ADB

Asia Solar Energy Initiative

A Primer

Asian Development Bank

Asia Solar Energy Initiative

A Primer

April 2011

Asian Development Bank

Printed in the Philippines.

ISBN 978-92-9092-314-5
Publication Stock No. RPT113107

Cataloging-In-Publication Data

Asian Development Bank.
Asia Solar Energy Initiative: A primer.
Mandaluyong City, Philippines: Asian Development Bank, 2011.

1. Solar energy. I. Asian Development Bank.

Note:
In this report, "$" refers to US dollars.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
Tel +63 2 632 4444
Fax +63 2 636 2444
www.adb.org

For orders, please contact:
Department of External Relations
Fax +63 2 636 2648
adbpub@adb.org

Printed on recycled paper.

This publication is part of a regional technical assistance project, Knowledge Platform Development for the Asia Solar Energy Initiative (RETA 7613). Said project is financed by the Asian Clean Energy Fund under the Clean Energy Financing Partnership Facility, established by the Government of Japan and administered by the Asian Development Bank.

Contents

Table and Figures

Table

Figures

Abbreviations

ADB	–	Asian Development Bank
AASEDF	–	Asia Accelerated Solar Energy Development Fund
ASEF	–	Asia Solar Energy Forum
ASEI	–	Asia Solar Energy Initiative
CSP	–	concentrating solar power
DMC	–	developing member country
EEG	–	Erneuerbare-Energien-Gesetz (2000 Renewable Energy Sources Act)
FIT	–	feed-in tariff
LIBOR	–	London interbank offered rate
OECD	–	Organisation for Economic Co-operation and Development
PRC	–	People's Republic of China
PV	–	photovoltaic

Weights and Measures

GW	–	gigawatt
kWh	–	kilowatt-hour
MW	–	megawatt
Wp	–	watt-peak

Executive Summary

The development, transfer, and adaptation of cleaner energy technologies are essential to combat climate change. With solar technology solutions diversifying rapidly in terms of application, efficiency, and cost, solar energy will play a crucial role in the global energy mix in the medium to long term. While developed nations have accounted for about 87% of the world's installed capacity so far, Asia and the Pacific offers exponential growth opportunities. Large parts of the region are on prime equatorial and tropical land, enjoying some of the world's highest solar insolation levels and boasting significant solar energy generation potential. Furthermore, given the region's exceptionally high economic growth rates and continuing population growth, the present and projected energy demand gap in Asia and the Pacific provides a huge market opportunity for solar energy development.

In May 2010, the Asian Development Bank (ADB) announced the launch of the Asia Solar Energy Initiative (ASEI), targeted to assist in identifying, developing, and implementing 3,000 megawatts (MW) of solar power in Asia and the Pacific over the next 3 years. Overall, ASEI aims to create a virtuous cycle of solar energy investments in the region, toward achieving grid parity, so that ADB developing member countries optimally benefit from this clean, inexhaustible energy resource. To meet its target, the ASEI will use an integrated, multipronged approach featuring three interlinked components:

(i) **Knowledge management.** The Asia Solar Energy Forum is an exclusive regional knowledge management platform linking with knowledge hubs globally to facilitate solar technology transfer to Asia and the Pacific, deliver quality inputs to policy and decision makers in solar power development, exploit economies of scale that the large regional market offers, and facilitate innovation in financing mechanisms.

(ii) **Project development.** The ASEI will assist in identifying, developing, and implementing 3,000 MW of solar power generation projects in Asia and the Pacific. The chosen projects are expected to produce a demonstration effect showcasing the feasibility and sustainability of various forms of public and private solar power generation projects. ADB plans to finance up to $2.25 billion directly under the ASEI and leverage an additional $6.75 billion in solar investments over the same period, using instruments such as London interbank offered rate (LIBOR)–based loans, donor contributions, grant funds, innovative risk mitigation mechanisms, carbon market support measures and direct support.

(iii) **Innovative finance.** A separate and targeted Asia Accelerated Solar Energy Development Fund will help mitigate risks associated with solar energy projects and buy down the up-front cost of solar energy development to catalyze solar energy growth, which will accelerate progress toward achieving grid parity. ADB aims to raise $500 million from financing partners, which will then be used to design innovative mechanisms so that commercial banks and the private sector are encouraged to invest in solar technologies and projects.

In addition to catalyzing large-scale grid applications, the Asia and Pacific region will also benefit from improved social and rural development enabled by decentralized solar power generation for remote and rural communities and from the economic benefits contributed by indigenous solar manufacturing and ancillary industries. Beyond Asia and the Pacific, the region can serve as a model for others that are similarly placed, such as northern Africa, Latin America, and the Caribbean. More importantly, the realization of the region's solar market growth potential will trigger a wave of innovation, efficiency improvements, and scale to accelerate solar energy's march to achieving grid parity globally.

Introduction

Solar energy is a clean, virtually inexhaustible source of energy. Over the past decade, increasing awareness of climate change hazards and energy security considerations has forced the global community to focus on renewable energy sources, such as solar energy, resulting in unprecedented growth in solar energy applications. Historically, the high cost of large-scale investments in solar generation has restricted solar energy development to member countries of the Organisation for Economic Co-operation and Development (OECD). However, solar energy applications are becoming more economically attractive globally with the expanding scale of market penetration and production, technology improvements, and the rising cost of electricity generated from fossil fuels. Within a few years, unsubsidized solar power could cost no more to end-customers in many markets than electricity generated by fossil fuels or by renewable alternatives to solar energy.

Today, Asia and the Pacific is characterized by very high rates of economic growth, far outpacing the global average, and continuing population growth. These two factors pose a formidable challenge to ensuring access to adequate and clean energy supplies at affordable prices, especially for the region's national governments to meet their economies' ever-increasing energy demands. These growing pressures, coupled with climate change and energy security considerations, are now driving the region to recognize and to promote national policies for solar energy applications amid the rapid decline in solar energy generation costs.

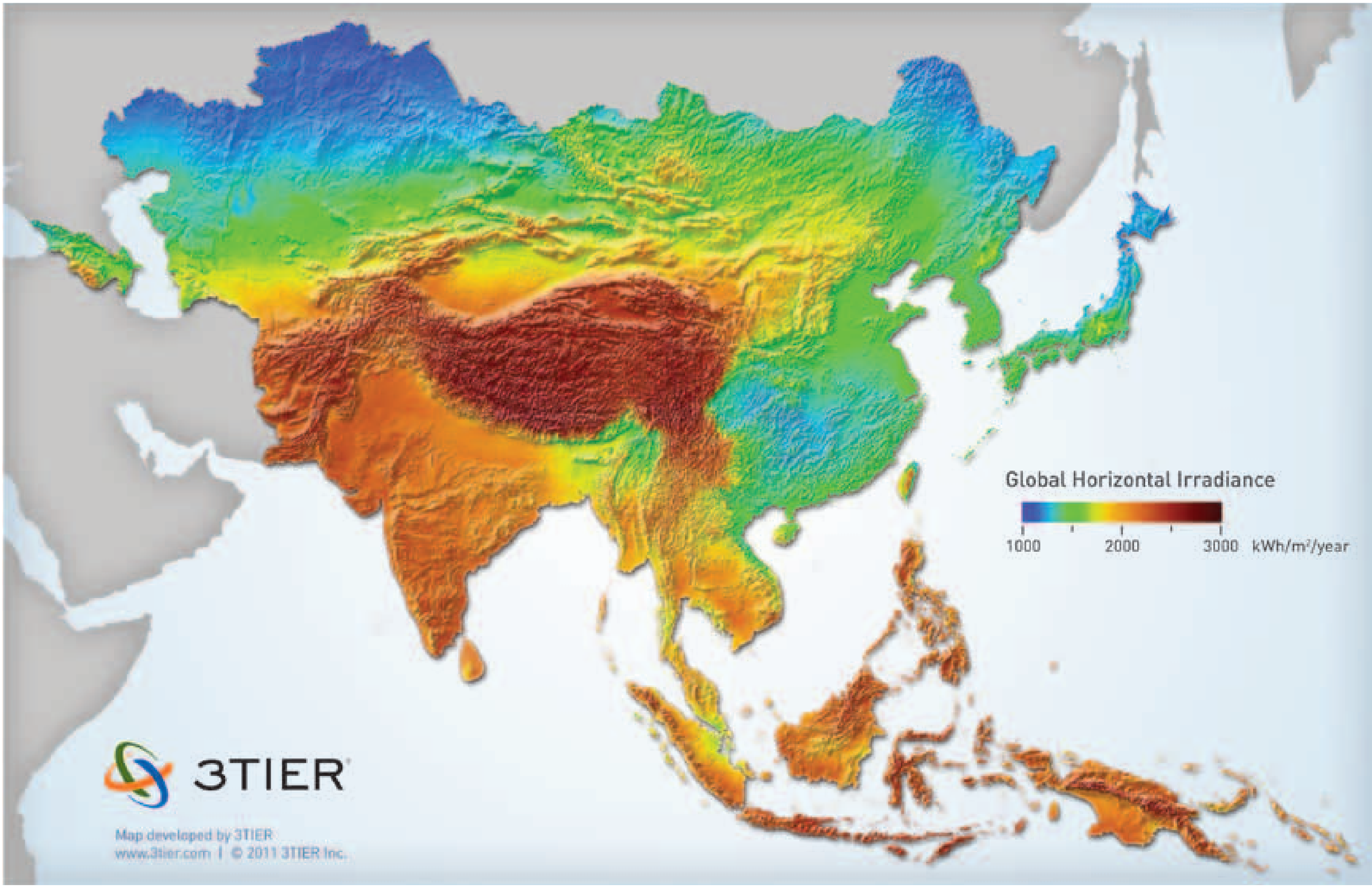
Opportunistically, large parts of Asia and the Pacific are endowed with high levels of solar insolation[1] and have significant solar energy generation potential for both large-scale grid and off-grid applications (see Figure 1). As a decentralized form of energy, solar energy holds promise in providing power to the millions of people in the region with no access to traditional energy supplies. As an added and perhaps more important benefit, rapid and sustainable development of solar energy applications in the region is key to accelerating solar energy's global march to achieving grid parity.

Recognizing the importance of solar energy development in Asia and the Pacific, the Asian Development Bank (ADB) announced the launch of the Asia Solar Energy Initiative (ASEI) in May 2010. The overall objective of the ASEI is to create a virtuous cycle of solar investments in Asia and the Pacific toward achieving grid parity by helping developing member countries (DMCs) realize the fruits of a clean, renewable source of energy. Thus, the ASEI will help create an enabling environment for solar-generated electricity to become increasingly competitive with the retail rate from mainstream networks that are presently dominated by fossil fuel sources. It aims to help DMCs strengthen energy security, pursue economic growth, and sustain economic development, as well as increase energy access for rural and livelihood development. The ASEI plans to initiate this virtuous cycle through solar project identification and development, knowledge management, and innovative financing.

This report provides information to relevant stakeholders on the importance of developing the solar energy sector in Asia and the Pacific, investment opportunities and challenges in the sector, and the approach adopted by the ASEI to facilitate the rapid deployment of solar energy applications in the region.

[1] Insolation, derived from the phrase "incident solar radiation," is a measure of the amount of radiated solar energy emitted by the sun received on a given unit surface area of the earth. It is typically expressed in watts per square meter or kilowatt-hours per square meter per day.

Figure 1 **Solar Irradiance in Asia**



kWh/m²/year = kilowatt-hour per square meter per year.

Source: 3TIER Inc. 2011. www.3tier.com. (Reproduced with permission).

Global Trends and Successful International Initiatives

According to the Renewable Energy Policy Network for the 21st Century, solar photovoltaic (PV) technology is the fastest-growing power generation technology globally, spread across over 100 countries. Between 2004 and 2009, total grid-connected solar PV capacity grew annually at an average rate of 60%. By 2009, solar PV accounted for about 16% of all new electric power capacity additions in Europe, and higher growth can be expected in the solar PV space in the next 4–5 years. There has also been a resurgence of concentrating solar power (CSP) technology since 2005. Global capacity, nearly all in Spain and the United States, increased by over 70% between 2005 and 2009, from 354 megawatts (MW) to about 610 MW. Currently, new facilities are being planned not only in Spain and the United States but also in Algeria, Egypt, India, Morocco, and the United Arab Emirates, indicating that CSP technology is rapidly scaling up.[2]

These capacity additions are coupled with declining production costs of solar plant components due to rapid technological advances (e.g., increases in efficiency, new manufacturing techniques, and use of new materials); shifting of manufacturing bases to low-cost centers in Asia; increasing scales of production; and consistent demand-side pull from national solar promotion programs. Figure 2 illustrates the critical role of scale in terms of cumulative production and size of production lines on a watt-peak (Wp)[3] basis.

Globally, a number of countries led this wave of market development, with Germany, Japan, Spain, and the United States as pioneers. Five countries had a cumulative installed PV generation capacity of at least 1 gigawatt (GW) in 2009: Germany, with 9.80 GW; Spain, 3.40 GW; Japan, 2.70 GW; the United States, 1.20 GW; and Italy, 1.05 GW (footnote 2). These countries accounted for about 87% of the total global capacity. Other countries that have developed, or are developing, substantial solar PV capacity include Australia, the People's Republic of China (PRC), France, Greece, India, the Republic of Korea, and Portugal due to new policy and economic support schemes.

Germany and Spain have been the two most active promoters of solar energy through their highly attractive feed-in tariff (FIT) regimes. Germany's FIT, designed under the Renewable Energy Sources Act (EEG), has been hugely successful and is generally regarded as the best example of an effective tool to promote renewable energy technologies.[4] The FIT provides costlier solar PV technologies with relatively higher preferential tariffs but allows the adjustment of tariffs downward for new projects with increased efficiency and reduced costs, thus promoting investment and cost reduction at the same time. Similarly, Spain designed a FIT, allowing optional incentives for sales to the wholesale electricity spot market as well as fixed incentives.[5]

---

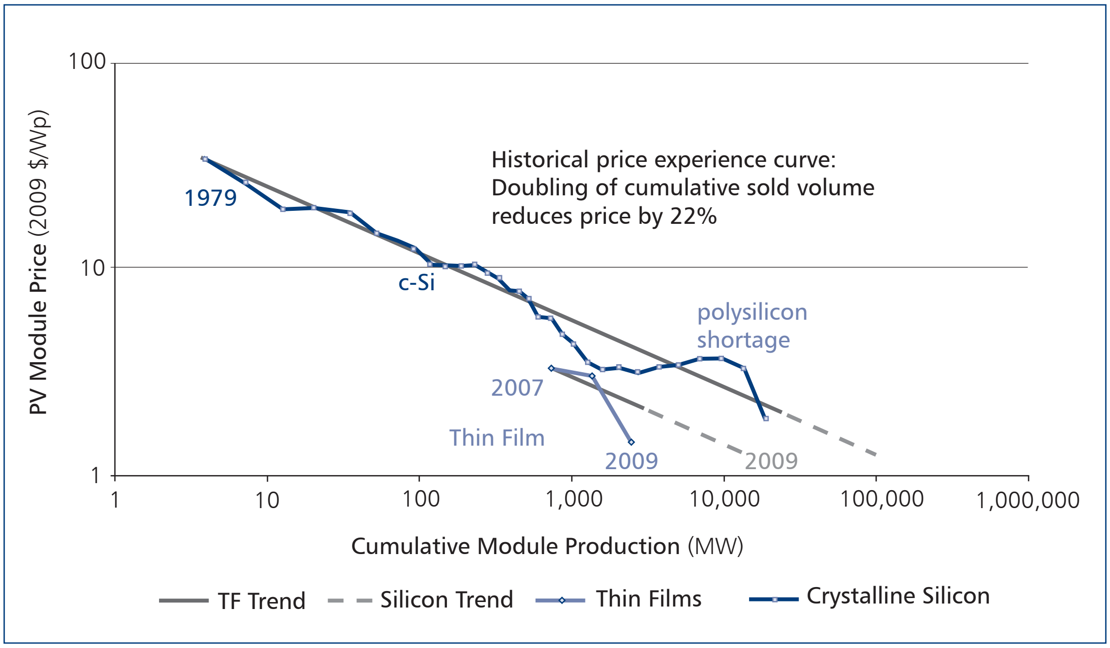
[2] Renewable Energy Policy Network for the 21st Century. 2010. *Renewables 2010 Global Status Report*. Paris.

[3] The nominal (i.e., standardized) power of a solar cell, and also a PV-module, is expressed in Wp. This is calculated based on standardized laboratory test conditions (i.e., insolation of 1,000 watts per square meter, cell junction temperature of 25°C, and air mass of 1.5 solar spectral insolation distribution).

[4] Government of Germany. 2000. *Erneuerbare-Energien-Gesetz.* Berlin. April. The EEG was also the first act of its kind among the European Union countries, inspiring and triggering the creation of similar regulatory frameworks across Europe.

[5] Government of Spain. 2007. *Real Decreto 661/2007*. Madrid. May.

Figure 2 Photovoltaic Module Price Experience Curve since 1979



MW = megawatt, Wp = watt-peak.

Source: Jäger-Waldau, A. 2011. Ispra: European Commission's Directorates-General Joint Research Center, Institute for Energy. (SET for 2020, EPIA 2009.)

Alternatively, the United States has been promoting solar energy development through a combination of federal tax credits, state-level renewable purchase obligations, and up-front subsidies. It implemented the Solar America Initiative (2007–2009) aimed at making PV-generated electricity cost-competitive with conventional electricity sources by 2015. Finally, Japan has been promoting solar installations through up-front capital subsidies. In 2009, it introduced a net model FIT scheme, which paid owners of grid-connected solar power systems a premium rate for surplus electricity generated.

Solar Investment Opportunities in Developing Member Countries

An ADB study projected that energy demand for Asia and the Pacific will grow at an annual average rate of 2.4% until 2030, more than double the world's average over the same period.[6] One of the biggest challenges confronting policy makers in the region is how to provide adequate, affordable access to clean energy for a large, growing population. Added to this are issues of energy security and pricing, especially for the poorest, as well as energy delivery, especially across diverse terrains and climate conditions. An estimated 900 million people in ADB DMCs have no access to electricity.

These struggles present vast opportunities for solar energy development in the region. Solar energy also offers substantial solutions to help address the energy challenges confronting Asia and the Pacific. These prospects are often mutually reinforcing, and some are described here.

Huge market potential with exponential growth prospects and development co-benefits. The present and projected gap in energy demand for the region provides a huge opportunity and market potential for any energy-generating technology that can meet the demand on a sustained basis. The distributed power generation potential of solar energy can help sustainably meet the energy needs of tropical and subtropical DMCs, which offer the best opportunities to harness solar insolation. The high solar potential, along with the high energy demand, offers exponential growth opportunities for solar energy applications in Asia and the Pacific.

Additional potential benefits accompany solar energy development in the region. These include access to clean energy for marginalized groups, social and rural development through the provision of decentralized generation to remote and rural communities, economic benefits from the development of indigenous solar energy manufacturing and ancillary industries, and significant potential for future cost reduction and scale-up in solar technology applications.

National programs promoting solar energy as a mainstream energy source. The potential for solar power cost reduction associated with technology development; increased scale of market penetration; manufacturing improvements in material, fabrication technology and processes; and a shift to low-cost production centers was introduced in the previous section. Until now, all these have been possible due largely to the demand from European markets, and to some extent American and Japanese markets. However, these markets offer only a modest growth opportunity compared with the exponential growth possibility in the new and emerging markets of Asia and the Pacific. Market development in the region is thus critical to the next wave of global investments in solar energy applications that will accelerate the global progress of solar energy toward grid parity.

In this regard, the region is witnessing the emergence of some of the largest solar promotion programs globally, such as the Jawaharlal Nehru National Solar Mission in India, Golden Sun Program of the PRC, and Thailand's Small Power Producer scheme for renewable energy. If these

---

6 ADB. 2009. *Energy Outlook for Asia and the Pacific.* Manila.

programs are able to achieve the scale envisaged, they have the potential to create a huge wave of demand, which, in turn, will spur increased innovation, efficiency in production, and cost reduction in solar energy applications. The competitiveness of solar energy against traditional and alternative energy sources around the world will consequently be increased.

Simple, easy-to-operate technology. Although solar manufacturing is still a technology-intensive process, the operation and maintenance of solar PV and solar thermal (i.e., low temperature) applications are less cost-intensive than conventional technologies, although they still require skilled personnel to manage sensitive and high-technology components. The control, monitoring, and alarm functions are fully automated and provide 24/7 surveillance to each one of the solar generator's components. Solar technology applications function efficiently at ambient temperatures and pressures, create no noise, limit pollution through available disposal and recycling programs for dead battery systems and solar panels, and can be installed in a modular manner. Besides these advantages, in tropical countries like those found in South Asia and Southeast Asia, the generation profile of solar PV technology closely parallels electricity demand, with its maximum output coming in the early afternoon of hot summer days. However, remote locations with limited resources and human capacity would require some support for maintenance, particularly for the balance of plant equipment, such as inverter and battery storage.[7]

Potential for high-cost electricity replacement. A number of countries in Asia and the Pacific are confronted with very high costs of energy production. For example, the price of electricity in the smaller islands of Indonesia, Maldives, and the Philippines, as well as Pacific island countries, is exceptionally high due to the distributed nature of the demand. This necessitates the use of diesel-based generators that make power very costly. Solar energy development provides an excellent opportunity to replace expensive fossil fuels in situations where the demand is remote and distributed, and where grid development and centralized generation are not possible.

As scale increases, new supply chains and business models will develop, and suppliers will attain the needed critical mass. Subsequently, equipment costs will decline, enhancing the attractiveness of solar energy production and reinforcing the above-mentioned opportunities.

---

[7] In the context of solar energy, "balance of plant" refers to all equipment for the safe operation and technical coordination of a solar power plant that are not included in the capture and concentration of solar radiation and its conversion into electricity or heat. Further, the lack of practical and cost-effective, large-scale energy storage remains a major barrier to the widespread use of solar (and other intermittent renewable) energy, but various solutions are already being explored.

Key Challenges to Solar Energy Development in Asia and the Pacific

Despite the significant potential and opportunity for solar energy development, and the geographic and socioeconomic advantages, most DMCs in the region lag behind developed countries in harnessing solar power. This situation runs the risk of a "solar divide," where developing countries do not participate in the fruits of green growth that developed countries are pursuing, creating a paradoxical situation where countries rich in solar resources cannot develop their resources while countries with relatively poor solar resources do. This suboptimal utilization of potential is rooted in a number of challenges that DMCs are currently striving to overcome.

Constraints in transmission and distribution grids. The PV technology road map of the International Energy Agency cites grid accessibility and integration issues as challenges that may prevent solar PV technology from achieving its global objective of providing 11% of global electricity production by 2050.[8] The distributed and remote nature of renewable projects limits their coverage through existing transmission grids. Most DMCs are hesitant to deploy limited funds to transmission development for such renewable projects of relatively lesser scale (i.e., those generating energy intermittently). Simultaneously, transmission losses can be crippling for solar developers, as the net available energy for sale will be lower. Thus, there is a need to develop an internationally agreed upon set of codes and standards for connecting solar (and other remote location and intermittent renewable energy) projects. Development in smart grid[9] and storage technologies is expected to lead to increased deployment of a variety of solar power generation technologies in the region.

High costs and insufficient budgetary resources. The steep up-front cost of solar projects, high borrowing costs, and the lack of access to long-term capital are stalling solar energy growth. The high cost of solar technologies during the transition stage (i.e., before the costs are competitive with alternate, but polluting, power generation technologies) means that in most cases, they have to be supported through a combination of public funds and user levies, the quantum of which are usually limited by government budget constraints and customer affordability. In this regard, the large-scale participation of Asia and the Pacific in solar energy development is key to a rapid reduction in solar power generation costs and unsubsidized supply.

Lack of appropriate financing mechanisms. The availability and cost of long-term debt remain one of the biggest challenges for solar energy project developers in the region. Long-term loans

---

8 4,500 terawatt-hours per year corresponding to 3,000 GW of cumulative installed capacity. International Energy Agency. 2010. *Technology Roadmap: Solar Photovoltaic Energy*. Paris.

9 A smart grid is an electricity network that can cost-efficiently integrate the behavior and actions of all users connected to it—generators, consumers, and those that are both—to ensure an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. European Regulators Group for Electricity and Gas (ERGEG). 2010. *ERGEG-Public Consultation: Position Paper on Smart Grids*. No. E09-EQS-30-04. Berlin.

for nonrecourse financing are generally available in emerging markets where there is a directly subsidized FIT, strong power purchase agreement regime, creditworthy offtaker, and clear regulatory signals. Without such an enabling environment, the cost of debt increases, and the available tenor decreases. Loan tenors for renewable energy projects in emerging economies vary typically between 10 and 12 years (sometimes up to 18 years from export credit agencies under arrangements facilitated by OECD), while solar projects have a life of 25 years. Moreover, the risk perception of financiers is distorted due to the very few project-financed solar projects in the region, high dependence on government subsidies, lack of exposure to solar power generation projects among financiers in the region, and inadequate data on insolation levels. These factors become reflected in the high interest rates for debt. Financing solutions that facilitate solar energy investments under such adverse circumstances are needed to catalyze solar energy development in the region.

Constraints in institutional capacity. Although some DMCs, such as the PRC, India, and Thailand, have formulated policy and regulatory frameworks for the promotion of solar energy, many DMCs lack the institutional capacity to design and develop these frameworks, thereby creating a demand pull for solar energy. Weak institutional capacity of government is viewed as risky by investors hesitant to commit to projects that rely exclusively on support mechanisms that are not well developed, have shorter durations, or are likely to change over time. Generally, the lack of strategic capacity-building and training activities, and parallel research and development programs, are key obstacles to stimulating catalytic solar energy development in Asia and the Pacific. The spread of knowledge and good practices on the various issues and aspects of solar energy will be helpful in enhancing and strengthening the sector in the region.

Inadequate coordination of knowledge management activities highlighting existing information gaps. Most DMCs pursuing solar energy development often set targets for, and offer projects on, public–private partnerships without adequate project preparatory measures, and with insufficient data on solar insolation and climate conditions that influence the output of solar power generation. Thus, information and perception gaps persist in the minds of investors, manufacturers, suppliers, and financiers, who play a major role in implementing solar energy development policy. Further, the absence of a comprehensive knowledge-sharing mechanism exclusively for solar energy and stable grid development in the region accentuates this gap by limiting the dissemination of lessons learned and best practices to local stakeholders, policy makers, and project developers.

The Asia Solar Energy Initiative: A Strategy for Catalytic Solar Energy Development in Asia and the Pacific

On 3 May 2010, recognizing the key challenges and opportunities for solar energy development in Asia and the Pacific, ADB President Haruhiko Kuroda announced the launch of the ASEI aimed at identifying, developing, and implementing 3,000 MW of solar electricity generation and associated smart grid projects over the next 3 years. This sizable initiative aims at accelerating solar energy's progress toward grid parity. The current trends are shown in Figures 3 and 4, illustrating the projected levelized cost of electricity for PV and CSP, respectively. Featuring an integrated, multipronged approach for developing solar energy in the region, the ASEI has three interlinked components:

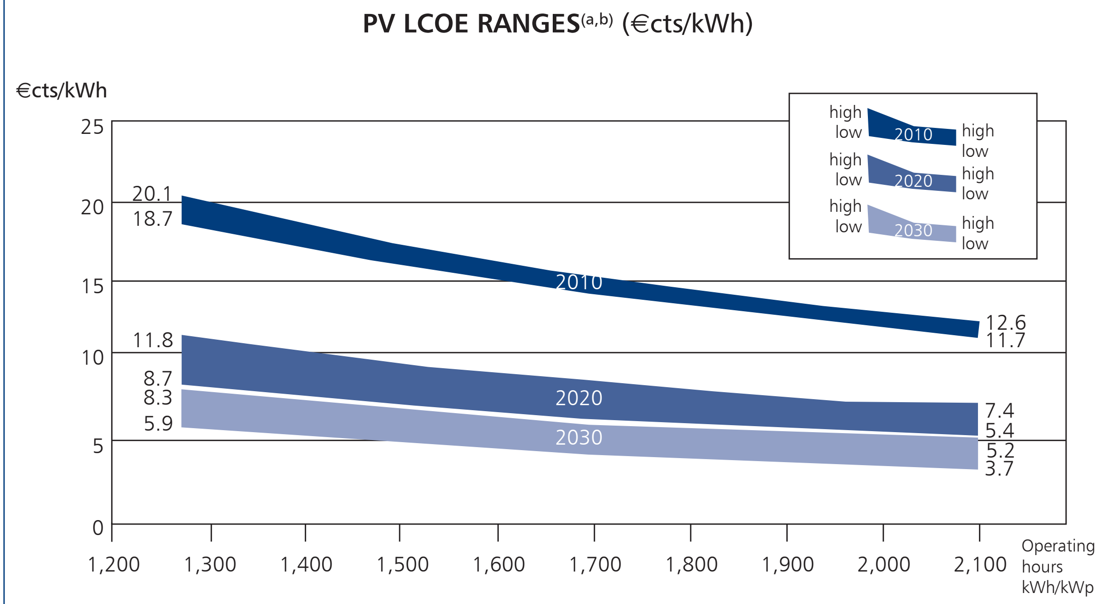
(i) **Knowledge management.** Development of a regional knowledge platform dedicated to solar energy in Asia and the Pacific.
(ii) **Project development.** Assistance in the identification and development of 3,000 MW of solar generation and associated smart grid projects.
(iii) **Innovative finance.** Provision of innovative financing solutions for projects to mitigate risks, buy down the initial high technology adoption cost of solar power generation projects, and encourage solar energy development.

Knowledge Management: The Asia Solar Energy Forum

The Asia Solar Energy Forum (ASEF) is envisioned as an independent, nonpartisan, nonpolitical, regional knowledge management platform that links with knowledge hubs globally to facilitate solar energy technology transfer to Asia and the Pacific, provide quality inputs for effective policy and decision making for solar power development, and suggest innovative financing mechanisms to promote solar energy projects. ADB approved two regional technical assistance projects, with a total budget of $3 million funded by the Japan-financed Asian Clean Energy Fund, to support the organization of the first two meetings of the ASEF in Manila and Tokyo and its establishment as a nonprofit institution.[10] While ADB is committed to supporting the ASEF during its inception, in the long term, the ASEF is conceived to be a self-sustaining, member-supported, nonprofit society, whose members are countries, utilities, financiers, manufacturers, and other stakeholders of solar energy from all over the world.

ASEF milestones in 2010. The decision to constitute such an institution, focused on tracking and disseminating knowledge to reduce barriers to solar power development in the region, was arrived at during the inaugural meeting of the ASEF held in Manila from 5 to 6 July 2010. After exploring the potential for, and analyzing the barriers to, solar energy development in Asia and

Figure 3 **Photovoltaic Levelized Cost of Energy in Sunbelt Irradiation Conditions 2010, 2020, and 2030**



kWh = kilowatt-hour.

[a] Turnkey photovoltaic (PV) systems > 1 megawatt-peak (MWp); 85% performance ratio; lifetime until 2020 is 25 years and after 2020, 30 years; operation and maintenance (O&M) costs 1.5% of Capex; Debt financing with weighted average cost of capital (WACC): 6.4%; System Price 2010: €2,800/kWp (kilowatt-peak).

[b] Low and high levelized cost of energy (LCOE) correspond, respectively, with the lowest and highest turnkey system price within the price range.

Source: Alliance for Rural Electrification/Spanish Photovoltaic Association/European Photovoltaic Industry Association. Oct 2010. Unlocking the Sunbelt Potential of Photovoltaics; National Renewable Energy Laboratory, EPIA SET For 2020, A.T. Kearney analysis.

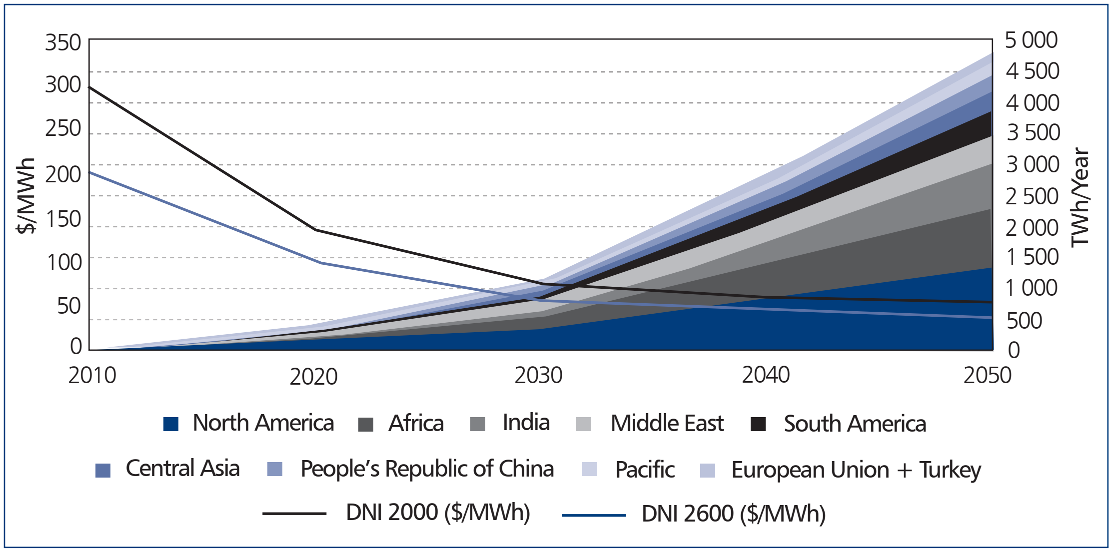
the Pacific, over 200 solar energy–related professionals from 34 countries unanimously concluded that an exclusive regional knowledge management platform should be established. The plenary authorized the creation of a preparatory committee, comprising representatives from organizations that participated in the inaugural meeting, whose task was to design the ASEF organization and governance structure, outline priority focus areas, and identify specific deliverables.

The committee, chaired by ADB, met in Bangkok on 3 September 2010 to draft the proposed ASEF charter, work plan, and organizational structure for the consideration of the participants of the second ASEF meeting held in Tokyo from 1 to 2 December 2010. Over 300 delegates from 38 countries attended, and unanimously accepted the draft charter.

The ASEF is an inclusive, open, and flexible organization with a light governance structure and optimal delegation of responsibilities to the contributing member organizations for the delivery

[10] ADB. 2010. *Needs Assessment and Development of the Solar Energy Program. Manila; ADB. 2010. Knowledge Platform Development for the Asia Solar Energy Initiative*. Manila.

Figure 4 Projected Evolution of the Levelized Electricity Cost from Concentrating Solar Power Plants



DNI = direct normal irradiance, MWh = megawatt-hour, TWh = terawatt-hour.

Source: International Energy Agency. 2010. *Technology Roadmap: Concentrating solar power (foldout).* Paris.

of agreed priority themes and work areas of high quality and practical value. The private sector is particularly expected to play a prominent role in the management of the ASEF. The ASEF will have the following primary objectives:

(i) Knowledge sharing and consultations.
  (a) Track and disseminate information to ASEF members on successful solar energy development projects in developed and developing countries, including emerging technologies and lessons from commercial operations of demonstration plants (e.g., molten salt storage for CSP, solar hybrid plants, linear Fresnel plants, and new thin-film technologies); organize major conferences to raise awareness and understanding on issues of topical interest; and facilitate networking.
  (b) Explore and discuss financially viable instruments for development in consultation with various stakeholders to facilitate business in solar power generation and smart grid development for grid-connected as well as stand-alone urban and rural solar applications.
  (c) Propose to stakeholders innovative financing and risk mitigation mechanisms for long-tenor loans and guarantees that make solar energy projects financially viable.
  (d) Conduct matchmaking among the foreign and domestic private sectors; manufacturers; project developers; engineering, procurement, and construction contractors and financiers.
  (e) Together with ADB and partner organizations, identify new solar power development proposals in DMCs and help conduct pre-feasibility studies to attract interest.
(ii) Policy and regulatory framework development.
  (a) Together with ADB and partner organizations, analyze best practices of policy, legal, and regulatory frameworks; and share these with DMC governments.
  (b) Help enhance institutional capacity of DMCs for developing and implementing policy, legal, and regulatory frameworks for solar energy and smart grid applications.

(iii) Capacity development for local stakeholders.
   (a) Assist local utilities in DMCs, cooperating with equipment manufacturers and relevant private sector entities, to localize technology, adapting it to local conditions and parameters, for developing smart grids at transmission and distribution levels (e.g., use of stable current, voltage, and frequency management using storage devices; bill collection mechanism with two-way meters; and voltage and frequency control systems).
   (b) Enhance capacity of local financing, insurance, and legal firms for appraising solar and smart grid project proposals.
   (c) Facilitate training and capacity-building activities pertaining to various aspects of solar energy for different stakeholders as needed or as the opportunity arises.

Project Development: 3,000 Megawatts of Solar Capacity Committed

The ASEI is committed to identifying, developing, and assisting implementation of 3,000 MW of solar power over the next 3 years at an estimated cost of $9 billion. Starting from May 2009, the phasing of such investments is expected to be 500 MW over year 1; 1,000 MW over year 2; and 1,500 MW over year 3.

Overall, the targeted projects are expected to demonstrate and model the feasibility and sustainability of various types of public and private solar energy generation projects, including large-scale clustered development of grid-connected projects, building-integrated PVs,[11] rooftop-distributed power generation projects in cities, and off-grid or local-grid rural electrification projects. Pilot demonstration projects to be promoted by DMC governments will also be among the ASEI's focus. Such projects will establish models for financiers and private sector entities that will be investing in projects in ADB DMCs.

Initial projects in year 1. The first projects supported under the ASEI are two private sector–led solar PV electricity generation projects in central Thailand: a 73.0 MW project and a 44.5 MW project. As the trustee for the Asia Pacific Carbon Fund, ADB was also selected as partner for five solar power projects (i.e., two 10.0 MW solar power plants and 10.7 MW of building-integrated PV projects) being developed in the PRC. A 1.5 MW CSP plant has also been implemented near Beijing in the PRC. Other potential projects under consideration over the ASEI's first year included (i) four demonstration CSP projects in the PRC, 50 MW each in four provinces; (ii) solar power transmission project in Gujarat, India, enabling 500 MW of solar power generation capacity to be connected to the grid; (iii) a 5 MW grid-connected solar PV demonstration project and two off-grid, solar-wind hybrid plants (0.5–1.0 MW) in Bangladesh; and (iv) private, large-scale PV and solar thermal projects under concessions in five provinces in the PRC, in collaboration with state utilities and private distribution companies.

---

[11] Building-integrated PVs refer to PV systems integrated with a building structure. The PV elements are used to replace conventional building materials to form an integral part of the building, such as roof, skylights, or facades, and also to function as a principal or ancillary electrical power source. Existing structures may also be fitted with building-integrated PV modules.

[12] The Clean Technology Fund is one of two climate investment funds designed to help developing countries pilot low-emission and climate-resilient development. Specifically, the Clean Technology Fund promotes scaled up financing for demonstration, deployment, and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emission savings. It is expected that the fund will finance programs in 15–20 countries or regions. Climate Investment Funds. www.climateinvestmentfunds.org.

Potential projects in year 2 and year 3. The private sector is expected to implement the bulk of projects financed under the ASEI. In this regard, several DMC governments already have ongoing programs to attract investments in solar power generation, notably the PRC, India, and Thailand. A cluster development of solar PV parks in Rajasthan and Gujarat states in India through public–private partnerships is already in the ADB pipeline. Further, the Philippines has in place some manufacturing capacity for solar panels and plans to use this to develop solar energy power generation, which has been identified as a future objective. To assist the Philippines, the Clean Technology Fund[12] approved an allocation of $400 million in November 2009 for a project, Investment Plan for Philippines, which is envisaged to include 100 MW of solar power generation. Finally, Uzbekistan is also interested in seeking assistance from ADB in rapidly developing its solar energy resources. The size of PV projects tends to be small, as developers benefit from the modular nature of the technology. With better understanding of the CSP technology, developers are expected to also pursue large grid-connected projects that would allow more capacity to be added in later years through fewer transactions. Appendix 1 provides an overview of the policy environment in DMCs that would create the demand for more solar projects.

Solar resource mapping for portfolio development. The ASEI proposes to make considerable investments in systems for generating and gathering insolation data in DMCs through current or proposed programs. The ASEI will focus on using satellite-based global data to identify about a dozen large potential sites across a country for detailed ground-level measurements. Subsequently, based on identification of probable high potential sites and third-party resource modeling results (considering other factors such as land availability, transmission accessibility, and tariff and regulatory regimes), assistance would be provided for inviting bids from the private sector to develop bankable solar energy projects. Together with targeted incentive programs that draw on international experience, early resource mapping is expected to provide a portfolio of projects in a systematic manner.

Enabling environment for solar demonstration projects. The recent trend in solar energy development is very encouraging and points to high growth. As of December 2009, the cumulative global solar PV capacity increased to 22.9 GW. In 2009, 10.7 GW of solar PV cells were produced globally, a 51% increase over 2008. Of the total, the PRC and Taipei,China accounted for 5.2 GW, and the largest manufacturer with 10% share has most of its production capacity in Malaysia.[13] The global capacity addition was 7.2 GW, mostly in Germany, Spain, Italy, Japan, and the United States (in this order). The overcapacity has led to a sharp fall in the price of panels, with prices falling by 30% in 2009 alone.[14] Recent bids of $0.10 per kilowatt-hour to $0.16 per kilowatt-hour in the PRC[15] reflect the production overcapacity and the highly competitive market. Other countries are also considering measures that will help bring grid parity in a few years.

With greater knowledge sharing, lower risk perception, and the large number of new producers and project developers, the ASEI is well placed to identify projects that will demonstrate suitable business models, financing structures, and technologies in several more DMCs with good solar insolation and high availability of land that has little alternate use. As the price of equipment gets lower, solar energy with small storage capacity will also be a viable option to extend electricity for lighting to the 900 million people in Asia and the Pacific who lack access.

---

[13] Earth Policy Institute. 2010. *Solar Cell Production Climbs to Another Record in 2009*. Washington, DC. September.

[14] With silicon as a key component in solar PV panels, the price of PV modules was also influenced by the new production capacity of silicon refining factories, leading to a drop in prices from about $480 per kilogram in 2005 to $52 per kilogram in 2010. Intersolar Europe 2010. Munich, Germany. 9–11 June 2010.

[15] Government of the PRC, National Development and Reform Commission and National Energy Administration. 2010. *Second PV Concession Tender Notice*. http://nyj.ndrc.gov.cn/ggtz/t20101026_376846.htm.

Transition issues surrounding nascent solar project development. Notwithstanding the inventory of potential solar projects in the region, large-scale deployment of solar energy in Asia and the Pacific is still confronted with several barriers. The ASEF will provide an appropriate platform for finding ways and means to address them. Meanwhile, some key issues need to be kept in mind during the transition stage—before solar power generation reaches grid parity in Asia and the Pacific. Specifically, consumers need not unduly suffer in the short term to enhance the viability of solar in the long term. The following are some precautions in this regard:

(i) With the existing levels of energy conversion efficiencies, the land area required for a solar power plant is fairly large—about 2.5–3.0 hectares per MW (depending upon the technology) for solar PV technology, and about 2.5 hectares per MW for CSP technology. The most suitable regions for utility-scale projects would be deserts or otherwise degraded land areas that cannot be used for growing food or forests essential to communities.

(ii) Solar power has been an obvious choice for remote applications (e.g., communication towers and weather stations), but its high price marginalizes households with low income levels needing only a small amount of electricity for lighting and entertainment. The highest social return would be to such households, but they probably need to wait until solar power generation reaches grid parity.

(iii) In most countries, households pay a high electricity tariff, which reflects the higher cost incurred by the utility to provide the service. Similarly, commercial establishments pay high tariffs, but these expenses are passed on to the end-consumer of the commercial products and services. There is a need to encourage solar PV installations at a point nearest to the load centers. One such opportunity is the installation of PV systems in high-income households and commercial establishments that have large roof spaces and building facades suitable for solar PV installations. Therefore, a suitable business model is needed to open this market for solar PV in Asia and the Pacific. Europe and the United States have already established solar service companies that develop building-integrated and rooftop-based solar leasing businesses. ADB is installing a (approximately) 370 kilowatt-capacity solar PV project on the roof of the Facilities Block of its headquarters building in Manila, aiming to pioneer this independent power producer–style development of solar energy for rooftop applications in the region.

To implement the ASEI component of developing 3,000 MW of solar power in 3 years, ADB plans to provide direct technical assistance to DMC governments for conducting pre-feasibility studies, preparing projects, and structuring solar generation projects as public–private partnerships. Moreover, ADB intends to provide assistance in terms of financing and expects to leverage additional funds for solar energy investment. Efforts are already under way to find innovative ways and means of attracting large amounts of private investment. ADB will leverage instruments, such as LIBOR-based loans, donor contributions, grant funds, innovative risk mitigation mechanisms, carbon market support measures, and direct support, which will contribute to the improved financial viability of solar projects in the region.

Innovative Finance: The Asia Accelerated Solar Energy Development Fund

To supplement its direct financing, ADB devised the Asia Accelerated Solar Energy Development Fund (AASEDF). The AASEDF is a solar technology–specific fund intended to support solar project and program preparation in DMCs by mitigating related risks, thereby attracting debt at a lower cost, and providing power generation incentives so that consumers are not required to bear the high cost of the technology before it becomes fully commercial in a particular market. ADB is working to raise about $500 million over the next 3 years from donor countries for the AASEDF to buy down the initial high technology adoption costs of solar power generation projects, and to design innovative mechanisms, encouraging commercial banks and the private sector to invest in solar technologies and projects. These financing interventions are expected to rapidly enlarge the solar energy market, a key to reaching grid parity quickly.

Up until now, donor contributions for supporting carbon emission reductions in developing countries have gone to general purpose funds that mostly target capacity building and barrier lowering to encourage private sector investment, more often as foreign direct investment. Although these have helped raise awareness and formulate environment-friendly policies and regulations, they have failed to contribute to a direct reduction in the cost barrier of any particular clean energy technology. The AASEDF is a shift in approach that will directly impact the cost barrier and set off a virtuous cycle of solar energy development.

Two of the most prominent alternate sources of funds available to DMCs for solar project development are the Global Environment Facility and Climate Investment Funds (footnote 12), both of which are not designed to catalyze solar project development specifically. For example, Global Environment Facility resources are intended to promote broad environmental and/or climate change benefits, such as reduced greenhouse gas emissions, and are allotted to DMC governments only, posing a challenge when most solar energy projects are intended for private sector implementation. Moreover, the Climate Investment Funds provide support enough only for the viability of a few clean energy demonstration projects and are therefore unable to support large-scale solar capacity deployment.

The AASEDF is intended to catalyze solar capacity in Asia and the Pacific. It will encourage visible private sector participation by keeping transaction and opportunity costs low for the sector and by offering risk mitigation and incentive generation products while solar technology remains at the precommercial stage, ultimately unburdening end-consumers of the initial high cost of solar power. More specifically, AASEDF resources are proposed to be used for the following activities:

(i) **Project and program preparation.** To enable a steady development of the solar electricity market that would (a) permit sustainable buildup of solar generation capacity, (b) provide incentives to manufacturers to invest in research and development, (c) allow for consistent price discovery, and (d) enable gradual appreciation and mitigation of technical issues, it is necessary that solar electricity generation projects be seen as part of a multistage, multiyear development program rather than as ad hoc projects. Thus, it would be beneficial if countries that have adequate land and demand to sustain solar electricity generation programs develop larger-capacity sites that can then be used to bid for capacity establishment in multiyear stages. For example, at a suitable place, land and site infrastructure could be developed for 500 MW of capacity that could then be offered for bidding annually in 100 MW capacity creation for 5 years. However, this development method, though beneficial in the long term, would entail greater up-front project development costs, which governments may be reluctant to commit. Grant funds under the AASEDF, either alone or pooled with resources made available by governments or bilateral or multilateral donors, could be used for preparing such programs. In addition to land and site infrastructure development, AASEDF resources may be used to lower the up-front cost of common facilities of such "solar parks," like water

[16] Public and private meteorological satellite data are available for many DMCs, but there is limited or no insolation data available from ground stations against which satellite data can be properly correlated and verified. This uncertainty results in exploration risks, also referred to as insolation or resource risk. Arriving at an overall risk quantification is key to completing a bankable report for financial participants.

supply and transmission systems for power evacuation. These will significantly lower both transaction and project costs, encouraging the private sector to develop solar projects.

(ii) **Risk mitigation.** Some AASEDF funds will be used to mitigate risks associated with the development of solar power generation projects such as

(a) **Exploration risk.** One of the main issues in developing solar power generation projects is the lack of insolation data.[16] Good-quality data are essential for appropriately designing facilities, as well as predicting their revenue streams with reasonable accuracy. Many sites would need exploration and data collection (e.g., requisite insolation levels) to determine their suitability for development and to minimize the related risks. DMCs and private sector developers are reluctant to undertake such studies, thereby significantly slowing the formulation of enabling policies and project development. Therefore, it is proposed that some AASEDF funds be used to pay for, or reimburse, costs incurred by governments for quality data collection.

(b) **Specification risk.** Given the paucity of good quality data, a major risk that is associated with solar electricity generation projects, especially during the first 5 years of the project's commercial operation, is the variation between the specified and actual insolation levels at a site. Given that this difference directly impacts the revenue stream of the project and therefore its financial viability, the uncertainty leads sponsors and their financiers to take different views on the probability of annual energy production estimates throughout the project's lifetime.[17] Often, this ends in project delays and/or unacceptably high solar generation costs, leading to smaller programs by governments. Thus, some AASEDF funds can be considered for guaranteeing the cumulative revenue effect of the difference between specified and actual insolation levels of identified solar generation projects over their first 5 years. Similarly, other specification risks may be considered, such as an unexpected or inadequate performance of components under actual ambient temperature, atmospheric conditions, humidity, and dust levels, when they are significantly different from those specified in the bid document.

(c) **Offtake and payment risk.** Given that the price of electricity generated from solar power stations will be more expensive than that from conventional fossil-fired generation sources, commercial sentiments are likely to be against offtake and payment of solar-based generation. This can often lead to a perception of risk among developers and financiers of solar power and lead to increases in the end-price. Multilateral development banks, such as ADB, are in the best position to play the middleperson's role, guaranteeing the faithful performance of governments or utility companies in terms of power purchases from solar power generation projects. In this regard, AASEDF resources might be used to issue (or reinsure) (1) credit guarantees, covering both political and commercial risks against defaults on offtake and payments by purchasers of solar-based electricity; and/or (2) political risk guarantees, which may include breach of contract by the offtaker.

(iii) **Generation incentives.** In the long term, the ASEI aims to reduce the cost of solar-based generation to be close to alternate fossil fuel-based generation. This will enable DMCs to choose solar-based generation capacity, despite its intermittency, as another option in

---

[17] The lack of robust data results in lenders insisting on 90%–99% (P90–P99) probability levels for energy production and revenue in helping assess whether a loan can be adequately serviced by a project's projected cash flows. Sponsors typically take a P50 level and increase their internal hurdle rate to compensate for the insolation risks assumed as a first mover in the market.

[18] The Clean Energy Financing Partnership Facility is an umbrella operational arrangement established by ADB in April 2007 to enhance the administrative coordination and efficiency of funds aimed at providing specific financing to DMCs to improve energy security and transition to low-carbon economies through cost-effective investments in technologies and practices that result in greenhouse gas mitigation. Fund resources also finance policy, regulatory, and institutional reforms that encourage clean energy development.

the course of planning their generation sources. However, the high price of solar power will be an issue during the transition period. A preferred method to address this issue is by tariff shaping. If the project receives "added" revenues in the first few years as an incentive, the tariff can be lower in later years, which then eases the tension between the techno-commercial nature of dispatch operations in a network, and the desirability to buy green electricity. Countries such as Thailand, and some provinces and states in the PRC and India, have adopted such schemes. However, their budgets are limited, and if the solar market is to grow, additional resources for such incentives need to be provided, for instance, in the first 5 years by donor-assisted funds such as the AASEDF.

The AASEDF is structured as a multidonor fund under the Clean Energy Financing Partnership Facility administered by ADB.[18] While all DMCs will be eligible for support, the AASEDF will prioritize projects in large markets that accelerate the deployment of significant solar energy generation capacity and cost reduction that would contribute largely to lowering costs, consequently making solar technology affordable to many more markets. There will be two key conditions for AASEDF support: (i) the host country government shares a part of the cost of transition projects by way of fiscal or tax incentives with project developers, or by announcing adequate FITs; and (ii) the procurement process (for selection of project developers or purchase of solar equipment) is open to all ADB member countries in a fair and equitable manner.

Conclusion

The ASEI has the potential to not only drive down costs and to usher in innovation in the solar space, but also to demonstrate replicable models to sustain solar capacity additions in Asia and the Pacific. It is also expected to serve as a model for other regions of the world, such as northern Africa, Latin America, and the Caribbean, which are similarly placed. There has been keen support for the ASEI and ADB leadership in this area.

Beyond the next 3 years, measures of ASEI's success will be the widespread reach of solar energy generation programs across DMCs in Asia and the Pacific, and the extent of mainstreaming of solar energy as an option for generating capacity addition in all DMCs with significant potential for solar energy in the region. ADB is committed to seeing this success in the future of Asia and the Pacific.

Appendix 1

Renewable Energy Policies and Regulations in Developing Member Countries

Bangladesh

In Bangladesh, a number of domestic solar energy systems are used in houses around the country. The use of solar energy on this scale is advantageous, as over 50% of homes in the country do not have access to grid electricity. The Government of Bangladesh has been emphasizing developing solar homes under its Bangladesh Climate Change Strategy and Action Plan.[1] This plan has set up a specific program for solar energy development, with the government exploring an incentive scheme to encourage entrepreneurs who wish to start solar projects. Potential applications of solar energy for industrial and agricultural uses could also be examined.

Brunei Darussalam

The Government of Brunei Darussalam is assessing the viability of large-scale PV electricity generation. To promote this effort, the government has initiated a solar energy demonstration project known as Tenaga Suria Brunei, with a capacity of 1.2 MW. The plant first connected to the power grid of the Department of Electrical Services in May 2010, and is now operating at full capacity after completing a 3-month testing period.

People's Republic of China

The People's Republic of China (PRC) has become a world leader in the manufacture of solar photovoltaic (PV) technology and is now first-ranked in PV cell exports. However, the PV market demand in the PRC remains small, with more than 95% of the country's PV cell products exported. In 2009, PRC's cumulative PV-installed capacity was 305 megawatts (MW). Independent PV power systems met 40% of this demand, supplying electricity to remote districts not covered by the national grid. To promote the use of renewable energy, the PRC introduced the Renewable Energy Law, which came into effect on 1 January 2006.[2] It covers four schemes: a cost-sharing scheme, a feed-in tariff scheme, a mandatory grid-connection system, and an economy-wide target system. An amendment to the law provided power grid companies with revenues for purchasing clean power generated from the surcharge on retail power tariffs and set a minimum target for the amount of electricity that the grid companies must buy from renewable energy projects. The

[1] Government of Bangladesh. 2008. *Bangladesh Climate Change Strategy and Action Plan 2009*. Dhaka. September.

[2] Government of the PRC. 2006. *The Renewable Energy Law*. Beijing.

PRC has set goals to raise the share of renewables in total primary energy consumption to 10% in 2010 and 15% in 2020.

Building-integrated PV systems, as well as large PV installations in desert areas, are being encouraged by the government, which began providing a subsidy of CNY20 ($2.93) per watt for building-integrated PV projects in early 2009. It is likely that the national targets for solar PV technology—400 MW in 2010 and 1,800 MW in 2020—announced in 2007 will be significantly increased. Experts predict that PRC installed capacity could reach 1 GW in 2010 and 20 GW in 2020.

In 2010, the government carried out two rounds of bidding for solar PV projects, the first time for adding 10 MW at one location and the second for adding 280 MW at 13 locations. The selection of the bidder was based on the price of electricity offered. The bidding was highly competitive, and the announcement of winning bidders indicated a price range of $0.11–$0.16 per kilowatt-hour.[3] It is understood that the low bids prompted internal discussions, since many feel that the rates are not sustainable and may be harmful for the domestic solar industry.

India

To address the country's growing energy demand and future concerns around energy security and climate change, the Government of India has put in place a structure of policy and regulatory initiatives to encourage investments for harnessing the abundant potential of solar energy.

In view of the growing awareness on the use of solar power and its climate change and environmental benefits, the National Action Plan for Climate Change[4] recommended the launch of a national solar mission in India. Thus, the Jawaharlal Nehru National Solar Mission was launched to promote power generation from solar energy. Its objective is to create conditions to drive down costs toward grid parity through rapid scaling up of capacity and technological innovation. The mission aims to achieve grid parity for solar by 2022 and parity with coal-based thermal power by 2030.

Indonesia

Indonesia is utilizing PV systems to increase its electrification ratio target, which was 66.2% in 2009. During the same year, the government allocated Rp658.7 billion (about $65 million) to provide new and renewable energy–based power generation for Indonesia's distributed power systems. The program provided electricity to around 94,000 households, particularly households in 18 of the outermost islands of Indonesia.

Lao People's Democratic Republic

The Lao People's Democratic Republic is actively developing solar energy projects for rural electrification. In 2005, the government developed the world's first hybrid generation system with solar PV and small-scale pumped water storage technology. The system, operated by the local community in the north, is still running without any trouble.

---

[3] Government of the PRC, National Development and Reform Commission and National Energy Administration. 2010. *Second PV Concession Tender Notice*. http://nyj.ndrc.gov.cn/ggtz/t20101026_376846.htm.

[4] Government of India. 2008. *National Action Plan on Climate Change*. Delhi.

Malaysia

Malaysia is continuously encouraging the development of renewable energy in the economy through policy and various strategies. The Five-Fuel Policy has made renewable energy one of the components in the fuel mix for power generation after oil, coal, gas, and hydro.[5] The Small Renewable Energy Power Program was launched, encouraging production of renewable energy by small power generators and allowing the sale of generated electricity to utilities. The Ninth Malaysia Plan[6] specified a target for electricity grid-connected renewable energy generation—300 MW in Peninsular Malaysia and 50 MW in Sabah.

Maldives

The Government of the Maldives has a clear strategy to expand solar PV power generation to incorporate more reliable and sustainable means of electricity generation into the existing power system. Presently, the Maldives is dependent on diesel to provide electric power to island communities. Support can be provided to solar technology solutions to reduce the dependence on diesel, increase the proportion of renewable energy, reduce import of diesel, and enhance the energy security of the country.

Pakistan

Pakistan has set a target to add 5% (about 10,000 MW) of electricity through renewable energies by 2030. In July 2009, the government announced that 7,000 villages would be electrified using solar energy in the next 5 years. The Punjab provincial government is also targeting new projects aimed at power production through coal, solar energy, and wind power.

Sri Lanka

The government endeavors to reach a minimum level of 10% of the electricity grid using nonconventional renewable energy by 2015, and 6% of the households using off-grid electricity systems by 2010. The 10-year horizon development framework of the government, which started in 2007, emphasizes sustainable development of energy sources and delivery systems at competitive prices. It targets increasing fuel diversity and security through investing in both conventional sources and nonconventional renewable energy. The grid and off-grid energy systems are planned to ensure access to electricity to 98% of the households by 2016.

Thailand

As part of its strategy to diversify the energy mix and to promote renewable energy, the Government of Thailand has prepared an Alternative Energy Development Plan, 2008–2022[7] and set a target of 20.4% for primary commercial energy from renewable energy sources by

---

[5] Government of Malaysia. 2001. *Energy Policy in the Eighth Malaysia Plan/Five Fuel Policy.* Kuala Lumpur.

[6] Government of Malaysia. 2006. *Ninth Malaysia Plan*. Kuala Lumpur.

[7] Government of Thailand, Department of Alternative Energy Development and Efficiency. 2009. *Renewable Energy Policy in Thailand.* Bangkok.

2022. The Ministry of Energy is promoting decentralized power generation mainly by supporting the country's Small Power Producer and Very Small Power Producer programs. The Small Power Producer Program allows private developers to build, own, and operate 10–90 MW power projects and to enter into power purchase agreements with the Electricity Generating Authority of Thailand. Solar energy projects originally received a fixed adder to the tariff (i.e., subsidy) of B8.0 (about $0.23)[8] per kilowatt-hour for 10 years from the start of commercial operations, which fell to B6.5 (about $0.19) at the end of 2009. The solar adder tariff has been hugely successful, with over 1,500 MW of signed power purchase agreements, and the government is no longer accepting new proposals.

Table A1 provides a summary of policies used in Asia and the Pacific.

Table A1 Renewable Energy Promotion Policies in Selected Countries of Asia and the Pacific

Country	Feed-in Tariff	Renewable Portfolio Standard or Quota	Capital Subsidies, Grants, and Rebates	Investment or Other Tax Credits	Sales Tax, Energy Tax, Excise Tax, or VAT Reduction	Tradable Renewable Energy Certificates	Energy Production Payments or Tax Credits	Net Metering	Public Investment, Loans, or Financing	Public Competitive Bidding
Developed or Transition										
Australia	(*)	X	X			X			X	
Japan	X	X	X	X		X		X	X	
New Zealand			X						X	
Republic of Korea	X		X	X	X				X	
Developing										
PRC	X	X	X	X	X		X		X	X
India	(*)	(*)	X	X	X	X	X		X	
Indonesia	X			X	X					
Malaysia									X	
Mongolia	X									X
Pakistan	X							X		
Philippines	X	X	X	X	X		X	X	X	X
Sri Lanka	X									
Thailand	X				X				X	

PRC = People's Republic of China, VAT = value-added tax.

Notes: Entries with an asterisk (*) mean that some states or provinces within these countries have state- or province-level policies, but no national-level policy. Only enacted policies are included in table; however, for some policies shown, implementing regulations may not yet have been developed or effective, leading to lack of implementation or impacts. Policies known to be discontinued have been omitted. Many feed-in policies are limited in scope or technology. Some policies shown may apply to other markets beside power generation, for example, solar hot water and biofuels.

Source: Renewable Energy Policy Network for the 21st Century (REN21). 2010. *Renewables 2010 Global Status Report*. Paris: REN21 Secretariat.

[8] Government of Thailand, Energy Regulatory Commission. 2009. *Thailand Energy Regulatory Developments*. Bangkok.

Asia Solar Energy Initiative: A Primer

The common use of solar energy and other cleaner energy technologies is key to combating climate change while sustaining global economic growth. Previously, the high cost of solar generation restricted its advancement to developed economies. Today, the new and emerging markets of Asia and the Pacific offer exceptional expansion opportunities—a rapidly increasing energy demand from a large and growing population, good solar irradiation, and enough patches of otherwise unusable land.

The Asia Solar Energy Initiative of the Asian Development Bank aims at developing 3,000 megawatts of solar power and associated smart grid projects in Asia and the Pacific within 3 years. This initiative features three interlinked components on knowledge management, project development, and innovative financing that are intended to accelerate solar energy's progress toward grid parity.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than $2 a day, with 903 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org
ISBN 978-92-9092-314-5
Publication Stock No. RPT113107

Printed on recycled paper

ISBN 978-92-9092-314-5
9 789290 923145

Printed in the Philippines