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SUMMARY

Guidebook for Deploying Distributed Renewable Energy Systems

Distributed renewable energy, such as off-grid and mini-grid systems, can help connect remote and isolated rural areas where grid extension is not a financially and economically viable option. Photo credit: ADB.

This report provides a framework for implementing commercially viable distributed electrification solutions and shares lessons from a pilot in the Philippines.

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Overview

Ensuring affordable, reliable, sustainable, and modern energy for all that meets environmental goals has become central to development and energy policymaking. Goals 7 and 13 under the 2030 Agenda for Sustainable Development and nationally determined contributions under the Paris Agreement advocate universal energy access that mitigates climate change. Transforming development trajectories on a course toward sustainable development entails adopting more renewable resources in providing modern energy for all.

The developing countries of the Asia and Pacific region have been progressing well in providing modern energy—in particular, electricity—but rural and remote areas lag behind. According to the International Energy Agency (2018), over 900 million people have gained access to electricity in developing

economies in Asia from 2000 to 2017. However, about 351 million still don't have electricity access in 2017, the majority of whom are in rural areas.

Grid extension has been effective in bringing the region's electrification rates to current levels. However, it is not financially and economically viable in remote and isolated rural areas. Geographic complexity, remoteness, and low electricity demand make extending transmission and distribution too costly.

Distributed renewable energy, such as off-grid and mini-grid systems, presents an alternative solution. Its use could be temporary or permanent. It could complement and supplement national electrification plans and support the universal access and climate change mitigation goals of the region's developing countries.

Pursuing distributed renewable energy solutions entails an enabling legal, regulatory, and market environment, an understanding of locally available natural resources given the electricity demand, and the ability to choose the optimal renewable energy technology or combination of technologies.

Guiding framework

The Asian Development Bank, through its Energy for All Initiative—also known as Energy for All—has been providing its developing member countries with technical assistance to increase lending activities in energy access, and assist in formulating energy strategies that fulfill the Sustainable Development Goals and developing member countries' nationally determined contributions. Experience through the years consequently developed into a framework—comprising regulatory, institutional, and market scanning; supply and demand analysis; project design optimization; project implementation; and social, economic, and environmental impact assessment—that could guide the deployment of distributed renewable energy systems in remote and isolated rural areas.

Figure 1: Framework for Deploying Distributed Renewable Energy Systems

Source: ADB.

Of primary importance is scanning the legal, regulatory, and market environment, which influences the feasibility and growth potential of distributed renewable energy systems. Often, remote and isolated rural areas are not commercially viable, which necessitates government support and intervention. The World Bank's Regulatory Indicators for Sustainable Energy suggests looking into a national electrification program and legal framework for distributed electrification, the ability to charge cost-reflective tariffs, and the provision of financial incentives.

Understanding the electricity needs and renewable energy potential of an area is essential for a sound

electrification plan. This will help a country determine which remote and isolated areas need government support to increase the viability of adopting distributed renewable energy systems. This would also help determine an area's available renewable resources that could be tapped. The geospatial mapping provides an overview of the distributed and off-grid markets of a country and reconciles the data sets on energy supply and demand on national and specific areas. To further understand an area's electricity requirements, the multi-tier framework for measuring energy access organizes the levels of access in terms of electricity supply, services, and consumption, and can help select possible renewable energy technologies depending on the characteristics of the site.

The renewable resources, electricity requirements, and available renewable energy technologies in the area determine the renewable energy technology or combination of technologies to be used. With so much to consider, optimization tools, such as the Hybrid Optimization of Multiple Energy Resources, can help analyze the performance and cost of an electrification system, and suggest the least-cost technology options. Conducting a social, economic, and environmental impact assessment is recommended after deploying distributed renewable energy systems to assess and quantify the benefits to the community. Documenting both the quantitative and qualitative benefits will be valuable for future replication.

Pilot project in the Philippines

With the Philippine government's support, the framework had been applied to Cobrador Island's hybrid solar photovoltaic mini-grid. The pilot project extended the island's electricity access from 8 hours to 24 hours a day, which resulted in increased entrepreneurial activities; more and better livelihood opportunities and tourism potential; enhanced social services (healthcare, education, and security and safety); and more environmentally conscious residents. Other benefits include an increase in the number of grid-connected households from 161 to 260, a lower tariff from ?30 ($0.60) to ?15 ($0.30) per kilowatt-hour, and a potential reduction of carbon dioxide emissions by 52,600 kilograms per year from 2015 to 2017. The Cobrador case demonstrates the importance of government support, an enabling legal and regulatory environment, accurate and realistic demand estimates, and building local capacity for operation and maintenance.

With energy policymakers, development investors, and other stakeholders as intended audience, this report aims to offer guidelines for incorporating distributed electrification in national electrification programs, present techniques and tools that can be used to optimize utilization of renewable energy sources for off-grid electrification, present the case study of the Philippines' Cobrador Island solar photovoltaic-diesel hybrid mini-grid, and document the outcomes and lessons to contribute in mainstreaming distributed renewable energy solutions.

Contents

Introduction

This chapter describes how the Asian Development Bank (ADB) has responded to energy poverty in Asia and the Pacific, which includes its Energy for All Initiative. It also introduces distributed electrification solutions as a viable option for countries in the region with complex or extreme geographies that pose challenges to national electrification.

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Regulatory and Institutional Environment

Chapter 2 proposes a procedure to assess the regulatory and institutional environment for the viability of renewable energy mini-grid and distributed electrification. A proposed market and regulatory assessment is presented in Box 1. While it is not a foolproof procedure, it provides an organized start for policymakers, development investors, and the private sector in determining the feasibility of undertaking such off-grid and distributed electrification projects in the various developing member countries.

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Supply and Demand Analysis

Chapter 3 analyzes the energy supply and demand scenario at a subnational level using geospatial mapping techniques and the multi-tier framework (MTF) for measuring energy access. For a better understanding of how to conduct geospatial mapping, this chapter features Myanmar's map layers that help analyze existing power infrastructure, potential demand in off-grid areas population density, and available renewable energy resources that may be tapped. A detailed supply and demand analysis of households' electricity services could be performed using the MTF approach. Knowing the existing and aspired tier gives light to possible renewable energy technology options. The chapter lists renewable energy solutions—which had Energy for All involvement—that could be deployed in off-grid areas.

Read more.

Finding the Least-Cost Technology Option

Chapter 4 focuses on finding the least-cost technology option for off-grid sites. Modeling tools, including Hybrid Optimization of Multiple Energy Resources (HOMER), are presented for rapid cost assessment and selection of the least-cost option.

Read more.

Case Study—Cobrador Hybrid Solar Photovoltaic Mini-Grid

Chapter 5 recounts an early iteration of the methodology to the Philippines. The Energy for All Initiative helped the National Electrification Administration (NEA) of the Philippines explore the applicability of renewable energy mini-grids in off-grid areas within the distribution franchise areas of electric cooperatives. A solar photovoltaic–diesel hybrid mini-grid was implemented in the island of Cobrador to demonstrate that a distributed renewable energy system can provide Tier 5 level of energy access.

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Economic, Social, and Environmental Impact

Chapter 6 assesses the social, economic, and environmental impacts of installing solar photovoltaic system in Cobrador Island. Findings are based on interviews and surveys conducted a year after the hybrid mini-grid was commissioned, and simulations of impact factors.

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Conclusion

Chapter 7 concludes with some general key points, lessons, and best practices from the Cobrador Island case study.

Read more.

Resources

Asian Development Bank. 2019. *Guidebook for Deploying Distributed Renewable Energy Systems: A Case Study on the Cobrador Hybrid Solar PV Mini-Grid*. Manila.

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