chawla
- Tanmay Tathagat
- Upmanyu Patil
- Vikas Gaba
- Vivek Salwan
- Yeshi Wangdi

Others:

- *Kazi Ahsan Uddin, Project Management Specialist, USAID/Bangladesh*
- *Aditya S. Banerjee, Deputy Chief of Party, USAID Urja Nepal*

REVIEWERS

- Aaron Schubert, Director, Indo-Pacific Office, USAID/India
- Apurva Chaturvedi, Senior Regional Clean Energy Specialist, Indo-Pacific Office, USAID/India
- Kazi Ahsan Uddin, Project Management Specialist, USAID/Bangladesh
- Miriam Croos Moraes, Project Development Specialist, USAID/Sri Lanka
- Monali Zeya Hazra, Senior Regional Energy Specialist and Mission Environment Officer, Indo Pacific Office, USAID/India
- Shanker Khagi, Senior Energy Specialist, USAID/Nepal
- Shayan Shafi, Energy Team Leader, USAID/Bangladesh
- Yeshi Wangdi, Bhutan Country Manager, USAID SAREP

SUGGESTED CITATION

South Asia Regional Energy Partnership, SAREP2024; Energizing South Asia – Impact Stories on Clean Energy Transition, USAID/India

Photo Credit: Ujjval Trivedi

TABLE OF CONTENTS

Photo Credit: Ujjval Trivedi

FOREWORD

Steven G. Olive, Ph.D
Mission Director, USAID/India

The publication of Energizing South Asia – Impact Stories on Clean Energy Transition, a compilation of impact stories from the South Asia region's region's clean energy transition journey, is both timely and inspiring. This publication is so much more than a collection of anecdotes. Here, we document and celebrate achievements that have resulted from the collaborative efforts of like-minded, mission-driven partners in the South Asia region to accelerate humanity's progress toward a sustainable future. The United States Agency for International Development (USAID), is proud to have supported and played a key role in many of the stories captured here.

Two noteworthy characteristics of the global clean energy transition effort are reflected prominently in the South Asian experiences highlighted in this publication: the necessity of a regional approach when seeking to address the challenges and opportunities of the clean energy transition, and the undeniable power of regional collaboration in accelerating sustainable solutions to problems that transcend borders.

This book also highlights that South Asia does not need to search beyond the region to find best practices in the area of clean energy: many of the innovative clean energy solutions championed in South Asian countries originated within the region itself.

South Asia is pioneering and manufacturing at scale innumerable groundbreaking technologies and approaches that simultaneously provide the answers to previously intractable problems in countries worldwide, while evolving the clean and renewable energy sector as a whole. At the same time, South Asia also provides an opportunity to showcase the scalability and effectiveness of solutions piloted elsewhere, providing proof of concept that can affect transformative change.

A notable example is India's effort to decarbonize its public transportation through the widespread deployment of e-buses, which can significantly reduce carbon emissions. USAID's South Asia Regional Energy Partnership (SAREP) program introduced a payment security mechanism to reduce loan default risks for transport service providers interested in transitioning to e-buses, overcoming the transition's main impediment and accelerating large-scale adoption of clean public transportation. India's success offers inspiration and a blueprint for sustainable public transportation, particularly for the Global South, where similar models could be adapted to achieve carbon reduction goals.

Another standout story is "Market Transformation for Energy Efficiency by EESL." This initiative showcases innovative business models that not only lower the costs of energy-efficient appliances but also catalyze the development of new markets from scratch. Supported by USAID, these business models can be a replicable blueprint for other countries aiming to engage the private sector in advancing energy efficient appliances. Similar examples of partnerships and collaborations in Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka are featured in the stories throughout this publication. These stories highlight the diverse ways in which USAID's partnerships with South Asian organizations have catalyzed energy sector developments in the region.

I want to thank my colleagues from the USAID energy team and SAREP for taking the initiative to collate stories of the clean energy transition from across South Asian countries. I hope that this publication provides an important resource to learn, replicate, and scale clean energy solutions throughout the Indo-Pacific region and worldwide.

Steven G. Olive, Ph.D


BANGLADESH
BANGLADESH
BANGLADESH

IMPACT STORIES

Development of a PBS-based Distribution System in Bangladesh

Bringing Reliable, Affordable Electricity to Rural Communities

Bangladesh's Palli Bidyut Samity (PBS)-based Distribution System has transformed rural electrification through local ownership and global partnerships. This innovative model has brought reliable electricity to millions, driving socio-economic growth across the country's underserved regions.

CONTEXT

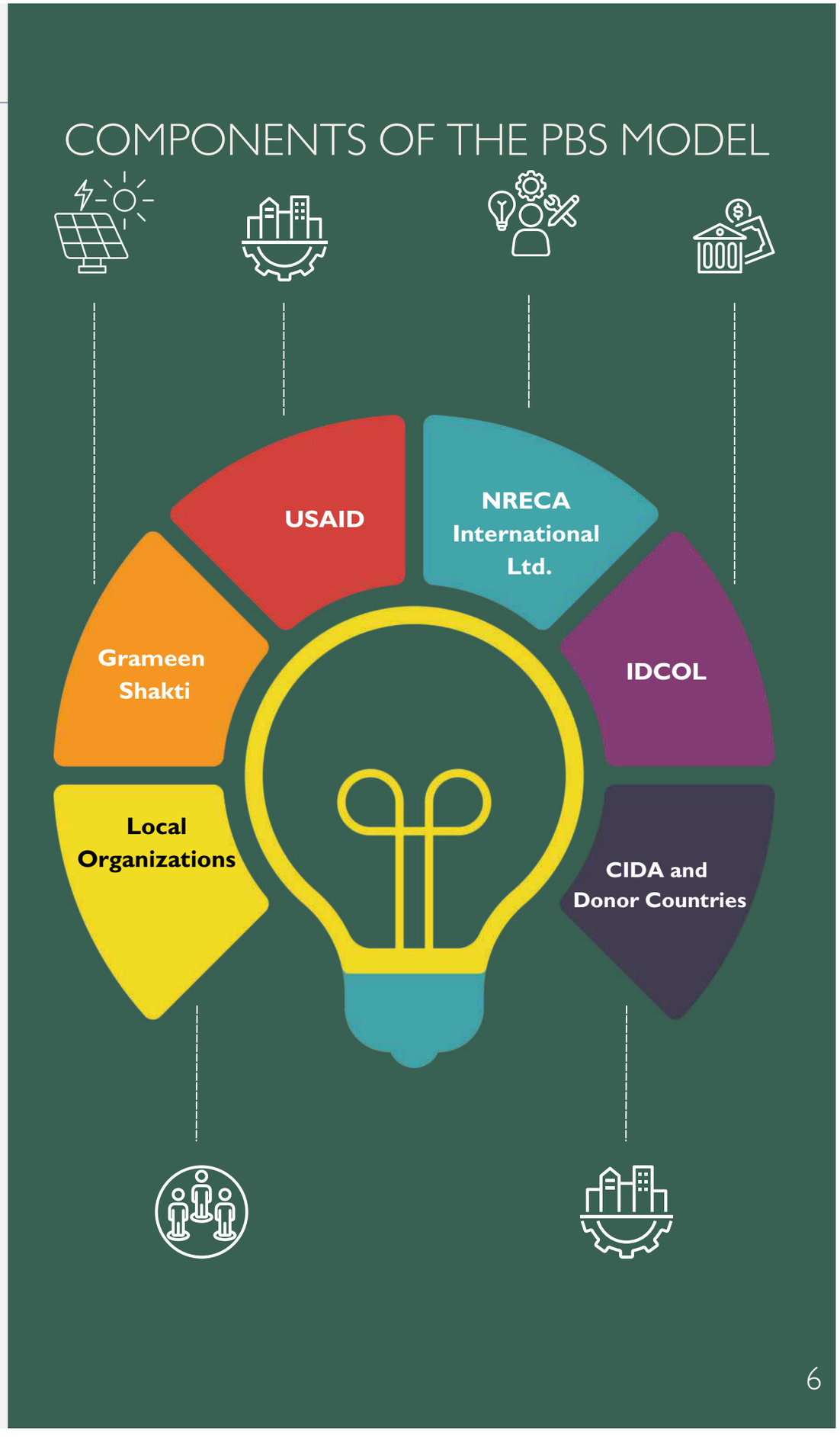
Bangladesh, a densely populated country with a large rural population, has historically struggled with providing reliable electricity to its people, particularly in remote areas. However, through innovative community-based approaches, significant progress has been made in electrifying rural Bangladesh. The Palli Bidyut Samity (PBS)-based distribution system, which is modeled after the U.S. Rural Electric Cooperative model, has been at the forefront of this transformation. Supported by the United States Government (USG), including agencies like USAID, this initiative has not only brought electricity to millions but has also empowered local communities and driven socio-economic development.

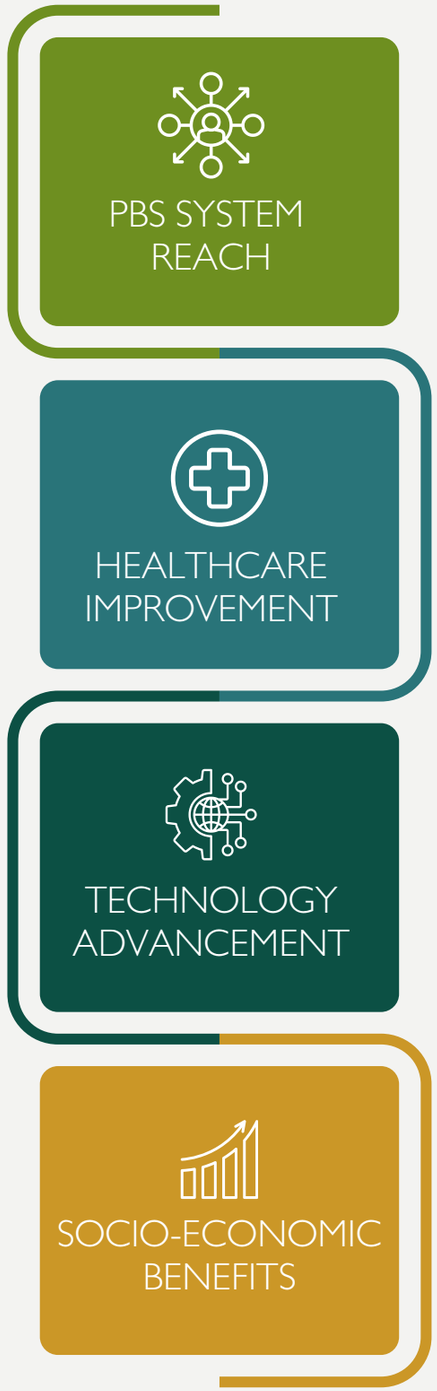
INTERVENTIONS

The PBS model operates as a network of rural cooperatives. Each PBS is a locally owned and managed entity, responsible for distributing electricity within its designated area. Feasibility studies, conducted by an international organization, helped lay the groundwork for the successful implementation of this model.

Local organizations have played a crucial role as well. An important addition to the project was integrating solar home systems with the grid-based electricity. Other organizations have also collaborated with PBSs for measures such as financing the expansion of rural electrification projects, and facilitating the scaling up of renewable energy projects, such as solar irrigation pumps and mini-grids, which complement PBS's grid-based services. Technical assistance was also provided under the Rural Power for Poverty Reduction (RPPR) Program, further strengthening the capacity of PBSs to manage rural electrification efforts effectively.

The USAID-funded Bangladesh Advancing Development and Growth through Energy (BADGE) project also partnered with PBSs to modernize infrastructure, enhancing efficiency and reliability.





- **85,337** Villages Electrified
- **138 Million People**
- **55%** Electricity Distribution
- **Two-Thirds Rural Coverage**

- Cold Storage for Vaccines
- Diagnostic Equipment

- Smart Meters
- Automated Billing Systems
- Reduced Technical Losses
- Improved Revenue Collection

- SME Growth
- Job Creation
- Agricultural Improvement
- Education Enhancement

IMPACT

The impact of the PBS-based distribution system, supported by the USG and local organizations, has been transformative. Today, the REB distributes more than 55% of the generated electricity, and over two-thirds of Bangladesh's rural areas are covered by PBSs, providing electricity to more than 134 million people. This electrification has led to significant socio-economic benefits, including the growth of small and medium enterprises (SMEs), increased agricultural productivity, and improved access to education and healthcare.

For example, the availability of reliable electricity has allowed SMEs in rural areas to operate more efficiently, leading to job creation and increased income levels. In agriculture, the electrification of irrigation systems has boosted crop yields and reduced the dependency on rain-fed agriculture, thereby improving food security. In the education sector, access to electricity has enabled schools in rural areas to use modern teaching aids, such as computers and projectors, enhancing the quality of education. Similarly, in healthcare, rural clinics equipped with reliable electricity can now offer better services, including cold storage for vaccines and the use of diagnostic equipment.

KEY TAKEAWAYS

The development of the PBS-based distribution system in Bangladesh is a prime example of how community-based approaches, supported by international partnerships, can achieve significant development outcomes. With the backing of the USG and collaboration with local organizations, the PBS model has transformed rural electrification in Bangladesh, bringing electricity and opportunities for economic growth and improved quality of life to millions. As Bangladesh continues its journey towards universal electrification, the lessons learned from the PBS experience will provide valuable

Financial Viability: Balancing affordable electricity with operational costs is crucial for sustainability.

System Efficiency: Addressing theft, technical losses, and capacity building is

Collaboration: Ongoing international and local support is vital for the PBS system's growth.

Renewable Integration: Expanding renewable energy is essential to meet demand sustainably.

Innovative Financing: Public-private partnerships are needed to ensure PBSs' financial stability and growth.

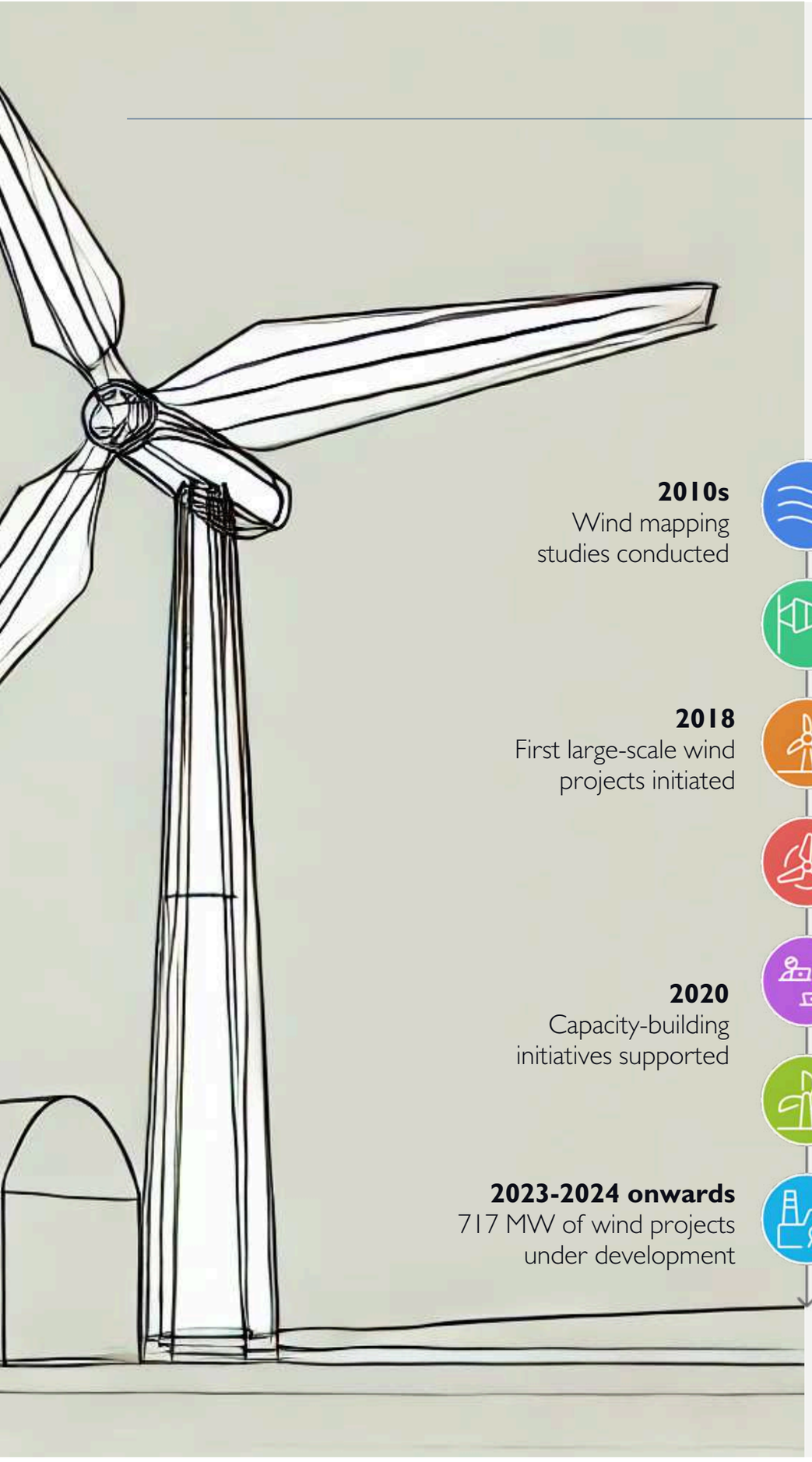
Identification of Wind Potential in Bangladesh

Paving the Way for Renewable Energy Growth in the Country

Bangladesh, a country with a growing energy demand, has historically relied heavily on natural gas and imported fossil fuels for power generation. However, the government has been exploring renewable energy sources to diversify its energy mix and reduce carbon emissions. While solar energy has been the primary focus, the identification of wind potential in Bangladesh has emerged as a crucial development in the country's renewable energy landscape.

CONTEXT

The identification of wind potential in Bangladesh began with a series of wind mapping studies initiated in the early 2010s. These studies, supported by international partners like the U.S. National Renewable Energy Laboratory (NREL) and the United States Agency for International Development (USAID), focused on assessing the viability of wind energy in coastal areas and other suitable locations. These assessments employed advanced technologies such as meteorological towers, Sonic Detection and Ranging (SODAR) systems, and sophisticated modeling techniques to gather accurate wind data across various regions of the country. The data collected from these assessments played a crucial role in identifying areas with favorable wind speeds and suitable terrain for wind farm development. The findings of these assessments, coupled with the government's commitment to renewable energy, paved the way for the subsequent implementation of wind power projects.



2010s
Wind mapping studies conducted

2015-2017
USAID provides wind data training

2018
First large-scale wind projects initiated

2019
Tenders floated or 150 MW wind power

2020
Capacity-building initiatives supported

2023
Tenders floated or 150 MW wind power

2023-2024 onwards
717 MW of wind projects under development

INTERVENTIONS

Following the identification of suitable sites, the government, in collaboration with local and international partners, began the implementation of wind energy projects. IDCOL played a pivotal role in financing and facilitating these projects. By 2023, Bangladesh successfully installed its first major wind power projects, totaling 62 MW of capacity. These projects include installations in Cox's Bazar and Feni, areas identified as having high wind potential. The success of these initial projects has paved the way for further development, with 717 MW of onshore wind projects currently in the pipeline.

IMPACT

The identification and development of wind energy resources in Bangladesh have had a significant impact on the country's renewable energy sector. The 62 MW of installed wind capacity contributes to the diversification of Bangladesh's energy mix, reducing the country's reliance on fossil fuels and enhancing energy security. The projects have also provided valuable lessons in the integration of wind power into the national grid, which has been predominantly reliant on conventional energy sources.

Moreover, the development of wind energy has created new opportunities for local businesses and communities. The involvement of local EPCs in the construction and maintenance of wind farms has generated employment and contributed to the growth of the renewable energy industry in Bangladesh. The success of these projects has also attracted further investment in the sector, with international investors showing interest in Bangladesh's wind energy potential

KEY TAKEAWAYS

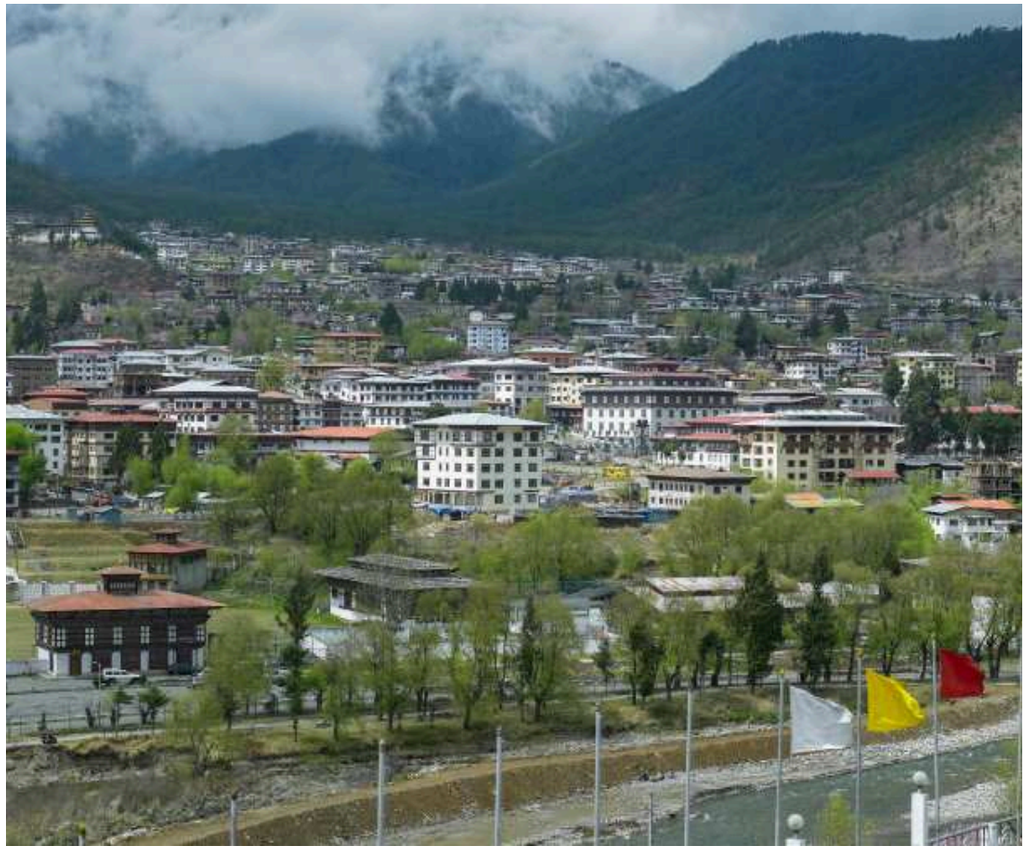
Despite the progress made, the development of wind energy in Bangladesh has not been without challenges. The intermittent nature of wind poses challenges for grid integration and requires robust energy storage solutions. The limited availability of suitable land, especially in densely populated areas, necessitates careful planning and innovative approaches to wind farm siting. Additionally, the initial high costs of wind turbine technology, coupled with logistical challenges in transporting and installing large turbines in remote coastal areas, have posed significant barriers.

Looking forward, Bangladesh aims to overcome these challenges by continuing to attract investment in the wind energy sector and enhancing local capacity for wind power development. The government is also exploring offshore wind potential, which could significantly increase the country's wind energy capacity.

BHUTAN

BHUTAN

BHUTAN



IMPACT STORIES

Accelerating Clean Cooking Access in Bhutan

A Transformative Shift towards Smart, Clean Cooking Solutions

Bhutan has ensured nearly 100% electricity coverage, powered by renewable energy, but approximately 23% of the population continues to depend on inefficient and unclean cooking technologies. The Clean Cooking Program, initiated in October 2022, aims to bridge this gap by accelerating the adoption of smart induction stoves across the country.

CONTEXT

While Bhutan has nearly universal electricity coverage, around 23% of its population still does not have access to clean cooking technologies, which pose health, environmental, and economic challenges. To bridge this gap and support the nation's commitment to the Sustainable Development Goals (SDGs) and the Paris Agreement, Bhutan launched the Clean Cooking Program. By replacing traditional stoves with efficient induction cookers, this program aims to reduce import dependency on Liquified Petroleum Gas (LPG), enhance energy efficiency, and contribute to Bhutan's sustainable development aspirations.

Electricity Coverage

Bhutan achieves nearly 100% electricity coverage, powered by renewable energy

Cooking Fuel

23% of Bhutan's population still relies on inefficient and unclean cooking technologies

Health & Environmental Impact

Significant health risks, environmental degradation, and increased economic burdens result from unclean cooking

INTERVENTIONS

The Clean Cooking Program in Bhutan is structured in three key phases. The inception phase involved distributing 40 smart induction stoves, including three units for Controlled Cooking Tests (CCT) to evaluate the efficiency of the stoves compared to LPG and infrared cook stoves. Results showed that the induction stove was, on average, 135% more efficient than LPG stoves and 30-55% more efficient compared to infrared stoves.

Building on these results, the pilot phase distributed 650 stoves across the country. The final phase envisions a nationwide rollout to achieve 100% access to clean cooking technology. The clean cooking program aims to eventually ensure every household in Bhutan has access to modern, efficient cooking technologies.

01

Program Goals

- Reduce LPG import dependency
- Enhance energy efficiency
- Support Sustainable Development Goals (SDGs)
- Align with Paris Agreement commitments

02

Key Partners

- UN ESCAP
- Modern Energy Cooking Services
- ATEC Global
- Local governments and beneficiaries

STARTED IN OCTOBER 2022

03

Advanced Stove Technology

- IoT-enabled induction stoves designed by ATEC Global
- Provide real-time energy consumption data
- Facilitate carbon financing opportunities

04

Investment Details

- Total investment: USD 70,000 for stove procurement
- Beneficiary Contribution: Ngultrum 1,000–2,300 (approximately USD 12–28) for cooking pots

IMPACT

The initiative has successfully distributed 650 induction stoves, which are not only more efficient but also equipped with IoT technology to monitor energy consumption. The IoT technology supports carbon financing, helping to reduce greenhouse gas emissions by an estimated 104.75 tCO2e annually. The program also aims to enhance market transformation by training local vendors in repair and maintenance of stoves and incorporating IoT elements. It supports local vendors and helps create green jobs while promoting sustainability. The involvement of local vendors in the program supports clean cooking solutions through after-sales support.

The program has also allocated some stoves to highland communities who face limited access to cleaner cooking due to their remote locations. The use of electric cookstoves is anticipated to reduce the burden they face. The Clean Cooking Program faced challenges such as funding limitations in the pilot stage, delays in stove shipment from manufacturer, limited availability of induction pots, and reluctance from some households to switch due to old habits. Despite these challenges, the program has begun to impact households across Bhutan.

KEY TAKEAWAYS

The pilot phase of the Clean Cooking Program highlighted several key insights that will be crucial for scaling the initiative nationally and ensuring long-term success:

- Leveraging Carbon Financing: Carbon financing can be effectively used to support the most efficient clean cooking technologies, providing an innovative funding model for expanding the program.
- Community Openness to New Technologies: The positive adoption by households during the pilot phase demonstrated a willingness within the community to transition to new technologies, which is encouraging for future expansions.
- Expanding the Market for Induction-Compatible Cookware: There is a need to increase the availability of induction-compatible pots in the market to support the widespread adoption of induction stoves.
- Enhancing Local Vendor Participation: Local vendors play an important role in maintaining and supporting clean cooking technologies. Their participation needs to be strengthened through training and capacity building in order to build a robust ecosystem for clean cooking solutions.
- Addressing Adoption Barriers: Efforts to overcome household reluctance due to old habits must continue, including community engagement and education to demonstrate the benefits of cleaner cooking technologies.

Strategic Hydropower Development in Bhutan - the 18MW Suchhu Project

Ensuring Energy Security Through Strategic Hydropower Development

The 18 MW Suchhu Hydropower Project (SHPP) in Haa Sangbaykha aims to harness Bhutan's vast hydropower reserves while addressing domestic energy security and reducing seasonal power imports.

The project was part of Bhutan's strategic approach to harness its underutilized hydropower resources while ensuring economic resilience and energy security. It contributes to Bhutan's Power System Master Plan 2040 (PSMP-2040) and supports the nation's energy resilience by providing a flexible energy supply that can be fed into the grid when not required locally. Additionally, this intervention aims to address the economic downturn by fostering local employment and community involvement.

CONTEXT

Bhutan holds immense hydropower potential, estimated at around 37 GW across 155 sites, with 33 GW identified as technically and economically viable. Sustainable development of this resource is critical for Bhutan's economic, financial, and social growth. However, realizing this potential poses numerous challenges, including the need to secure domestic energy supply during seasonal shortages, overcome financial constraints, and create employment opportunities to stimulate economic recovery following the COVID-19 pandemic.

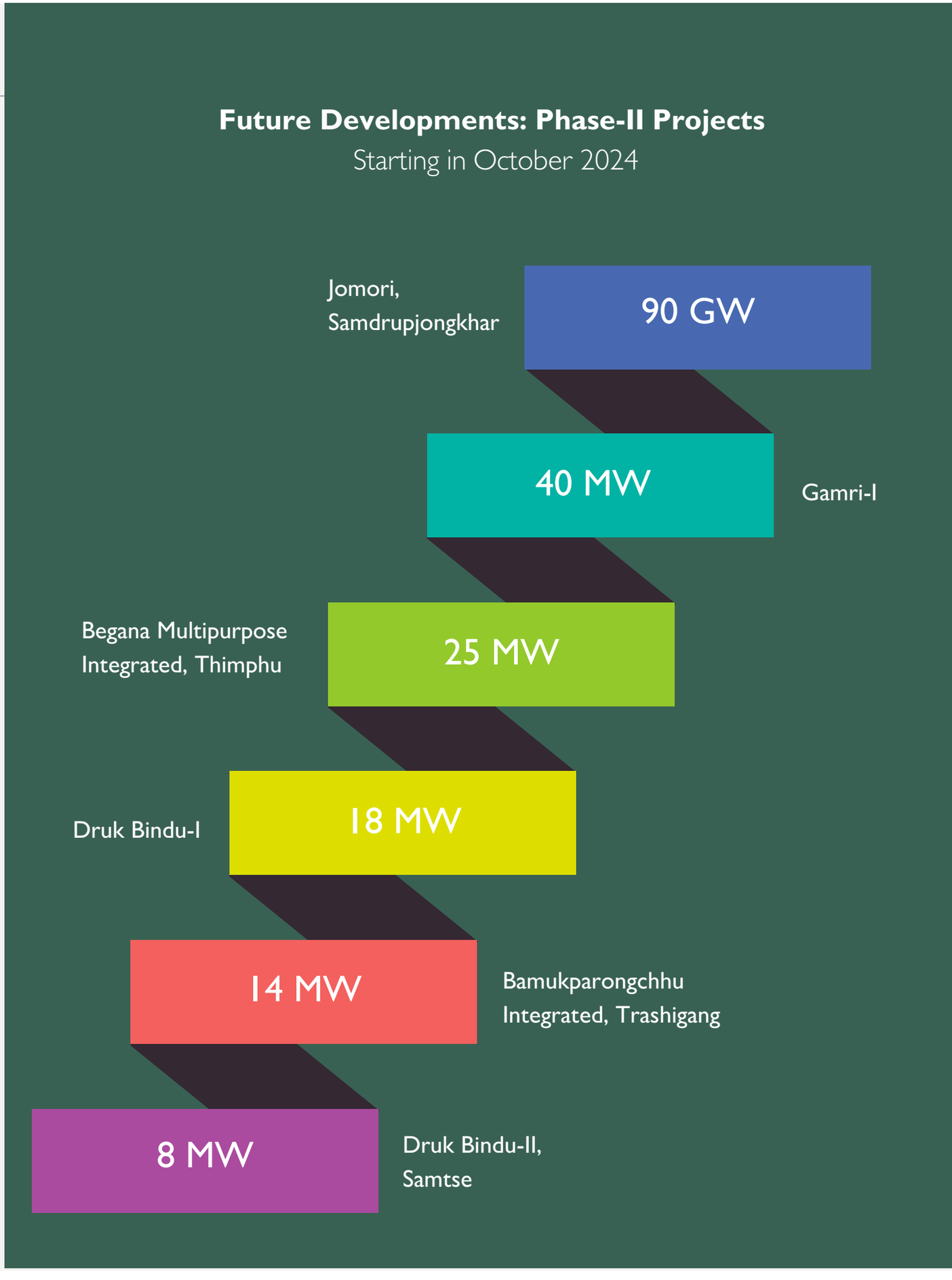
INTERVENTIONS

The Suchhu Hydropower Project is one of the three small-scale hydropower projects initiated during Phase I by Druk Hydro Energy Limited (DHyE), a subsidiary of DGPC, following a feasibility study in June 2021. The project's strategic interventions include harnessing Bhutan's underutilized hydropower potential with a strong emphasis on sustainable development, local empowerment, and environmental stewardship. The construction involved local civil, hydro-mechanical, and control contractors, as well as international electro-mechanical contractors for key components. The aim was to foster community involvement, create economic opportunities in rural areas, and minimize the need for power imports during lean seasons.

IMPACT

The Suchhu Hydropower Project, with its 18 MW capacity, has significantly contributed to Bhutan's clean energy sector, while also avoiding annual greenhouse gas emissions of 69,678.7 tCO2e. By involving local contractors in the design, installation, and commissioning of equipment, the project has generated employment opportunities and fostered skill development within the local community. The financing, structured with 30% equity and 70% debt from local financial institutions, underscores the value of local collaboration in advancing sustainable development.

Additionally, training programs during the operation and maintenance phase, to be led by DGPC, will further build local expertise in hydropower construction and maintenance



KEY TAKEAWAYS

The Suchhu Hydropower Project showcases Bhutan's commitment to sustainable and localized energy solutions. Capacity building has emerged as a significant takeaway of the project, highlighting the importance of training local contractors and fostering skills in hydropower construction. Some of the other key takeaways are:

- Community Engagement: The involvement of local contractors in the construction phase helped foster community participation and build local capacity, ensuring the long-term sustainability of the project.
- Addressing Financing and Technical Challenges: The project's financing structure and the use of both local and international contractors illustrate how financial and technical challenges can be overcome through strategic collaboration.
- Adapting to Geological and Climatic Conditions: Overcoming the challenges of poor geological conditions and frequent seasonal power outages required tailored solutions and strategic planning.

Renewable Energy Access for Bhutan's Remote Communities

Solar Mini-grid at Shangsa Lunana

The 33 kWp solar mini-grid at Shangsa Lunana aims to provide clean, reliable, and renewable energy to one of Bhutan's remotest communities, overcoming challenges related to geographic isolation and reliance on traditional fuels.

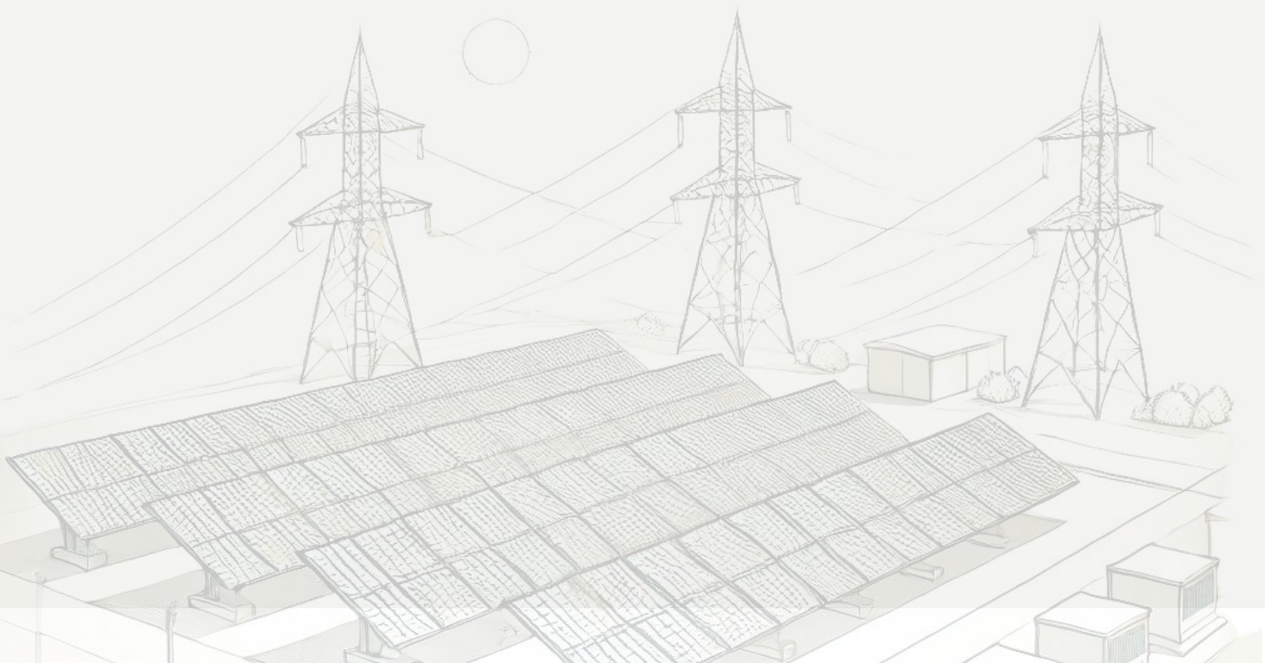
Located in Lunana Gewog, Gasa Dzongkhag, Shangsa village, at an altitude of 3,600 meters above sea level, this community exemplifies the need for last-mile energy access solutions. In such a geographically isolated and climatically harsh environment, ensuring energy access has been a complex challenge.

CONTEXT

The village's remote location, distance from motorable roads, and reliance on traditional fuels created significant obstacles to accessing reliable and clean energy. The residents have long relied on firewood, yak dung, and liquified petroleum gas (LPG) for heating and cooking, while their lighting needs were met from basic solar home lighting systems which provided only intermittent lighting.

These challenges underscored the necessity of an intervention that could provide sustainable energy solutions, improve quality of life, and reduce environmental and health impacts.

The project succeeded in setting up a solar mini grid at an altitude of 3,600 meters above sea level in harsh weather, to provide clean, reliable, and renewable energy to the local community. This addressed both the critical needs of reducing firewood dependency and providing convenient, sufficient lighting facilities.



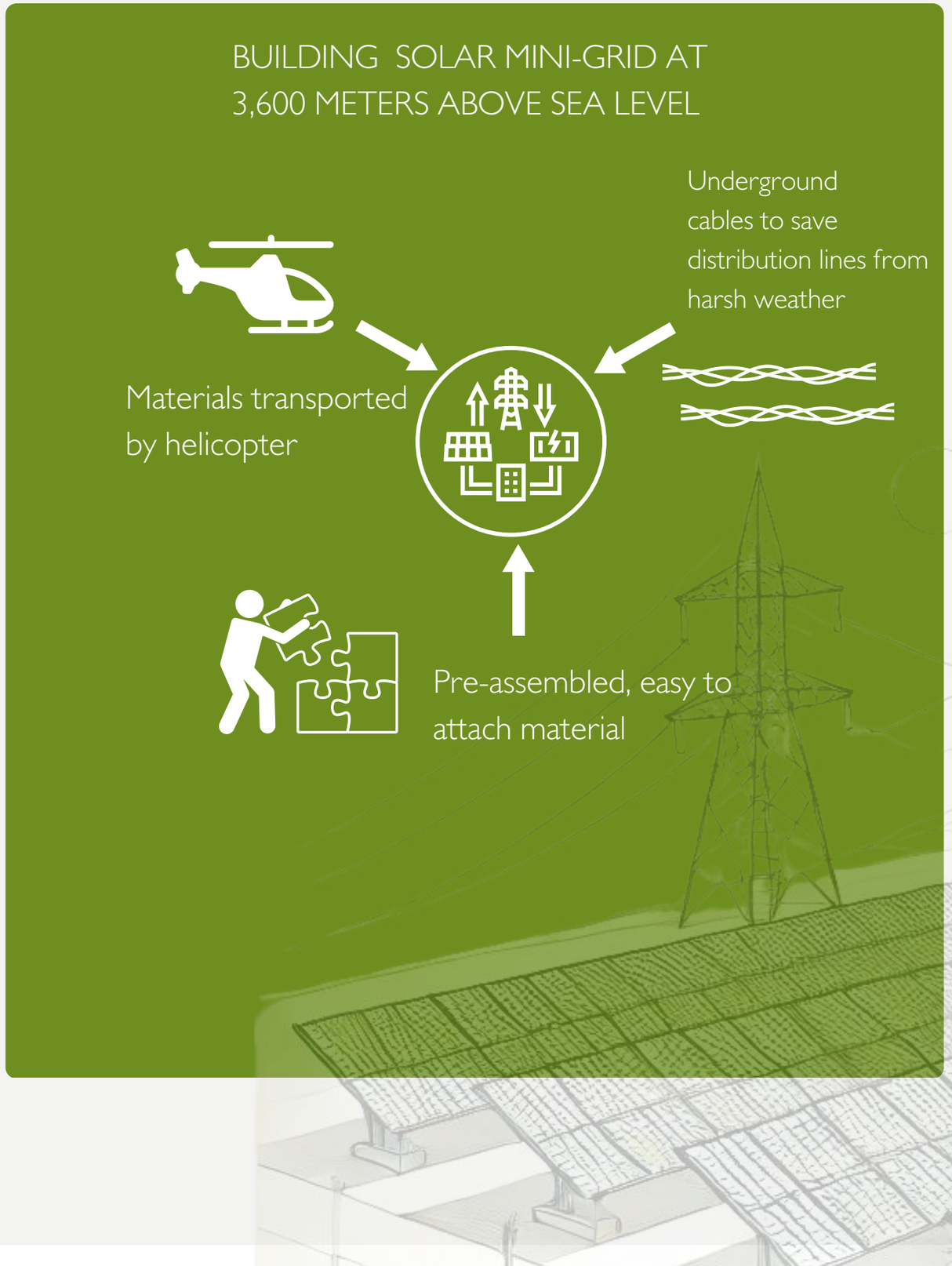
INTERVENTIONS

The intervention involved the installation of a 33 kWp solar mini-grid plant, generating approximately 40.70 MWh of energy annually for the community. The project was implemented from November 2023 to August 2024, with an investment of USD 0.255 million. Partners included the Department of Energy, Ministry of Energy and Natural Resources, the local government of Lunana Gasa District, and the Shangsa community.

A Shangsa Solar Management Committee was also established to oversee the plant's operation and maintenance. The local community participated in installation, testing, and commissioning. The plant has been handed over to the community with the appointment of a dedicated plant operator, funded by household energy bills, to manage the system's operation and maintenance.

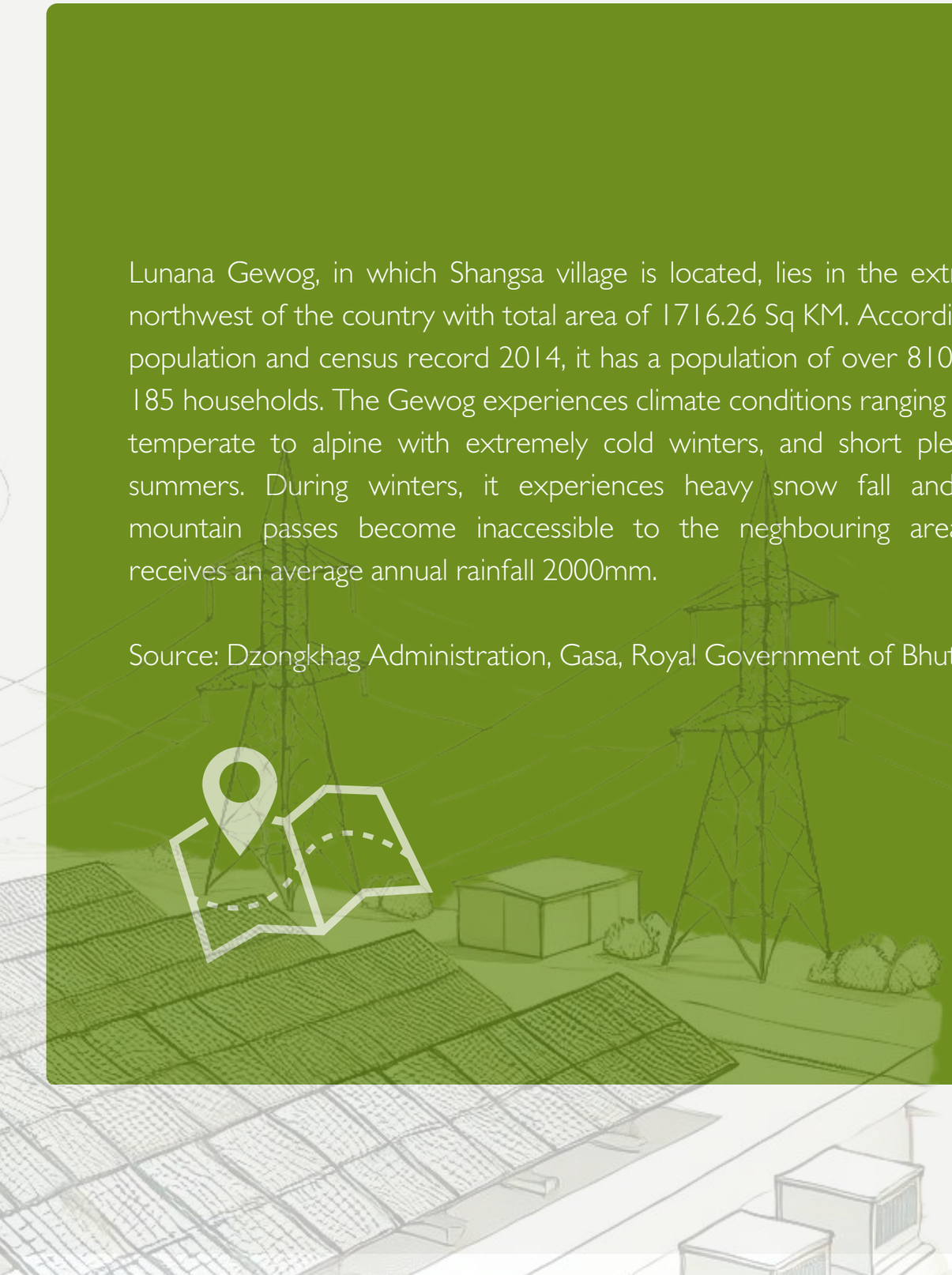
IMPACT

The solar mini-grid plant in Shangsa has brought clean, reliable energy to 11 households. The 33 kWp plant now supplies adequate electricity for daily use. The intervention is estimated to avoid 370.9 tCO2e annually, and it marks Bhutan's first off-grid solar mini-grid at such a high elevation. A dedicated plant operator, funded by household energy bills, manages the system's operation and maintenance.



Lunana Gewog, in which Shangsa village is located, lies in the extreme northwest of the country with total area of 1716.26 Sq KM. According to population and census record 2014, it has a population of over 810 with 185 households. The Gewog experiences climate conditions ranging from temperate to alpine with extremely cold winters, and short pleasant summers. During winters, it experiences heavy snow fall and the mountain passes become inaccessible to the neghbouring areas. It receives an average annual rainfall 2000mm.

Source: Dzongkhag Administration, Gasa, Royal Government of Bhutan



KEY TAKEAWAYS

The success of the Shangsa Solar Mini Grid project provides several key insights for similar high-altitude clean energy initiatives. Some of the key takeaways are:

- **Community engagement:** The complete involvement of the community throughout installation, testing, and commissioning was important in building local capacity and ensuring sustainable operations.
- **Tailored solutions for harsh climates:** Due to the challenging climatic conditions and lack of machinery at the remote spot, pre-assembled, easy-to-attach materials were chosen, and underground cables were used to protect the distribution line from severe weather.
- **Overcoming logistical challenges:** Helicopter services had to be deployed for transportation of materials, emphasizing the importance of logistical planning in similar projects.
- **Adapting project timelines:** The project was executed within the six-month working window that aligns with the community's availability and the area's short summers.

INDIA
INDIA
INDIA
INDIA

IMPACT STORIES

Market Transformation for Energy Efficiency: Energy Efficiency Services Limited (EESL) Story

Buildings, Agriculture and Municipalities

Energy Efficiency Services Limited (EESL), a public sector ESCO under the Ministry of Power, Government of India, is advancing India's net-zero emissions goal by driving energy efficiency in sectors like buildings, agriculture, and municipalities, through innovative business models, such as demand aggregation, bulk procurement and energy efficiency as a service. This has reduced the cost of energy-efficient appliances and significantly increased their market share.

Programs like UJALA (Unnat Jyoti by Affordable LEDs and Appliances for All), the Street Lighting National Program (SLNP), the Energy Efficient Fans Program (EEFP), and the Super-Efficient Air Conditioner (SEAC) demonstrate the success of market-driven approaches.

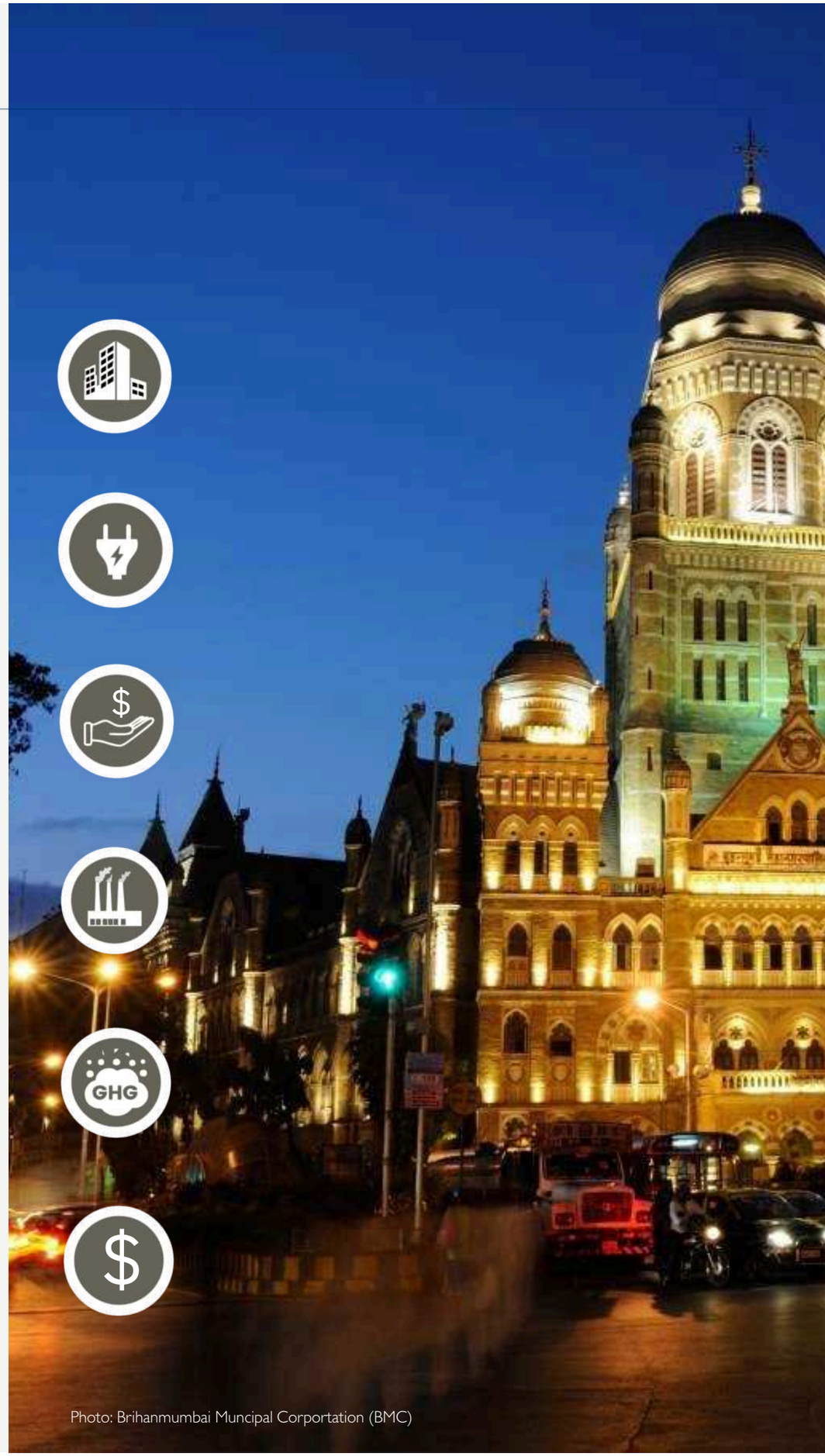


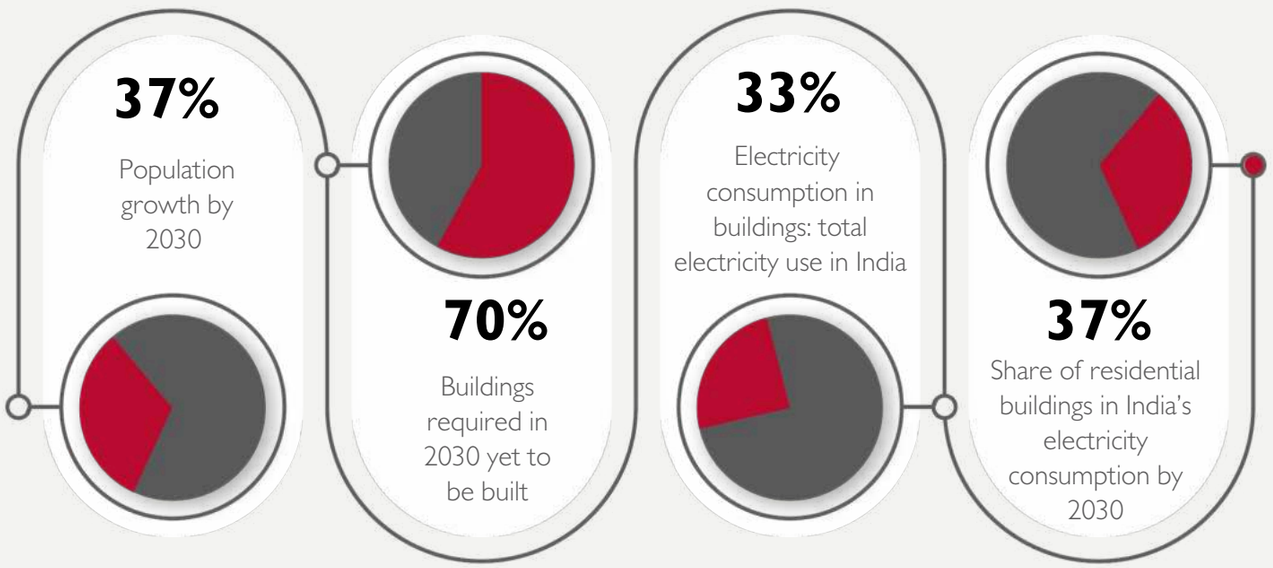
Photo: Brihanmumbai Muncipal Corportation (BMC)

CONTEXT

Energy is a primary driver for development, driving industrial growth, job creation and income generation. India's total electricity generation in FY 2023-24 was about 1,508 BUs, with a peak demand of 243 GW. The Bureau of Energy Efficiency, Government of India states that over 100 GW of additional coal capacity can be avoided by 2047 through energy efficiency. India could reduce emissions by 623 MtCO2e by 2031 in an ambitious scenario.

The potential of energy efficiency often goes unnoticed because its benefits are not as immediately visible as, say, large-scale renewable projects, and its investment size ("ticket size") tends to be smaller. The efforts of EESL have brought a much-needed visibility and scale to this sector. EESL, with a national mandate and a market-based approach, to advance energy efficiency, is bridging this critical gap by leveraging its unique position.

EESL has accelerated energy efficiency adoption by utilizing innovative business models and bulk procurement, leveraging demand from the public sector—a market often overlooked by private players.



INTERVENTIONS

EESL's innovative bulk procurement strategy aggregated national demand, leveraged economies of scale to significantly lower energy-efficient product costs. This reduced prices for consumers, elevated energy efficiency standards and also boosted local manufacturing.

Key Interventions:

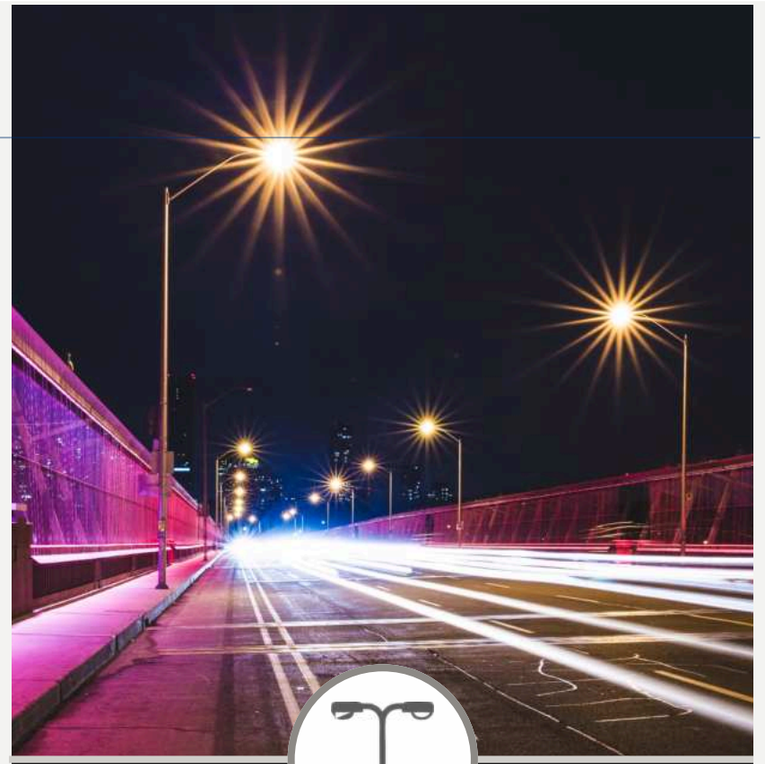
- Unnat Jyoti for Affordable LEDs for All (UJALA) program
- Street Lighting National Program (SLNP)
- Municipal Energy Efficiency Program (MEEP)
- Agriculture Demand Side Management (AgDSM) program
- Building Energy Efficiency Program (BEEP)
- Super-Efficient Air Conditioner (SEAC) program
- Energy Efficient Fans Program (EEFP)
- National Efficient Cooking Program (NECP)

Unnat Jyoti by Affordable LEDs for All (UJALA) program

- World's largest zero-subsidy LED initiative.
- Incandescent bulbs were replaced with affordable, high-quality LEDs.
- Over 4.07 billion LEDs sold since program launch.

⇩

- LED costs reduced from USD 3.5 to 80 cents.
- 47,883 million kWh of energy saved annually.
- Domestic LED production increased from one million to 40 million units per month.



Street Lighting National Program (SLNP)

- World's largest streetlight replacement initiative
- Replaced conventional streetlights with LEDs, integrating a Central Control and Monitoring System (CCMS) in municipalities.
- 13.3 million LED streetlights installed

⇩

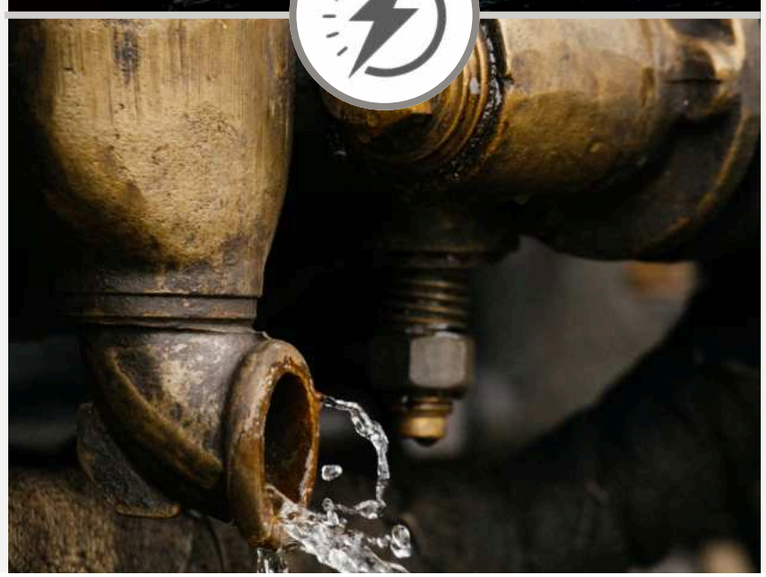
- Approx. 9 billion kWh of energy saved annually.
- 6.19 million tons of CO_2 averted.
- Peak demand reduction of 1,498 MW.
- Approximately 13,000 jobs created.

Municipal Energy Efficiency Program (MEEP)

- Upgraded inefficient water pump systems.
- 5 States / UTs and 390 cities engaged.

⇩

- Potential to save 100 million units of electricity annually.
- Potential to reduce 3.9 million tons CO2.



Agriculture Demand Side Management (AgDSM) Program

- Distributed BEE 5-star energy efficient agricultural pumps with smart control panels which can be remotely operated.
- 83,107 energy-efficient pumps deployed in Andhra Pradesh and Uttar Pradesh.

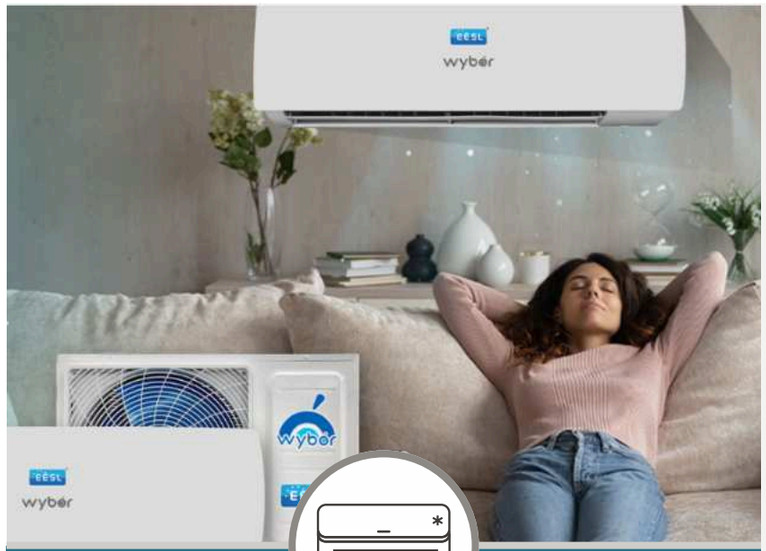
⇩

- 210 million units of energy saved annually.
- 150,000 tons CO2 emissions saved annually.
- Improved quality of life for farmers through easier pump operation.

Building Energy Efficiency Program (BEEP)

- Replaced in-efficient lighting and cooling equipment with energy-efficient alternatives in public buildings.
- Over 12710 public buildings (including schools, offices, railway stations and airports) retrofitted with energy-efficient appliances.
- 1,661,690 appliances replaced or installed.

Photo: Public Works Department, Maharashtra



Super Efficient Air Conditioning (SEAC) Program

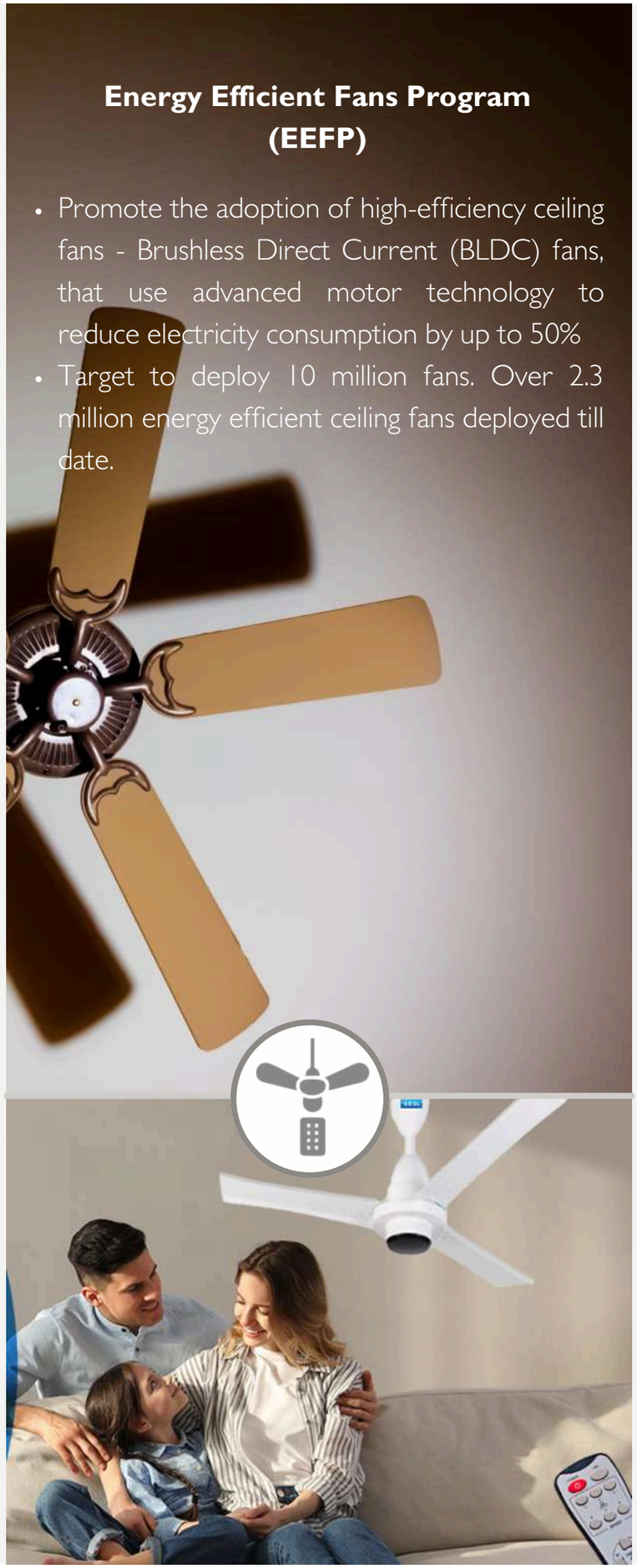
- Addressing the rising demand from cooling, by introducing air-conditioners with higher levels of efficiency.
- Introduced models with 6.2 ISEER for 1.0 TR and 5.8 ISEER for 1.5 TR, exceeding the BEE 5-Star efficiency standard by 25%.

⇩

- Over 3000 super-efficient ACs deployed
- Created a market for super-efficient ACs.

Energy Efficient Fans Program (EEFP)

- Promote the adoption of high-efficiency ceiling fans - Brushless Direct Current (BLDC) fans, that use advanced motor technology to reduce electricity consumption by up to 50%
- Target to deploy 10 million fans. Over 2.3 million energy efficient ceiling fans deployed till date.



National Efficient Cooking Program (NECP)

- Initiative under the Government of India's Go Electric Campaign
- Target to deploy two million induction cook stoves.

IMPACT

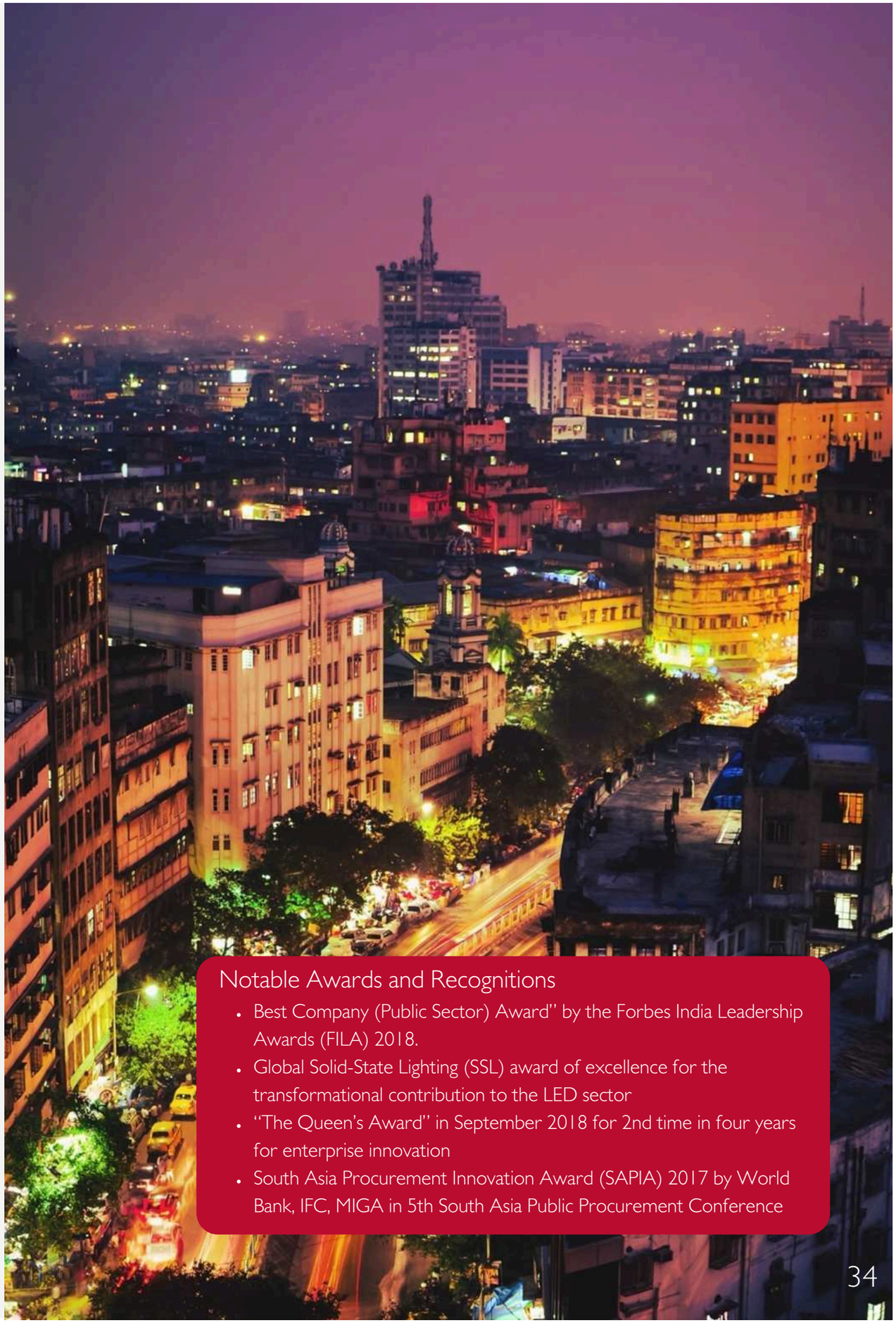
EESL has achieved electricity savings of over 58,650 million kWh and avoided demand of 11,646 MW. EESL efforts have resulted in savings of over 3.0 billion USD in energy bills for its customers.

KEY TAKEAWAYS

EESL's business models such as demand aggregation and bulk procurement have made energy-efficient solutions affordable. By focusing on widely used products with high energy-saving potential, EESL was able to maximize impact. The standardization of product specifications ensured quality and further reduced prices, facilitating large-scale adoption.

EESL also played a pivotal role in creating market demand for energy-efficient products by leveraging the scale and influence of the public sector. It has expanded its programs across sectors like electric vehicles, smart meters, electric cooking, cooling and lighting, demonstrating that energy efficiency initiatives can be scaled and adapted globally.

EESL's model is flexible and can be tailored to different country contexts while maintaining scalability and affordability.



Notable Awards and Recognitions

- Best Company (Public Sector) Award" by the Forbes India Leadership Awards (FILA) 2018.
- Global Solid-State Lighting (SSL) award of excellence for the transformational contribution to the LED sector
- "The Queen's Award" in September 2018 for 2nd time in four years for enterprise innovation
- South Asia Procurement Innovation Award (SAPIA) 2017 by World Bank, IFC, MIGA in 5th South Asia Public Procurement Conference

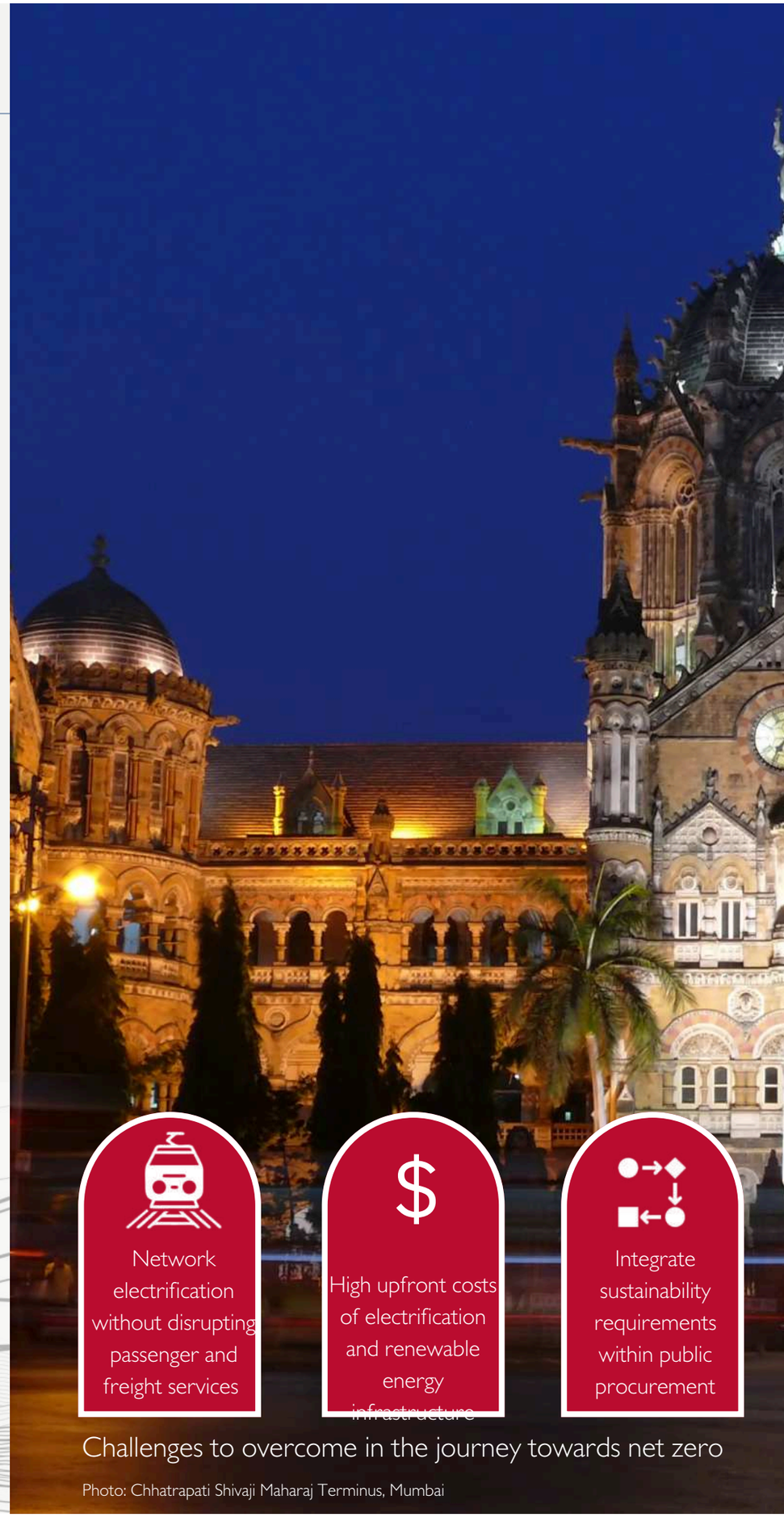
Indian Railways' Journey Towards Net Zero Carbon Emission by 2030

Decarbonizing One of the World's Largest Rail Networks

Indian Railways, is on an ambitious journey to achieve Net Zero Carbon Emissions (NZCE) by 2030; far ahead of India's 2070 target. This transformative endeavor requires comprehensive electrification of the railway network, adoption of energy-efficient measures, and integration of renewable energy sources, across its vast operations. This decarbonization mission is not only essential for India to meet its climate targets but also critical for reducing operational costs and modernizing a national asset that annually transports over eight billion passengers.

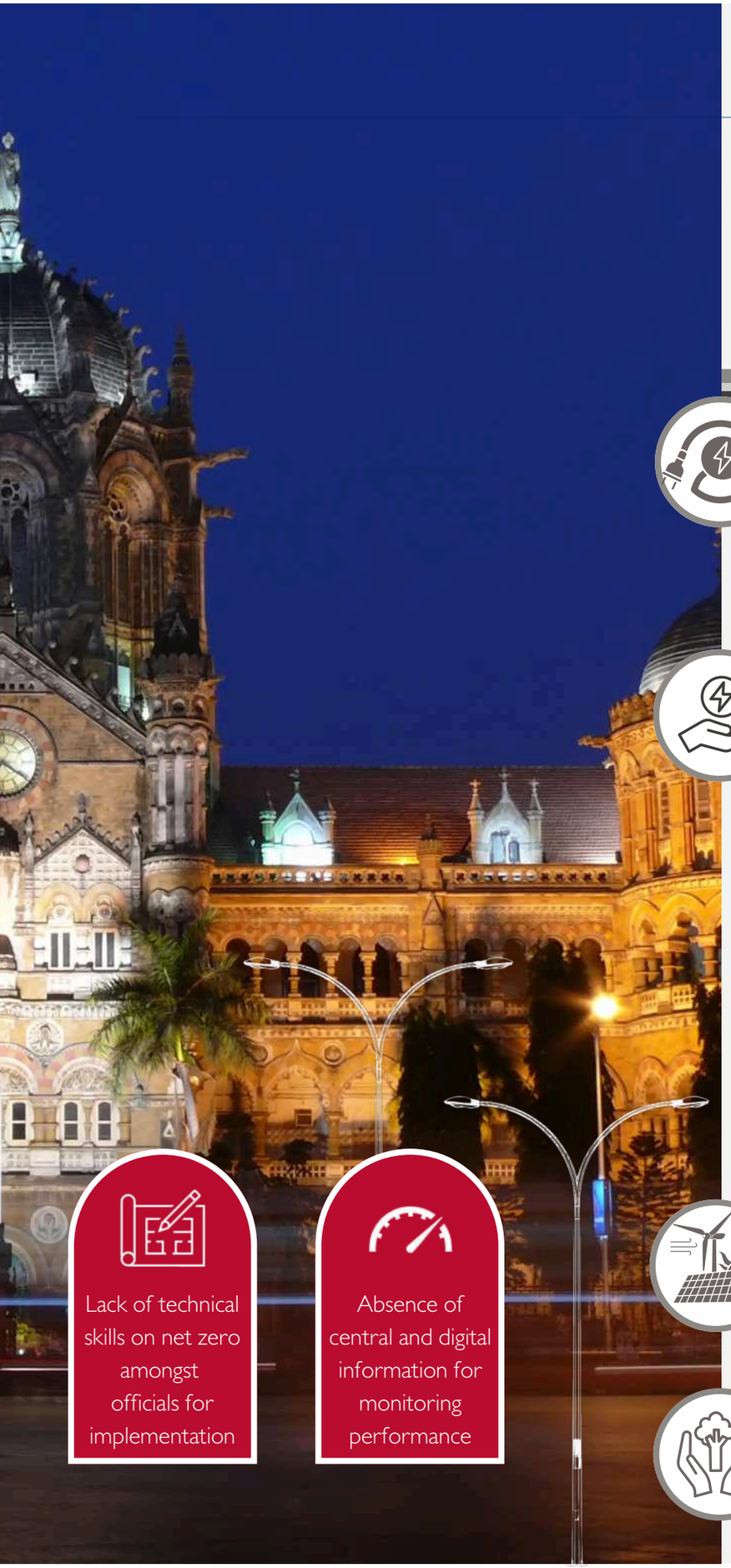
CONTEXT

Indian Railways is the largest transportation operator in the country, with an energy demand of 3.63 GW, projected to rise to 8.2 GW by 2030. Over 30 GW of renewable capacity is required to achieve the net zero emission target. This would result in emissions abatement of over 60 million tons of CO_2e annually; presenting an opportunity for contributing to India's net zero targets.



Challenges to overcome in the journey towards net zero

Photo: Chhatrapati Shivaji Maharaj Terminus, Mumbai



INTERVENTIONS

Electrification

Indian Railways has phased out diesel locomotives and is electrifying the entire 65,000 kilometers network.

During 2023-24, a total of 7,188 Route Kilometers (RKM), which is twice the length of India from North to South, were electrified.

Enhancing Energy Efficiency

In 2022, Indian Railways introduced the Energy Efficiency Policy and Action Plan to reduce non-traction energy consumption. This time-bound action plan focuses on:

- Improving energy efficiency in buildings and achieving net zero certifications.
- Procurement of energy-efficient equipment and appliances
- Central monitoring, smart control of electrical assets (IR-NIYANTRAC)
- Enhancing power quality.
- Building capacity of technical staff on net zero implementation

For reducing energy in traction loads; regenerative braking technology has been adopted in three-phase electric locomotives, Electric Multiple Units (EMUs) and Mainline EMUs.

Renewable Energy Adoption

A Renewable Energy Action Plan was developed to enable large-scale renewable energy procurement through Renewable Energy Round the Clock (RE-RTC). Distributed renewable energy are being deployed at railway stations and service buildings.

Afforestation

To offset emissions and contribute to carbon sequestration, afforestation on vacant land and between sections of its tracks is being carried out.

IMPACT

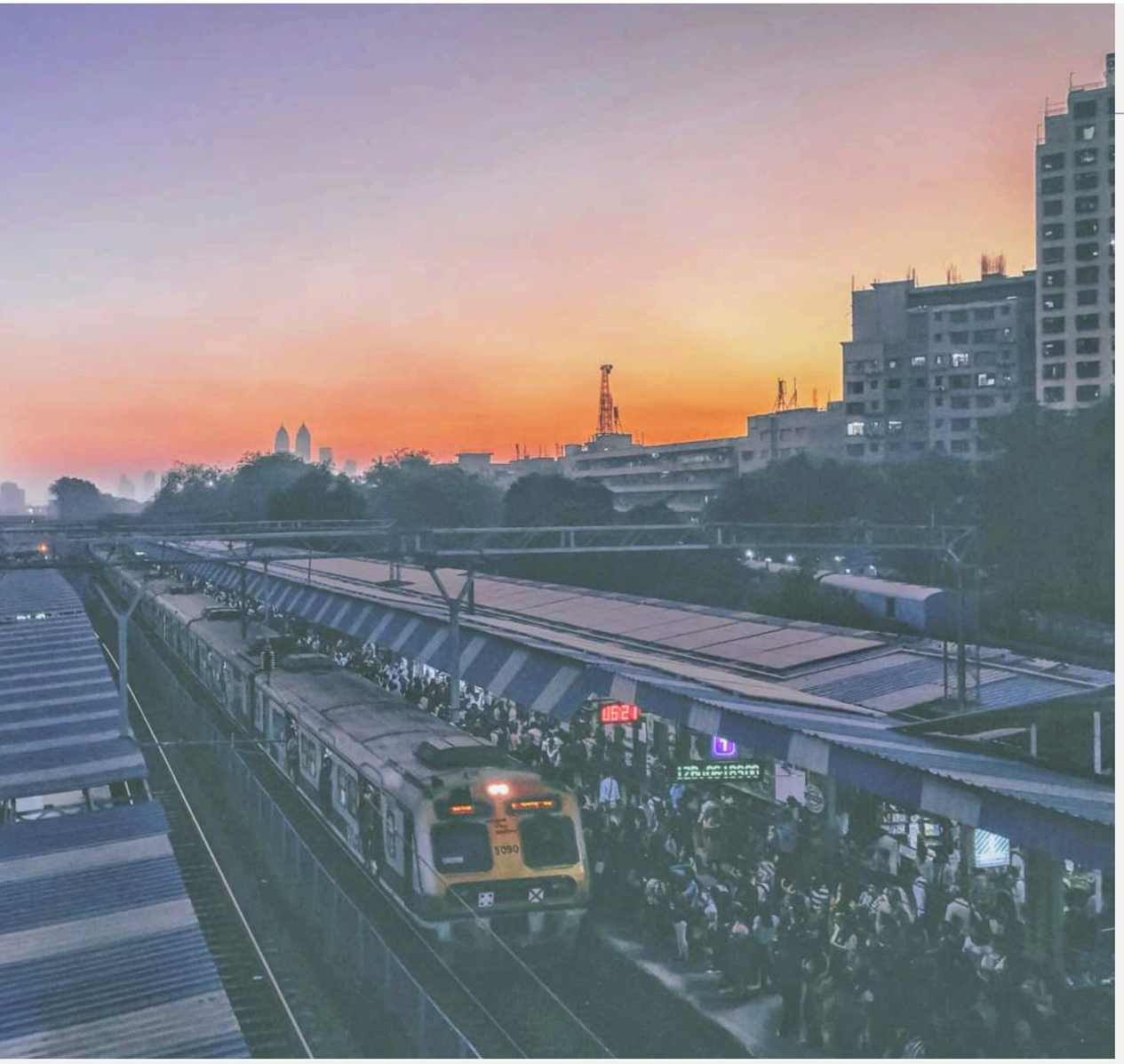
Indian Railways is currently the largest electrified railway system globally among networks with over 10,000 operational route kilometers (RKMs).

Energy Efficiency (EE) requirements are now mandated in all Indian Railway procurements. Specifying Net Zero (SuperECBC compliant) standards in tenders of new buildings and railway stations, along with procuring energy efficient appliances, has resulted in life-time energy savings of over 1,170 GWh and avoided over one million tons of CO2 emissions.

Renewable energy (RE) efforts include award of a groundbreaking 1,600 MW Renewable Energy Round the Clock (RE-RTC) tender at a competitive rate of ~6 cents /kWh, the first of its scale globally. Additionally, a 175 MWp of rooftop solar capacity has also been installed to date.

Indian Railways' approach to sustainable procurement has institutionalized net zero interventions, now being emulated by other government agencies. Government agencies are referencing and replicating these energy efficiency and renewable strategies to reduce energy use and procure renewables.

97%	1	1000+	74	4	~ 85,000	~9000	1	
Electrification	Policy on EE	Buildings	Buildings	Railway stations	BLDC fans	Air-conditioners	Pilot	IR - NIYANTRAC
broad gauge network	Energy Efficiency Policy and Action Plan Adopted	Investment grade energy audits completed	Awarded BEE's Shunya / Shunya + Certification	Tenders with Super ECBC compliance integration	BEE 5-star labelled fans procured	BEE 5-star labelled air-conditioners procured	Low Carbon Cooling Pilot at Headquarters of Northern Railways	Smart monitoring and control of electrical assets initiated



KEY TAKEAWAYS

Indian Railways' path to net zero offers key insights for integrating sustainability into large-scale public infrastructure. Setting clear, time-bound policies and action plans is crucial to achieving ambitious targets. Strong leadership is essential to drive initiatives, while training officials on net zero practices accelerates adoption and ensures effective implementation.

Embedding sustainability into public procurement reduces risks, promotes widespread adoption of net zero interventions, and future-proofs investments. Institutionalizing these practices also builds confidence for other government agencies to follow suit. Monitoring systems help track progress and ensure energy goals are met.

The Indian Railways' example also highlights the importance of piloting innovative technologies to demonstrate feasibility for larger-scale deployment. A structured approach to scaling clean energy solutions reduces risks, encourages new technology adoption, and fosters cost-effective innovation.

1	1600	3.5	175	1400+	58		92	
RE Action Plan	MW	billion USD	MWp	Railway officials	Trainers	Self-paced courses	million	
Renewable Energy Action Plan adopted	RE-RTC capacity added at a rate of 6 cents / KW	Investment mobilization potential	Rooftop solar deployed	Trained on net zero implementation	Trained on EE and RE concepts and implementation	On net zero concepts and implementation developed.	Saplings planted	

Smart Metering Market Transformation in India

250+ million

India's smart metering program is the largest in the world being implemented through public private partnership (PPP). Starting small with a few pilots & players, India's smart metering market has gradually transformed into full-scale national roll-out with large number of developers, private equity (PE) firms, manufacturers and equipment providers.

CONTEXT

Revamping power distribution has been high on Government of India's (GoI) agenda. Reform initiatives like rural electrification, network strengthening, digitization, etc. have been implemented to improve operational & financial performance of distribution utilities (discoms).Despite these interventions, Indian discoms continued to face challenges related to: (i) financial sustainability; (ii) quality of service & supply; (iii) integration of renewables; and (iv) customer centricity. One of the key root causes for weak performance had been absence of real-time measurement of data from distribution assets & end-to-end energy accounting. To address this, Smart metering was introduced to address both legacy issues as well as pave way for modern services to customers

USAID has been associated with GOI, and has provided continuous technical assistance through this market transformation journey

CHALLENGES

Financial sustainability of discoms

- High distribution losses
- Tariff not reflective of costs
- High accumulated losses hampering investments for modernization

Enables real time energy audit & subsequent reduction in commercial losses

Quality of Service & Supply (QOSS)

- Ensure 24x7 reliable power supply

Enables faster resolution of outages through outage management system

Integration of Renewable Energy (RE)

- Ambitious targets of RE installation
- Intermittent nature of RE

Enables renewables integration when coupled with net metering

Customer centricity

- Poor customer services
- Lack of real time analytical insights

Enhances customer experience through introduction of loyalty programs and personalized services

INTERVENTIONS

Initiation Phase (2010-2014)

Measures to create institutional structures to build stakeholder confidence

India Smart Grid Task Force (ISGTF)

ISGTF served as the focal point for all smart grid (SG) activities. As a first step, SG pilot projects were taken up to test various SG technologies. ISGTF was subsumed into National Smart Grid Mission (NSGM)

Launch of Smart Grid Pilot Projects

GoI implemented 12 SG pilots. These SG pilots provided insights for developing approaches for scale-up initiatives

Foundation Phase (2015-2019)

Measures to promote large scale smart meter installation

Ministry of Power

- 4 Large scale SG projects sanctioned under NSGM in capex mode
- Funds allocated for 35 mn smart meters installation
- Released smart metering technical standards
- Released Advanced Metering Infrastructure (AMI) functional specifications

Energy Efficiency Services Limited (EESL)

- Launched tender for 10 mn smart meters in Uttar Pradesh & Haryana in opex mode
- Other implementation states: Andhra Pradesh, Bihar, Delhi and Madhya Pradesh

Central Electricity Regulatory Commission (CERC)/ Forum of Regulators (FoR)

- Model smart grid regulations issued by FoR and adopted
- Mandate to transition to smart prepaid metering introduced in Revised Tariff Policy 2018

USAID supported GoI in implementation of the first successful SG pilot project at Ajmer Vidyut Vitran Nigam Limited (AVVNL) based an innovative Pay for Service ("or rental") model. This rental model was later adopted by EESL & GoI for scale up initiatives

Consultative Workshop on Smart Metering

Laid the foundation of National Rollout of Smart Prepaid Metering

135 stakeholders

from 40+ organizations

Scale up Phase (2020 – on-going)

Measures to enhance utility readiness & private sector participation

Policy regulations to promote smart metering

- Electricity (Rights of Customers) Rules, 2020 mandated smart prepayment meters for new connections
- The Amendment to Electricity Act 2021 removed provision of security deposit for smart pre-paid meters

Empanelment Process for AMI Service Providers (AMISPs)

- Successful demonstration of end-to-end AMI solutions prior to tender participation
- 58+ public and private entities including large project developers, PE firms, manufacturers, etc. empaneled

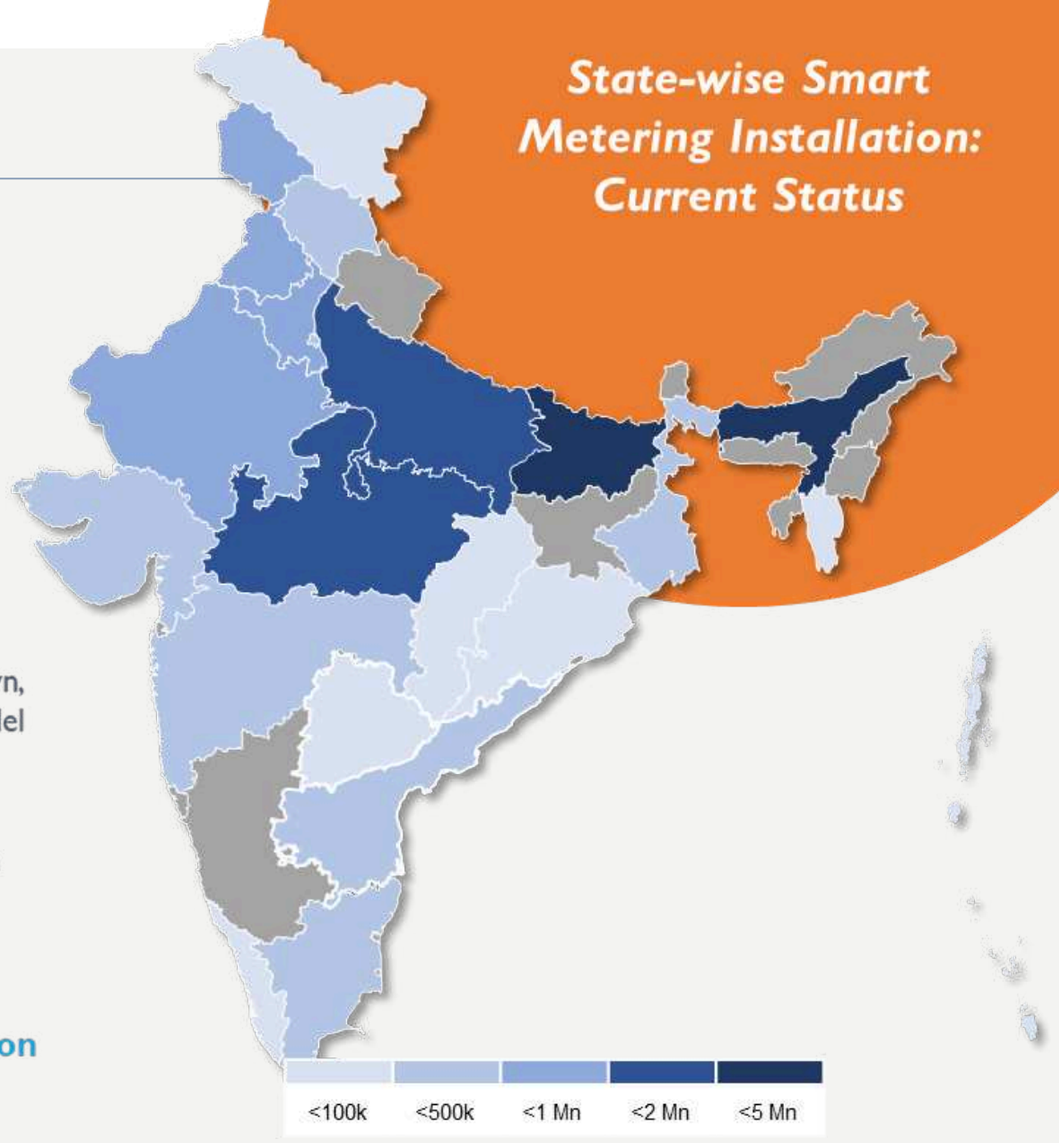
Model Standard Bidding Documents

- Projects on Design, Build, Finance, Own, Operate & Transfer (DBFOOT) model to standardize procurement
- No upfront utility capex requirement
- Innovative payment security mechanism
- Pre-payment infrastructure

Launch of Revamped Distribution Sector Scheme

- Reforms-based & results-linked scheme to improve power quality, reliability, & affordability & reduce distribution losses
- Comprises of: (i) Metering and distribution infrastructure works including installation of 250 mn+ smart pre-paid meters; & (ii) Training, capacity building and other supporting activities

State-wise Smart Metering Installation: Current Status

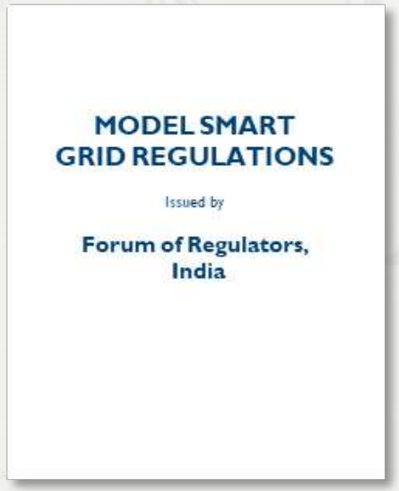


Increased Private Sector Participation

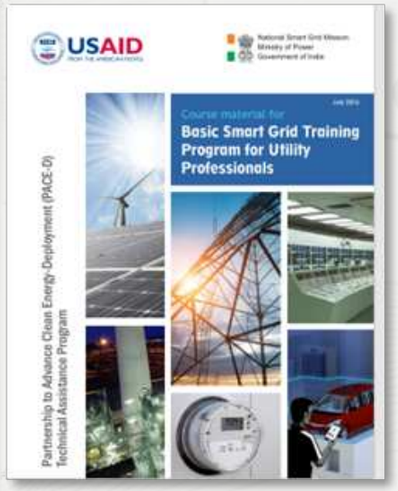
- Tenders for 110 mn smart meters awarded
- Contracts awarded to *large project developers like* Adani, Intellismart, Genus Power, NCC, Polaris, etc.
- *PE firms like* I Squared Capital, Singapore's sovereign wealth fund GIC, etc. invested in smart metering companies

USAID supported GOI on several interventions to enable smart metering ecosystem in India.

Model Smart Grid Regulations



Smart Grid Training Course



Standard Bidding Documents (SBD)

Investment Analysis Tool

Customer Engagement Toolkit

Roadmap for Smart Grid Knowledge Center (SGKC) & Virtual SGKC

IMPACT

The market transformation had an impact on all stakeholders: Industry, Utility & Customer

Industry

Standardization of procurement

Risk-balanced innovative business model for implementation

Visibility of large market

Increased private sector participation and financing

Utility

Reduced power pilferage & cost to serve customers

Increased operation efficiency through automated meter reads

Accurate & timely billing

Accurate prediction of power demand

Customer

Faster resolution of power outages

Greater visibility and control over energy consumption

Flexible recharge options – anytime, anywhere & for any value

Reduction in monthly bills through energy efficiency tips

KEY TAKEAWAYS

Strong government commitment
- Sustained policy push at the federal level
- Creation of dedicated institutional structures for planning and implementing projects
- Allocation of funds for scale-up

Clear implementation mandate
- Mandates through modification of metering regulations
- Release of GoI funds linked to implementation

Strong government-utility-industry interface
- Extensive industry consultations to design a responsive tender
- Buy-in across stakeholders on the project framework

Enhancing utility preparedness
- Model documents/tools to manage projects
  - Model templates – project reports, SBDs, protocols,
  - Web-based investment analysis tool
  - Customer engagement toolkit

Pilots for learnings and boost investor confidence
- Test various technologies and document learnings
- Provided insights for designing scale-up initiatives

Standardization of bidding framework
- Technical standards and functional requirements standardized
- Utilities obligated to follow SBDs' terms & conditions

Unique PPP approach backed by strong digitally enabled payment security mechanism
- Flexibility to choose technology and vendors to meet project requirements
- Direct debit facility for recovery of investments

Customer engagement embedded right from onset
- Value proposition communicated to ensure active customer participation
- Customer engagement toolkit to engage customers proactively

The Compelling Case of Competitive Procurement in India

Fueling the Exponential Growth of RE and Power Transmission in the Country

Mainstreaming renewable energy is pivotal to achieving the energy transition goals of India. However, the scale of deployment necessitated flow of private capital in the sector, which can also bring in efficiencies and lower associated costs. The sector in 2010s was plagued by challenges such as high tariffs, payment delays, and transmission constraints, which were overcome by successfully adopting competitive procurement.

200 GW
and increasing...

CONTEXT

India's ambitious renewable energy targets necessitated a transformation in both policy and financing. With initial solar tariffs set at INR 17.91/kWh in 2010, renewable energy was seen as too expensive, particularly in comparison to conventional sources of electricity. The financial stress on State Electricity Boards (SEBs) and such high tariffs further complicated renewable energy scaling efforts. Government of India recognized that without substantial private investment and policy innovation, achieving the target of 175 GW renewable energy (RE) by 2022 and the larger goal of 500 GW of non-fossil capacity by 2030 would not be feasible.

On the other hand, power transmission was emerging as a major bottleneck for large-scale integration of RE, requiring it to be developed in a timely and cost-effective manner so as to ensure that the clean power is affordable and accessible to end-consumers.

CHALLENGES

Financial Sustainability of Discoms

- High accumulated financial losses
- Tariffs not reflective of costs

High Tariffs

- RE tariffs much higher as compared to conventional sources
- Transmission tariffs were based on costs, thereby introducing inefficiencies

Congestion in the Grid

- Requirement of new transmission corridors
- Mismatch in the project development timelines between RE and transmission

Ambitious Growth Targets

- An increase of 5 times required till 2022 (2014 as base year)
- Increase of around 3 times required in annual capacity addition, 2023 onwards till 2030

MITIGATION STRATEGIES

- Design and setup of robust payment security mechanisms to reduce the financial risk perceived by investors
- Incentives like feed-in tariffs, accelerated depreciation, tax holidays, capital subsidies etc. will accelerate the adoption, especially during initial stages.
- Dedicated corridors for flow of 'green power' required along with grid strengthening. Timelines for project development of transmission system optimized.
- Enabling inflow of commercial capital through standard contracts and conducive regulatory environment

INTERVENTIONS

1. Major initiatives by Government of India in Renewable Energy

Central schemes/targets: Jawaharlal Nehru National Solar Mission, 175 GW by 2022 and 'Panchamrit' (500 GW by 2030)

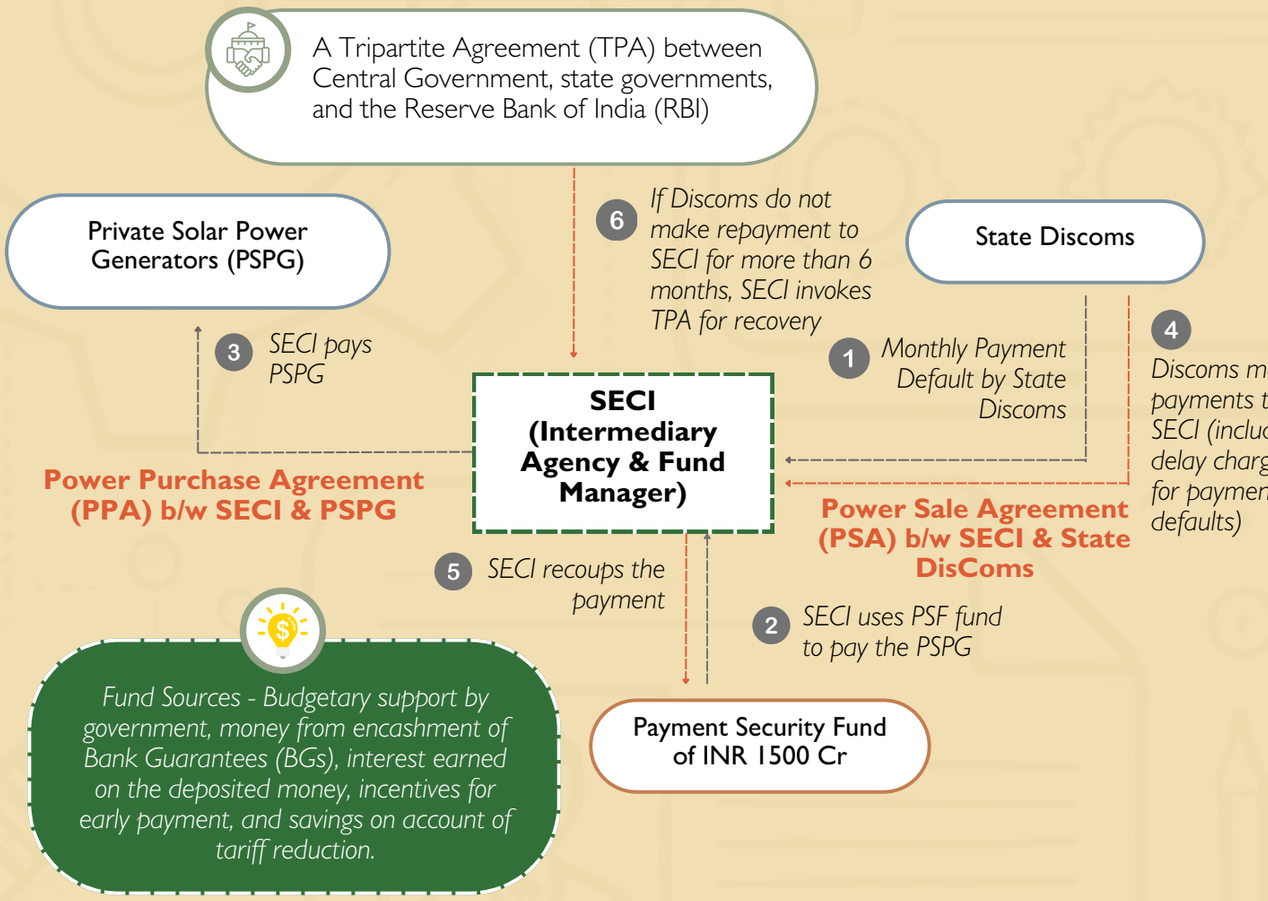
Dedicated nodal agency: Solar Energy Corporation of India (SECI)

Designing bidding frameworks: Competitive bidding guidelines, standard bidding documents, introduction of Reverse Auctions

Designing Payment Security Mechanism

Policy Support: Mandating power procurement through competitive bidding: Introducing incentives such as Accelerated Depreciation, Tax Holiday, Generation-based incentives, waiver of transmission charges, inclusion of RE under priority sector lending, etc.

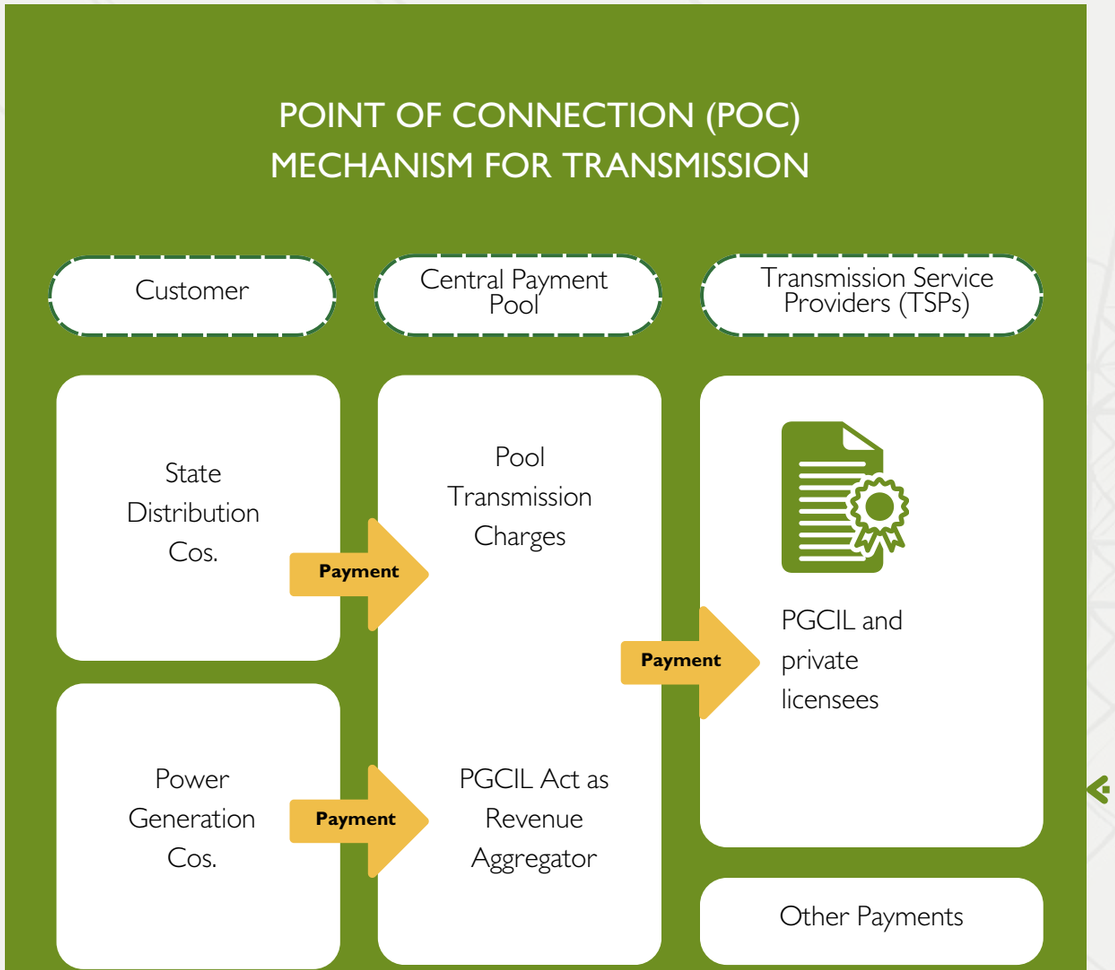
PAYMENT SECURITY MECHANISM FOR RE (SECI)



Key Features of PSM

- PSM covers delay in payments to SECI by entities (DISCOMs/ State utilities/ bulk consumers), so that timely payment to developers can be ensured
- Initial allocation of INR 500 Crs. from GOI to PSM fund.
- SECI is responsible to make the payments within the due dates as per terms of Power Purchase Agreement (PPA)

2.Major Initiatives by Govt. of India in Transmission



Key Features of PoC Mechanism

- Payment security mechanism, based on the principle of a national integrated transmission grid, where charges and losses are apportioned on the basis of quantum and location. This considerably reduces risk exposure of the transmission sector.
- Diversification in the credit risk of state-owned distribution utilities on all India basis and associated pooling benefit reduces counter party risk.

Central schemes: National Electricity plan, Green Energy corridors

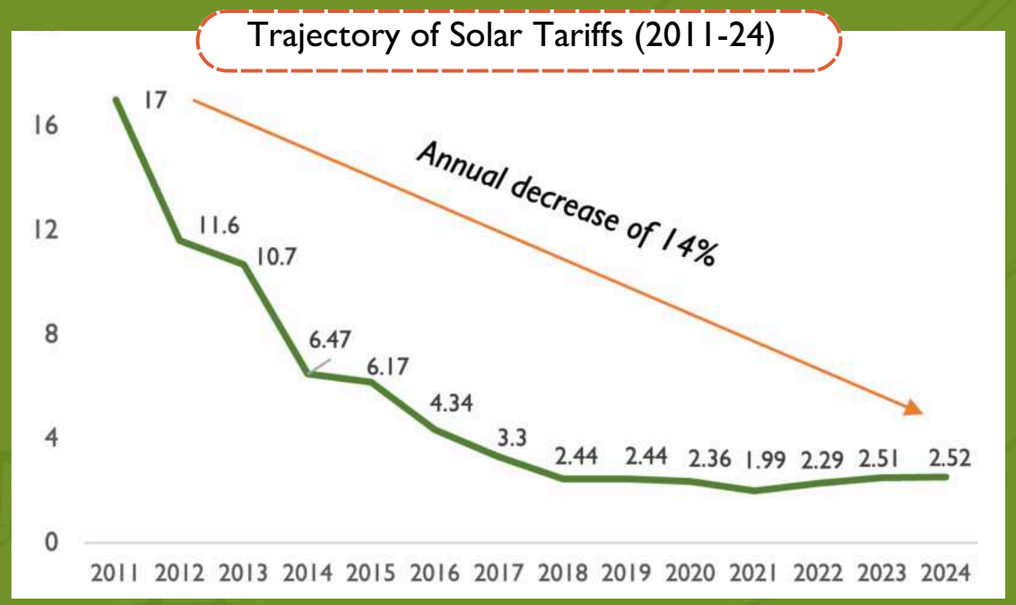
Notification of centralized bidding agency: Subsidiaries of Power Finance Corporation (PFC) and Rural Energy Corporation (REC)

Designing bidding frameworks: Competitive bidding guidelines, standard bidding documents, introduction of Reverse Auction

Regulatory mechanism for reducing payment delays/defaults by state Discoms

Policy support: Mandating transmission service procurement through competitive bidding, reducing project development timelines for RE-linked projects, incentives for early commissioning

IMPACT



RE achieved price parity with conventional power

Solar

- Tariffs dropped by more than 80% in the last 13 years, and are currently lower than thermal power.
- Lowest tariff of INR 1.99 per unit achieved in Dec 2020.

Transmission

- Tariffs determined through TBCB reduced by 30-40% as compared to cost-plus tariffs

Increased investor confidence resulting in flow of international capital

- Around INR 4.1 lakh Cr. invested in RE since 2010
- More than INR 1.3 lakh Cr. invested in transmission, with private developers constituting around 2/3rd investments
- Innovative instruments like InvITs and green bonds have been successfully deployed to recycle the scarce 'construction capital' into greenfield projects

Changing energy mix aligned with India's energy transition goals

- Installed RE capacity increased by 3.5 times in last 9 years
- 46.3% of India's installed capacity is now renewables - totaling 200 GW

KEY TAKEAWAYS

Robust frameworks

A robust competitive bidding framework is required to ensure transparency, enhance bankability, and balance risk allocation between different entities.

De-risking investments

Risk perception of the investors can be reduced through stringent payment security mechanisms and policy frameworks especially during the nascent stages of adoption.

Conducive and consistent policy over long term

Consistent policy framework to be adopted by the government, thus providing long-term visibility to the investors.

Visibility of future pipeline

Definitive plans (for next 2 years) identifying future projects need to be in place, further enhancing investor confidence and providing visibility of future investment opportunities.

Mobilizing International Capital for Clean Energy – The Green Bond Option

Raising Capital for a Sustainable Future

USD 25 BN AND COUNTING…

Green bonds have emerged as one of the preferred options for investments by international investors in India owing to the operational nature of underlying assets. Green bonds have been instrumental in recycling capital especially in the RE sector, thus enabling the redeployment of scarce 'construction capital' and thereby accelerating the growth in clean energy sector. So far, India's share is less than 1% in the overall green bond market and holds a great potential for raising capital to meet the investments needs of the clean energy sector.

CONTEXT

India's committed goals around clean energy require a significant investment, around USD 656 billion by 2032, translating to approximately USD 82 billion annually. Such a huge quantum of capital required for meeting the Nationally Determined Contributions (NDCs) for climate action, requires an orbital shift from the current levels. Traditional funding mechanisms have often proven insufficient due to high risk premiums and limited availability of financing. In this context, green bonds offer an innovative financing tool, enabling countries to raise capital from international markets for clean energy and other environmentally sustainable projects.

Introduction to Green Bonds

What are Green Bonds?

Debt Instruments issued by sovereigns, corporates and other organizations to finance green projects or activities supporting mitigation and adaptation activities to deal with climate change.

Target Sectors

Mitigation - Reducing Emissions

- Energy
- Transport
- Industry

Adaptation - Increased Resilience

- Food and Water Security
- Community, Livelihoods
- Ecosystem, Built Environment

Green Bond Principles

Encouraging Transparency, Disclosures & Integrity

1 Use of Proceeds
Eligible Green Projects

2 Project Selection
Evaluation as per different taxonomies

3 Reporting
Periodic Information: Performance, Impact

4 Management of Proceeds
Transparency, Audit

CHALLENGES

How much 'greenium'

Investors are reluctant to pay a premium for green bonds compared to conventional bonds. Issuers find no benefit in deploying green bonds as a financing tool.

Market dynamics

These bonds are subject to the same market dynamics as traditional bonds, including geopolitical risks and fluctuating interest rates, hence, no major relaxation for investors.

Compliance costs

Issuers incur extra costs such as external audits to verify the usage of the capital raised, thus impacting the overall financial viability.

Currency of issuance

Investors prefer investing in hard currencies like US Dollars rather than local currency, which is a disincentive for issuers especially Sovereigns.

Despite these hurdles, the implementation of robust Green Bond Frameworks, aligned with International Capital Market Association (ICMA) guidelines, has improved transparency and investor confidence.

INTERVENTIONS

SOVEREIGN GREEN BONDS

Govt. of India

- India intends to reach Net-Zero by 2070, as stated in its Nationally Determined Contributions
- The investment requirement has been estimated to run into several trillions of dollars
- The Government of India kicked off its Sovereign Green Bond Program in 2023
- INR 160 billion (~USD 2 billion) was raised in the first financial year

- The issuance enabled funding of innovative green schemes, policies and programs
- This sovereign green bond program was supported by the World Bank

	First Issuance			Follow-up Issuance	
Tenor	5 years	10 years	Tenor	5 years	10 years
Amount	INR 40 billion (USD 490 million)	INR 40 billion (USD 490 million)	Amount	INR 40 billion (USD 484 million)	INR 40 billion (USD 484 million)
Coupon	7.10 %	7.29 %	Coupon	7.10 %	7.29 %
Oversubscription	2.4x	3.8x	Oversubscription	1.7x	2x

End Utilization

- Solar powered water pumps (KUSUM) — INR 8 BILLION
- Energy Efficient 3-phase electric locomotives — INR 85 BILLION
- Investment in Metro projects (Equity) — INR 32 BILLION

GREEN BONDS ISSUANCES IN INDIA

RENEW POWER: GREEN BONDS WITH CREDIT ENHANCEMENT

ReNew

The NASDAQ-listed company has deployed GREEN BONDS as key component of its capital raise strategy.

TRANSACTION STRUCTURE FOR RAISING USD 68 MN (WITH CREDIT GUARANTEE)

DFI (ADB) → LOCAL PARTNER (IIFCL) → INVESTOR → 85 MW WIND PROJECT

14% GUARANTEE | 28% GUARANTEE | USD 68 MILLION

KEY TAKEAWAYS

- ADB & IIFCL's project bond guarantee enhanced the credit rating of the bond to AA+
- The USD 68 million (INR 4.5 billion) transaction paved way for a consistent bond issuance program
- Renew Power's operational capacity has expanded to 9.5 GW (9x from the first issuance in 2015)

USD 15 billion+
Total Capital Raised till Date

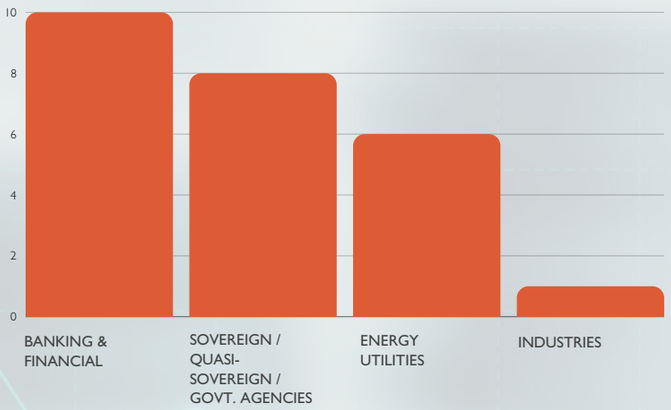
USD 4 billion
Total Capital Raised from Green Bonds

20 Tera Watt hour
Annual Clean Energy Generation

16 Million Tons
GHG Emissions avoided from operations

IMPACT

Since 2015, Thematic/GSSS Bonds have been deployed by diverse public and private organizations to finance sustainable activities.



GREEN	Indian Railway Finance Copn.	**USD 500 million**	Acquire/refinance green assets
SOCIAL	NABARD	**USD 125 million**	Refinance drinking water projects
SUSTAINABILITY	HDFC Bank	**USD 300 million**	Lending towards EVs, SMEs and Affordable Housing
SUSTAINABILITY LINKED	Ultratech Cement	**USD 400 million**	General corporate purposes with sustainability objective

India's innovative use of GSSS Bonds including green bonds is driving significant investments in renewable energy and sustainable urban projects.

KEY TAKEAWAYS

Building Trust Through Transparency and International Cooperation in Green Finance

The success of green bonds in India is closely tied to transparency and accountability. The Green Bond Principles require rigorous reporting and external reviews, which have been critical in building investor trust.

Second, green bonds have proven to be an effective mechanism to diversify the investor base, attracting not only traditional investors but also those focused on environmental and social impact.

Collaboration between domestic and international stakeholders has been important in scaling green bond adoption. By working with entities like the US Treasury Department, the World Bank, and ADB, India has been able to leverage global expertise and financial backing to drive its sustainability agenda. These learnings offer valuable insights for other emerging economies looking to finance their climate goals.

Changing the Landscape of Public Transportation – India E-bus Story

Scaling electric buses through innovative business models

Achieving price parity with internal combustion engine (ICE) vehicles has been one of the major challenges hindering the adoption of electric buses in India. Innovative procurement mechanisms combining the strengths of demand aggregation and opex-based models have been successfully deployed in India. The prices discovered for e-bus operations, through such mechanisms, have been 20-30% lower than compressed natural gas (CNG) and diesel buses respectively. This early success will play a catalytic role in accelerating adoption across other segments, thereby contributing significantly to the clean energy transition targets.

CONTEXT

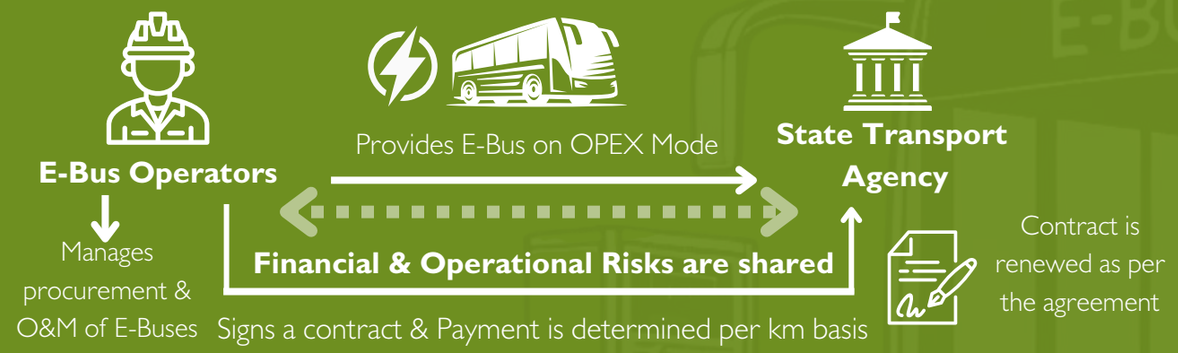
India's commitment to clean energy transition is anchored in its ambitious Panchamrit goals, which include reducing projected carbon emissions by one billion tons by 2030, reducing carbon intensity by 45%, and achieving net-zero emissions by 2070. Reducing the carbon intensity is significant to achieving such goals, and considering the quantum of greenhouse gas (GHG) emissions emitted by the transportation sector, its decarbonization becomes critical.

Transportation accounts for about 14% of the energy related emissions. However, considering the GDP growth forecast for India, it has the potential to increase significantly in the future. Amongst the different segments, road transport contributes about 90%, hence, adoption of electric buses is imperative to achieving the decarbonization of transportation sector.

USAID has been associated with the implementation of GOI schemes relating to deployment of electric buses, and has provided technical assistance for this market transformation journey.

CHALLENGES	MITIGATION
Financial Sustainability of Public Transport Authorities (PTAs) • Dependence on grants leading to uncertain cashflows • Ticket price not reflective of costs • High losses negatively impacting the ability to invest upfront	• Demand aggregation to diversify and distribute risks amongst PTAs • Robust Payment security mechanism
High Upfront Procurement Costs • Cost of procuring electric bus is 3-4 times that of ICE buses.	• Opex based contracts with recovery spread over a period of 12 years
Standardization of Specifications • Availability of multiple variants of electric buses, inhibiting the ability to achieve economies of scale	• Harmonizing specifications during demand aggregation, thereby achieving the required scale for evoking interest from larger OEMs/operators
Limited Charging Infrastructure • Increasing range anxiety of users constraining adoption specially in case of intercity routes	• Development of captive charging in depots

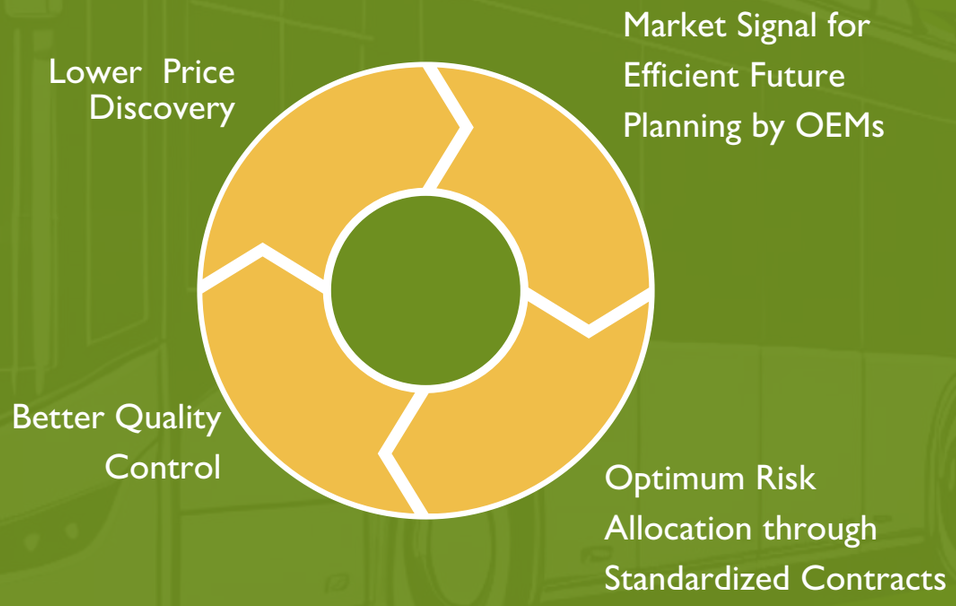
BENEFIT OF GROSS COST CONTRACT (GCC) MODEL



- Private operator invests in the purchase of bus and setting up charging infrastructure
- Operation and maintenance done by private operator for a tenure of 12 years
- PTAs pay a per kilometer fee for the duration of the contract
- Penalties are levied in case of deviations from predefine service levels beyond the threshold

Demand aggregation along with GCC has been successfully used for accelerating the adoption of e-buses in India.

BENEFITS OF DEMAND AGGREGATION



INTERVENTIONS

	50,000 E-Buses by 2027	**2019-2024** FAME II	**2022** NEBP	**2022-2027** PM-eBus Sewa	**2024-2026** PM E-DRIVE	**2024-2039** PM-eBus Sewa PSM
NODAL AGENCY		Ministry of Heavy Industries	Convergence Energy Services Ltd	Ministry of Housing and Urban Affairs	Ministry of Heavy Industries	
BUSINESS MODEL		Only GCC Model	----- Demand Aggregation through GCC/other models -----			
POLICY/SCHEME DETAILS		• Capex subsidy of INR 20,000/ kWH • Demand aggregated through Grand Challenge	No subsidy provided	• Operational subsidy of INR 20-22 per km • Deployment in Tier 2 and Tier 3 cities (population between 3 lakhs to 40 lakhs) • Includes financial support to upgrade their depot infrastructure	• Capex subsidy of INR 10,000 per kWH • Focus on large cities (population more than 40 lakhs) and intercity routes • Continuation of Fame II scheme	• Payment security mechanism to address issue of delayed payments and de-risk investments • Funds of 3,400 crores allocated which will be supported by re-coupment from state funds using Direct Debit Mechanism (DDM)
BUSES SANCTIONED		Total 6,862 subsidy eligible sanctioned: • 3,390 (State direct tender) • 3,472 (Grand challenge)	• 6,465 buses across 6 cities awarded	• Target to deploy 10,000 buses. 1,390 e-buses have been awarded. Tender of 4,588 is currently live	• Target to deploy 14,028 buses	• Support deployment of 38,000 ebuses

USAID Interventions :

- Technical assistance to implement the PM-eBus Sewa and PM E-DRIVE schemes and support on-ground deployment.
- Contribution of INR 120 Crs to PSM scheme

IMPACT

Scale of Adoption
Over 18,000 E-buses have already been tendered, setting the groundwork for larger-scale adoption.

Cost Efficiency
By aggregating demand, the GCC model achieved economies of scale, resulting in a 31% reduction in costs compared to diesel buses.

Financial Viability
PSM expected to play a crucial role in de-risking investments and ensuring financial stability, making the sector more attractive to private operators

STATE-WISE ELECTRIC BUSES IN INDIA

No	STU	E-Busses as of Sept' 2023
1.	Gujarat	325
2.	Andaman	40
3.	Andhra	100
4.	Assam	15
5.	Karnataka	441
6.	Odisha	50
7.	Bihar	25
8.	Maharashtra	1,414
9.	West Bengal	80
10.	Chandigarh	80
11.	Delhi	1,280
12.	Himachal	110
13.	J&K	40
14.	Goa	83
15.	Kerala	110
16.	Telengana	75
17.	UP	740
	Total	5,008

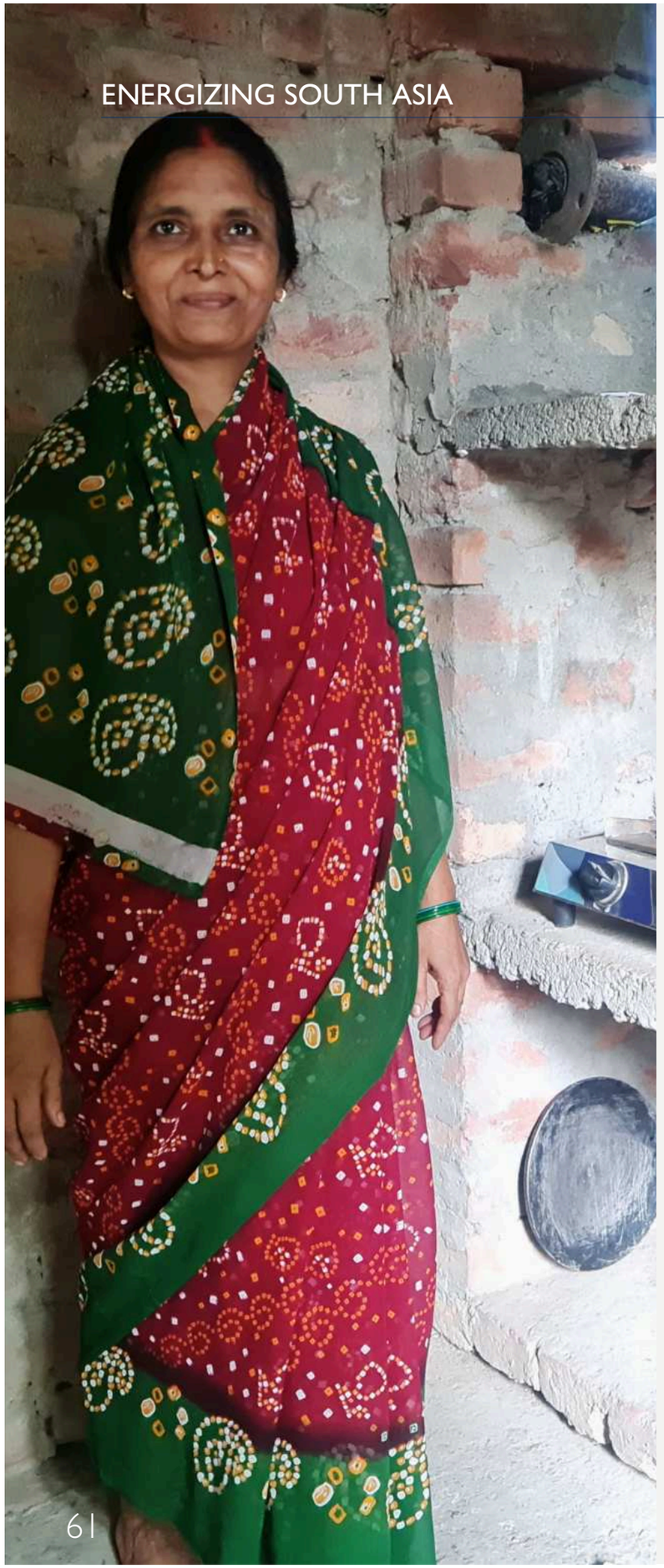
KEY TAKEAWAYS

Procurement mechanism
Centralized procurement approach through demand aggregation, has proven effective in reducing costs and standardizing e-bus specifications

De-risking investments
Credit enhancements like payment security mechanism will reduce risk perception and enhance investents

Business model
Use of opex-based models to spread payments over a longer period, thus utilizing the lower operating costs associated with electric buses

Incentives
Incentives in the form of capital and/or operational subsidy required to provide the initial push for accelerating adoption



Scaling Access to Clean Energy through Women Micro-Entrepreneurship in Rural India

Empowering Women to Drive Sustainable Energy Adoption in Rural Communities

A clean energy initiative by Swayam Shikshan Prayog (SSP) empowers women in 500 villages across Bihar and Maharashtra to promote and sell biodigesters, providing sustainable energy solutions. Supported by financial assistance and partnerships, the program is creating economic opportunities for women while expanding access to affordable clean energy in rural areas.

CONTEXT

In rural India, many households continue to rely on traditional, inefficient energy sources like firewood for cooking, contributing to health risks, environmental degradation, and high household energy costs. Over 39% of rural households do not use liquefied petroleum gas (LPG) as their primary cooking fuel, and small-scale farmers face rising expenses and soil degradation due to reliance on chemical fertilizers.

Despite efforts like the Ujjwala program, gaps in last-mile distribution prevent widespread adoption of cleaner energy solutions. Current alternatives, such as biodigesters, face challenges like complex installations and poor quality materials, making them difficult to adopt. To address these issues, a new, accessible solution is needed that meets the specific energy needs of rural households and farmers while being affordable and easy to implement.

INTERVENTIONS

Proof of Concept: Tested biodigester adoption with Sistema.bio since 2019.

SAREP Partnership: Leveraged fund to scale up commercially viable business models.

Women-led Model: Trained local women (Sakhis) as micro-entrepreneurs for last-mile distribution.

Biodigester Solution: Offered Sistema.bio's pre-fabricated units converting waste to energy and fertilizer.

Product Innovation: One-day installation, training, financing, after-sales service, and 10-year warranty.

Local Promotion: Sakhis conducted household visits, community meetings, and digital campaigns.

Carbon Financing: Reduced product cost by 60-75% using carbon credits.

Targeted Marketing: Mapped early adopters based on technical criteria (e.g., livestock ownership).

Knowledge Sharing: Documented lessons for public dissemination to inspire similar programs.

The program, launched in August 2022, focuses on scaling access to affordable clean energy for rural populations through women-led micro-entrepreneurship. Women from local communities were trained and empowered to promote and sell portable biodigesters developed by a company called Sistema.bio. These biodigesters convert livestock waste into biogas, providing a sustainable alternative to traditional cooking fuels. They also produce bio-slurry, a byproduct that improves farm productivity when used as a fertilizer.

The project partnered with carbon financing initiatives, including a grant under the SAREP Partnership Fund (SPF) from USAID SAREP, which allowed rural households to access these technologies at a reduced cost. The upfront cost of biodigesters was cut by 60-75%, making them more accessible to rural families. The micro-entrepreneurs conducted field demonstrations to showcase the product's benefits, using early adopters to build trust and encourage others to invest in the solution.

IMPACT

With women leading the marketing, distribution, and sales of biodigesters, the program has underlined their role as last-mile enablers of clean energy and put them in the position of changemakers within their communities.

500+ rural women

Trained in entrepreneurship

INR 3.4 Million

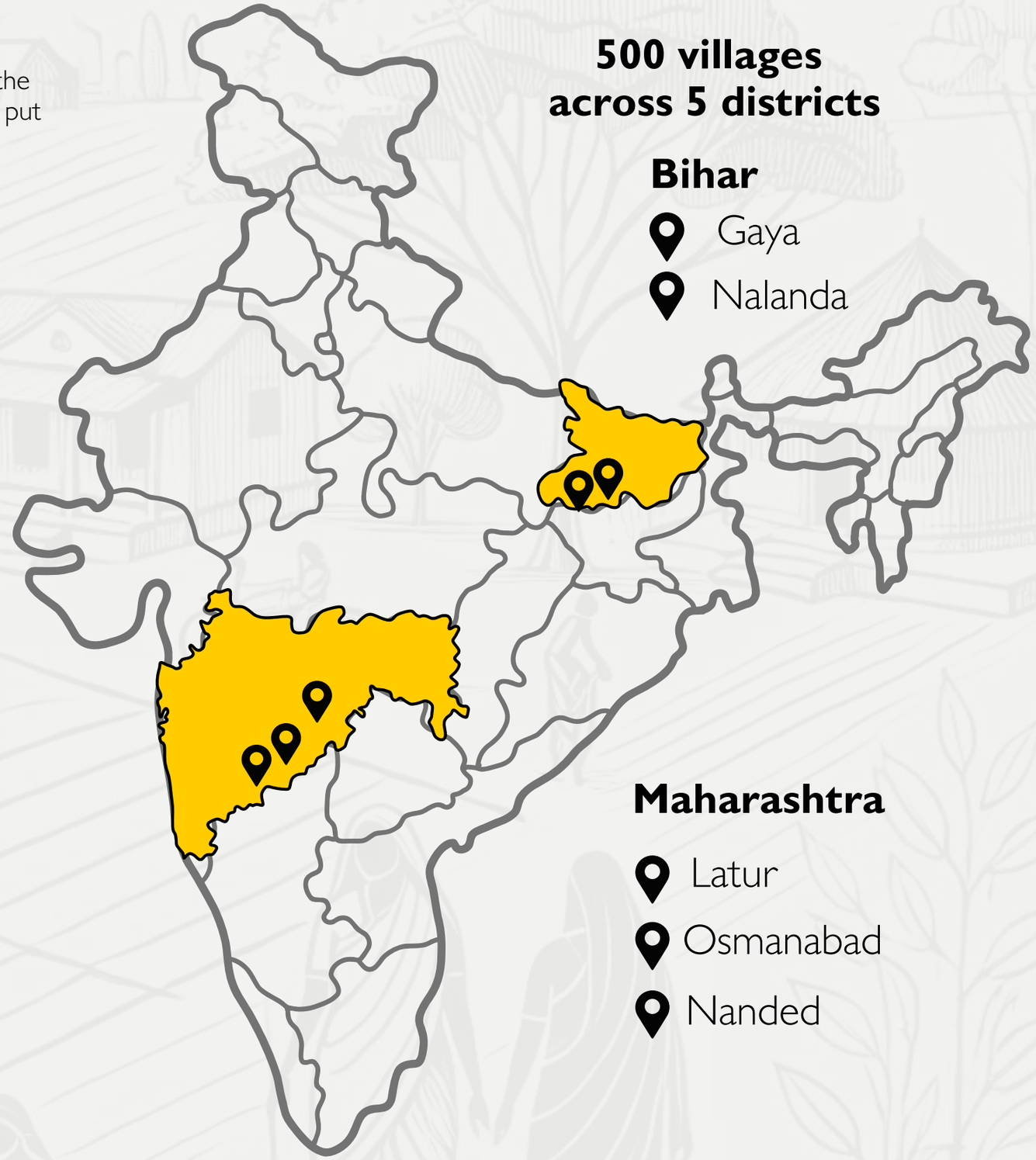
Additional income

100,00+ families

Reached through last-mile interventions

7500+ families

Adopted commercial bio-digesters



KEY TAKEAWAYS

The initiative can serve as a replicable model for other regions looking to empower women and improve energy access through micro-entrepreneurship with the following key learnings:

Carbon Financing and Financial Innovation: The program highlighted the effectiveness of using carbon financing to reduce the cost of clean energy solutions for end-users. Without these incentives, adoption rates would have been significantly lower, demonstrating the continued need for financial innovation to lower barriers for rural populations.

Local Knowledge and Demonstrations: Field demonstrations and early adopters played an important role in promoting biodigesters. The women-led micro-entrepreneurship model proved highly effective, as these entrepreneurs leveraged local knowledge and trusted networks to build strong relationships with customers.

Product-Market Fit: The discontinuation of Subjee Coolers underscored the importance of product-market fit. The success of biodigesters contrasted with the failure of the coolers, emphasizing that solutions must be tailored to meet specific local needs and preferences.

This program has laid the groundwork for expanding access to clean energy in rural India and serves as a model for other regions looking to empower women and improve energy access through micro-entrepreneurship.

India Rising: Charting the Course for Renewable Energy Leadership

India has evolved as a global climate leader, driven by its forward leaning targets and innovative market mechanisms. Through a combination of enabling policy and regulatory reforms, transmission evacuation infrastructure, modern and flexible grid, competitive procurement, and private sector participation, India has transformed its energy landscape, attracting significant investments and becoming a model for other countries pursuing sustainable energy transitions.

CONTEXT

As of 2024, India is the fourth-ranked country globally in renewable energy (RE) installed capacity, including fourth in wind power and fifth in solar power capacity. However, this success has not come overnight, the seeds having been sown much earlier.

With dedicated ministry supervising RE growth, India's renewable energy journey began with the establishment of ambitious targets. Initially set at 175 GW of renewable energy capacity by 2022, the target was enhanced to 500 GW of non-fossil fuel capacity by 2030.

The country adopted a multi-pronged strategy involving policy reforms, infrastructure development, grid strengthening measures, power market reforms, private sector engagement, and a series of policy and regulatory interventions. The goal has been not only to build renewable energy capacity but also to simultaneously integrate it efficiently into the national grid, ensuring that this energy can be reliably transmitted from generation sites to demand centers.

CHALLENGES

- High costs of renewable energy generation with solar tariffs in 2010 as high as INR 17.91/kWh, making it uncompetitive.
- Financially unstable offtakers of RE power, primarily the State Electricity Boards (SEBs)
- Delays in payments from distribution companies (DISCOMs)
- Underdeveloped transmission infrastructure
- Grid's inability to handle the variability of renewable sources like wind and solar created technical barriers

INTERVENTIONS

Key Enablers

I. Policy and Regulations

India's clean energy journeygot bolstered with the launch of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. A series of transformative policies and regulatory reforms enabled India to to achieve 200 GW of installed renewable energy capacity.

Key policy and regulatory initiatives driving this success include the following:

- **Renewable Purchase Obligations (RPO)**, mandated utilities to diversify their energy portfolio and invest in cleaner technologies
- Waiver of **Interstate Transmission System (ISTS)** eliminated transmission charges for RE developers , resulting in reduced project costs.
- **Framework for Forecasting, Scheduling, and Imbalance Handling** helped in ensuring effective grid integration of renewable energy at large scale
- **Green Energy Open Access Rules** enabled industrial and commercial consumers to purchase renewable energy directly from RE developers.
- **Solar Parks and Ultra Mega Solar Power Projects** enabled the development of large-scale, grid-connected solar power projects by facilitating well-equipped solar parks infrastructure.

2. Power Market Reforms Enhancing Renewable Energy Integration

India's power market reforms have enabled renewable energy integration through transparent pricing and competitive platforms. Notable reforms include the Renewable energy certificates (REC), Real-Time Market (RTM) for near-real-time trading, Green Term Ahead and Day Ahead Market for short-term renewable trading, Green Energy Open Access (GEOA) rules for direct procurement, and Ancillary Services Markets for grid stability. These measures have enhanced competition, investment, and flexibility, aligning with India's renewable energy goals.

3. Competitive Bidding

Competitive procurement has been a transformative factor in making India a global leader in renewable energy. The National Solar Mission adopted the process of inviting tariff-based bids which reduced solar tariff from Rs.6.48/ kWh in March 2013 to Rs.1.99/kWh in December 2020. This process attracted both domestic and international players, driving significant investment, fostering innovation, and enhancing competition, making it one of the largest and most cost-efficient producers of renewable energy globally.

Photo Credit: District Rewa, Government of Madhya Pradesh

Example Case Project: Rewa Solar Park

Rewa Solar Park with 750 MW installed capacity stands as a landmark project in India's renewable energy journey and became one of the largest solar park in the world during 2019-20.

Highlights:

Funds Mobilized:
INR 4,000 crores (around USD 475.74 million).

Bidding Process:
Reverse bidding process, lead to record-low tariffs with first year tariff of INR. 2.97/unit.

Strong Procurer:
First solar park in India to sell power to an entity other than state utilities ie. Delhi Metro

Environmental Impact:
This project reduces carbon emission equivalent to approx. 15 lakh ton of CO2 per year.

4. Enhancing Power System Operational Flexibility

To accommodate the increasing share of RE and ensure grid stability, several measures were implemented to enhance operational flexibility within the power system.

Flexible Operation of Conventional Coal based Plants:
India, largely coal-dependent, has adopted flexible coal plant operations to support renewable energy integration. **CEA's 2023 regulations** require coal plants to operate at 40% minimum load with ramp rates of 2-3% per minute. Pilots by **USAID** successfully demonstrated this flexibility. **CERC's Grid Code** and **Ancillary Services** also mandate compliance with **AGC signals**, enabling strategic use of coal plants for renewable energy goals.

Integration of Storage Systems:
The Indian government promotes **BESS** and **pumped storage** to integrate renewable energy. Key policies include the **National Framework for Energy Storage, Energy Storage Obligation**, and an I**STS waiver** for projects commissioned by June 2025. Pumped storage is also emphasized under the **National Hydropower Policy (2018)** for long-duration storage and grid stability.

The Security Constrained Unit Commitment (SCUC) mechanism is added to CERC's Grid Code, to optimize generating unit commitments to maximize reserves and ensure grid security.

5. Strengthening India's Grid for Renewable Energy

India has expanded its transmission infrastructure for renewable energy integration and adopted technologies like **High-Voltage Direct Current (HVDC)** and **Flexible AC Transmission Systems (FACTS)** to improve efficiency and reduce losses.

Transmission Capacity Augmentation

India doubled its transmission capacity over the past decade, adding 194,599 Ckm for a total of 481,326 Ckm. In 2024, the government allocated USD 1.2 billion for solar grid expansion, up from USD 570.84 million in the previous year, and adopted FACTS devices to enhance capacity and reduce transmission losses.

Central Transmission Utility (CTU)

CTU was established to expand interstate transmission, ensure efficient renewable energy evacuation to high-demand areas, and manage the Point of Connection (PoC) mechanism for unified payment for transmission assets.

Green Energy Corridor (GEC):

The Government of India initiated GEC to develop transmission lines for evacuating renewable energy. By 2024, Phase I completed over 9,000 Ckm of its 9,700 Ckm target, connecting RE-rich states like Gujarat, Rajasthan, Tamil Nadu, and Karnataka. Phase II aims to add 10,750 Ckm of transmission lines

Renewable Energy Management Centers (REMCs):

REMCs were established at national, regional, and state levels, particularly in RE-rich states, to integrate large-scale renewable energy , real-time monitoring, and advanced forecasting tools.

IMPACT

Fourth largest RE capacity:
India has an installed capacity of 200 GW of renewables

Energy Security
By diversifying its energy sources, India has enhanced its energy security, reducing dependence on fossil fuel imports and stabilizing energy prices.

Cost Competitiveness
Solar tariffs dropped sharply, making renewable energy cost-competitive with conventional sources.

Private Sector Participation
Private investments have driven transmission infrastructure, while competitive procurement lowered project costs.

Grid Integration
The combination of the Green Energy Corridor and grid-strengthening measures enabled the system to handle larger shares of renewable energy.

Job Creation
The renewable energy sector has generated nearly 1.02 million jobs until 20232 contributing to economic growth and sustainability.

KEY TAKEAWAYS

India's emergence as a global leader in renewable energy stems from a combination of policy reforms, market-driven adjustments, infrastructure development, and grid modernization initiatives. This integrated approach has allowed India to scale up renewable energy deployment rapidly while maintaining cost efficiency. India's experience demonstrates that a comprehensive and integrated approach is essential for achieving ambitious renewable energy goals.

USAID has supported Government of India in its renewable energy journey through technical assistance on policy and regulatory frameworks, large-scale grid integration and power market reforms.

MALDIVES

IMPACT STORIES

Supporting Clean Energy Transition in Small Island Developing States

Powering a Renewable Future for the Maldives

The Maldives, a low-lying island nation vulnerable to the impacts of climate change, has long been reliant on diesel for energy, a costly and environmentally damaging dependency. To address this, the Maldives, in partnership with the Asian Development Bank (ADB), launched the Preparing Outer Islands for Sustainable Energy Development (POISED) project. This ambitious initiative aims to transition the island's energy grids to hybrid renewable energy systems, reducing both emissions and costs, while enhancing energy independence. The project represents a significant step toward a cleaner, more resilient energy future for the Maldives.

CONTEXT

As a Small Island Developing State (SIDS), the Maldives faces a growing energy demand and is entirely dependent on imported fossil fuels to meet its energy needs. This reliance not only contributes to high greenhouse gas emissions but also places a significant burden on the government's budget due to high subsidy costs.

Moreover, the existing diesel-based power generation grids are inefficient and costly to maintain, making the transition to renewable energy both an environmental and economic imperative.

Diesel Dependence

The Maldives relies heavily on imported diesel for energy generation

Environmental and Economic Challenges

- High greenhouse gas emissions from diesel.
- Diesel subsidies strain government finances.
- Inefficient, costly diesel-based power grids.

Need for Clean Energy Transition

Shifting to renewable energy for growing energy needs is crucial for both environmental and economic reasons.

INTERVENTIONS

The POISED project is transforming the existing energy grids across the Maldives' archipelago into a hybrid renewable energy system. This large-scale initiative, which began in December 2022 and is still ongoing, has focused on installing energy management and control systems, advanced energy storage solutions, and making improvements to distribution networks. By reducing the dependence on diesel to generate electricity, POISED aims to lower costs and emissions while relieving the financial strain on government subsidies.

In Phase 5 of the project, solar photovoltaic (PV)-diesel hybrid systems were installed in 12 inhabited islands of Thaa Atoll. Of these, six islands (Th. Dhiyamigili, Th. Gaadhiffushi, Th. Kandoodhoo, Th. Vandhoo, Th. Hirilandhoo, Th. Omadhoo) now have systems with the capacity to operate without the diesel generators during daylight hours, thanks to a combination of 2.5 MW of solar PV, a 2.25 MWh Battery Energy Storage System (BESS), and upgraded grid infrastructure. This intervention reflects a holistic energy transformation, combining solar energy with improved grid management to meet energy needs in a sustainable way.

Received the Greening the Islands Awards (GTI) in 2021 for innovative energy solutions.

IMPACT

Environmental Benefits

- Decrease of 3,305 tCO_2e in annual emissions
- 2.6 MW of clean energy added to national grid

Capacity Building

Local technicians trained in operation and maintenance of hybrid systems

Social Benefits

- Reliable and cleaner energy supply
- Potential for job creation in renewable energy sectors

Operational Advantages

- Reduced fuel consumption lowers electricity production costs
- Enhanced energy supply stability, reducing outages
- Less reliance on diesel generators reduces noise levels

Community Engagement

Awareness raised on renewable energy and energy efficiency

KEY TAKEAWAY

The POISED project exemplifies how international cooperation and local commitment can drive a clean energy transformation in a geographically unique and vulnerable region. By reducing dependency on diesel and promoting the adoption of renewable energy, the Maldives is taking vital steps toward a more sustainable and resilient future.

A critical takeaway from the project has been the importance of establishing proper plans and agreements among all key stakeholders. Effective coordination and clear communication between partners, including government entities, development banks, and local councils, have been vital to overcoming challenges and ensuring project success.


NEPAL
NEPAL
NEPAL

IMPACT STORIES

Nepal's Hydropower Surge: Mobilizing Billions through Strategic Advisory

The Government of Nepal targets 28,500 MW of installed capacity by 2035, with 15,000 MW for export, requiring $46 billion in the energy sector. Despite its hydropower potential and role in regional GHG reduction, the sector faces challenges in attracting private funding.

CONTEXT

Nepal has faced difficulties in attracting credible international investors to meet foreign direct investment needs. This is partly due to a limited experience in negotiating and finalizing key transaction documents, such as Power Development Agreements (PDAs) and Power Purchase Agreements (PPAs), at a high standard. There is also a need to strengthen the sector's environmental and social risk management practices. Project development—whether hydropower, transmission, or solar—can lead to environmental and social issues, such as biodiversity loss or resettlement.

To attract international financing, Nepalese energy projects must follow commonly accepted international Environmental and Social (E&S) principles, such as the IFC Performance Standards or the Hydropower Sustainability Standards (HSS). Nepal's reliance on traditional bank financing has made it challenging to scale the necessary debt and equity into the sector. Even projects with guaranteed cash flows backed by NEA-sponsored PPAs struggle to secure financial closure due to the limitations of the domestic capital market.

To support the sustainable development of Nepal's energy sector, USAID, through its Urja Nepal project, has played a crucial role in extending critical advisory support, including sharing of best practices in Environmental and Social Impact Assessments (ESIAs) and other risk management measures.

Photo Courtesy: Tamor Energy Pvt. Ltd

INTERVENTIONS

The agency has supported 26 private sector and public sector-led power projects, including the largest independent power producer (IPP) project (Upper Tamor Hydropower Project of 285 MW) and large Government-led projects (West Seti and SR6 of 1200 MW under development by National Hydroelectric Power Corporation (NHPC) limited, an Indian hydropower development company.

The advisory services included thorough financial reviews through detailed models to ensure accurate and reliable revenue revenue projections, investment estimates, and operational cost assessments. The services included detailed assessment of technical designs, particularly alignment to environment and safety regulations, review engineering plans, and analyze water resource availability.

The support extended to guidance on contract negotiations, financial modelling, and risk assessments. In addition, the agency trained government officials from the Ministry of Energy, Water Resources, and Irrigation (MoEWRI), the Nepal Electricity Authority (NEA), and the Department of Electricity Development (DoED) to strengthen their negotiation and project management skills.

ADVISORY SERVICES

- Provided financial, legal, and strategic support to government and IPP projects
- Deep dive technical reviews
- Contract documental and reviews

ENVIRONMENTAL & SOCIAL STANDARDS

- Ensured projects followed global Environmental and Social Impact Assessment (ESIA) practices.

TRAINING

- Trained officials from MoEWRI, NEA, and DoED on negotiations and project management skills.

EXAMPLES OF ADVISORY SUPPORT

- Assisted in negotiations of the 669 MW Lower Arun hydropower project, attracting approximately $0.7 billion in foreign investment.
- Supported NEA in signing MoUs with SJVN for Arun 4 (490 MW) and Phukot Karnali (480 MW) hydroelectric projects.
- Supported award of West Seti and SR6 hydroelectric projects to NHPC of India, helping attract approximately $3.5 billion in foreign investment from India.
- Supported Upper Tamor Hydropower Project (285 MW) in securing financial closure for approximately $414 million.

IMPACT

11 Hydropower IPPs (768.3 MW) achieving financial closure, securing $1.16 billion in investment.

5 Government-owned hydropower projects (3,902 MW) moving towards financial closure, mobilizing $5.87 billion in investment.

8 Solar PV IPPs (85.1 MW), mobilizing over $170 million in investment.

1 Hydropower (135 MW) moving toward financial closure, mobilizing $280 million in investment.

1 Transmission-Line (112 km 400kV Butwal-Gorakhpur) line, mobilizing $60 million[BA1] .
[BA1]Life of project - totals $7.54 billion

Total Investment mobilized – USD 7.5+ Bn

KEY TAKEAWAYS

Innovative Financing
Using tools like green bonds, guarantees, and blended finance can attract more private investment for large-scale clean energy projects. For projects that are technically, and socially feasible but financially unviable, blended and concessional finance is necessary to make it attractive to the private sector.

Blended Finance for Challenging Projects
Projects that are technically feasible but financially difficult can benefit from concessional or blended financing to make them viable for investors.

Expert Advisory Support
Professional transaction advisory services help ensure projects meet international standards, secure funding, and successfully negotiate key agreements.

Stakeholder Collaboration
Ongoing engagement and transparency with stakeholders are crucial for smooth project implementation and successful outcomes.

Sustainability is Imperative
Promoting the use of ESIAs and rigorous environmental and social safeguards are necessary to attract low-cost concessional capital from abroad.

Photo Courtesy: Investment Board of Nepal

Laying the Groundwork: Open Access as a Catalyst for Competitive Power Markets in Nepal

Nepal has embarked on an ambitious journey to reform its electricity market by introducing Open Access through the General Network Access (GNA) Framework. This transformative step aims to enhance competition, support cross-border power trade, and boost private sector participation in the electricity sector. Despite significant challenges, including a lack of policy and legal clarity, Nepal has made significant advancements to foster a fair, transparent, and efficient power market that will benefit all stakeholders, from independent power producers (IPPs) to consumers.

CONTEXT

Since the introduction of the 1992 Electricity Act, Nepal's power generation sector has seen accelerated growth, with over 60% of the installed capacity now owned by independent power producers (IPPs). However, the state-owned Nepal Electricity Authority (NEA) is still the main buyer for electricity, which can limit competition and reduce market efficiency. To promote more private sector participation, there was a need to introduce Open Access in the Nepal power market.

To drive further reform and introduce competition, the Electricity Regulatory Commission (ERC) has been mandated to implement Open Access, enabling buyers and sellers to transact directly, both domestically and across borders.

CHALLENGES

- Complex legislative reforms required for legal, regulatory, and licensing processes
- Limited awareness among stakeholders
- Concerns regarding infrastructure adequacy
- Technical and human resource constraints within key stakeholders
- Need for an independent system operator

Need for an independent system

INTERVENTIONS

By leveraging its strong bilateral relationships, USAID/Nepal through its Urja Nepal project provided the Government of Nepal (GoN) with comprehensive technical assistance, capacity building, and strategic advisory support. This included helping establish the GNA Framework, strengthening stakeholder capacities, and facilitating consultations between the Ministry of Energy, Water Resources, and Irrigation (MoEWRI), ERC, NEA, , and the private sector.

With Urja Nepal support, the GoN was able to issue guidelines to the ERC to put in place a regulatory framework for Open Access/GNA despite larger reforms to the Electricity Act being stalled. This legal provision, as stated in the ERC Act which was drafted with the assistance of USAID/Nepal through the Nepal Hydropower Development Program (NHDP), has been critical in advancing the foundations for wholesale competition in Nepal.

USAID'S TECHNICAL ASSISTANCE

- Capacity building at MoEWRI on Open Access concepts and processes
- Advisory support in developing General Network Access (GNA) Framework
- Facilitated policy dialogues among key stakeholders
- Support for ERC Commissioners on legal provisions and international best practices

IMPACT

The MoEWRI issued the GNA Framework to ERC in March 2024, setting the stage for an inclusive electricity market in Nepal. This is a landmark achievement in Nepal's journey towards competitive power markets. The framework paves the way for non-discriminatory access to the transmission network, making it possible for private developers to sell power directly to consumers. This will not only enhance transparency and competition but also encourage private investment, including in transmission infrastructure. . Currently, Urja Nepal is assisting the ERC in developing the Directives needed to officially enable GNA in the marketplace.

USAID's sustained support amidst political changes showcases the importance of continuous advocacy and strategic partnerships in overcoming institutional barriers and achieving long-term reform goals.

March 2024: MoEWRI issued the GNA Framework to ERC.

GNA Framework outlines eligibility criteria for GNA, including Cross Border Electricity Trade (CBET)

Classifies different types of GNA and their commercial features.

GNA enabled ERC to develop detailed directives for power market operations, dispute settlement, and wheeling charges.

KEY TAKEAWAYS

Regulatory Innovation:
Embedding competition provisions early, as seen with the 2019 ERC Act, can serve as a safeguard against delays in broader legislative reforms. This allows policymakers to advance market competition without waiting for comprehensive sector reform.

Stakeholder Sensitization
Working across the power value chain is critical to achieving the broad support needed to promote market reform

Support Regulatory Changes
Regulatory reforms, like the innovative approach of General Network Access (GNA), need clear guidelines to be effective, even if broader laws are delayed.

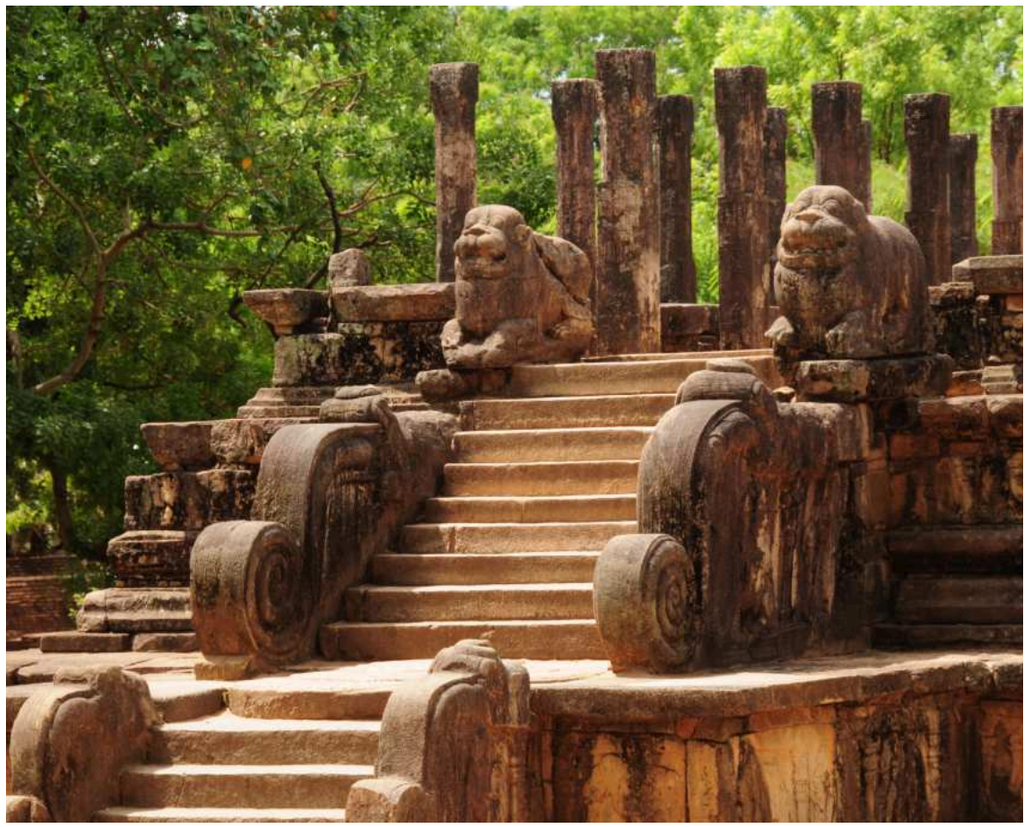
Focus on Fundamentals
GNA will promote competition and private sector participation in traditionally monopolized sectors like electricity, without the need for comprehensive reform. Progress made via GNA will automatically promote market competition, enabling the private sector to introduce efficiencies, innovation, and greater transparency under Nepal's existing legal framework.

Plan for Infrastructure Early
Legal changes must be backed by upgrades in infrastructure, IT, and institutional capacity to ensure successful implementation.

SRI LANKA

SRI LANKA

SRI LANKA



IMPACT STORIES

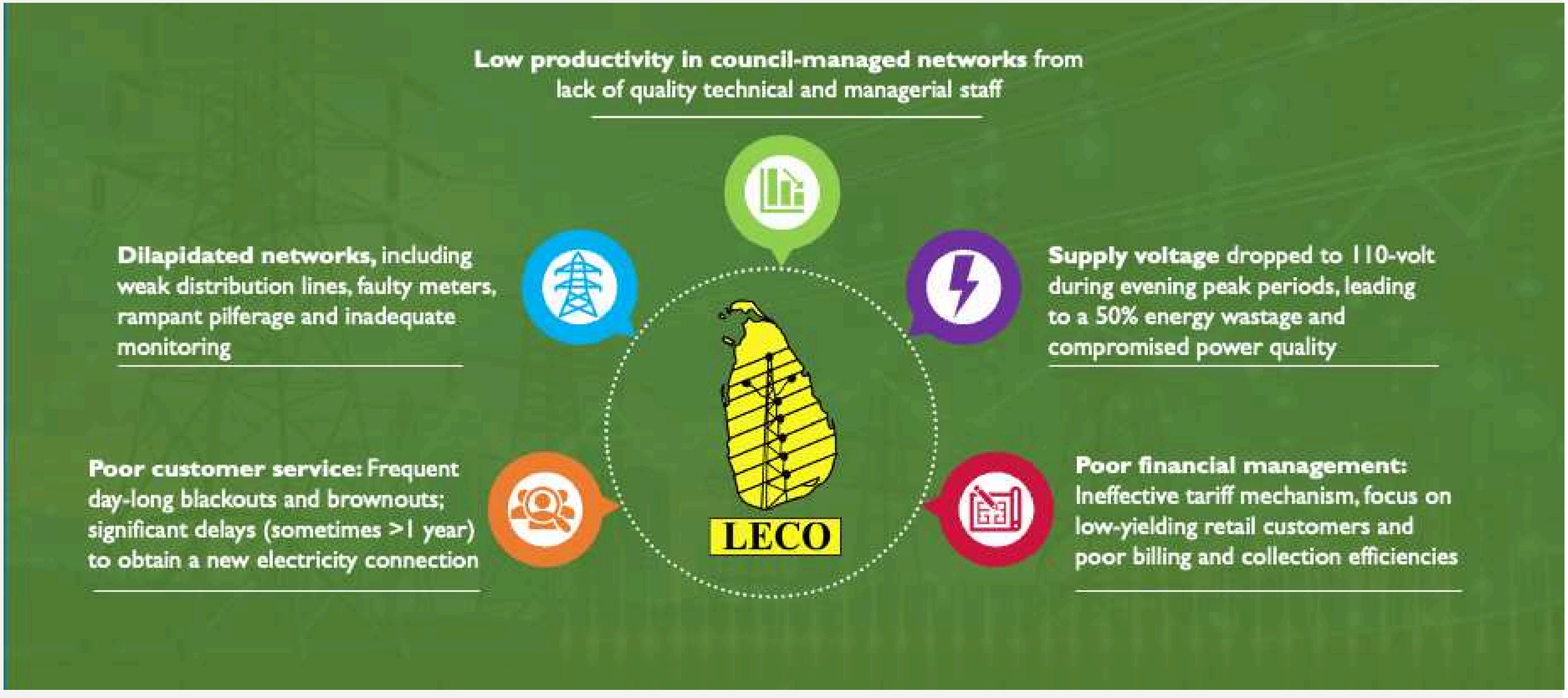
Transforming Power Distribution in Sri Lanka: Case of Lanka Electricity Company (LECO)

CONTEXT

Electricity access improved marginally from 1970 to 1980 in Sri Lanka due to institutional challenges faced by council-operated networks like day long blackouts, load shedding, long waiting period for new service connection, etc.

LECO was established in 1983 to mitigate the distribution challenges and improve operational efficiencies of regions served by local authorities.

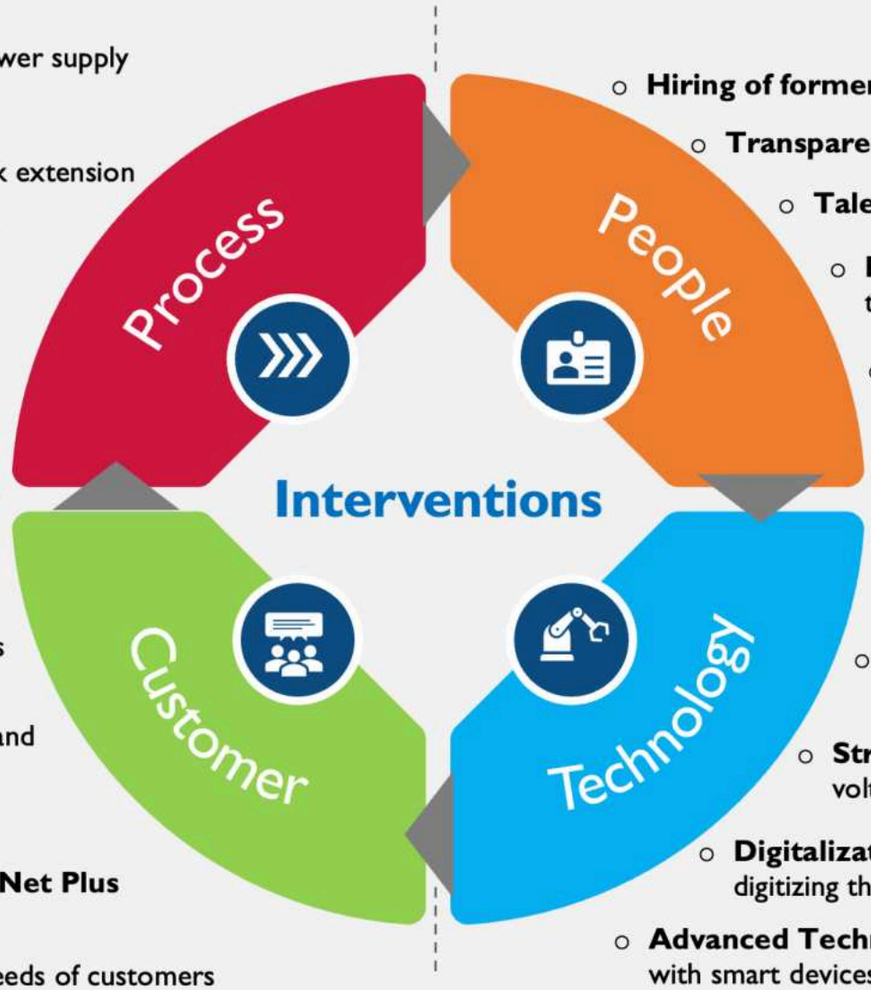
CHALLENGES


Low productivity in council-managed networks from lack of quality technical and managerial staff
Dilapidated networks, including weak distribution lines, faulty meters, rampant pilferage and inadequate monitoring
Supply voltage dropped to 110-volt during evening peak periods, leading to a 50% energy wastage and compromised power quality
Poor customer service: Frequent day-long blackouts and brownouts; significant delays (sometimes >1 year) to obtain a new electricity connection
Poor financial management: Ineffective tariff mechanism, focus on low-yielding retail customers and poor billing and collection efficiencies
LECO

Process for intervention design

- LECO conducted a diagnostic assessment to identify root causes of inefficiencies.
- LECO **identified 4 key areas** for interventions
- Interventions focused on: operations restructuring; infrastructure upgradation; enhancing customer experience and digitalization
- Operational efficiency & financial performance improved gradually over last 4 decades

INTERVENTIONS: The Four Pillars of Success



- **Dedicated planning department** to optimize power supply
- **Network planning** to design greenfield network
- **Mapping distribution system** to support network extension
- **Audited network assets** to optimize maintenance schedule and reduce costs
- **Installed meters** at low-voltage distribution transformers
- **Integrated asset lifecycle planning** for asset management

- **Hiring of former CEB employees** at senior level positions
- **Transparent hiring practices** to swiftly recruit the best talent
- **Talent acquisition** - Hiring right talent and on time
- **Best-in-class technical training** centre to conduct field trainings
- **Continuous training** at all levels and across disciplines

- **Doorstep bill delivery** to improve collection efficiency
- **Dedicated vehicles** for faster customer complaints resolution
- **Self-service payment kiosk** to ease bill payment and improve efficiency
- **Pioneered net metering** scheme in Sri Lanka
- Two new solar PV schemes- **Net Accounting** and **Net Plus** to address the power quality issues
- **Dynamic customer service** analysis to address needs of customers

- **Infrastructure upgradation** to maintain voltage stability and quality of supply
- **Aerial Bundled Conductors (ABC)** for low-voltage distribution
- **Strategic feeding arrangement** to reduce excessive voltage drops
- **Digitalization** - In-house software to improve productivity by digitizing the manual processes
- **Advanced Technology** – Pilots on AI/ML based solutions in conjunction with smart devices for residential demand response

IMPACT

Revenue realization increased at a compounded annual growth rate of 19% from 2018 to 2023

Distribution losses

Distribution loss decreased from **28%** in 1980 to **4%** in 2019.

Billing System

Bill payment expanded from banks and branches **to omnichannel options**: kiosks and online.

Supply voltage levels

Voltage improved from **85V/110V** to the desired 40**0V/230V**

New service connection

Waiting period **reduced from 1 year** in the 1980s to just **10 days**

KEY TAKEAWAYS

Knowing your network & assets

Knowing your network and maping assets to have a clear visibility of the infrastrucute is at the core

Talent acquisition & retention: Building skilled workforce

Streamlined hiring practices reduces personnel onboarding layers and enables faster implementation of interventions

Technology Embracing innovation

Adoption of latest technologies and innovations improves operational efficiency

Customer: Enhancing service quality

Enhancing customer satisfaction at all customer-utility touchpoints to obtain customer buy-in for new initiatives

SOUTH ASIA

SOUTH ASIA

SOUTH ASIA

IMPACT STORIES

Evolution of CBET Policies and Regulatory Instruments

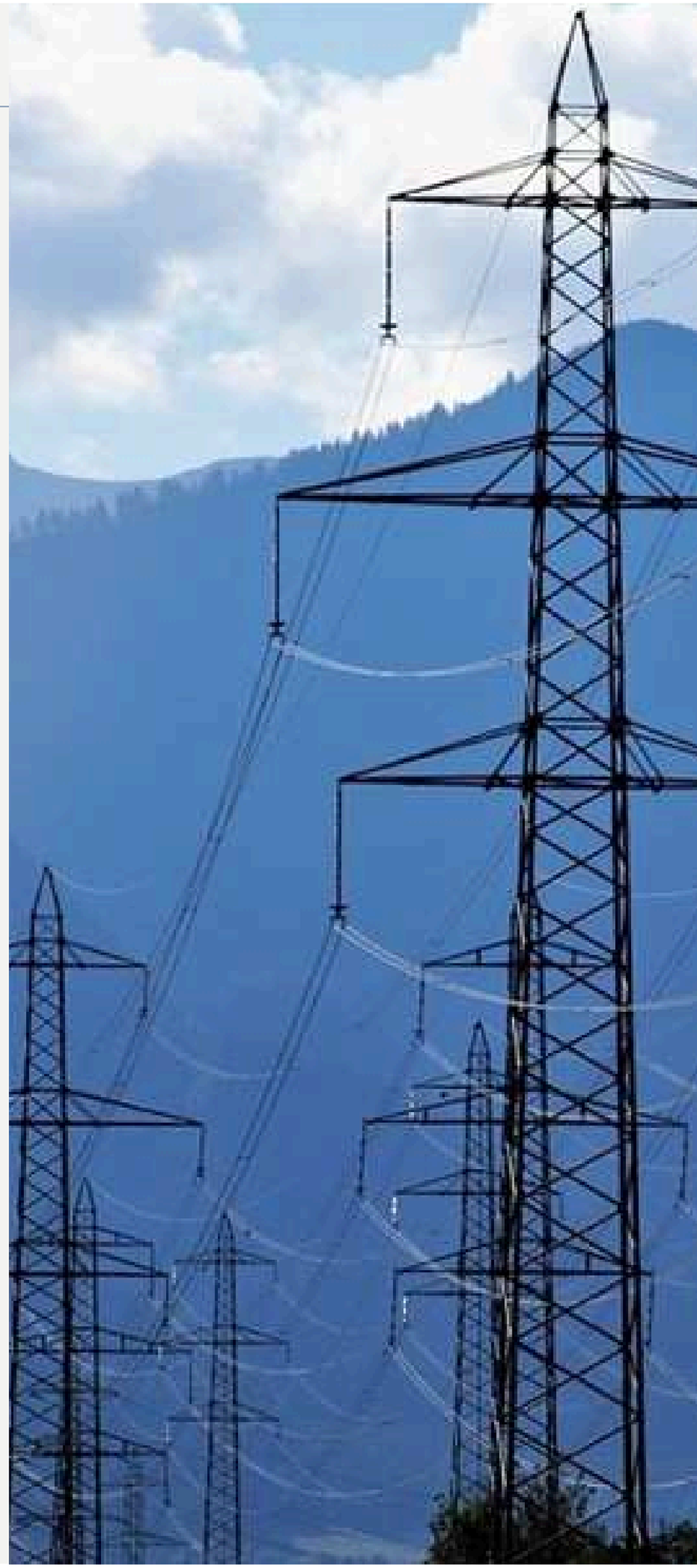
A Harmonized Path to Energy Integration

South Asia's cross-border electricity trade (CBET) has emerged as a key driver for regional energy integration, bolstered by coordinated policies and regulatory reforms. The region is gradually unlocking the potential for a unified and efficient energy market, setting a precedent for deeper cooperation in cross-border energy commerce. It is doing so through sustained efforts in harmonizing policies, regulations and grid codes, establishing clear operational frameworks, building consensus, strengthening political will, and fostering collaboration among nations.

CONTEXT

The South Asian region is among the fastest-growing economic regions in the world. Its economic dynamism has translated into rapidly increasing energy demands. The region also possesses vast clean energy resources, including over 350 GW of hydropower, more than 1,000 GW of solar, and 1,289 GW of wind potential, with energy resources spread across the region, albeit unevenly. A coordinated effort to harness these regional resources is crucial to meet South Asia's growing energy needs while promoting a cleaner and sustainable energy future.

However, despite significant opportunities for collaboration, the power sector in South Asia has historically been regulated within national boundaries, with countries at varying stages of policy and regulatory evolution. Recognizing the urgent need for effective cross-border electricity trade (CBET), regional stakeholders have made concerted efforts to advance a coordinated set of guidelines, policies, and regulatory instruments across the region, laying the foundation for an integrated, South Asian regional energy market.



INTERVENTIONS

Bilateral and regional initiatives have played a significant role in promoting CBET across South Asia. Over the past decade, these initiatives have facilitated notable advancements in the development of CBET-specific guidelines and regulatory frameworks aimed at creating a fair and transparent energy market in South Asia.

USAID has been supporting South Asian countries for the last two decades, for advancing CBET and regional energy cooperation in a focused manner, it has provided technical assistance and knowledge support, for task force studies and capacity building, aimed at building regional consensus.

EVOLUTION OF CBET-SPECIFIC POLICY & REGULATIONS

2016
- Guidelines on Cross Border Trade of Electricity (India)

2018
- MoU for the Establishment of BIMSTEC Grid Interconnection
- Guidelines for Import/Export (Cross Border) of Electricity (India)

2019
- CERC CBET Regulations (India)

2021
- Sustainable Hydropower Development Policy (Bhutan)
- Procedure for Approval and Facilitating Import/Export (Cross Border) of Electricity (India)

2023
- Electricity Grid Code Regulations (India)
- Electricity Grid Code (Nepal)

2024
- Common Minimum Grid Code for facilitating CBET in South Asia under SAFIR
- Grid Code Regulations (Bhutan)
- Sri Lanka Electricity Act

- CBET Specific Policies/Regulations
- Policies/Regulations with CBET Provisions

IMPACT

Regional Frameworks

- Common Minimum Grid Code adopted by South Asia Forum Infrastructure Regulations (SAFIR) member countries

National Policies and Regulations

- Sri Lanka: Electricity Act No. 36 (2024) promulgated that includes legal provisions for CBET.
- Nepal: First Grid Code (2024) adopted in alignment with the Common Minimum Grid Code.
- Bhutan: Grid Code Regulation (2024) incorporates CBET provisions for cross-border trade.
- India: Amendment to Cross Border Trade of Electricity Guidelines Issued, Indian Electricity Grid Code includes CBET provisions

CBET Growth

- Common Minimum Grid Code adopted by South Asia Forum Infrastructure Regulations (SAFIR) member countries
- MW cross border power trade **increase five folds in last decade**
- **46% Growth from 12.8 TWh in 2017-18** to **18.7 TWh in 2020-21**
- Trade in 2023-24: **18 TWh**

Multilateral and Trilateral Trade

- Trilateral CBET agreement signed between Nepal Electricity Authority, NTPC Vidyut Vyapar Nigam (NVVN) Ltd. India, Bangladesh Power Development Board (BPDB) to export 40 MW from Nepal to Bangladesh via the Indian grid.
- CBET through Indian Power Exchange **increased by 3 times in last 3 years**

Regional Planning initiated

- BIMSTEC Grid Interconnection Coordination Committee (BGICC) established in 2018
- Key focus on Transmission Interconnection Plan development and developing BIMSTEC policy on Transmission and Tariff.

KEY TAKEAWAYS

CBET-specific national guidelines, policies, and regulatory frameworks are building blocks to accelerate regional power trade.

Common Regional frameworks and policies based on common principles are critical

Harmonization through consensus-building

Strengthened regional institutions support the long-term sustainability of CBET.

Market-Based CBET in South Asia

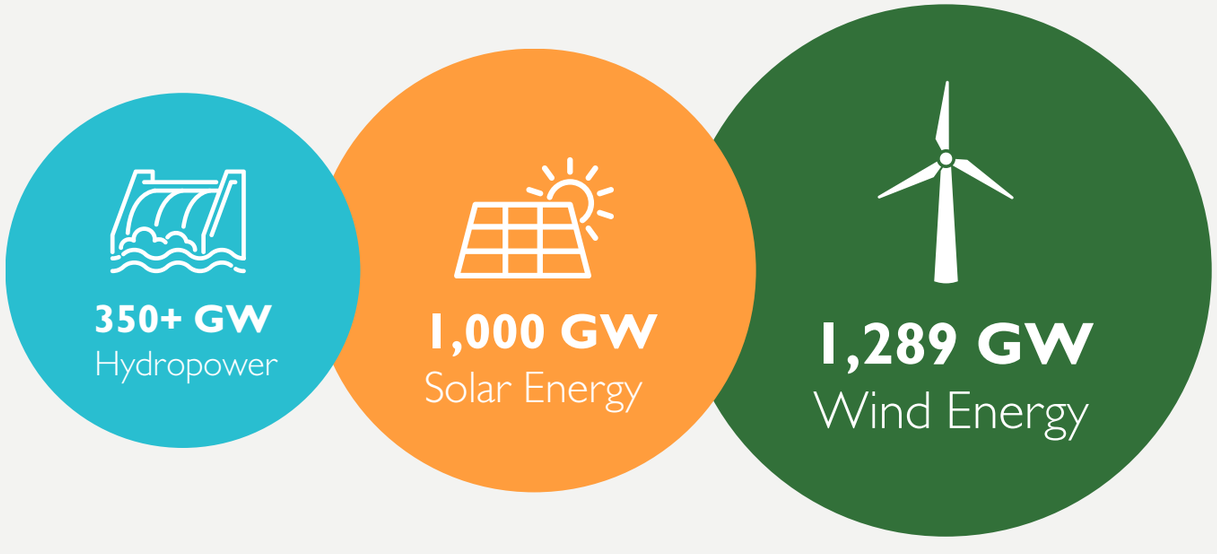
Bridging Borders, Powering Progress with Collaborative Energy Trade

South Asian countries are at different stages of power sector reform, with India being the only country in the region to have a fully functional competitive power market platform. Building consensus on market integration and opening national electricity markets for cross-border trade has required navigating complex political, strategic, policy, regulatory, and technical factors.

CONTEXT

South Asia possesses immense renewable energy resources. Traditionally, electricity trade here occurred through bilateral contracts and non-market mechanisms. While these agreements laid the groundwork for cooperation, they lacked the flexibility needed to competitively optimize the development and utilization of energy resources.

South Asia Renewable Energy Potential



TIMELINE OF MARKET-BASED ELECTRICITY TRADE THROUGH POWER EXCHANGE

2012
Stakeholder support and outreach started

2016
India introduces Guidelines for Cross Border Trade of Electricity (refined in 2018)

2019
CBET regulation by Central Electricity Regulatory Commission (CERC)

2021
Market-Based CBET commenced through India's PX on April 17 with Nepal as first participant

2022
Bhutan joins market-based CBET through India's PX

INTERVENTIONS

The transition to market-based CBET was facilitated by a blend of supportive policies, regulatory frameworks, and technological tools, alongside extensive capacity strengthening.

Since 2012, USAID has actively supported stakeholders in transitioning to market-based CBET through consensus-building with regional task forces, supporting various technical studies. These included developing strategies for transitioning to trilateral/multilateral CBET, supporting the development of technological tools, and conducting mock exercises on a South Asia Regional Power Exchange. This included working with a range of stakeholders including policymakers, regulators, investors and financial Institutions, Think Tanks, Planning Authorities and Transmission Utilities, System Operators, Regional Institutions (SAFIR, SAARC, BIMSTEC, etc.) and Parliamentarians.

TECHNOLOGICAL TOOLS AND CAPACITY BUILDING

Integrated Power Exchange Transaction Model for Dispatch Scheduling & Bidding (IMDSB)

- Customized power market software
- Provided hands-on training to Nepal and Bhutan

Python-Based Power Exchange Transaction Model (PPTM)

- Built on the foundation of IMDSB
- Offers real-time decision support and automates analytical processes

Pilot Inflow Forecasting System and Hydro-Meteorological Network

- Helps optimize power generation in Bhutan for PX trading

IMPACT

Since the launch of market-based CBET through India's PX, the volume of electricity traded has quadrupled. This growth represents a significant milestone in regional energy cooperation, allowing countries like Nepal and Bhutan to maximize their energy portfolio while providing India access to clean energy resources of these countries.

Volume of electricity traded through India's PX

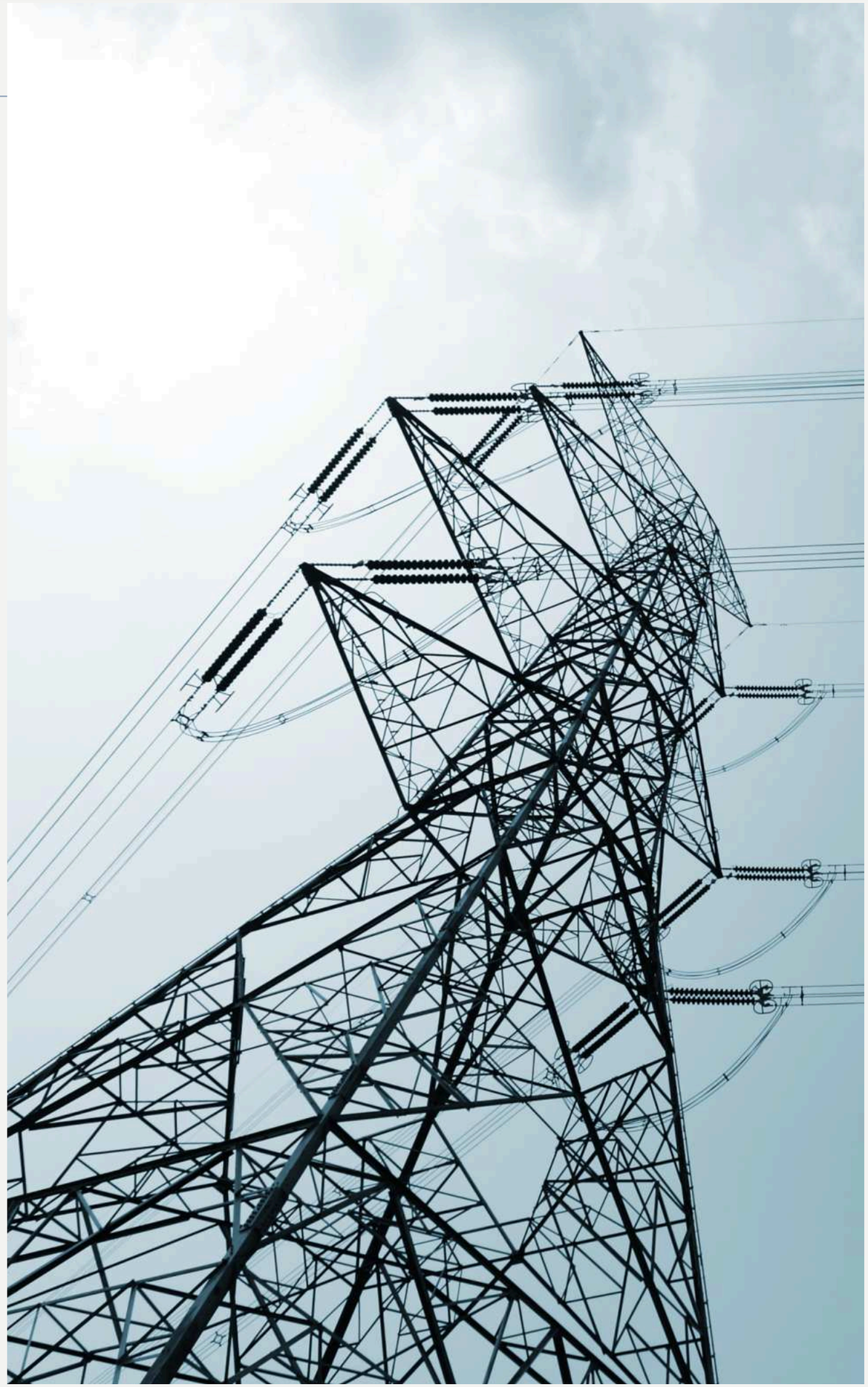
1.1 TWh in 2021-22

4.2 TWh in 2023–24

IMDSB Model

Facilitated 4,714 GWh of electricity to be traded optimally since 2022

Ensured energy trade is efficient and economically optimal



KEY TAKEAWAYS

Regional Integration Requires Sustained Collaboration	• Energy market integration is a complex and evolutionary process • Regular technical studies, capacity-building programs, and knowledge exchanges are crucial to build and maintain momentum
Alignment of Frameworks is Critical	• Policy, regulatory, and technical frameworks need alignment for unified markets
Importance of Power Market Reform	• Development of domestic power markets is desirable to advance CBET • Helps in leapfrogging towards a South Asia Regional Electricity Market
Continuous Efforts and Collaboration	• Regular technical studies, capacity-building programs, and knowledge exchanges are essential
Replicable Model for Other Regions	• Success offers a model for regions aiming for cooperative, market-based energy systems • Demonstrates that regional collaboration leads to benefits in energy security and economic growth

DISCLAIMER: This publication is made possible by the support of the American people through the United States Agency for International Development (USAID). It was prepared by RTI International for the South Asia Regional Energy Partnership (SAREP) activity, task order number 72038621F00002.

The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. The information contained herein is provided by the contributing authors and partner institutions.

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
T 202.712.4810 F 202.216.3524

@USAID
facebook.com/usaid
#usaidpartners
#workwithUSAID

USAID
FROM THE AMERICAN PEOPLE