

## SUMMARY

# Handbook for Rooftop Solar Development in Asia

*The Asian Development Bank shares its experience in reducing its carbon footprint by implementing a rooftop solar photovoltaic system at its headquarters in metropolitan Manila.*

## Overview

With the cost of solar photovoltaic (PV) systems decreasing, alongside rising fossil fuel and electricity prices, implementing a rooftop solar PV system is becoming an attractive option, even in heavily urbanized areas. The Asian Development Bank has predicted increased energy demand in Asia's future, and rooftop solar PV is one option, among many alternative energy solutions, that can meet that demand in a sustainable manner.

This handbook was written in 2014 to support ADB's Asia Solar Energy Initiative, which aims to create a virtuous cycle of solar energy investments in the region, so that developing Asian countries may optimally benefit from the clean and inexhaustible energy provided by the sun.

As a point of reference, this handbook provides examples from ADB's experience in implementing its own rooftop solar PV system, which was completed in 2012. Though this handbook was written to be accessible to all audiences, experienced developers may find ADB's experience helpful. The handbook answers questions that people encounter along the way, including issues dealing with design considerations before installing a PV system, the permits required, available incentives and financing options, procurement, installation considerations including safety issues, and operation and maintenance of the system.

## Rooftop Solar: A High-Benefit Power Source

Present-day solar PV technology, a low-carbon energy solution, is well suited for much of Asia and the Pacific. With large areas of the region endowed with bountiful solar radiation, many countries in the region have the ideal conditions for utilizing solar energy.

Most solar PV systems tend to be one of two types. The first type are utility-scale installations with a capacity usually above 1 megawatt (MW). They require large, open land areas with few shadows. The second type is distributed generation, which may be ground-mounted or installed on rooftops. They generate power during the day, while feeding surplus power back into the power grid. Residences can be sufficiently supplied with small systems of usually up to 20 kilowatts (kW), while larger public, commercial, and industrial buildings may have systems with a capacity as large as 1 MW.

Although much smaller in capacity than power plant-type installations, the rooftop solar system has many benefits in helping us change how we produce energy and make our world a better place to live. The benefits are summarized in Table 1.

**Table 1: Benefits of Rooftop Solar Power**

<b>Construction</b>	
Site access	Photovoltaic (PV) systems are at the point of consumption, thus do not require additional investment for access during construction or for operation and maintenance.
Modularity	They can be designed for easy expansion if power demand increases.
<b>Operation and Maintenance</b>	
Primary energy supply	Solar energy is freely available, and the PV system does not entail environmental costs for conversion to electricity.
Maintenance	PV systems require little maintenance.
Peak generation	These systems offset the need for grid electricity generation to meet expensive peak demand during the day.
Mature technology	PV systems nowadays are based on proven technology that has operated for over 25 years.
<b>Impact</b>	
Investments	Rooftop PV system costs help offset part of the investment needed for new power generation, transmission, and distribution in the power grid.

Cost	Fuel savings from PV systems typically offset their relatively high initial cost.
Environment	PV systems create no pollution or waste products while operating, and production impacts are far outweighed by environmental benefits.

Source: ADB.

## Case Study: How ADB Transformed Its Rooftop

To demonstrate the types of choices developers can make in implementing a rooftop solar PV system, this handbook references ADB's experience in implementing its Headquarters Rooftop Solar Power Project. As such, this section provides some preliminary background information on that project. More of its details are revealed throughout this handbook where relevant.

As an institution that promotes sustainable development within its developing member countries (DMCs), ADB sought to lead by example by transforming its 23-year-old headquarters building in Manila into a showcase for sustainability. The idea was that if ADB could cost-effectively transform a building of this age to meet present-day Leadership in Energy and Environmental Design (LEED) certification standards, that the transformation would inspire others to follow suit.

Thus, beginning in 2007, ADB embarked on a number of retrofits, which started with making energy efficiency improvements. Efficient ventilation and air conditioning, lighting, and other technologies have since enabled ADB to reduce energy consumption by 4% (as of 2014). A newly constructed car park building also sought to be "green," by utilizing a solar PV system and batteries for lighting. Upon installation of the ADB Rooftop Solar Power Project, ADB received a LEED Gold rating from the United States Green Building Council.

Coinciding with these efficiency improvements were plans to install a large distributed rooftop solar PV system in ADB's main headquarters. The decision was based on a number of reasons.

First, ADB understands the benefits of solar energy. ADB has been actively promoting this technology in its DMCs under the Asia Solar Energy Initiative, which was launched in 2010. ADB wanted to lead by example and produce solar energy at ADB headquarters.

Second, ADB needed to showcase how commercial buildings in Asia can reduce their carbon footprint and diversify energy supply with renewable energy. The project preparation, approval, financing, and implementation had to be easily replicable and scalable for enabling wider use of solar energy.

Finally, ADB took the opportunity to start a market for solar PV systems. As more commercial buildings implement similar rooftop projects, costs will reduce, and deployment of the technology will accelerate.

Other enterprises have since followed suit, as ADB's rooftop solar project has proven to be a cost-effective and reliable power source. The system has a capacity of 571 kW and generates 50,000 kWh of

electricity per month under average weather conditions. This is enough to power 245 Metro Manila households using an average of 2,500 kilowatt-hours (kWh) per year. The solar-generated electricity supplements ADB's purchase of geothermal-generated electricity from AdventEnergy, which supplies an average of 1.5 gigawatt-hours (GWh) of electricity per month.

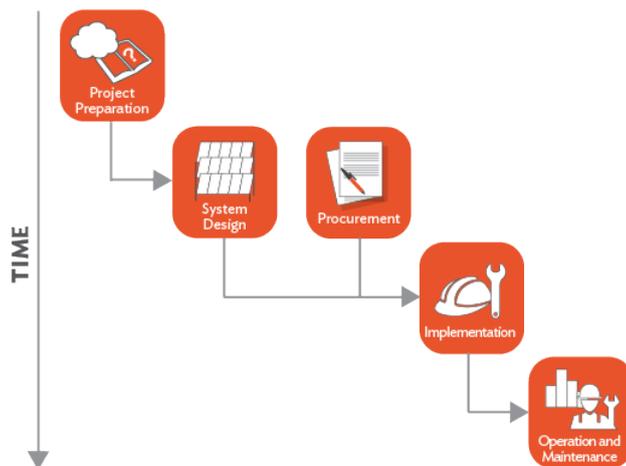
Thus, the ADB Headquarters building, located in the Philippine capital of Manila, is powered by 100% renewable energy. Making that transition has enabled ADB to cut its annual carbon footprint by 50% and reduced its emissions by more than 9,500 tons of carbon dioxide equivalent.

## Handbook Contents

This handbook breaks down the development of rooftop solar PV systems into five chapters: (1) project preparation, (2) system design, (3) procurement, (4) implementation, and (5) operation and maintenance. These chapters correspond to the five different stages of project development.

Figure 1 depicts a flowchart of the sequence of events in developing a rooftop solar project. As depicted in the flowchart, some of these stages will inherently overlap with each other. The subsequent sections will denote when these overlaps may happen, as relevant.

Figure 1: Rooftop Solar Project Stages



Note: Arrows represent the flow of information from one stage to another. Time increases going down through the stages.

Source: ADB.

### Chapter 1: Project Preparation

This chapter gives several key aspects developers should investigate to help decide if it is worth proceeding with a rooftop solar PV project. The investigation includes assessments of the site conditions, legal and regulatory frameworks, business models and financing options, and implementation arrangements.

## **Chapter 2: System Design**

This chapter outlines many of the system design aspects, including how to assess the site and resources, select suitable components for the system, configure the array, estimate system performance, and conduct due diligence.

## **Chapter 3: Procurement**

This chapter describes a method to procure experts' services to design, install, and maintain the rooftop solar system: the one-stage, two-envelope procedure used for the rooftop system of ADB.

## **Chapter 4: Implementation**

This chapter outlines the steps that should be taken to implement the project, including acquiring necessary permits and clearances, installing the various components, and the final testing and commissioning of the solar power system.

## **Chapter 5: Operation and Maintenance**

This chapter contains activities to maintain and monitor performance of a solar PV system.

## **Conclusion**

## **Lighting the Way: ADB's Rooftop Solar Project**

### **Annex 1: ADB Rooftop Solar Project Process**

### **Annex 2: ADB Rooftop Solar Project Permits and Clearances**

### **Annex 3: Policy, Regulation, and Incentives for Solar Rooftops in the Philippines**

### **Annex 4: ADB Rooftop Solar Project Shading Analysis**

### **Annex 5: ADB Rooftop Solar Project Technical Outline**

### **Annex 6: Sample Solar Services and Site Lease Agreement**

## **Resources**

Asian Development Bank. 2014. *Handbook for Solar Development in Asia*. Manila: Philippines.



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