FINANCING CLEAN ENERGY IN DEVELOPING ASIA

Edited by Bambang Susantono, Yongping Zhai, Ram M. Shrestha, and Lingshui Mo

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ASIAN DEVELOPMENT BANK

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Abbreviations

ABC	–	anchor-business-community
ACR	–	American Carbon Registry
ACMF	–	ASEAN Capital Markets Forum
ADB	–	Asian Development Bank
ADF	–	Asian Development Fund
AEC	–	ASEAN Economic Community
AC	–	alternating current
ACGF	–	ASEAN Catalytic Green Finance Facility
AIF	–	ASEAN Infrastructure Fund
APAEC	–	ASEAN Plan of Action on Energy Cooperation
APG	–	ASEAN Power Grid
AQI	–	air quality index
ASEAN	–	Association of Southeast Asian Nations
ASSURE	–	Scaling up Renewables Plus Storage in ASEAN
BAFO	–	best and final offer
BAU	–	business as usual
BEV	–	battery-operated electric vehicle
BTH	–	Beijing-Tianjin-Hebei
CAGR	–	compound annual growth rate
CBS	–	Concession Bidding Scheme
CCER	–	China Certified Emission Reduction
CCS	–	carbon capture and storage
CDM	–	Clean Development Mechanism
CEFPF	–	Clean Energy Financing Partnership Facility
CER	–	certified emission reduction
CERF	–	Clean Energy Revolving Fund
CFPS	–	Canadian Fund for Climate Sector in Asia II
CGIF	–	Credit Guarantee Investment Facility

CIF	–	Climate Investment Funds
CO_2	–	carbon dioxide
CORSIA	–	Carbon Offsetting and Reduction Scheme for International Aviation
COVID-19	–	coronavirus disease
CTF	–	Climate Technology Fund
CVER	–	China GHG Voluntary Emission Reduction Program
DC	–	direct current
DFI	–	development finance institutions
DMC	–	developing member country
DRES	–	distributed renewable energy systems
EDC	–	Electricité du Cambodge
EELS	–	energy efficiency labeling system
EERF	–	Energy Efficiency Revolving Fund
EMS	–	energy management system
EPC	–	engineering, procurement, and construction
EPC	–	energy-saving performance contracting
ESCO	–	Energy Service Company
ESG	–	Environmental, Social, and Governance
ESMAP	–	Energy Sector Management Assistance Program
ETS	–	emissions trading scheme
EV	–	electric vehicle
FCF	–	Future Carbon Fund
FCV	–	fuel cell vehicle
FIL	–	financial intermediation loan
FiT	–	feed-in tariff
FPO	–	fixed price option
GDP	–	gross domestic product
GFP	–	Green Financing Platform
GHG	–	greenhouse gas
GTFS	–	Green Technology Financing Scheme
ICMA	–	International Capital Market Association
ICAO	–	International Civil Aviation Organization
IEA	–	International Energy Agency
IETA	–	International Emissions Trading Association
IFB	–	invitation for bid
IFC	–	International Finance Corporation

IPP	–	independent power producer
IRENA	–	International Renewable Energy Agency
ITMO	–	internationally transferred mitigation outcome
JCM	–	Joint Credit Mechanism
KOC	–	Korean Offset Credits Program
LC	–	letter of credit
LCD	–	liquid crystal display
LCDI	–	Low Carbon Development Initiative
LED	–	light-emitting diode
MME	–	Ministry of Mines and Energy
MNRE	–	Ministry of New and Renewable Energy
MOU	–	Memorandum of Understanding
NAMA	–	Nationally Appropriate Mitigation Action
NDCs	–	Nationally Determined Contributions
NDRC	–	National Development and Reform Commission
NZE	–	Net Zero Emission by 2050
OCR	–	ordinary capital resources
OECD	–	Organisation for Economic Co-operation and Development
O&M	–	operation and maintenance
P-DMC	–	Pacific developing member country
PPA	–	power purchase agreement
PPP	–	public–private partnership
PPP	–	purchasing power parity
PRC	–	People’s Republic of China
PREIF	–	Pacific Renewable Energy Investment Facility
PREP	–	Pacific Renewable Energy Program
PRG	–	partial risk guarantee
PSOD	–	Private Sector Operations Department
PV	–	photovoltaic
RBL	–	results-based lending
RCEP	–	Regional Economic Cooperation Partnership
RESCO	–	Renewable Energy Service Company
SCF	–	Strategic Climate Fund
SDG	–	Sustainable Development Goal
SDS	–	Sustainable Development Scenario
SEACEF	–	Southeast Asia Clean Energy Facility

SMEs	–	small and medium-sized enterprises
SPV	–	special purpose vehicle
SREP	–	Scaling Up Renewable Energy Program in Low Income Countries
TA	–	technical assistance
T&D	–	transmission and distribution
TLFF	–	Tropical Landscapes Finance Facility
TPES	–	total primary energy supply
TPP	–	Trans-Pacific Partnership
TTIP	–	Transatlantic Trade and Investment Partnership
USAID	–	United States Agency for International Development
VCS	–	Verified Carbon Standard

Weights and Measures

GW	–	gigawatt
kWh	–	kilowatt-hour
kWp	–	kilowatt-peak
MW	–	megawatt
TWh	–	terawatt-hour

About the Editors

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1 Introduction

The Asia and Pacific region is expected to play a crucial role in tackling climate change as it is responsible for about half of the current global carbon emissions. Many countries have already announced contributions toward implementing greenhouse gas mitigation under the Paris Climate Agreement. Major economies like Japan, the People's Republic of China, and the Republic of Korea have recently announced that they aim to achieve net zero emissions around the middle of this century, while several other countries in the region are considering similar targets.

Reducing emissions means transitioning to clean energy, a move that is also crucial for energy security and sustainable development. Fossil fuels meet 85% of energy needs in the region, with several countries heavily dependent on imports, rendering them economically vulnerable. One-tenth of the region's population, meanwhile, still lacks access to electricity, with many more people depending on traditional biomass for cooking and heating; many urban areas endure serious air pollution.

Huge additional investments and the mobilization of private finance are required to fund the required rapid shift to clean energy. The global and regional landscape for energy financing has evolved in recent years, with emerging new sources of finance, such as climate finance and carbon markets, alongside new instruments, like green bonds and new innovative risk mitigation measures. These developments offer opportunities for energy entrepreneurs, project developers, investors, and financing institutions. However, investment in clean energy, such as solar, wind, bioenergy, hydropower, and geothermal, along with energy efficiency projects, requires an adequate understanding of the risks, uncertainties, and challenges involved in financing both on the supply and demand sides. These projects are very different from conventional energy projects. Risks and challenges can vary not only by type of project but also by country. It therefore becomes crucially important to select an appropriate combination of financing instruments, risk mitigation measures, funding sources, and business models for the effective financing of each clean energy project. In many cases, innovative financing approaches may be required to address project-specific barriers and risks.

While countries in Asia and the Pacific are at varying levels of maturity in terms of clean energy development and financing, several examples of successful clean energy financing can be found in developing countries of the region. Multilateral development institutions like the Asian Development Bank (ADB) have also been actively engaged in clean energy development, and lessons learned can be valuable in helping identify appropriate financing mechanisms and business models for new project developments. No publication currently provides such information in the context of the developing countries in Asia and the Pacific.

This book aims to provide an up-to-date account of the financing approaches, policies, and business models available for the development of clean energy resources. These are complemented by appropriate examples of clean energy projects and programs from developing countries in the region. A variety of clean energy projects are covered, including distributed renewable energy systems, hydropower, and those focusing on demand-side energy efficiency. The book also discusses key barriers to financing clean energy development and innovative policies and measures adopted to overcome them in different country and project contexts.

This book is primarily intended to benefit the potential developers of, and investors in, clean energy projects, as well as financing institutions and policy makers in the region. The materials may also be useful to interested readers in academia and the research community.

The book is organized into two volumes. **Volume 1** contains four parts and Volume 2 contains two parts.

Volume 1, **Part 1** comprises **Chapter 2**, which presents an overview of how renewable energy resources—solar, wind, hydro, solid biomass, waste-to-energy, and geothermal—in different countries and subregions of Asia and the Pacific are currently used. It also presents the potential of renewable energy resources in selected countries, which illustrates significant prospects for their further development across the region. It discusses historical trends of overall energy intensity (i.e., energy use per unit of gross domestic product) of different countries, as well as the specific energy consumption of major sectors in selected countries. The chapter presents historical patterns of investment in renewable energy and discusses prospects for renewable energy development under future low-carbon development scenarios and their investment implications. In view of some major countries in the region already setting targets for net zero emissions by around 2050, and others considering such goals, this chapter discusses the key implications of meeting these targets. Furthermore, the chapter provides an overview of clean energy policies promoting renewable energy and energy efficiency in various countries.

Part 2, encompassing three chapters, focuses on the role of multilateral development banks, like ADB, and other public institutions in leveraging their funds to mobilize private sector finance for clean energy development. **Chapter 3** discusses different initiatives and investments that ADB has undertaken to assist its developing member countries in clean energy transitions. It discusses ADB's financing targets, funding sources, and financing modalities for clean energy. The chapter also discusses prospects for clean energy financing with ADB strategies like promoting clean energy uptake through a multisectoral approach, using appropriate business models to make clean energy more viable and affordable, providing modern energy access to all, advancing technology to improve energy efficiency, and strengthening infrastructures and equipment for better renewable reliability and resilience. The chapter includes an interesting discussion on ADB's financial resources mobilization through the issuance of green bonds. It also looks at the role played by the bank in mobilizing private capital to finance clean energy projects through syndicated loans (or B loans) from commercial banks.

Chapter 4 discusses attracting more private financing in the renewable energy sector in ADB developing member countries in the Pacific under its Pacific Renewable Energy Program. It describes the role of the program, particularly its credit enhancement mechanism, in encouraging private sector investment in renewable energy power generation projects, and in hedging against the key risks associated with these projects though instruments like partial risk guarantees and letters of credit. The chapter also presents the key barriers to developing renewable energy in these countries.

Chapter 5 showcases the approach and experience of the Green Financing Platform (GFP) project initiated by ADB for accelerating air quality improvement in the Greater Beijing–Tianjin–Hebei Region, one of the most heavily polluted regions in the People's Republic of China. The chapter describes the design and implementation approaches of the GFP project and highlights lessons learned from the successful implementation of the project. An innovative aspect of the GFP project involves the use of public financing instruments, such as cofinancing, guaranties, and intermediary loans, to leverage private capital into clean energy projects helping to reduce air pollution and carbon emissions.

Part 3 comprises four chapters discussing clean energy financing approaches at selected subregional or country levels.

Chapter 6 looks at clean energy financing in Association of Southeast Asian Nations (ASEAN) members. It discusses estimated investment needs to meet the regional group's targets for renewable energy and energy intensity by 2025, as well as financing gaps. Furthermore, it describes prevailing sources of finance and financing schemes. It presents an outlook for regional cooperation in energy financing, discusses the barriers to improve clean energy financing in the region, and presents key policy financing instruments adopted and success stories in ASEAN member states. It highlights the diversity of members in terms of the maturity of their clean energy markets and financing. The dominance of public financing in clean energy investments in ASEAN, and the inadequate understanding of domestic banks about green investment markets and credit risks associated with clean energy investments, are further highlighted in the chapter.

Chapter 7 presents the case of developing Southeast Asia's first large-scale national solar park project in Cambodia, through a public–private partnership (PPP). It discusses the instrumental role played by ADB, which is providing end-to-end support to the government and national power utility of Cambodia. ADB provided financial and technical assistance throughout the development and construction phases of the project in multiple ways, including helping the utility design and conduct a competitive tender for procuring the first 60-megawatt solar power plant from the private sector within the park. It also discusses ADB's role in the government's adoption of an open and transparent competitive bidding process, which resulted in a low power purchase agreement tariff. In addition, the chapter presents the key factors behind the successful design and implementation of the project, and highlights the structure adopted to allocate risks and accountability among the project's key stakeholders.

Chapter 8 deals exclusively with distributed renewable energy systems, which are very important for providing energy access to people in remote and isolated areas. The chapter initially looks at distributed renewable energy technologies and the role different systems play in providing energy access. The major focus of the chapter however is on the four common types of business models for distributed energy systems that are typically based on the proponent of the project: (i) community-led; (ii) private sector-led; (iii) utility-led; and (iv) a combination of the three, i.e., a hybrid or multiparty business model that includes a public–private–people partnership model. The chapter discusses a set of criteria that provides a basis for choosing and designing an appropriate business model. It also examines a practical application of the public–private–people partnership model in the case of the distributed renewable energy system in Malalison Island, the Philippines. The Malalison Island case study highlights the role of ADB grants in catalyzing private sector investment in providing energy access to people in isolated areas through distributed renewable energy systems.

Chapter 9 analyzes policies and measures adopted by the People's Republic of China to promote clean energy development in different stages of the country's development, and their impact on investment. The chapter discusses the evolution of Chinese clean energy policies, from one based on government-push (i.e., government-led) before 2016 to the market-oriented approach thereafter. It assesses the performance of clean energy policies and discusses the investment implications of clean energy policies, lessons learned, and ways to meet the challenge of carbon neutrality.

Across two chapters, **Part 4** deals with two highly important aspects of large-scale, low-carbon energy transition: the mobilization of private sector finance for clean energy and carbon finance. **Chapter 10** discusses the innovative private financial instruments necessary for a low-carbon transition in ASEAN member countries and East Asia. It identifies barriers to the upscaling of private investment for a low-carbon transition, based on a review of recent developments in private financing as well as stakeholder surveys. A major message of the chapter is that regionally coordinated policy solutions could unleash the private financing needed to support a clean energy transition.

Chapter 11 discusses the role of carbon trading in clean energy financing. It includes reviews of current international carbon markets as well as existing and emerging domestic carbon markets in Asia and the Pacific. The critical elements of a carbon market that affect clean energy investment and financing are also discussed. Furthermore, the chapter analyzes the indicators of carbon markets related to clean energy financing—like the number of eligible emissions-reduction projects, certified emissions reductions, and carbon price—and assesses the impact of existing carbon markets on clean energy investment and financing. Key factors that would enhance the role of the carbon market in clean energy financing are examined.

Volume 2 of the book, which is under preparation, contains **Parts 5 and 6**.

Part 5 has three chapters dealing with the approaches and practices of clean energy financing. **Chapter 12** focuses on different options for financing clean energy in general, and renewable energy in particular. The chapter reviews the literature on the public sources of finance, including climate finance, and domestic sources, including private sources. The chapter also presents alternative and innovative instruments used for financing clean energy investments. It discusses barriers to clean energy financing in two categories: barriers associated with the adverse business environment due to the coronavirus disease (COVID-19), and those associated with the nature of clean energy investment projects. It also describes risk mitigation measures. Four cases of energy financing experiences from developing countries in Asia and the Pacific are included.

Chapter 13 focuses on financing hydropower projects and discusses the role of hydropower in the context of climate change mitigation. It describes the evolution of hydropower finance, from public sector financing, through to PPPs, private sector project financing, and the new bilateral financing mechanism. Variants of financing models are presented with examples of relevant hydropower projects from Asia and the Pacific. The chapter presents an overview of climate financing used for hydropower and factors behind the relatively low access of hydropower projects to climate finance at present. It also discusses the opportunities and challenges for developing hydropower.

Chapter 14 is dedicated to approaches of financing demand-side energy efficiency projects or programs. It presents a rich discussion on different mechanisms for financing energy efficiency projects and their implementation modalities and institutional frameworks at the conceptual level. It also discusses key factors that need to be considered for the selection of appropriate financing mechanisms. The chapter presents specific country-level examples of energy efficiency financing options and identifies what is needed to achieve energy efficiency market transformation at scale, highlighting the enhanced relevance of energy efficiency in a COVID-recovery context.

Part 6 consists of chapters focused on policies and strategies adopted to develop specific clean energy resources in selected countries of South Asia. **Chapter 15** discusses the innovative policies, financing mechanisms, and institutional setups that helped the development of solar energy. It describes the development of large solar parks in India (i.e., Charanka Solar Park in Gujarat and Bhadla Solar Park in Rajasthan). Also discussed are innovative policies and financing mechanisms, such as the Partial Risk Guarantee Fund for Energy Efficiency and the Venture Capital Fund for Energy Efficiency and Partial Risk Sharing Facility, as well as measures to mitigate interconnection risks that create enabling conditions for private sector participation. The successful implementation of several energy efficiency projects is discussed, as is the role of institutions like Energy Efficiency Services Limited in reducing energy efficiency project costs by taking performance risks and bulk procurements.

Chapter 16 examines solar power financing in Bangladesh. It includes a review of the status of renewable energy development in the country, and discusses policies for solar power development, including financial incentives for renewable energy development. Financial interventions and mechanisms for solar power development in the country are also discussed, while the chapter identifies key barriers to the development of renewable energy and suggests some measures to overcome them.

The book's final chapter reviews the policies, strategies, and financing mechanisms adopted by Sri Lanka to develop renewables-based power generation. It presents the evolution of renewable energy development in the country and discusses energy sector policies, regulatory/institutional frameworks, and innovative measures introduced to promote renewable energy. Furthermore, the chapter discusses sources of financing and risks associated with the financing of renewable energy projects. Key lessons learned during the country's renewable energy development, which could be useful for other developing countries, are also presented.

PART 1

Role of Clean Energy in Asia and the Pacific

2 Clean Energy Resources, Utilization, Investments, and Prospects in Asia

Ram M. Shrestha

Introduction

Countries in the Asia and Pacific region are expected to play a major role in addressing the global problem of climate change as the region is responsible for a large share of greenhouse gas (GHG) emissions. Countries in the region have made declarations on their Nationally Determined Contributions (NDCs) to reduce GHGs following the Paris Agreement on climate change. That most countries in the region depend heavily on fossil fuels for energy supply presents a challenge to their local and regional environmental sustainability and national energy security. Further, a significant population in the region (especially in South Asia) lack access to electricity supply and clean energy for cooking and heating. As such, governments have set targets to provide clean energy for all by 2030 as a part of their Sustainable Development Goals (SDGs). Clean energy provision, therefore, forms a crucial solution to meet the SDGs, the GHG mitigation targets under the Paris Agreement, and to address the issues of environmental sustainability and energy security.

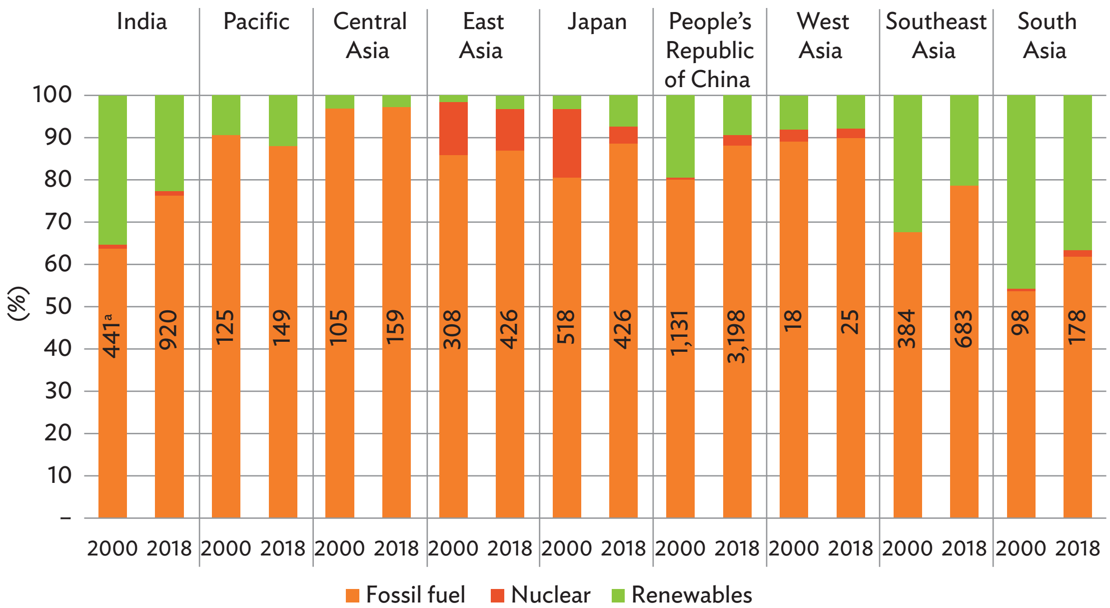
This chapter discusses the status of energy utilization and the share of renewable energy sources in total energy supply, and the possible future role of renewable energy in the medium and long term. It also discusses the potential of renewable energy sources and compares them with the present level of utilization of renewable energy in the countries, with a view to harnessing this in the future. The chapter also presents the evolution of energy intensities. It briefly discusses the investment needs for clean energy development, policies adopted toward such development, and the prospects for clean energy development.

Primary Energy Supply and Role of Renewable Energy

This section discusses how the primary energy supply has changed in different subregions of Asia and the Pacific during 2000–2018.[1] The role of renewable energy during the period is also discussed in terms of their share in total primary energy supply (TPES). TPES in the Asia and Pacific region has grown at a compound

[1] In this section, the Asia and Pacific region has been divided into subregions as follows: South Asia: Bangladesh, Nepal, Pakistan, and Sri Lanka; Pacific: Australia and New Zealand; East Asia: Hong Kong, China; Mongolia; the Democratic People's Republic of Korea; the Republic of Korea; and Taipei,China; Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam; Central Asia: Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan; West Asia: Armenia, Azerbaijan, and Georgia. The People's Republic of China (PRC), India, and Japan are treated individually.

Figure 1: Total Primary Energy Supply of the Asia and Pacific Region, 2000 and 2018
(Mtoe)



Mtoe = million tons of oil equivalent.

[a] Numbers in bar graph represent total primary energy supply.

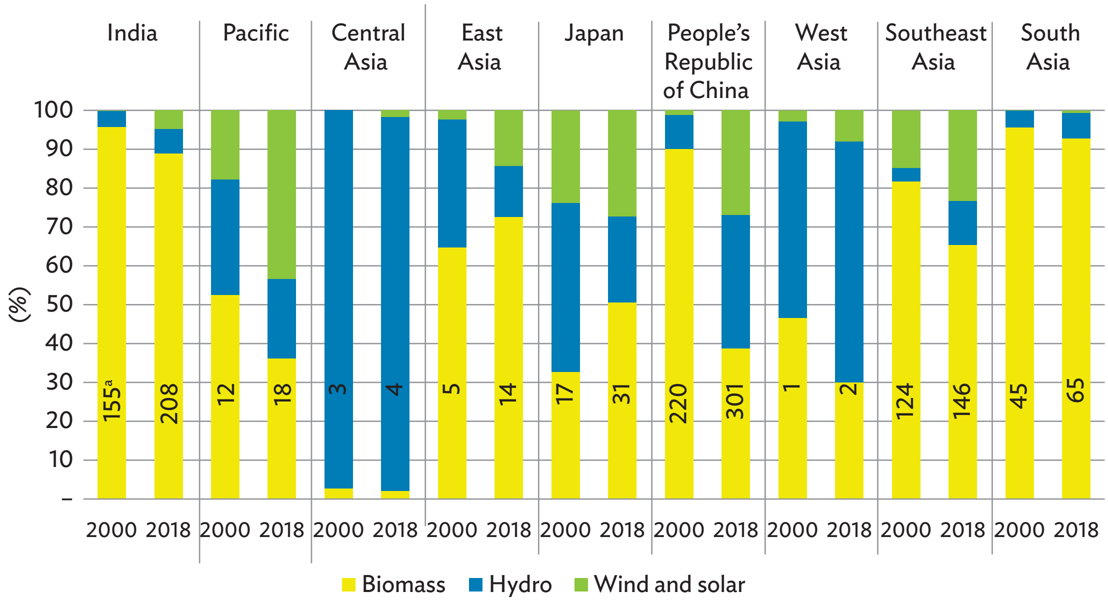
Source: Author based on the data in International Energy Agency (IEA). 2020. *IEA Online Database*. Paris: IEA (accessed 22 February 2021).

annual growth rate (CAGR) of almost 4% during 2000–2018. The growth of TPES varies widely across the countries in the region: It was declining at the CAGR of 1% in Japan and increasing at 6% in the People's Republic of China (PRC).

Figure 1 shows the TPES for the Asia and Pacific region. Except for Japan, all other countries and subregions experienced a rise in TPES in 2018 compared to that in 2000. In the PRC, TPES increased at CAGR of 6% during 2000–2017. This was followed by India (4.2%), South Asia (3.4%), Southeast Asia (3.3%), Central Asia (2.3%), East Asia (1.8%), West Asia (1.7%), and the Pacific (1.0%). In the case of Japan, TPES decreased by almost 18% in 2018 compared to 2000. The figure also shows a decreasing share of renewable energy in TPES during 2000–2018 in the Asia and Pacific countries and subregions except Japan, the Pacific, and East Asia. There was an increase in the share of renewable energy from 3% to 7% in Japan, 9% to 12% in the Pacific, and 2% to 3% in East Asia during 2000–2017.

Figure 2 shows the mix in different countries and subregions between 2000 and 2018. It shows a decreasing share of bioenergy in Asia and the Pacific except Japan (and East Asia) and an increasing share in the use of solar and wind energies in almost all countries and subregions.

Figure 2: Renewable Energy Supply Mix in Countries and Subregions of the Asia and Pacific Region, 2000 and 2018 (Mtoe)



Mtoe = million tons of oil equivalent.

[a] Numbers in bar graph represent total primary renewable energy supply.

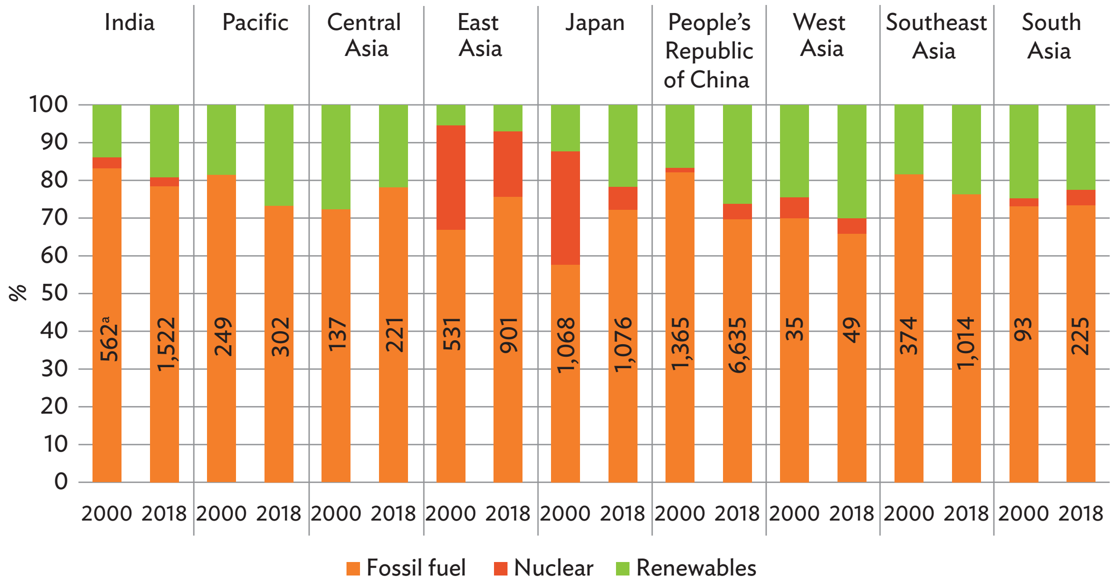
Source: Author based on the data in International Energy Agency (IEA). 2020. *IEA Online Database*. Paris: IEA (accessed 22 February 2021).

Role of Renewable Energy and Electricity in Different Sectors

In this section, the role of renewable energy in power generation and final demand sectors like industry, transport, and buildings are discussed.

Figure 3 shows the changing role of renewables in electricity generation. The share of renewables in electricity generation had increased for almost all countries and subregions, except for Central Asia and South Asia. The share of electricity generation from renewables increased from 17% in 2000 to 26% in 2018 in the PRC, and from 12% to 22% in Japan. In other countries and subregions, the share increased from 18% to 27% in the Pacific, 18% to 24% in South East Asia, 24% to 30% in West Asia, 14% to 19% in India, and 5% to 7% in East Asia. In South Asia, the share decreased from 25% in 2000 to 22% in 2017 mainly due to increased coal consumption for electricity production in Pakistan and Sri Lanka.

Figure 3: Total Electricity Generated by Different Fuels in Asia and the Pacific, 2000 and 2018
(TWh)



TWh = terawatt-hour.

[a] Numbers in bar graph represent total electricity generated.

Source: Author based on the data in International Energy Agency (IEA). 2020. *IEA Online Database*. Paris: IEA (accessed 22 February 2021).

Table 1 shows the energy mix (expressed in fuel shares) in final demand sectors of different subregions and countries of the Asia and Pacific region. In the industry sector, while all the countries or subregions have experienced an increment in the share of electricity during 2000–2018, the rate of industry electrification was most rapid in East Asia, including the PRC. The share of fossil fuels had decreased during the period in the Asia and Pacific region except for India, South Asia, and Southeast Asia. The share of other renewables (i.e., solar, wind, and bioenergy) was negligible or nil in the industry sector in all parts of Asia and the Pacific.

The transport sector has been increasingly electrified during 2000–2018 in East Asia, Japan, the PRC, Pacific, and Southeast Asia in that the share of electricity in the total energy consumption of the sector had increased in these countries and subregions. The use of biofuels in the sector, although very small (mostly around 1% of the sector's total energy consumption in 2018), seems to be taking place in most subregions of Asia and the Pacific. The biofuel share was significant (4%) only in Southeast Asia.

In the buildings sector, the share of electricity had increased during 2000–2018 in all countries and subregions except West Asia, with the share of electricity in 2018 varying from 13% in South Asia (excluding India) to 56% in East Asia and 61% in the Pacific. The share of bioenergy (i.e., biofuels and waste) had decreased in all parts of the region except in East Asia and Japan, where the share of biofuels had increased slightly. The share of other renewables in 2018 was below 2% or negligible in the region except in the PRC where the share was 8%.

Table 1: Sectoral Final Energy Consumption: Shares of Different Fuels in Asia and the Pacific, 2000 and 2018 (%)

Country/ Region	Sector	2000				2018			
		Fossil Fuel	Other Renewables[a]	Biofuels and Waste[b]	Electricity	Fossil Fuel	Other Renewables	Biofuels and Waste	Electricity
India	Industry	53	–	31	16	64	–	16	20
	Transport	98	–	–	2	97	–	1	2
	Buildings[c]	15	–	79	6	21	–	61	18
Pacific	Industry	60	–	12	28	57	–	14	29
	Transport	99	–	–	1	99	–	–	1
	Buildings	30	1	12	57	31	2	6	61
Central Asia	Industry	75	–	–	25	71	–	–	29
	Transport	97	–	–	3	97	–	–	3
	Buildings	92	–	–	8	85	–	–	15
East Asia	Industry	67	–	2	31	45	–	4	51
	Transport	99	–	–	1	98	–	1	1
	Buildings	60	–	1	39	41	1	2	56
Japan	Industry	63	–	3	34	59	–	5	36
	Transport	98	–	–	2	97	–	1	2
	Buildings	53	1	–	46	43	–	2	55
People's Republic of China	Industry	79	–	–	21	65	–	–	35
	Transport	98	–	–	2	95	–	1	4
	Buildings	26	1	67	6	44	8	19	29
West Asia	Industry	88	–	2	10	62	–	3	35
	Transport	95	–	–	5	99	–	–	1
	Buildings	50	–	13	37	61	2	6	31
Southeast Asia	Industry	60	–	24	16	60	–	16	24
	Transport	100	–	–	–	96	–	4	–
	Buildings	17	–	69	14	20	–	40	40
South Asia	Industry	61	–	26	13	67	–	16	17
	Transport	100	–	–	–	100	–	–	–
	Buildings	13	–	80	7	18	–	69	13

– = zero or negligible value. Figures also represent rounded numbers.

[a] Other renewables includes solar photovoltaic, solar thermal, tide, wind, and other renewable resources.

[b] Biofuels and waste include industrial waste, municipal waste (renewable and nonrenewable), primary solid biofuels, biogases, biogasoline, biodiesels, other liquid biofuels, non-specified primary biofuels, and waste and charcoal.

[c] Buildings includes residential as well as commercial and public services.

Source: International Energy Agency (IEA). 2020. *IEA Online Database*. Paris: IEA (accessed 22 February 2021).

Renewable Energy Resources Potential and Utilization

To determine the future role of renewable energy, it is important to understand the potential of available renewable energy resources as well as the level of their present utilization. To that end, information on resource potential of different renewable energy sources (i.e., solar, wind, solid biomass, waste-to-energy resources, hydropower, and geothermal) are compiled in this section and are compared with the present utilization of the respective resources in terms of power generation capacity installed and energy production. There are different notions of the resource potential, i.e., theoretical, technical, economic, exploitable, market, etc. However, there is a noticeable gap in the information available on the potential of different renewable energy resources for countries in the Asia and Pacific region. Often, different notions of the potential appear to have been used in various published sources without a clear definition of the terms. While economic and technical potential would be more useful notions for the present study, this information is not uniformly available for all countries. Therefore, the compiled information on the potential is nonuniform as different types of potential are included depending on the nature of available data. The discussion of individual renewable energy resources and their present utilization follows next.

Solar energy. During 2010–2018, solar electricity production in Asia registered a very high growth. It increased by fifty-four-fold, i.e., from over 5.3 terawatt-hours (TWh) in 2010 to over 292 TWh in 2018. During the same period, the global production of solar electricity increased by only sixteen-fold.[2] Moreover, Asia accounted for more than half of total solar electricity production in the world in 2018. The PRC alone contributed nearly 84% of the installed photovoltaic (PV) capacity and over 60% of solar PV-based electricity production in Asia in 2018.

Table 2 presents the range of theoretical potential of solar energy (in TWh) in selected countries that are calculated for the present study using the information on land area available and global horizontal irradiance (GHI).[3] The land area considered for calculating the potential in the table excludes land with identifiable physical obstacles to utility scale photovoltaic plants. It also excludes the land that is possibly under land use regulations due to nature and cropland protection.[4] Note that the range of the potential has been calculated by using the country-specific minimum and maximum values of GHI.[5] The values of the theoretical potential shown in the table should be considered as indicative of the order of magnitude of the potential and not the definitive figures. The table also shows the values of practical (or "technical") potential expressed in terms of kilowatt-hour/kilowatt-peak (kWh/kW_{peak}) of solar power capacity and the present level of utilization of the solar PV-based electricity production in 2018. As can be seen from the table, the present utilization as a percentage of the minimum potential varies from 0.01% in Indonesia, Kazakhstan, the Lao People's Democratic Republic (Lao PDR), and Myanmar to 35.36% in Japan. Similarly, the present utilization as a percentage of the maximum potential varies from 0.01% in Cambodia, Indonesia, Kazakhstan, the Lao PDR, and Myanmar to 24.97% in Japan. This indicates that there remains a significant unutilized solar potential for future development in the region.

2 International Renewable Energy Agency (IRENA). 2020. *Renewable Energy Statistics 2020*. Abu Dhabi: IRENA.

3 Energy Sector Management Assistance Program (ESMAP). 2020. *Global Photovoltaic Power Potential by Country*. Washington, DC: World Bank. ESMAP (2020) defines the "theoretical potential" as the resource potential "characterized by the amount of energy physically available, without considering any constraints or a particular PV system" and the "practical (or technical) potential" as the potential "characterized by the annual average of PV power production, taking into account the theoretical potential, real-world PV system performance, and configuration, as well as topographic and land-use constraints." In Table 2, the theoretical potential with land constraints is calculated as a product (multiplication) of the area of country's land available after considering land use constraints and "global horizontal irradiance" (GHI) (kWh/m^2).

4 This corresponds to the "Level 2" land area defined under the "practical potential" in ESMAP (2020) (see footnote 3 for the source). Note also that the land area considered is the "evaluated area" by the ESMAP study, which is less than the total land area.

5 Footnote 3.

Table 2: Solar Energy Potential and Utilization in Selected Countries

	Theoretical Potential Considering Land Use Constraints (TWh)	Average Technical Potential (kWh/kW_p) (ESMAP, 2020)	Utilization, TWh (2018) (IRENA, 2020)
Australia	4,465–7,346	4.71	9.92
Bangladesh	119–136	3.88	0.27
Cambodia	246–301	4.13	0.04
People's Republic of China	7,997–17,481	3.88	178.06
India	3,195–4,363	4.32	30.70
Indonesia	1,767–2,659	3.77	0.12
Japan	177–251	3.45	62.66
Kazakhstan	3,601–5,325	3.69	0.38
Republic of Korea	71–80	3.82	9.20
Lao People's Democratic Republic	220–291	3.87	0.02
Malaysia	305–374	3.74	0.44
Myanmar	709–891	4.14	0.07
Nepal	66–98	4.00	0.07
New Zealand	318–439	3.68	0.09
Pakistan	1,404–2,075	4.71	1.54
Philippines	270–370	3.93	1.25
Sri Lanka	80–99	4.21	0.14
Thailand	374–434	4.06	4.5
Viet Nam	281– 476	3.55	0.10

kWh/kWp = kilowatt-hour/kilowatt-peak, TWh = terawatt-hour. Figures on the theoretical potential in the second column are the author's estimates using data from ESMAP (2020).

Sources:
Energy System Management Assistance Program (ESMAP). 2020. *Global Photovoltaic Power Potential by Country*. Washington, DC: The World Bank.
International Renewable Energy Agency (IRENA). 2020. *Renewable Energy Statistics 2020.* Abu Dhabi.

Wind energy. According to IRENA,[6] total wind electricity production (onshore and offshore) in Asia experienced over fivefold increase during 2010–2018, i.e., from 71 TWh in 2010 to 440 TWh in 2018. The available data on wind energy potential of the region are mostly inadequate and indicative. The wind resource potential in terms of its electrical power capacity (in gigawatt [GW]) and energy production (in TWh/year) of selected countries are shown in Table 3. The table also shows the level of wind power capacity (in megawatt [MW]) installed in 2019 and wind electricity production (in gigawatt-hour [GWh]) in 2018. These data indicate that several countries in the region have a large untapped wind resource for low-carbon energy development in the future.

[6] Footnote 2.

Table 3: Wind Energy Potential and Utilization in Selected Countries

	Potential			Utilization (Source: IRENA, 2020)	
	Capacity, GW	Production, TWh/year	Source	Installed Capacity, MW (2019)	Production, GWh (2018)
Australia	Onshore: 880[a] Offshore: 660[a]	3,100[b] 3,100[b]	Teske et al. (2016)	7,133	31,848
Bangladesh	30[b]	NA	Tetra Tech ES (2020)	3	5
Cambodia	65[d]	154.83[d]	Lahmeyer International (2015)	–	–
People's Republic of China	NA	7,644[c]–24,700[d]	Liu et al. (2011)	210,478	366,452
India	302[e]	NA	MNRE (2021e)	37,505	55,009
Indonesia	9	NA	ADB (2016)	76	6
Japan	NA	NA		3,786	7,481
Republic of Korea	NA	NA	Hong et al. (2019)	1,512	2,465
Lao People's Democratic Republic	116[c,f]	135[c,f]	Lee et al. (2018)	–	–
Myanmar	33.83[d]	79.5[d]	Lahmeyer International (2015)	–	–
New Zealand		51[g]/42[h]/34[i]	Kelly (2011)	689	2,068
Pakistan	12.76[c]	34[c]	Farooq and Kumar (2013)	1,236	2,651
Philippines	NA	NA		427	1,153
Sri Lanka	24[d]	NA	Young and Vilhauer (2003)	128	326
Thailand	380.98[d]	899.57[d]	Lahmeyer International (2015)	1,507	1,641
Viet Nam	26.76[d]	64.35[d]	Lahmeyer International (2015)	375	310

– = zero or negligible value, ADB = Asian Development Bank, GW = gigawatt, IRENA = International Renewable Energy Agency, MNRE = Ministry of New and Renewable Energy, NA = not available, TWh = terawatt-hour.

Potential figures represent rounded numbers.

[a] Maximum installable potential.
[b] Maximum recoverable potential.
[c] Technical potential.
[d] Theoretical potential.
[e] Gross potential at 100 meters above ground level.
[f] Technical potential at 100-meter hub considering various exclusions.
[g, h, i] Potential of projects at average capacity factor of 45%, 35%, and 30%, respectively.

Sources: Compiled by the author.

Hydropower. Hydropower represents the largest source of electricity based on renewable energy accounting for 67% of total renewable energy-based electricity production in Asia in 2018. Hydropower production in Asia was 1,772 TWh in 2018, i.e., a 50% increase from its 2010 level.[7] Table 4 presents the hydropower potential in selected countries of Asia and the Pacific along with the present state of utilization of the resource. Note that available information on the potential are not of similar type: technical potential is reported for some countries, while theoretical potential, economic potential, and exploitable potential are reported for other countries.[8] As can be seen from the table, in many countries, the exploitable hydropower potential is substantially higher than the present level of utilization of the resource, suggesting that there still remains a significant development potential in those countries.

Table 4: Hydropower Potential and Utilization in Selected Countries

	Potential			Exploitable Potential (Source: Zhou et al., 2015)	Utilization in 2019 (Source: IHA, 2020)	
	GW	TWh/year	Source	TWh/year	Installed Capacity,[a] MW	Production, TWh
Australia	8[b]	12[c]	Teske et al. (2016)	36	8,790	14
Bhutan	23.7[f]	NA	IHA (2017a)	48	2,326	9
Cambodia	10[d]	NA	ADB (2018)	NA	1,330	4
People's Republic of China	542[d]–694[e]	2,474[d]–6,083[e]	Liu et al. (2011)	2,329	356,400	1,302
India	21.13[d] (Small hydro)/ 145[d]	NA	MNRE (2020c)/MOP (2021)	387	50,071	162
Indonesia	75[e]/34[g]	NA	Tang et al. (2019)	477	5,886	17
Japan	NA	NA		40	49,905	87
Lao People's Democratic Republic	26.5[e]		IHA (2016)	77	7,200	20
Malaysia	22.5[d]	414[e]	Tang et al. (2019)	155	6,174	16
Myanmar	39.7[d]	NA	Tang et al. (2019)	347	3,331	11
Nepal	42[f]	NA	ADB (2017)	105	1,127	4
New Zealand	1.3[h]	NA	Kelly (2011)	115	5,354	25
Pakistan	60[d]	NA	IHA (2017b)	108	9,827	35
Philippines	13.1[i]	NA	DOE (2021)	24	4,385	10

continued on next page

[7] Footnote 2.

[8] See Zhou et al. (2015) for the definition of the different concepts of hydropower potential; Zhou Y., M. Hejazi, S. Smith S., J. Edmonds, H. Li, L. Clarke, K. Calvin, and A. Thomson. 2015. A Comprehensive View of Global Potential for Hydro-Generated Electricity. *Energy & Environmental Science*. 8: pp. 2622–2633.

Table 4 *continued*

	Potential			Exploitable Potential (Source: Zhou et al., 2015)	Utilization in 2019 (Source: IHA, 2020)	
	GW	TWh/year	Source	TWh/year	Installed Capacity,[a] MW	Production, TWh
Sri Lanka	2[f]	NA	Shrestha et al. (2013)	NA	1,719	5
Thailand	15.1[e]	100[d]	Tang et al. (2019)	55	4,510	6
Viet Nam	35[d] (19 to 21)[f]	NA	IHA (2014)	45	16,759	52

ADB = Asian Development Bank, DOE = Department of Energy, GW = gigawatt, IHA = International Hydropower Association, MNRE = Ministry of New and Renewable Energy, MOP = Ministry of Power, MW = megawatt, NA = not available, TWh = terawatt-hour, TWh/year = terawatt-hour per year.

[a] Including pumped storage capacity.
[b] Maximum installable potential.
[c] Maximum recoverable potential.
[d] Technical potential.
[e] Theoretical potential.
[f] Economic potential.
[g] Exploitable potential.
[h] Potential for additional development.
[i] Untapped potential.

Sources: Compiled by the author.

Solid biomass. Bioenergy resource exist in different forms, i.e., solid biomass (fuelwood, agricultural residues, and animal waste), renewable municipal waste, liquid biofuels, and others. Bioenergy as a whole accounted for 6% of the total renewable energy-based electricity generation in Asia in 2018.[9] Table 5 presents the present installed capacity and production of electricity based on solid biomass resource (excluding, bagasse, renewable municipal waste, and animal waste) in selected countries of Asia and the Pacific. It also presents the potential for power (capacity) and energy generation from such solid biomass resource in the countries. The table indicates that there remains significant unexploited potential for power generation based on the resource in the region.

Table 5: Potential and Utilization of Solid Biomass Energy in Selected Countries

	Potential			Utilization (Source: IRENA, 2020)	
	Capacity, GW	Production, TWh/year	Source	Installed Capacity, MW (2019)	Production, GWh (2018)
Australia	16[a]	108[b]	Teske et al. (2016)	174	1,148
Cambodia	NA	15[c]	Lahmeyer International (2015)	13	11
People's Republic of China	NA	13,553 PJ (in 2020)[d] 22,150 PJ (in 2050)[d]	Liu et al. (2011)	9,729	40,833

continued on next page

[9] Footnote 2.

Table 5 *continued*

	Potential			Utilization (Source: IRENA, 2020)	
	Capacity, GW	Production, TWh/year	Source	Installed Capacity, MW (2019)	Production, GWh (2018)
India	18[f]	120–150 million metric tons per year[e]	MNRE (2020a)	10,046	17,781
Indonesia	50.0	470 million GJ per year	Tun et al. (2019)	1,582	9,094
Japan	NA	NA		2,261	21,095
Republic of Korea		230	Hong et al. (2019)	764	5,231
Lao People's Democratic Republic		6.4[c]	Lahmeyer International (2015)	–	–
Malaysia	NA	NA		774	1,508
Myanmar	NA	60[c]	Lahmeyer International (2015)	3	20
New Zealand	NA	NA		75	309
Pakistan[f]	2.49 (2030) 3.69 (2050)	14.18 (2030) 21.00 (2050)	Farooq and Kumar (2013)	51	179
Thailand	NA	200[c]	Lahmeyer International (2015)	3,410	26,258
Viet Nam	NA	84.8[c]	Lahmeyer International (2015)	11	39

– = zero or negligible value, GJ = gigajoule, GW = gigawatt, GWh = gigawatt-hour, MNRE = Ministry of New and Renewable Energy, MW = megawatt, NA = not available, PJ = petajoule, TWh = terawatt-hour.

[a] Maximum installable potential.
[b] Maximum recoverable potential.
[c] Theoretical potential of agricultural residues.
[d] Exploitable biomass potential of straw, wood, and energy crops.
[e] Surplus biomass availability per year.

Sources: Compiled by the author.

Waste to energy. Biomass waste including bagasse, biogas (mainly from animal waste), and renewable municipal waste is also considered a significant resource for energy production in several countries of Asia and the Pacific. Biomass waste of different kinds contributed to about a quarter of bioenergy-based electricity production in Asia in 2018.[10] Table 6 presents the potential of these biomass waste to produce energy in selected countries along with the level of installed capacity in 2019 and electricity production in 2018. Note, however, that the potential animal waste and municipal waste is a dynamic concept as it can vary with the economic growth and urbanization. As the table shows, only a small fraction of the potential has been presently harnessed to produce electricity in these countries—indicating significant opportunities to develop these energy resources.

[10] Footnote 2.

Table 6: Waste-to-Energy Potential and Utilization in Selected Countries

	Potential			Utilization (Source: IRENA, 2020)	
	GW	TWh/year	Source	Installed Capacity, MW (2019)	Production, GWh (2018)
Australia	NA	NA		701	2,370
Bangladesh	NA	251.56[a]	Hossen et al. (2017)	5	2
Cambodia	NA	4.96[b]	Lahmeyer International (2015)	38	66
People's Republic of China	NA	2,428 PJ[c]–5,971 PJ[d]	Liu et al. (2011)	6,808	26,468
India	5.69[e]	NA	MNRE (2020d)	181	217
Indonesia	2.6[f]	NA	Goembira (n.d.)	259	495
Japan	NA	NA		936	1,982
Republic of Korea	14	122	Hong et al. (2019)	450	731
Lao People's Democratic Republic	NA	3.12[c]	Lahmeyer International (2015)	40	46
Pakistan[g]	3.5 (2030) 6.1 (2050)	20.0 (2030) 34.6 (2050)	Farooq and Kumar (2013)	381	2,846
Thailand	NA	2.5[b]-18.8[h]	Lahmeyer International (2015)	848	2,447
Viet Nam	NA	32.84[b]	Lahmeyer International (2015)	369	402

GW = gigawatt, GWh = gigawatt-hour, MNRE = Ministry of New and Renewable Energy, MW = megawatt, NA = not available, n.d. = not dated, TWh = terawatt-hour.

[a] Theoretical potential of animal waste and municipal solid waste.

[b] Technical potential of biogas production (yearly value derived based on the estimated daily potential in the original source).

[c, d] Exploitable potential of municipal waste and biogas energy in 2020 and 2050, respectively.

[e] Technical potential.

[f] Total of municipal solid waste and cow dung potential.

[g] Technical potential of electricity generation of animal waste and municipal solid waste.

[h] Theoretical of potential biogas production (yearly value derived based on the estimated daily potential in the original source).

Sources: Compiled by the author.

Geothermal energy. Production of geothermal energy in Asia was 26 TWh in 2018 while the total installed power generation capacity of geothermal in the region was 4,584 MW. Table 7 presents the level of present utilization of geothermal energy along with the resource potential in selected countries. Indonesia is reported to have a plan to increase its geothermal power generation capacity to 5 GW by 2025[11] while the Philippines has a target to have its geothermal capacity to 3,200 MW by 2030.[12]

[11] ADB. 2018. *Developing Indonesia's Geothermal Power Potential*. Manila.

[12] Richter, A. 2020. Geothermal in the Philippines—An Urgent Revamp of Targets and Development Needed. *Asean Post*. 18 June.

Table 7: Geothermal Energy Potential and Utilization in Selected Countries

	Technical Potential			Utilization (2018) (Source: IRENA, 2020)	
	GW	TWh/year	Source	Installed Capacity, MW	Production, GWh
People's Republic of China	NA	1,000 PJ[a]	Liu et al. (2011)	26	144
India	10	NA	MNRE (2020b)	—	—
Indonesia	28	NA	ADB (2016)	1,946	13,296
Japan	23	NA	JOGMEC (2021)	482	2,457
New Zealand	3.6	NA	Kelly (2011)	941	7,815
Philippines	4.4	NA	Halcon (2015)	1,928	10,435

— = zero or negligible value; ADB = Asian Development Bank; GW = gigawatt; GWh = gigawatt-hour; JOGMEC = Japan Oil, Gas, and Metals National Corporation; MNRE = Ministry of New and Renewable Energy; MW = megawatt; NA = not available; TWh = terawatt-hour.

[a] Exploitable potential.

Sources: Compiled by the author.

Energy Efficiency

This section discusses the evolution of energy intensities of different countries and subregions and the sectoral energy efficiency indicators of few selected countries where such information are accessible.

Energy Intensity in the Asia and Pacific Region

Figure 4 shows the energy intensity (defined as energy used per unit of gross domestic product [GDP] at purchasing power parity) of selected countries of different subregions during 2000–2018. As can be seen, energy intensity had mostly improved in all the countries during this period. The highest improvement had taken place in the PRC and Sri Lanka—both countries had a 43% reduction in energy intensity in 2018 as compared to that in 2000.

Energy Efficiency at Sectoral Level

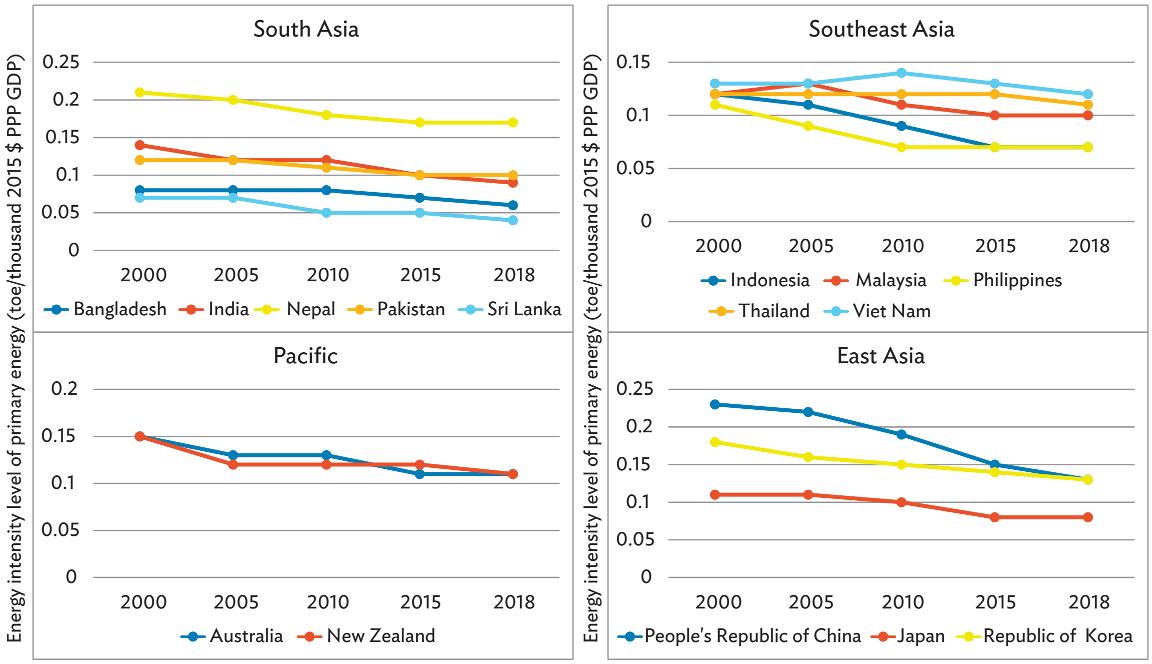
For most countries in Asia and the Pacific, information on energy efficiency at sectoral and subsectoral levels are either not available or not up-to-date. Therefore, this section briefly discusses energy intensities at the sectoral and subsectoral levels of countries in the region where such information are accessible in published international sources like the International Energy Agency (IEA).

Transport Sector

Significant developments are taking place in the Asia and Pacific region to improve energy efficiency in this sector. The growing penetration of electric vehicles is an important such activity. The PRC is leading the world in terms of battery-operated electric vehicles (BEVs). Global BEV stock in 2019 was 4.79 million of which 54% was in the PRC. Further, of the total world plug-in hybrid electric vehicle stock of 2.38 million in 2019, about one-third were in the PRC.[13] In India, 380,000 units of electric vehicles were sold during 2019–2020. According to a study, in the base case scenario, the electric vehicle market in India is expected to grow at CAGR of 44% between 2020–2027 and the annual sales are expected to reach 6.34 million units

[13] International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

Figure 4: Energy Intensity of Selected Countries in Asia and the Pacific, 2000–2018



GDP = gross domestic product, PPP = purchasing power parity, TOE = tons of oil equivalent.

Source: Author based on the data in International Energy Agency (IEA). 2020. *IEA Online Database*. Paris: IEA (accessed 22 February 2021).

by 2027.[14] In Japan, sales of electric vehicles was relatively small. It was slightly below 15,000 units and represented less than 1% of overall new vehicle sales.[15]

Another important development toward improving energy efficiency is the development of high-speed railways, which are considered to be a more efficient mode of transport than road or air transport. The high-speed railways are growing rapidly in the world and almost two out of three high-speed rail lines in the world are reported to be in the PRC.[16]

There were also improvements in the fuel economy of vehicles in the region. For example, in Southeast Asia, where vehicle ownership during 2000–2018 has almost tripled during 2000-2018, the fuel economy of the car fleet had improved by more than 30% over this period.[17]

Table 8 shows two different types of passenger transport energy intensity, i.e., energy use per unit of passenger-kilometers and per vehicle-kilometer, in 2018 for four countries. Similarly, it presents the energy intensity of freight transport in terms of energy use per ton-kilometer and per vehicle-kilometer. Note that the intensities are presented in an index form with the respective value in 2000 indexed as 100. As can be seen, Japan experienced the largest improvements in energy efficiency in both the passenger and freight transport during 2000–2018. Australia also had improvements in intensities of both kinds of transport services although much less than in Japan. The Republic of Korea had seen an increase in the passenger transport intensities, whereas New Zealand had a modest increase in freight transport intensities.

[14] *Economic Times*. 2020. Electric Vehicle Market in India Expected to Hit 63 Lakh Units Per Annum Mark by 2027. India Energy Storage Alliance. 22 December.

[15] *Japan Times*. 2021. Japan Lagging Much of the World in Shift to Electric Vehicles. 17 January.

[16] Tattini, J. and J. Teter. 2020. *Rail: Tracking Report, June 2020*. Paris: International Energy Agency (IEA).

[17] International Energy Agency (IEA). 2019. *South East Asia Outlook*. Paris: IEA.

Table 8: Transport Sector Energy Efficiency Indicators of Selected Countries in 2018 in Index Form
(Index value in 2000 = 100)

Mode/Vehicle Type	Indicator[a]	Australia	Japan	Republic of Korea	New Zealand
Cars/light trucks	Passenger-kilometer energy intensity	94	80	116[a]	95
Cars/light trucks	Vehicle-kilometer energy intensity	93	75	119[b]	90
Freight trucks	Ton-kilometer energy intensity	96	81	76[b]	102
Freight trucks	Vehicle-kilometer energy intensity	95	85	113[b]	115

[a] Indexed considering the indicator value in 2015 as 100.
[b] Indexed considering the indicator value in 2005 as 100.

Source: International Energy Agency (IEA). 2021. *IEA Energy Efficiency Indicators Database (December 2020 edition)—Highlights*. Paris: IEA (accessed 22 February 2021).

Industry sector. Energy intensities in 2018 (defined as energy use per unit of value added) in the case of manufacturing, chemicals and chemical products, basic metals, agriculture, forestry, fishing, and construction subsectors are presented in Table 9 for six selected countries of the Asia and Pacific region. Note that the figures in the table are expressed in an index form with the index value of the intensity in 2000 as 100. The decline in the energy intensity of the manufacturing subsector in 2018 was in the range of 10% in Australia to 50% in Kazakhstan as compared to the intensity in 2000.

Table 9: Industry Sector Energy Efficiency Indicators of Selected Countries in 2018 in Index Form
(Index value in 2000 = 100)

Subsector	Indicator[a]	Australia	Japan	Republic of Korea	New Zealand	Azerbaijan	Kazakhstan
Manufacturing	Per value-added energy intensity	90	61	58	80	86	50
Chemicals and chemical products	Per value-added energy intensity	111	48	71	73	45	88[b]
Basic metals	Per value-added energy intensity	67	83	129	108	61	67[b]
Agriculture forestry fishing	Per value-added energy intensity	141	110	60	90	88	104
Construction	Per value-added energy intensity)	44	91	119	98	192	132

[a] Indicators expressed in mega joule/US dollar (MJ/$) purchasing power parity 2015; however, they are presented in an index form in this table with the index value of 2000 as 100.

Source: International Energy Agency (IEA). 2021. *IEA Energy Efficiency Indicators Database (December 2020 edition)—Highlights*. Paris: IEA.

Residential sector. Table 10 presents the dwelling energy intensity (defined as energy use per floor area of dwelling) for space heating, lighting, and household appliances in the residential sector of four selected countries in 2018. It also shows the total residential sector energy intensity. The energy intensities of space heating and lighting show significant improvements in energy efficiency during 2000–2018. Energy intensity of household appliances in the countries exhibited an increase except in Japan. The overall residential energy intensity had decreased except in Australia.

Table 10: Residential Sector Dwelling Energy Intensity of Selected End Uses in 2018 in Index Form
(Index value in 2000 = 100)

End Use	Australia	Japan	Republic of Korea	New Zealand
Total residential	100	75	99	84
Residential space heating	82	71	77	82
Residential lighting	70	NA	NA	93
Residential appliances	120	80	134	134

NA = not available.
Source: International Energy Agency (IEA). 2021. *IEA Energy Efficiency Indicators Database (December 2020 edition)—Highlights*. Paris: IEA.

Service sector. Energy intensity of total services used (expressed in energy use in mega joule per unit [MJ per unit] of value added by total services in $ purchasing power parity [PPP] 2015) in 2018 in the Republic of Korea was 32% less than that in 2000, whereas it had decreased by 26% in Japan and New Zealand, and by 13% in Australia.[18]

Investment Trends in Clean Energy

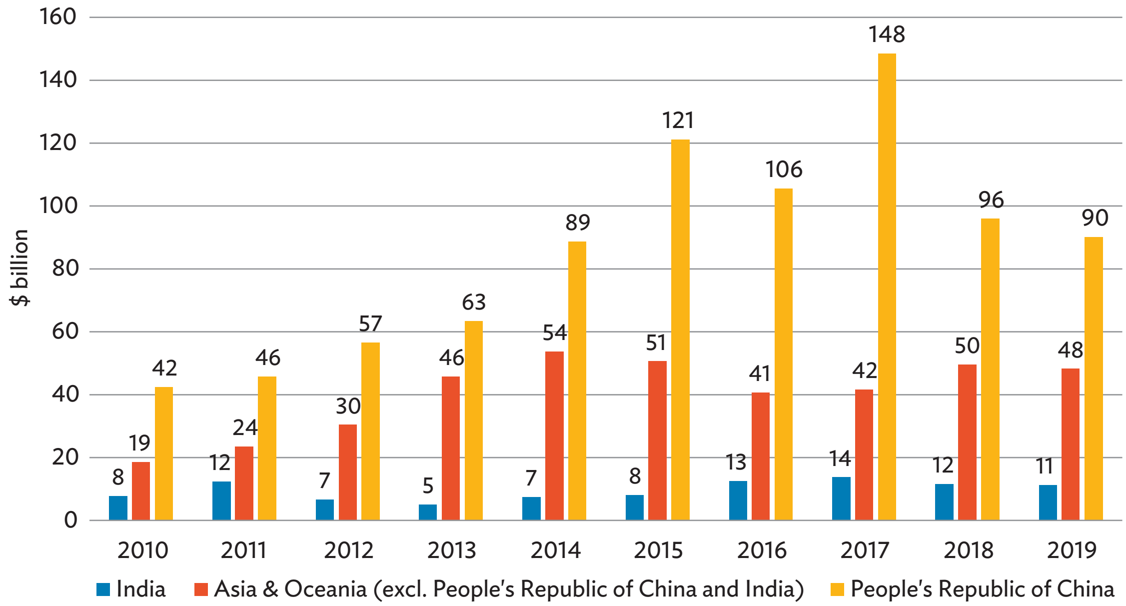
In the first part of this section, the present level of investment in renewable energy is discussed. This is followed by a discussion of future investment needs under alternative scenarios.

Present Investment in Renewable Energy

Figure 5 shows investment trends in renewable energy in the PRC, India, and the Asia and Pacific region (excluding the PRC and India) during 2010–2019. In the case of the PRC, investment in renewable energy had grown at a CAGR of 9%, increasing from $42 billion to $90 billion during 2010–2019. In India, investment in renewable energy increased from $8 billion to $11 billion showing CAGR of 4%. Asia and the Pacific (other than the PRC and India) had experienced the growth in investment at a CAGR of 11% during the period and investment in renewable energy increased from $19 billion to $48 billion. However, in recent years, investment in renewable energy exhibited a declining trend in the PRC and India. In the PRC, the government announced a suspension of the financial support for solar PV in 2018 causing the PV market to freeze. This may be the reason for the decline in renewable energy investment in that country besides the falling unit costs of solar and wind power technologies. In the case of India, the decline was mainly due to project financing delays resulting from problems with electricity distribution companies. In the case of Asia and the Pacific[19] (excluding the PRC and India), there is slight decrease in 2019 compared to 2018. A key reason for the decline included decreasing unit costs of solar PV, which reduced the dollar amount committed per MW of electricity. Other reasons included grid and land constraints (which held back renewable energy development activities) and auction bidding. Decline in investment in Indonesia, Japan, Malaysia, and Viet Nam also contributed to a recent overall decline in renewable energy investment in Asia and the Pacific (excluding the PRC and India).[20]

[18] International Energy Agency (IEA). 2021. *IEA Energy Efficiency Indicators Database (December 2020 edition)—Highlights*. Paris: IEA.
[19] In the original document, “Asia and Oceania” is used, which is written here as “Asia and the Pacific.”
[20] Renewable Energy Policy Network for the 21st Century (REN21). 2020. *Renewables 2020 Global Status Report*. Paris: REN21.

Figure 5: Investment Trend in Renewable Energy for Selected Countries and Subregions, 2010–2019



Source: Author based on the data in Renewable Energy Policy Network for the 21st Century (REN21). 2020. *Renewables 2020 Global Status Report*. Paris: REN21.

Information on investment on energy efficiency improvements are rather scarce. According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the PRC spent more than $62 billion in 2016, which was 0.66% of its GDP.[21] In India, the total investment on energy efficiency in 2016 was around $7 billion, which accounted for 0.28% of the country's GDP. Investment in energy efficiency in the rest of Asia was slightly more than $9 billion in 2016.

Future Investment in Clean Energy

A study carried out by the International Renewable Energy Agency (IRENA) has estimated investment needs for renewable energy and energy efficiency under its Planned Energy Scenario (PES) and Transformative Energy Scenario (TES).[22] Table 11 presents the average annual investment on renewable energy and energy efficiency in the power, industry, transport, and buildings sectors in different subregions of Asia and the Pacific during 2016–2050 that would be required under the two scenarios. In PES, a total of $825 billion would have to be invested on average annually on renewable energy and energy efficiency in these four sectors in the Asia and Pacific region during 2016–2050. In TES, which is a more ambitious low-carbon

[21] UNESCAP. 2018. *Energy Transition in Asia and the Pacific: Pathways to Ensure Access to Affordable, Reliable, Sustainable and Modern Energy For All*. Bangkok.

[22] IRENA. 2020. *Global Renewables Outlook: Energy Transformation 2050*. Abu Dhabi.
According to IRENA (2020), PES is the reference case providing a perspective on energy system developments based on governments' energy plans and other planned targets and policies (as of 2019), including Nationally Determined Contributions under the Paris Agreement unless the country has more recent climate and energy targets or plans. TES describes an ambitious yet realistic energy transformation pathway based largely on renewable energy sources and steadily improved energy efficiency (though not limited exclusively to these technologies). This would set the energy system on the path needed to keep the rise in global temperatures to well below 2 degrees Celsius (°C) and toward 1.5°C during this century.

Table 11: Investment in Energy Systems in Subregions of Asia and the Pacific(Average Annual, 2016–2050), billion/year

Sectors	East Asia[a]		South East Asia[b]		Rest of Asia[c]		Pacific[d]	
	PES	TES	PES	TES	PES	TES	PES	TES
Power (Renewable energy)[e]	252	351	27	61	91	136	5	14
Industry (Renewable energy+EE)	25	35	7	13	22	33	2	3
Transport (Renewable energy+EE)[f]	101	114	10	20	37	70	2	5
Buildings (Renewable energy+EE)	133	196	27	40	78	114	6	11

EE = energy efficiency, PES = planned energy scenario, TES = transformative energy scenario.

[a] The People's Republic of China, Japan, Mongolia, the Democratic People's Republic of Korea, and the Republic of Korea.

[b] Southeast Asia comprises Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

[c] Rest of Asia comprises West Asia consisting of Armenia, Azerbaijan, and Turkey; Central Asia consisting of Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan; South Asia consisting of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

[d] Includes Australia, Christmas Island, Cocos (Keeling) Islands, Fiji, Heard Island, McDonald Islands, the Federated States of Micronesia, New Caledonia, New Zealand, Norfolk Island, Papua New Guinea, French Polynesia, Solomon Islands, and Vanuatu.

[e] Investment in renewable power generation, power grids, and system flexibility.

[f] Investment in electrification and energy efficiency.

Source: IRENA. 2020. *Global Renewables Outlook: Energy Transformation 2050*. Abu Dhabi.

scenario, the corresponding investment needed would be significantly higher, i.e., $1.22 trillion. In all the subregions, the power sector would have the highest average annual investment among the sectors under both scenarios. Among the subregions, the level of annual investment would be the highest in East Asia.

Clean Energy Policies

Renewable Energy Promotion Policies

There are different types of policies to promote renewable energy. Table 12 shows renewable energy policies adopted by a number of countries in the Asia and Pacific region. Mainly, policies fall under three categories, i.e., regulatory policies, fiscal incentives and public financing, and other policies (mainly climate policies).

Regulatory Policies

Regulatory policies are about achieving objectives of the government through use of laws, regulations, and other instruments.[23] In the context of renewable energy, examples include mandates or quotas such as renewable portfolio standards, feed-in tariffs, and technology and/or fuel-specific obligations.[24]

[23] Organisation for Economic Co-operation and Development (OECD). n.d. *Regulatory Policy*. Paris: OECD.

[24] Renewable Energy Policy Network for the 21st Century (REN21). 2018. *Glossary*. Paris: REN21.

Fiscal Incentives and Public Financing

Fiscal incentives allow companies, households, or individuals to reduce their contribution to the public treasury via income or other taxes. Furthermore, public financing in renewable energy is a type of financial support mechanism in which governments provide assistance, often in the form of grants or loans to support the development or deployment of renewable energy technologies.[25]

Other Policies

These are policies that make clean energy resources and technologies relatively more attractive, although indirectly. Two alternative climate policies, i.e., carbon tax and tradable carbon emission permits through emission trading schemes (ETS) fall under this category. These policies are aimed to reduce carbon emissions by making fossil fuels relatively more expensive and at the same time making renewable energy resources and energy-efficient technologies relatively more attractive.

Table 12: Countries in the Asia and Pacific Region Implementing Renewable Energy Promotion Policies

Types of Renewable Energy Policy		No. of Countries in Asia and the Pacific That Adopt the Policy
Regulatory Policies	Feed-in tariff premium payment	20
	Electric utility quota obligation/renewable portfolio standard	11
	Net metering and/or billing	14
	Biofuel blend, renewable transport obligation, or mandate	12
	Renewable heat obligation or mandate, heat feed-in tariff, or fossil fuel ban for heating	3
	Tradable renewable energy	8
	Tendering	21
	Emissions trading scheme	4
Fiscal Incentives and Public Financing	Reductions in sales, energy, CO_2, VAT, or other taxes	20
	Investment or production tax credits	10
	Energy production payment	6
	Public investment, loans, grants, capital subsidies, or rebates	23
Other Policies[a]	Carbon tax	3

CO_2 = carbon dioxide, VAT = value-added tax.

[a] These policies have been added by the present author.

Source: Adapted from Renewable Energy Policy Network for the 21st Century (REN21). 2020. *Renewables 2020 Global Status Report*. Paris: REN21.

The policies mentioned in Table 12 and the countries in the region adopting these are discussed next.

Feed-in tariff and/or premium payment. This policy typically guarantees renewable energy generators specified payments per unit (per kWh of energy) over a fixed period. It may also establish regulations by which generators can interconnect and sell power to the grid. Numerous options exist for defining the

[25] Footnote 24.

level of incentive, such as whether the payment floats on top of the wholesale electricity price or whether the payment is structured as a guaranteed minimum price.[26] Economies adopting this policy are as follows: Armenia; Australia; India; Indonesia; Japan; Kazakhstan; Malaysia; Maldives; Mongolia; Nepal; Pakistan; the Philippines; the PRC; Sri Lanka; Taipei,China; Tajikistan; Thailand; Vanuatu; and Viet Nam.[27]

Tendering. This policy is a procurement mechanism in which renewable energy supply or capacity is acquired by a competitive selection from sellers (offering bids at the lowest price that they would be willing to accept) on the basis of price and non-price factors.[28] Countries adopting this policy include Afghanistan, Armenia, Australia, Bangladesh, Cambodia, India, Indonesia, Japan, Kazakhstan, Malaysia, Maldives, Mongolia, Nepal, the Philippines, the PRC, Singapore, Sri Lanka, Uzbekistan, and Viet Nam.[29]

Net metering and/or net billing. Under this policy, electricity generated by utility customers can receive credits for their excess generation, which can be applied to offset consumption in their current as well as future billing cycles. Under net metering, customers typically receive credit at the level of the retail electricity price. Under net billing, customers generally receive credit for excess power at a rate that is lower than the retail electricity price.[30] Countries adopting this policy are as follows:: Armenia, Australia, the Federated States of Micronesia, India, Malaysia, New Zealand, Pakistan, the Philippines, the Republic of Korea, Singapore, Sri Lanka, Thailand, and Viet Nam.[31]

Biofuel blend, renewable transport obligation, or mandate. This policy requires designated parties (consumers, suppliers, and generators) to meet a minimum and often gradually increasing standard for renewable energy (or energy efficiency), such as a percentage of total supply, a stated amount of capacity, or the required use of a specified renewable technology.[32] Biofuel blend obligation sets out an obligation that suppliers of road transport fuels must include a certain percentage of environmentally sustainable biofuels across their fuel mix.[33] Similarly, renewable transport obligation is a long-term mechanism that requires suppliers of transport fuel to ensure that a set percentage of the sales are from a renewable source.[34] Countries adopting this policy include Australia, India, Indonesia, Malaysia, New Zealand, the Philippines, the PRC, the Republic of Korea, Sri Lanka, Thailand, and Viet Nam.[35]

Electric utility quota obligation and/or renewable portfolio standard. This type of policy sets an obligation on a utility company, group of companies, or consumers to provide or use a predetermined minimum targeted share of renewable energy sources in total installed capacity, or total electricity or heat generated or sold. This policy is also named as “renewable obligations,” “renewable electricity standards,” and “mandated market shares.”[36] Countries adopting this policy are Australia, India, Indonesia, the Kyrgyz Republic, Malaysia, Palau, the Philippines, the PRC, the Republic of Korea, Sri Lanka, and Viet Nam.[37]

Tradable renewable energy certificate. Renewable energy certificate is a type of certificate awarded to a generator for each unit of renewable energy (generally 1 MWh of electricity) produced. Under this policy, participants in the market, such as generators or suppliers, participate in buying or receiving a number of certificates to meet the mandatory quotas established for the year. Such certificates can be collected to meet obligations and provide a tool for trading among participants.[38] Countries adopting this policy are Australia, India, Japan, Kazakhstan, Nepal, Pakistan, the Republic of Korea, and Viet Nam.

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26 Footnote 24.
27 Footnote 20.
28 Footnote 24.
29 Footnote 20.
30 IRENA, IEA, and REN21. 2018. *Renewable Energy Policies in a Time of Transition*. Abu Dhabi: IRENA, OECD/IEA, and REN21.
31 Footnote 20.
32 Footnote 24.
33 Government of Ireland, Department of Communications, Climate Action & Environment (DCCAE). n.d. *Biofuels*. Dublin: DCCAE.
34 International Energy Agency (IEA). 2015. *Renewable Transport Fuels Obligation (RTFO)*. Paris: IEA.
35 Footnote 20.
36 Footnote 24.
37 Footnote 20.
38 Footnote 24.

Renewable heat obligation or mandate, heat feed-in tariff, and fossil fuel ban for heating. This policy is similar to renewable transport obligation defined above. In this case, instead of transport, it is for heating. Three countries, i.e., Australia, the PRC, and the Republic of Korea have adopted this policy.

Public investment, loans, grants, capital subsidies, or rebates. Under this policy, financial support from the government is provided to support renewable energy development. The policy can include a capital subsidy to cover a part of the upfront capital cost of an asset (such as a solar water heater) and may include consumer grants, rebates or one-time payments by a utility, government agency or government-owned bank.[39] Countries adopting this policy in Asia and Pacific are Armenia, Australia, Azerbaijan, Bangladesh, Georgia, India, Indonesia, Japan, Kazakhstan, Malaysia, Nepal, New Zealand, Pakistan, the Philippines, the PRC, the Republic of Korea, Singapore, Sri Lanka, Tajikistan, Thailand, and Viet Nam.

Reductions in sales, energy, carbon dioxide, value-added tax, or other taxes. In several countries, governments have adopted the policy of reduction in taxes of different kinds (i.e., sales, energy, value-added, or other taxes) to reduce the cost of renewable energy systems for the installer or generator. This aims to increase their affordability and profitability.[40] Countries that have adopted this policy are Bangladesh, Fiji, India, Indonesia, Japan, the Kyrgyz Republic, Malaysia, the Marshall Islands, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, the PRC, the Republic of Korea, Sri Lanka, Tajikistan, Thailand, Vanuatu, and Viet Nam.[41]

Investment or production tax credits. These are fiscal incentives that allow the owner or investor of a qualifying property or facility with a tax credit based on the amount of renewable energy generated by that facility.[42] Ten economies, i.e., Fiji; India; Indonesia; Nepal; the Philippines; the PRC; the Republic of Korea; Taipei,China; Uzbekistan; and Viet Nam are reported to have adopted this policy.[43]

Energy production payment. The aim of this policy is to provide an attractive rate of return to compensate for the higher capital costs of some renewable technologies, as well as other non-economic barriers.[44] Countries adopting this policy are India, the Philippines, the PRC, the Republic of Korea, Sri Lanka, and Thailand.[45]

Carbon tax. A carbon tax is an instrument aimed at discouraging the use of fossil fuels by charging such fuels based on their carbon content. It indirectly serves to make low-carbon fuels and renewable energy sources relatively less expensive. Countries adopting such a policy include India, Japan, and Singapore.

Emissions trading scheme (ETS). Under such schemes, there is a cap on carbon emissions allowed for different entities and one is allowed to sell (or trade) any unused carbon allocation to buyers in a carbon market. The scheme provides incentives to adopt low-carbon fuels, renewables, and energy-efficient technologies. Countries that have adopted ETS include Japan, New Zealand, the PRC, and the Republic of Korea.

Energy Efficiency and Conservation Policies

There are different types of policies to promote energy efficiency. A policy can be either mandatory or voluntary depending on the countries adopting it. Below are some of the energy efficiency policies and countries adopting them.

[39] Footnote 24.
[40] Footnote 30.
[41] Footnote 20.
[42] Footnote 24.
[43] Footnote 20.
[44] Footnote 30.
[45] Footnote 20.

Building codes or building regulations. Building codes and regulations play a vital role by setting minimum requirements for energy-efficient design and construction. These codes provide a uniform outline for new as well as renovating old buildings. Markets adapting this policy are as follows: Australia, Bangladesh, Brunei Darussalam, Cambodia, India, Indonesia, Japan, Myanmar, New Zealand, Pakistan, the Philippines, the PRC, the Republic of Korea, Singapore, Sri Lanka, Thailand, and Viet Nam.

Standards and labeling. The main objective of this policy is to provide the consumer an informed choice about the energy saving of a product. This policy targets display of energy performance labels on end use appliances and equipment and lays down minimum energy performance standard.[46] Countries adapting this policy are Australia, Bangladesh, Brunei Darussalam, Cambodia, Indonesia, Japan, the Lao PDR, Malaysia, Nepal, New Zealand, Pakistan, the Republic of Korea, Singapore, Sri Lanka, and Viet Nam.

Fuel economy standard and/or regulations. Fuel economy is a standard measure of the rate of motor vehicle fuel consumption. Fuel economy standard is a government-mandated minimum requirement for the fuel economy of a motor vehicle.[47] Countries adapting this policy are Australia; Georgia; India; Japan; New Zealand; Pakistan; the PRC; the Republic of Korea; Singapore; Taipei,China; Thailand; and Viet Nam.

Financial incentives. Financial incentive is a monetary benefit offered to encourage energy efficiency implementation measures that otherwise would not take place. It can be in the form of tax rebate, subsidies, grants, loans, etc. For example, the Republic of Korea has tax exemptions to invest in energy-efficient facilities under the Special Tax Treatment Control Act. Likewise, in Malaysia, there is tax exemption for hybrid cars and electric cars.[48] Countries having this type of policy include Australia, Bangladesh, India, Indonesia, Japan, Malaysia, Nepal, the Philippines, the PRC, the Republic of Korea, Singapore, Sri Lanka, Thailand, and Viet Nam.

Public–private partnership. The public sector uses private companies, such as an Energy Service Company (ESCO) to provide technical, commercial, and financial services.[49] ESCOs can play a major role in the promotion of energy efficiency by offering business solutions for energy efficiency and conservation projects and taking the performance risk associated with energy efficiency programs. Countries that use ESCOs include: Australia, Brunei Darussalam, Georgia, India, Indonesia, Japan, the Lao PDR, Malaysia, Myanmar, New Zealand, the Philippines, the PRC, the Republic of Korea, Singapore, Sri Lanka, and Thailand.

Energy management ISO 50001. This standard provides a practical way to improve energy use through the development of an energy management system. It is mainly for the industrial sector. The certification calls for a company to develop an energy policy, establish goals to meet the policy, utilize data to meet goals, measure policy effectiveness, and continually make improvements to the policy.[50] Australia, Bangladesh, Brunei Darussalam, India, Indonesia, Japan, Malaysia, Maldives, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, the PRC, the Republic of Korea, Singapore, Sri Lanka, Thailand, and Viet Nam adopt this policy.

Apart from these policies, different countries adopt different type of policies. For example, in India, The Perform, Achieve and Trade (PAT) scheme is a flagship program of the Bureau of Energy Efficiency. This is a regulatory instrument to reduce specific energy consumption in energy-intensive industries, with an associated market-based mechanism to enhance the cost effectiveness through certification of excess energy saving, which can be traded.

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[46] Government of India, Bureau of Energy Efficiency (BEE). n.d. *Standards & Labeling.* India: BEE.

[47] Dictionary of Energy (2nd ed.). 2015. *F*. Elsevier. pp. 217–246.

[48] Energy Research Institute Network (ERIN). 2016. *Energy Efficiency Policy Update*. 4th ERIN Meeting held in Bangkok, Thailand.

[49] Carbonara N. and R. Pellegrino. 2018. Public–Private Partnerships for Energy Efficiency Projects: A Win–Win Model to Choose the Energy Performance Contracting Structure. *Journal of Cleaner Production*. 170: pp. 1,064–1,075.

[50] ISO. ISO 50001. Energy Management.

Prospects for Clean Energy Development

Some recent studies[51] have assessed the future role of renewables in the low carbon development in different parts of the world including Asia and the Pacific.[52] These studies consider both a planned (reference) scenario as well as alternative scenarios that consider low-carbon development that corresponds to the attainment of the targets of the Paris Agreement. For example, IEA[53] has assessed the future energy outlook under Stated Policy Scenario and Sustainable Development Scenario (SDS) until 2040.[54] This section first briefly discusses the outlook for future demand for electricity and renewable energy in Asia and the Pacific. Next, it discusses the prospects for clean energy in various subregions and major countries of the Asia and Pacific region under the SDS of IEA.[55] This is followed by a discussion of implications for clean energy if carbon neutrality is to be attained by 2050.

Future Demand for Electricity and Renewable Energy

According to IEA,[56] total demand for electricity in Asia and the Pacific was 927 million tons of oil equivalent (Mtoe) in 2019. Under the SDS, the demand would grow to 1,201 Mtoe by 2030 and to 1,506 Mtoe by 2040. Electricity's share in total final energy consumption would increase from 23% in 2019 to 29% in 2030 and 37% in 2040. Total demand for bioenergy in the region would decline, i.e., at a CAGR of 4% during 2019–2030 and 0.8% during 2019–2040. On the contrary, total demand for other renewables would increase quite rapidly, i.e., at the CAGR of 7.4% during 2019–2030 and at about 6% during 2019–2040.

Table 13 presents the future demand for electricity, bioenergy, and other renewables in 2030 and 2040 in industry, transport, and buildings sectors under the SDS scenario of IEA along with the respective actual consumption in 2019. The industry sector's demand for renewable energy in the Asia and Pacific region is estimated to grow at a CAGR of 3% during 2019–2030 and 2019–2040. The Asia and Pacific region is estimated to have a constant growth rate (about 2%) of demand for bioenergy during both 2019–2030 and 2019–2040. However, the demand for other renewables in the region is estimated to grow at a CAGR of 29% during 2019–2030 and 18% during 2019–2040.

The transport sector in the region would see a very high rate of electrification. Electricity demand of the sector is estimated to grow at a CAGR of 13% during 2019–2030 and 12% during 2019–2040. Bioenergy demand of the sector is estimated to grow very rapidly, i.e., at a CAGR of 18% during 2019–2030 and 11% during 2019–2040. The demand would increase by around 5 times in 2030 and almost by 8 times in 2040 compared to its 2019 value.

Electricity demand in the buildings sector in the region would account for 50% of total energy consumption in the sector in 2030 and 57% in 2040 as compared to 34% in 2019. Demand for bioenergy in the sector in the region is estimated to decline during 2019–2030 and 2019–2040 mainly due to a decrease in the demand for traditional biomass. Demand for other renewables in the region is estimated to grow at a very high rate, i.e., at a CAGR of 6% during 2019–2030 and 5% during 2019–2040.

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51 Footnote 22.

52 Footnote 13.

53 Footnote 13.

54 The SDS was developed to attain three of the SDGs, i.e., to achieve universal access to energy (SDG 7), to reduce the severe health impacts of air pollution (part of SDG 3), and to tackle climate change (SDG 13). According to IEA, this scenario is designed to limit the temperature rise to 1.65°C with a 50% probability.

55 Footnote 13.

56 Footnote 13.

Table 13: Demand for Electricity and Renewables in the Different Sectors of the Asia and Pacific Region in 2019, 2030, and 2040 (Mtoe)

Sector	Bioenergy			Other Renewables			Electricity		
	2019	2030	2040	2019	2030	2040	2019	2030	2040
Industry	75	91	107	1	12	26	498	595	695
Transport	12	75	107	–	–	–	17	66	170
Buildings	296	70	87	35	67	96	366	485	586

– = zero or negligible value, Mtoe = million tons of oil equivalent.
Source: International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

Renewable Energy in Power Generation

According to IEA,[57] the Asia and Pacific region produced 3,051 TWh of electricity based on renewables in 2019. This amounted to 24% of total electricity generation in the region and 47% of the global renewable energy-based electricity generation. Under the SDS of IEA,[58] electricity production from renewables in 2030 is estimated to 2.6 times of that in 2019 and it would increase to 4.5 times in 2040. The share of renewables in total electricity production would increase to 49% in 2030 and 70% in 2040 in the SDS.

Table 14 presents the power generation capacity based on renewable resources in selected countries and subregions of the Asia and Pacific region in 2019. It also presents the corresponding estimated capacity in 2030 and 2040 under the SDS. Under the SDS, the renewable power generation capacity in the Asia and Pacific region is estimated to grow at a very high rate, i.e., at a CAGR of 10.8% during 2019–2030 and 8.3% during 2019–2040. As a result, the total renewable energy capacity in the region would be tripled during 2019–2030 and would grow by over 4 times during 2019–2040. The share of renewable energy in the total generation capacity in the region would increase to 62% in 2030 and 74% in 2040.

Table 14: Renewable Power Generation Capacity in Selected Countries and Subregions in 2019, 2030, and 2040 (GW)

Country/Region	2019	2030	2040
Asia and Pacific Region	1,231	3,804	6,624
China, People's Republic of	796	2,285	3,752
India	137	641	1,334
Japan	126	210	284
Southeast Asia	74	342	668

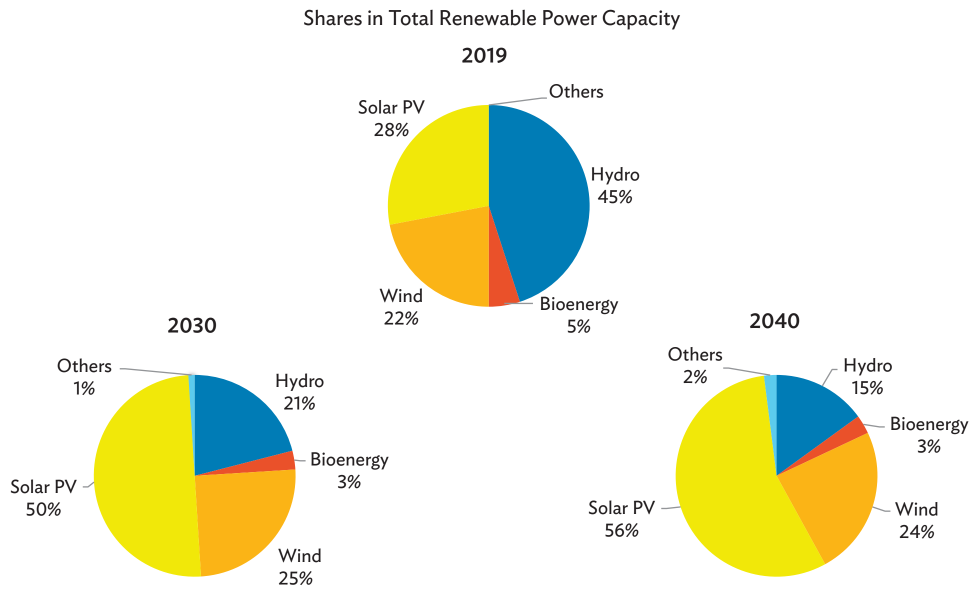
GW = gigawatt.
Source: International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

The PRC alone accounted for 65% of the total renewable energy installed capacity in the region in 2019 while India, Japan, and the Southeast Asia subregion had a share of 27%. The renewable energy capacity of the PRC would be increasing during 2019–2040, although at a slower rate than that of India. As a result, the PRC share would decrease to 60% by 2030 and 57% by 2040 under SDS whereas India's share in total regional renewable energy capacity would increase from 11% in 2019 to 17% by 2030 and 20% by 2040. Japan's share is estimated to decrease during the period.

[57] Footnote 13.
[58] Footnote 13.

Figure 6 presents the mix of the renewable power generation capacity in the Asia and Pacific region in 2019 together with the capacity mix in 2030 and 2040 under the SDS. Hydropower had the largest share (i.e., 45%) in the region's renewable energy power generation capacity in 2019. This would, however, change in the future with solar PV overtaking hydropower and having the largest share in total renewable energy capacity. Wind power would have the second-largest share, contributing about a quarter of the total renewable energy capacity in 2030 and 2040. Together, solar and wind would account for about three quarters of the total renewable energy capacity in 2030. By 2050, their share would further increase to 80% of the total renewable energy capacity.

Figure 6: Renewable Power Generation Capacity Mix in Asia and the Pacific in 2019, 2030, and 2040 (%)



PV = photovoltaic.

Note: "Others" comprises geothermal, concentrated solar thermal, and marine energy sources.

Source: Author based on the data in International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

Huge increase is estimated to take place in the solar PV capacity in the Asia and Pacific region during 2019–2040. The capacity is estimated to increase fourfold by 2030 and by ninefold by 2040 in the region as a whole as well as in the PRC under the SDS scenario. This can be seen from Table 15. As also can be seen from the table, the capacity would grow at a much higher rate in India and Southeast Asia during the period.

Table 15: Solar Photovoltaic Capacity in Selected Countries and Subregions in 2019, 2030, and 2040 under IEA Sustainable Development Scenario (GW)

Country/Region	2019	2030	2040
Asia and Pacific Region	351	1,888	3,683
China, People's Republic of	205	1,106	2,124
India	38	367	806
Japan	63	121	164
Southeast Asia	11	145	306

IEA = International Energy Agency, GW = gigawatt.

Source: International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

According to IEA, total wind power capacity in the Asia and Pacific region would increase fourfold by 2030 and fivefold by 2040 under the SDS scenario (Table 16). The growth of wind capacity during 2019–2040 would take place at a much higher rate in India, Japan, and Southeast Asia. By 2040, the capacity would be eightfold in India and ninefold in Japan. In Southeast Asia, the growth rate in the capacity would be even higher. The PRC presently has the highest wind power generation capacity in the region and it would remain so until 2040 although the growth rate would be relatively lower than that of India, Japan, and Southeast Asia.

Table 16: Wind Power Capacity in Selected Countries and Subregions in 2019, 2030, and 2040 under IEA Sustainable Development Scenario (GW)

Country/Region	2019	2030	2040
Asia and the Pacific Region	266	936	1,603
China, People's Republic of	210	614	929
India	38	163	334
Japan	4	18	40
Southeast Asia	3	61	140

IEA = International Energy Agency, GW = gigawatt.

Source: International Energy Agency (IEA). 2020. *World Energy Outlook 2020*. Paris: IEA.

Implications of Carbon Neutrality Targets

A number of countries in the world have announced their goal of achieving carbon neutrality (or net zero emissions) by around middle of the century. In Asia, the PRC has declared that it would achieve carbon neutrality by 2060 whereas Japan and the Republic of Korea have announced to do so by 2050. Of the three countries, only the Republic of Korea has announced its national strategy for attaining the carbon neutrality.

IEA[59] has analyzed the implications of carbon neutrality by 2050 under its "Net Zero Emission by 2050" (hereafter "NZE") scenario. It has identified the types of technologies and other measures needed to achieve carbon neutrality by 2050. The study finds that attaining carbon neutrality by mid-century would require the countries to adopt much stronger measures and technologies for decarbonization than those needed under SDS. Electricity is expected to play a larger role in the carbon neutrality scenario than in SDS. As the use of fossil fuels in some activities may not be avoidable, use of technologies like carbon capture, utilization, and storage (CCUS) will be necessary. The following discussion on key technologies and measures required under NZE is mainly based on the findings of the IEA study.

The power sector would see a 75% decrease in coal-fired generation globally during 2019–2030 in NZE scenario and most of this reduction would come from few countries and subregions including the PRC, India, and Southeast Asia. There would be a much larger generation from renewables and low-carbon technologies than in the SDS to meet the increased demand for electricity and to replace coal-fired generation that will be phased out under NZE Scenario. Solar PV becomes a major player in attaining carbon neutrality. The installed capacity of solar PV at the global level is estimated to increase by nearly 20% per year during 2019–2030 in NZE scenario. It is also estimated that some of the largest increases of PV capacity installations would take place in the PRC, India, and Southeast Asia that are currently the major consumers of coal. Further, a larger wind power capacity would be needed under NZE than in SDS. The IEA analysis also indicates that a country like the PRC would require installation of higher nuclear power generation capacity than would be needed under SDS.

[59] Footnote 13.

The growth of the power generation capacity of intermittent renewables and changes in demand patterns (e.g., due to electric vehicles) would require measures that can provide flexibility in power systems. This, in turn, would require installation of sufficient capacity of energy storage technologies, including battery storage systems.

The transport sector would require a larger switch to low-emission or zero-emission vehicle fleets and moves to cleaner aviation and shipping. It is stated that most of the additional emission mitigation from the sector in the NZE scenario would come from low-emitting passenger cars, light-duty trucks, buses, and two- or three-wheelers. Further, there would be a rapid growth of zero-emission vehicles like fuel cell vehicles under NZE.

In the industry sector, electrification and efficiency improvements are identified as the measures for additional reductions in energy-related carbon dioxide emissions from the sector under NZE. The IEA study states that additional efficiency improvements would mostly occur in the aluminum, paper, and cement sectors. The use of low-carbon hydrogen and CCUS in the industry sector would also contribute significantly to emissions reduction in NZE. Other important measures identified under NZE are accelerated adoption of highly efficient electric motors (with efficiency class IE4 or higher), heat pumps, and other low-carbon heat sources.

In the buildings sector, carbon neutrality would require larger deployment of efficient technologies and measures (including efficient appliances, heat pumps, and electric storage water heaters to meet heating needs) as well as smart systems in new buildings to allow demand-side response. Also needed is retrofitting of existing buildings.

Many of the measures and technology options identified under IEA's NZE scenario may be applicable also to Asian countries with climate neutrality goals. The "2050 Carbon Neutral Strategy of the Republic of Korea" envisages a large-scale use of renewables and hydrogen as well as deployment of energy-efficient technologies and CCUS. The strategy also requires that newly constructed public buildings with the gross floor area at 1,000 square meters (m^2) or larger should be designed as a zero-energy building from 2020, and that all public and private buildings with gross floor area larger than 500 m^2 will be required to be a zero-energy building by 2030.[60]

While a formal strategy for carbon neutrality in Japan is yet to be declared, a study by Oshiro et al.[61] identifies the need for a large-scale deployment of renewables (hydropower, biomass, solar, onshore and offshore wind, and ocean power) in power generation. In the buildings sector, options identified include heat-pumps and energy-efficient technologies that contribute to reduction of electricity demand. In the transport sector, the measures include larger use of electricity, hydrogen, and biofuel as well as energy demand reduction along with large-scale deployment of BEVs and fuel cell electric vehicles.

While country-specific strategies for carbon neutrality are expected to vary to some extent, the foregoing discussion highlights the predominant role that the clean energy technologies will play for attaining the goal of carbon neutrality and the opportunities that the carbon neutrality policy would offer for the development of new energy carriers like hydrogen and new technologies (like CCUS and fuel cell vehicles) as well as large-scale deployment of renewables.

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[60] Government of the Republic of Korea. 2020. *2050 Carbon Neutral Strategy of the Republic of Korea: Toward a Sustainable and Green Society*. Seoul.

[61] Oshiro, K., T Masui, and M. Kainuma. 2018. Transformation of Japan's Energy System to Attain Net-Zero Emission by 2050. *Carbon Management*. 9 (5). pp. 493–501.

Conclusion

This chapter presented the status and future opportunities for harnessing clean energy resources, i.e., renewable energy and energy efficiency in the Asia and Pacific region. It discussed the potential of renewable energy resources and present level of utilization of these resources and showed the existence of large unutilized resources of biomass, wind power, solar power, and hydropower. The chapter also discussed different types of policies adopted by countries and subregions for promoting renewable energy and energy efficiency.

The role of renewable energy in total primary energy supply was increasing throughout the region during 2000–2018. The CAGR of renewable energy supply ranges from 6% in East Asia to less than 1% in Southeast Asia during 2000–2018. Moreover, electricity production from renewable energy sources had also increased in the region, except for Central Asia and South Asia.

The present state of information on resource potential is, however, inadequate in most cases. As such, the present assessment is to be treated as indicative. However, one should also consider the major constraints that the development of renewable energy resources face (e.g., grid extension and system operation flexibility, etc.) in determining the actual level of the remaining potential that could be exploited over time.

This chapter also discussed the role of clean energy over a longer term in the context of low-carbon development along the targets set by the Paris Agreement. The review shows that there has to be a huge increase in the installed capacity and production of renewable energy sources in the Asia and Pacific region in the next 2–3 decades, which clearly demonstrates the significant prospects for the development of renewable energy in the region. Targets for attaining carbon neutrality by around middle of the century has been announced by some countries in Asia. Discussion of the implications of the carbon neutrality targets has shown that much higher level of deployment of new and clean energy technologies and resources would be required to attain the targets.

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PART 2

Leveraging for Clean Energy Finance

3 ADB's Experience in Clean Energy Finance

Yongping Zhai, Kee-Yung Nam, and Lyndree Malang

Introduction

Clean energy is vital to achieve sustainable and resilient growth, but its novelty and uncertainty have developing countries straying from its uptake and use. Clean energy finance has been expanding and supporting efforts to mainstream the adoption of more clean sources of energy. In the Asia and Pacific region, the Asian Development Bank (ADB) is among the prime movers of clean energy finance. ADB has been helping its developing member countries (DMCs) achieve affordable and clean energy for all (Sustainable Development Goal [SDG] 7), and take urgent action to combat climate change (SDG 13). It is also assisting its DMCs accomplish their Nationally Determined Contributions (NDCs) for the Paris Agreement, which aspires to strengthen global response and national abilities in mitigating and adapting to climate change.

The low-carbon future through clean energy development, however, encounters issues and challenges that often point to limited financial resources and imperfect information. Medium- to large-scale investments that involve conventional and mature technologies are perceived as less risky, incur higher returns on investments, and command broader sources of financing. But providing modern energy services to those in the remote rural areas requires innovative solutions that at times involve novel, unproven, and small-scale technologies and business models. The availability of financial resources is a challenge given the uncertainty of the returns on investments.

To help overcome the issues and challenges, multilateral institutions such as ADB, alongside the public sector, attempt to bridge the gaps in information, incentives, and institutions. Through its Clean Energy Program, ADB has been mainstreaming renewable energy and energy efficiency in its investments.[1] ADB has been involved in demonstrating the technical feasibility of new and advanced technologies in clean energy; providing financial leverage to new markets, new players, and project developers; and disseminating knowledge of best and worst practices through case studies—the worst cases and failures make knowledge richer and learning more robust. With its Strategy 2030, ADB has institutionalized tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability as one of its seven operational priorities.[2] The One ADB Approach—collaborations among various fields of expertise for integrated and multisector solutions—is expected to maximize the gains, reduce the risks, and ensure the relevance of clean energy financing in achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific.

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1 ADB. 2020. *Review of the ADB Clean Energy Program*. Manila.

2 ADB. 2018. *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*. Manila.

Indeed, a long history of clean energy interventions for its DMCs trails ADB, and a low-carbon future using clean energy resources is on the horizon. This chapter presents ADB's experience in providing clean energy financing to its DMCs for sustainable and low-carbon growth. It informs on the clean energy initiatives and investments ADB has carried out to assist its DMCs and provides an overview of the prospects expected in clean energy development and finance.

Initiatives in Clean Energy

In the 1990s, ADB provided fundamental preparatory support to help its DMCs mitigate greenhouse gas (GHG) emissions and integrate energy and environmental for sustainable development.[3] In 2002, the Renewable Energy, Energy Efficiency, and Climate Change (REACH) program was established to address poverty and climate change in Asia and the Pacific through renewable energy, energy efficiency, and clean energy technologies. Four bilateral trust funds from Canada, Denmark, Finland, and the Netherlands supported REACH.

Launched in July 2005, the Energy Efficiency Initiative aimed to expand ADB's investments in clean energy.[4] Since 2008, the Energy for All Initiative has been promoting access to affordable, modern, and clean energy among the region's poor, engaging in policy dialogues, and building capacity and sharing knowledge. Among the projects that the initiative supported include hybrid solar photovoltaic (PV) mini-grids in Cobrador Island and Malalison Island (Philippines), run-of-river mini-hydropower in Dostekhor Khola (Nepal) and Mindanao (Philippines), solar micro-grid in Khotang and Okhaldhunga (Nepal), solar home system swarm electrification in Bangladesh,[5] solar PV and biomass-based systems in Myanmar, and wind–solar hybrid mini-grid in Nepal.

ADB had two initiatives on wind power, the Small Wind Initiative 2009 and the Quantum Leap in Wind Initiative 2011. Through the Quantum Leap Initiative, the Philippines increased its wind capacity from 33 megawatts (MW) to over 400 MW. On the other hand, the Asia Solar Energy Initiative 2010 aimed to create a cycle of solar investments in Asia and the Pacific that will help achieve grid parity.[6] Its 3-gigawatt (GW) target was achieved in 2015 when investments that totaled $1.9 billion resulted in 3.022 GW of solar power generation. It also established a regional knowledge platform, the Asia Solar Energy Forum, which bridged the information gap between suppliers and developers in the public and private sectors, and supported the growth of local solar energy competence in the developing countries of Asia and the Pacific.[7] The Philippines and Thailand were among the countries where solar projects were pilot-tested. Under this initiative, ADB installed a 567-kilowatt capacity solar PV power system at its Manila headquarters in 2012 to test and demonstrate the system's viability.[8]

In 2011, ADB consolidated past initiatives in energy access, energy efficiency, and renewable energy under an umbrella program, the Clean Energy Program.[9] The Clean Energy Program has become the cohesive program that encompasses and guides ADB's investments, initiatives, and plan of action for greener and low-carbon growth.[10] It aims to lower energy-related emissions (including carbon dioxide), extend supply of modern energy services to all, and improve economy-wide energy efficiency to effectively reduce

[3] ADB. 2015. *Clean Energy Program: Accelerating Low-Carbon Development in Asia and the Pacific Region*. Manila.
[4] Footnote 3.
[5] Swarm Electrification creates a micro-grid among households that utilizes surplus electricity from Solar Home Systems to power other households. A smart meter is used to monitor the "trading" of electricity among households.
[6] ADB. 2011. *Asia Solar Energy Initiative: A Primer*. April
[7] Footnote 1.
[8] Footnote 1.
[9] A full articulation of the Clean Energy Program was circulated through a memo on 26 July 2011 among ADB's then operations departments and other Communities of Practice (Footnote 1). Prior to the memo, ADB's Clean Energy Program was already supporting other energy initiatives (Footnote 3).
[10] Footnote 3.

the rate of growth of energy demand. Together, these objectives were to contribute to attaining energy security for ADB DMCs.

Clean Energy Financing and Investments

Climate change and the need for more clean energy solutions have been driving the development of green finance and other financing sources. The leadership of the public sector in establishing the appropriate policies and institutions is essential to enable and maximize the potential of green and other clean energy financing. Multilateral financial institutions, such as ADB, are keen to provide the impetus not only in imparting knowledge and capacity building, but also in leveraging the financial resources for supporting and creating markets, players, and project developers. ADB has been allocating resources from its own resources and raising and managing funds for climate finance. It has an array of financing instruments available to its DMCs and has played key roles in pioneering and enriching climate funding in Asia and the Pacific.

Clean Energy Financing Targets

ADB's Strategy 2030 has seven key operational priorities and one of these is to scale up support in tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability. ADB undertakes that at least 75% of its operations will support climate change mitigation and adaptation by 2030. Also, ADB aims to increase climate financing using its own resources to $80 billion cumulatively from 2019 to 2030.[11] This is a small amount to the estimated $4.8 trillion total investment needed from 2016 to 2030 for ADB DMCs to achieve the commitments they made on their NDCs.[12] Still, ADB's climate financing serves as a catalyst for other multilateral financial institutions and donors to sponsor and fund clean energy projects in Asia and the Pacific.

Since 2005, ADB has been setting investment targets for clean energy. Its Energy Efficiency Initiative had set the target of $1 billion annual investments in clean energy starting 2008, which was exceeded as total clean energy investment was estimated at $1.75 billion in 2008, $1.31 billion in 2009, and $1.76 billion in 2010.[13] ADB's Energy Policy 2009 has increased the target investment in clean energy from $1 billion to $2 billion annually starting 2013 (Figure 1).[14]

The target for clean energy investments was met ahead of schedule in 2011 with $2.13 billion. ADB had been investing more than $2 billion annually since, except from 2018. ADB's total clean energy investments started to decline from 2016 with the falling costs of solar power and onshore wind (two of the key renewable energy sources) globally and changing market conditions with reduced subsidies.[15] These developments have allowed commercial banks to play greater role in clean energy investments, taking over substantial portions from multilateral development banks.

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[11] Footnote 2.

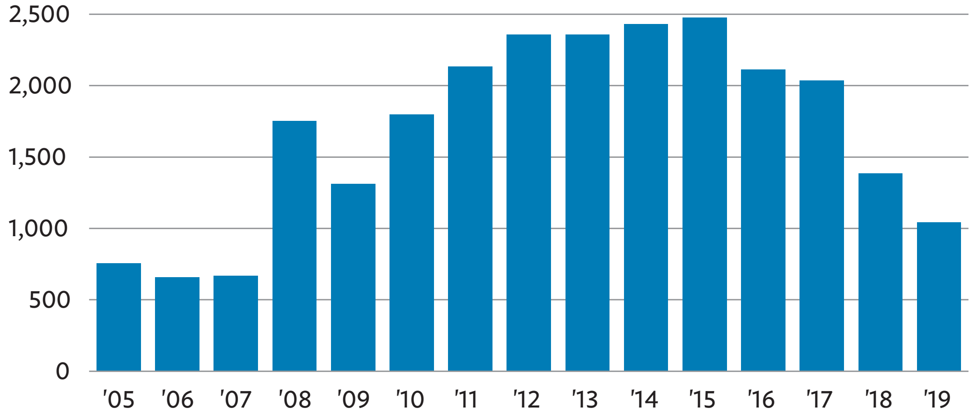
[12] Zhai, Y. Mo, L., and Rawlins, M. 2018. The Impact of Nationally Determined Contributions on the Energy Sector: Implications for ADB and its Developing Member Countries. *ADB Sustainable Development Working Paper Series*. No. 54. July.

[13] ADB. 2014. *Technical Assistance Completion Report – TA 6392-REG: Supporting the Implementation of the Energy Efficiency Initiative in Developing Member Countries*. Manila.

[14] Asian Development Bank. 2009. *Energy Policy*. Manila.

[15] Zhai, Y., and Lee, Y. 2019. *Global Renewable Energy Investment is Slowing Down. Should We Worry?* Asian Development Blog.

Figure 1: ADB Investments in Clean Energy, 2005–2019
($ million)



Source: Energy Sector Group, Asian Development Bank (ADB).

At the United Nations Climate Change Summit in September 2015, ADB was the first multilateral development bank to make a strong climate commitment. ADB committed to scale up climate financing from its own resources to $6 billion annually by 2020, $3 billion of which is energy-related mitigation investments. ADB met this commitment a year earlier as it doubled its climate-related financing to more than $6 billion in 2019 from $3 billion in 2014.[16] This comprised $1.4 billion for financing adaptation and $4.8 billion for mitigating climate change.[17] Climate mitigation activities include expanding support for renewable energy, energy efficiency, and sustainable transport; and building smart cities.[18]

For 2005–2019, ADB investment in clean energy and climate mitigation is estimated to total to about $25 billion. A significant portion was invested in large hydropower plants, many small solar and wind projects, and geothermal. ADB also invests substantially on transmission and distribution that integrate renewable energy into the system. To manage the intermittency of renewable energy, ADB has been funding energy storage and energy management systems. The corresponding cumulative carbon dioxide (CO_2) emissions reduction from these investments for 2005–2019 is estimated at 55 million tons of carbon dioxide equivalent (tCO_2-eq) per year, and additional installed capacity using renewable energy is approximately 38 GW.

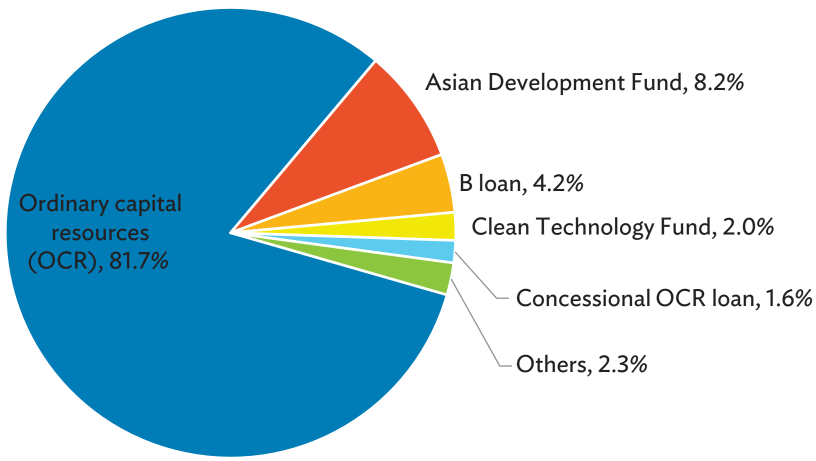
Clean Energy Fund Sources

ADB's ordinary capital resources (OCR) finance most of its lending, while trust and special funds, which largely consist of Asian Development Fund (ADF), finance the grants and technical assistance to the ADB DMCs. DMCs that have attained a higher level of economic development can avail of regular market-based OCR loans, while lower-income DMCs are offered concessional OCR loans. Paid-in capital, retained earnings (reserves), and proceeds from debt issuance—which include Green Bonds—fund OCR.[19] Funding sources for ADF mainly come from contributions of ADB's member countries, while sources for other trust funds are from financing partners and donors that may involve partnerships with private entities and member countries.

[16] ADB. 2019. ADB Meets Commitment to Double Annual Climate Financing to $6 Billion. *News Release*. 9 December.
[17] Nakao, T. 2019. Banking on Action: How ADB Achieved 2020 Climate Finance Milestone One Year Ahead of Time. Op-Ed - Opinion. Asian Development Bank. 9 December.
[18] Footnote 1.
[19] ADB. Funds and Resources: Ordinary Capital Resources.

OCR financed most of the clean energy and climate mitigation investments representing about 82% of the total financing for 2005–2019 (Figure 2). Special and trust funds make up the rest of the funding sources, and collectively contributed approximately 13% of the total clean energy and climate mitigation investments. Through loan syndications or B loans where ADB acts as lender of record, commercial banks and other eligible financial institutions funded about 4.2% of the total clean energy and climate mitigation investments.

Figure 2: Cumulative Clean Energy Investments by Fund Type, 2005–2019



Note: B loan refers to loan syndication; and OCR= ordinary capital resources.

Source: Energy Sector Group, Asian Development Bank.

To further its pursuit of environmentally sustainable growth, ADB has tapped into the green bond market to support climate mitigation and adaptation in its DMCs.[20] Green bonds have become common in Europe and the United States as more companies issue this instrument to finance plant development, but they are at a nascent stage in Asia except in the People's Republic of China (PRC).[21] Launched in 2015, ADB's Green Bond program has raised around $7.6 billion to date.[22] Proceeds from green bonds are allocated to a special sub-portfolio, which is linked to eligible projects.[23] The two initial considerations before investing in green bonds are the involvement of a company or project in renewable energy and energy efficiency projects, and their creditworthiness as with any other loans.[24] As of 31 December 2019, the allocation of ADB's green bond commitment to energy-related investments was approximately 29% of the total (Figure 3).

20 ADB. Asian Development Bank Green Bond Framework.

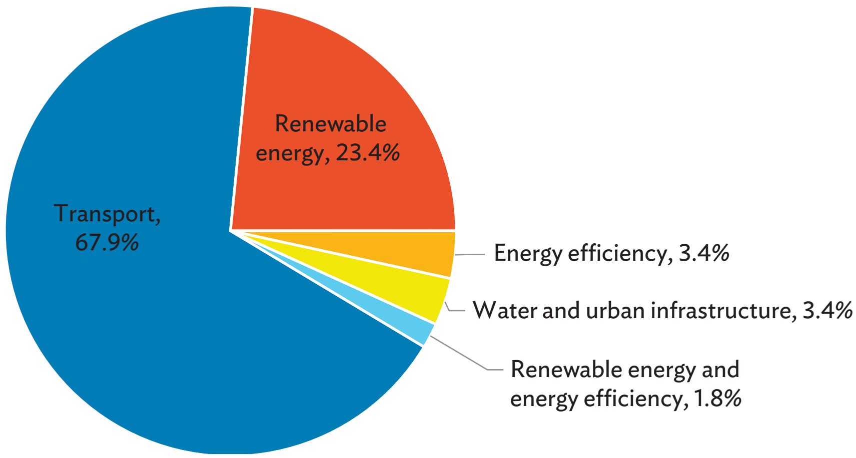
21 Isaac, D. 2019. Asian Development Bank Invests in Asian Renewables Developers' Maiden Green Bonds. *Asian Power: In Focus*. 19 March.

22 ADB. 2020. *ADB Green Bonds Newsletter and Impact Report*. Issue No. 5. July. Manila.

23 Footnote 20.

24 Jackie Surtani, ADB's Director of Infrastructure Finance for East Asia, Southeast Asia and the Pacific in an interview with Asia Power (Footnote 21).

Figure 3: ADB Green Bond Commitment by Sector (as of 31 December 2019)



Source: ADB. 2020. ADB Green Bonds Newsletter and Impact Report. Issue No. 5. July.

The ADF and Clean Technology Fund (CTF) are two of the trust funds that contributed the most to the total clean energy and climate mitigation investments for the period 2005–2019 with approximately 8% and 2%, respectively (Figure 2).[25] ADB administered and established other trust funds that help build capacity, develop institutions, and foster development in clean energy. Donor contributions have created a number of clean energy funds, and led to the eventual establishment of the Clean Energy Financing Partnership Facility (CEFPF) on 24 April 2007.

The CEFPF finances the deployment of innovative and more efficient clean energy technologies that result in GHG mitigation. It also supports institutional, policy, and regulatory reforms that encourage clean energy development.[26] As of 31 December 2019, CEFPF's cumulative project allocations to clean energy projects amounted to $264 million and supported 198 projects. The projects are expected to contribute about 24.8 terawatt-hours (TWh) equivalent of energy savings per year, 2,351 MW installed capacity of renewable energy, 7.8 TWh of renewable energy generation per year, and 24.8 million tCO_2-eq emission reduction per year.[27]

ADB Financing Modalities

Clean energy projects, which are important conduits to ADB's pursuit of inclusive and sustainable development, can avail of ADB's sovereign (public) and nonsovereign (private) financing.[28] Sovereign financing could be in the form of loans, grants, technical assistance, guarantees, and debt management products. Nonsovereign financing could be loans, guarantees, equity investments, or other financing

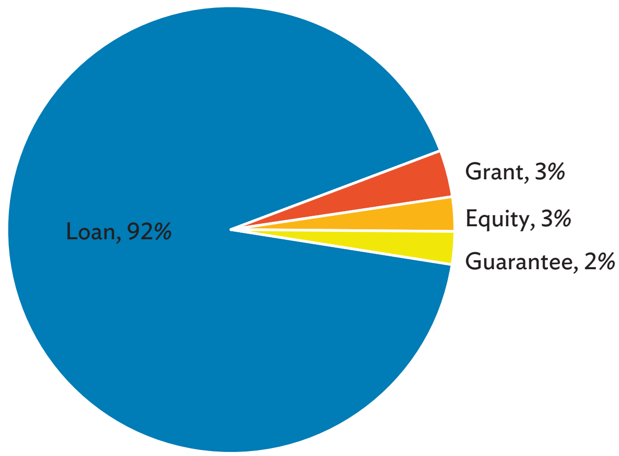
[25] The CTF is one of the two pools of financial resources under the Climate Investment Fund, the other being the Strategic Climate Fund. The CTF finances pilot-testing initiatives that demonstrate, deploy, or transfer low-carbon technologies to recipient developing countries.

[26] CEPFP comprises several funds that are supported by various governments: (i) the Clean Energy Fund by Australia, Norway, Spain, Sweden, and the United Kingdom; (ii) the Asian Clean Energy Fund by Japan; (iii) the Carbon Capture and Storage Fund by the Global Carbon Capture and Storage Institute and the United Kingdom; and (iv) the Canadian Climate Fund for the Private Sector in Asia by Canada.

[27] CEFPF. 2020. *CEFPF 2019 Annual Report*.

[28] ADB Public Sector (Sovereign) Financing – Financial Products and Modalities.; and ADB Private Sector (Nonsovereign) Financing – Financial Products: Private Sector Financing.

Figure 4: Clean Energy Investments by Modality, 2005–2019



Source: Energy Sector Group, Asian Development Bank.

arrangement—such as B loan to privately held, state-owned, or subsovereign entities.[29] B loan otherwise known as loan syndication, are funded by commercial banks and other eligible financial institutions with ADB acting as lender of record.[30] Approximately 4.2% of total clean energy investments for the period 2005–2019 were funded by B loan and many are located in the PRC (Figure 2). For the same period, approximately 91.8% of the total $25 billion clean energy and climate mitigation investments—covering both sovereign and nonsovereign financing—had been given out as loans to DMCs (Figure 4). Small percentages were provided to DMCs as grants (3.4%), equities (2.5%), and guarantees (2.4%).

Loans to the public sector come in various modalities: London interbank offered rate (LIBOR)-based loans, local currency loan product, concessional OCR loans, results-based lending (RBL), and multitranche financing facility. RBL has been added to the financing modalities of ADB in September 2019, and cases studies from Indonesia and Pakistan give an overview of RBL to enhance access to sustainable energy (Box 1).

Grants are offered to the poorest borrowing countries of ADB. Samples of projects under the grant components of investments are pilot-testing new technologies and business models; deploying less polluting, more efficient, and innovative technologies; and providing technical assistance. The technical assistance could be in the form of capacity building, economic and sector research, knowledge and experience sharing, project preparation, technology transfer, and standard and code development.

Equities amounting to $627.85 million were invested in private sectors that were involved in renewable technologies, energy efficiency, and cleaner fuel, particularly in solar, wind, small hydro, waste to energy, district cooling, and combined cycle gas turbine for 2005–2019. ADB provided guarantees to clean energy projects amounting to $418.11 million in the same period.

[29] In each case, (i) without a government guarantee; or (ii) with a government guarantee, under terms that do not allow ADB, upon default by the guarantor, to accelerate, suspend, or cancel any other loan or guarantee between ADB and the related sovereign.

[30] ADB. 2010. Commercial Cofinancing and Guarantees. Manila.

Box 1: Result-Based Lending for the Transition to Sustainable Energy

Following a 6-year pilot period, the Asian Development Bank (ADB) has made results-based lending (RBL) a regular financing modality for its operations in September 2019. RBL is a performance-based form of financing, where disbursements are linked to the achievement of results rather than to upfront expenditures (as is the case with traditional investment lending).[1] Out of the 22 projects in 12 developing member countries that have been approved to use the RBL modality, one supports Indonesia's transition to sustainable energy, while another gives Pakistan access to clean energy investment program. Both RBLs are ongoing.

The project in Indonesia, Sustainable Energy Access in Eastern Indonesia-Electricity Grid Development Program, which was approved on 14 September 2017, aims to support the development of electricity distribution networks to connect residential, commercial, and industrial customers in the Eastern Indonesian provinces in Sulawesi and Nusa Tenggara. Out of the $600 million total loan amount, the component that involves climate mitigation amounted to $72.35 million. This project complements two other loans that finance the construction, operation, and maintenance of solar and wind power plants in Eastern Indonesia and collectively, all three loans intend to contribute to reducing greenhouse gas emissions.[2] Disbursement of the $600 million hinges on the achievement of disbursement-linked indicators (DLIs).

The DLIs monitor number of total customers, annual sales of electricity sales, feeder line permanent interruptions, number of installed distribution transformer units, length of installed medium-voltage distribution lines, implementation of pilot-scale smart grid projects, enhancement of operational efficiency and resource optimization (use of digital prepaid or smart meters), and improvement of asset and waste management. The loan is almost fully disbursed as most DLIs have been partially achieved, and three exceeded and are within target.[3]

Familiar, reasonable, and achievable DLIs have been contributing to the successful implementation of the RBL for Eastern Indonesia. In this project, the DLIs do not require separate measurement efforts as they are already being tracked by the management information systems of the state electricity corporation, Perusahaan Listrik Negara (PLN). While ambitious, the DLIs have been achievable measures of progress as they were developed in consultation with experienced PLN planners. They are also as close as possible to the government-driven Electric Power Supply Business Plan of PLN (or the Rencana Usaha Penyediaan Tenaga Listrik) targets, and have considered PLN's actual performance during 2010–2016.[4]

The other RBL project in Pakistan, Access to Clean Energy Investment Program, was approved in 25 November 2016 with a loan amount of $403.6 million. It aims to contribute to the national goal of enhanced energy security. One of its four components is the installation of micro-hydropower plants in rural off-grid areas, and decentralized solar plants for education and primary health care facilities.

DLIs included monitoring of power generation capacity added from clean energy sources and number of locations with installed renewable energy-based power plants; ensuring that benefits accrue to girls and women; improving governance, procurement, and financial management; promoting effective performance monitoring; and tracking progress on energy efficiency measures. The overall conclusion of the audit conducted in 2019 is that compliance to contractual obligations and rules is critical for the success of the project.[5]

Notes and Sources:

[1] ADB. Results-Based Lending for Programs.

[2] Eastern Indonesia Renewable Energy Project comprising Phase 1: 72 megawatts (MW) wind power plant in South Sulawesi, and Phase 2: 21 MW solar in North Sulawesi and three 7 MW solar in West Nusa Tenggara.

[3] Update as of 30 June 2019. Indonesia: Sustainable Energy Access in Eastern Indonesia-Electricity Grid Development Program. Sovereign Project 50016-001.

[4] ADB. 2020. *Project Implementation Document: Perusahaan Listrik Negara Sustainable Energy Access in Eastern Indonesia—Electricity Grid Development Program*. November.

[5] Government of Punjab Energy Department. 2019. *Access to Clean Energy Investment Program: Energy Department, Government of the Punjab Audited Project Financial Statements* (*July 2017-June 2019*).

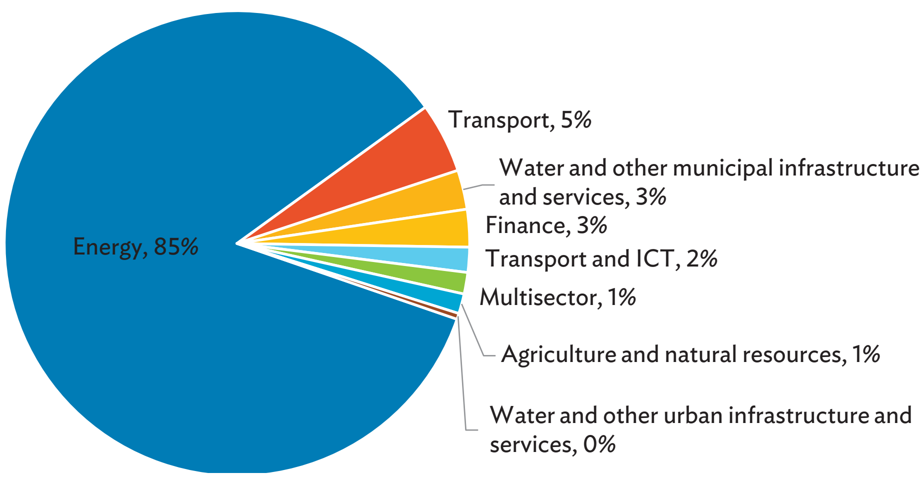
A set of new modalities has been approved to support the implementation of Strategy 2030, and this comprises guarantees in group A countries, policy-based guarantee, project readiness financing, and small expenditure financing facility.[31] Appendix 2 summarizes ADB's available financial products and modalities for development projects, which include clean energy investments.

ADB Clean Energy Financing among Its Developing Member Countries

Investment in the energy sector make up approximately 85% of the total clean energy and climate mitigation investments for 2005–2019 (Figure 5). With ADB's announcement in 2015 that it will invest $6 billion annually in climate finance by 2030—$3 billion of which will be energy-related mitigation investments—a new methodology for counting clean energy investments was adapted from 2016.[32] Only investments in the energy sector were counted as clean energy investments because ADB had to align its methodology the multilateral development banks' Technical Working Group on Climate Finance.[33]

South Asia had the highest share of total clean energy and climate mitigation investments at about 36%; with India having the largest share in the region and 24% of total clean energy and climate mitigation investments, followed by Bangladesh at 7%. Southeast Asia had almost a fourth of the total investments with Indonesia (5%), Thailand (5), Viet Nam (4%), and the Lao People's Democratic Republic (PDR) (4%), as top recipients. A fifth of the total investments went to East Asia, as significant amounts were received by the PRC (Figure 6).

Figure 5: Clean Energy and Climate Mitigation Investments by Sector, 2005–2019



ICT = information and communication technology.

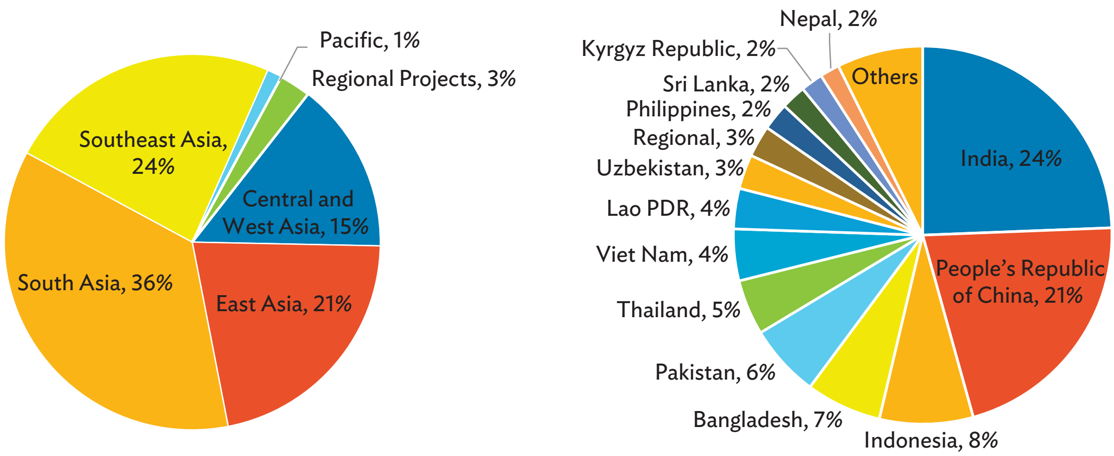
Source: Energy Sector Group, Asian Development Bank.

31 Group A (concessional assistance-only) countries are those in need of greatest concession and are eligible for ADF) grants: Afghanistan, Bhutan, Cambodia, Kiribati, Kyrgyz Republic, Federated States of Micronesia, Lao People's Democratic Republic, Maldives, Marshall Islands, Nauru, Nepal, Samoa, Solomon Islands, Tajikistan, Tonga, Tuvalu, and Vanuatu. List as of 26 March 2021.

32 Footnote 1.

33 See Appendix Table A1 for a comparison of the previous and current methodologies.

Figure 6: Clean Energy and Climate Mitigation Investments by Subregion and Country, 2005–2019



Lao PDR = Lao People's Democratic Republic.

Source: Energy Sector Group, Asian Development Bank.

Prospects in Clean Energy Financing with ADB Strategy 2030

Moving forward, and with the ADB Strategy 2030 as the backdrop of clean energy investments, ADB will sustain its efforts, while looking into multisector concerns and aiming to deliver integrated and relevant solutions for sustainable development and low-carbon growth. The following are under consideration to further the reach of the ADB Clean Energy Finance.

Promoting clean energy uptake through a multisector approach. With the ADB Strategy 2030's One ADB Approach[34] and the global transition to low-carbon economy, projects that provide modern and sustainable energy could be achieved with expertise and knowledge from various sectors—agriculture, commercial, industry—and the private and public sector operations working together. A multisector approach in clean energy investments could mitigate the risks and leverage the benefits for ADB's DMCs, and will more likely result in a progressive, inclusive, resilient, and sustainable growth.

Providing modern energy access to all including cooking, cooling, and heating. While ADB has extended assistance to numerous clean energy projects, much are focused on providing electricity access and improving energy efficiency. Ensuring universal access to modern and reliable energy, however, includes not only electricity but also cooking, cooling, and heating. Available data on clean cooking show prospects for ADB assistance to approximately 1.67 billion people in developing Asia who have no access to clean cooking, with about 1.46 billion still relying on traditional biomass, as of 2018.[35] Investments in access to clean cooking require less in terms of amount, but their social development impacts transcend health, gender, agriculture, and rural development.

[34] The One ADB Approach brings together knowledge and expertise across ADB to effectively implement Strategy 2030.
[35] IEA. 2019. World Energy Outlook 2019. Paris.

On cooling, the scope of work is also huge as an estimated 592.7 million in Asia do not have access to cooling for essentials such as food and health.[36] Cooling can help in achieving universal health care, and is key to distributing vaccines to billions of people to eradicate coronavirus and other diseases. It is also important for food security as agricultural produces and perishable goods have to travel miles and cross borders. For those living in hot climates, such as DMCs in South Asia, productivity and well-being have become dependent on the availability of cooling technologies. Exploring options that use clean energy will make cooling solutions more sustainable and accessible.

On heating, ADB interventions have centered on the PRC given its high demand for space heating. The projects involved the introduction of renewable energy, mostly geothermal, and energy-efficient construction and operation of district heating. The biggest project, Shandong Province Clean Heating and Cooling, combines renewable energy technologies and waste heat recovered from industry and power plants. Support amounting to $750 million has been allocated from the Clean Energy Financing Partnership Facility since 2018. The use of low-carbon, low-emission, and energy-efficient district heating systems can be explored and replicated in other DMCs that experience cold winters, such as Mongolia, and other DMCs in Central and West Asia.

Promoting energy efficiency alongside the use of renewable energy resources. The projects of ADB that improve energy efficiency were fewer by number and type and less in volume compared to those that promote renewable energy. A review of the Clean Energy Progam of ADB conducted in 2019 (published in 2020) notes that while energy efficiency projects have great potential in reducing CO_2 emissions, they also require great effort and attention as they are more complex. Implementation of energy efficiency projects is not as straightforward, and their outcomes are not as tangible as those of renewable energy projects.[37]

ADB would have to accelerate the efforts in promoting energy efficiency solutions for the DMCs to simultaneously conserve economic and environmental resources, while bolstering the performance of existing energy infrastructure.[38] Complementing energy efficiency projects with renewable energy resources will strengthen ADB's efforts in realizing a low-carbon future for Asia.

Exploring and developing the potential of demand-side energy efficiency—such projects are lagging behind supply-side energy efficiency—in buildings, households, industries, offices, and transport can further help the transition to low-carbon. ADB could assist its DMCs in adopting digital technologies, such as artificial intelligence and big data, to enable consumers to save electricity through real-time demand–response applications. On the other hand, ADB can continue to foster supply-side energy efficiency with upgrades to and replacements, or new utilities using renewable energy resources.

Using the appropriate business models to make clean energy more viable and affordable. ADB has been pilot-testing not only technologies but also business models in clean energy projects to test for viability and scalability. It has witnessed the decline in the unit cost of solar PV system and onshore wind power through more private sector participation and timely government and development support. The costs of other equipment (such as batteries) necessary for adopting and increasing the use of renewable energy sources will likely decline as more users and developers get involved. In the meantime, ADB can contribute through continued pilot-testing, exploring not only new technologies, but also discovering new ways of doing business and encouraging participation at all levels.

[36] Sustainable Energy for All. 2020. *2020 Chilling Prospects—Tracking Sustainable Cooling for All.*

[37] Footnote 1.

[38] ADB. 2013. *Same Energy, More Power: Accelerating Energy Efficiency in Asia*. Manila.

Acceptance and accountability are nurtured when ADB involves the stakeholders at the onset. As Asia and the Pacific has to deal with last-mile electrification of isolated and remote rural areas, communities and community "champions" are important for successful project implementation. On the other hand, where private sector participation is feasible, it would be better to get them involved to increase the viability and longevity of the projects. Development in other modern energy services, access to clean cooking fuels and technologies, and access to clean cooling and heating, as well as in promoting energy efficiency, would have to level up, and they could do so with the use of appropriate business models.

In crafting innovative business models, the One ADB Approach—that is, bringing together the expertise of ADB from different fields—is helpful in generating dynamic and integrated solutions. ADB's assistance in having more relevant knowledge products, technical assistance, and capacity building that explore a wider range of business models could help increase the viability and scalability of the clean energy solutions, and lessen the risk associated with the clean energy investments.

Advancing high technology to improve energy efficiency. ADB has started transferring and deploying low-carbon technologies from developed to developing economies, or between developing countries, to help mitigate and adapt to climate change impacts. ADB also plans to pilot-test virus-resilient and energy-efficient centralized air conditioning systems. Advancing these technologies will further increase energy efficiency and contribute to climate mitigation efforts and respond to the immediate needs to overcome the coronavirus disease (COVID-19) pandemic. Partnership with private sector entities who lead technological evolutions and innovations may contribute to this endeavor.

Strengthening infrastructures and equipment for better renewable reliability and resilience.[39] ADB contributes to the energy transition not only through investments in renewable energy technologies, but also in transmission and distribution (T&D) systems to integrate renewable energy generation. Moving forward, ADB has to invest more, and update the T&D systems with smart grid technologies and energy storage systems. Digitization in electricity networks has become critical for monitoring, control and dispatch, trading, and storage.

The relative abundance, wide application, and commercial availability of solar and wind power necessitate good energy storages to manage their variable output and realize their full economic value. With their modular nature, solar and wind power could be utilized as part of on-grid and off-grid systems. As ADB deals with last-mile electrification, distributed energy mini-grids, often powered by solar and wind (and small hydro), play important roles in providing electricity to the remote and isolated areas of the DMCs. Smart grid technologies and energy storage systems are needed to manage variable output from these power sources. Another possibility is for centralized grids to have renewable energy mini-grids with the capability to operate in "island" mode. Such setup can provide a load-balancing function for the centralized grid, and is currently done in developed countries like Sweden.

Fortifying the T&D systems and investing in energy storages will ensure that the electricity systems remain reliable and resilient and are ready for the transition to sustainable energy. As the DMCs strive to join the global transition to sustainable energy and low-carbon growth, their grids need greater ability to absorb more intermittent renewable power generation.

[39] This section refers to Zhai (2018), and Zhai and Lee (2019).

Conclusion

Sustained efforts and the drive to stay relevant have enabled ADB to respond to changing demands. As development takes a shift to sustainable and low-carbon growth, so did the energy initiatives of ADB. Since access to energy goes hand-in-hand with economic growth and social development, the need to adopt greener and cleaner technologies have become vanguards in attaining the global climate goals and pursuing a prosperous, inclusive, resilient, and sustainable Asia and the Pacific. ADB has been providing financial and technical assistance to its DMCs for them to achieve their individual Nationally Determined Contributions (NDC) and collectively, Asia and the Pacific could contribute to reducing greenhouse gas (GHG) emissions and mitigating climate change.

A wide range of financing modalities are available to the DMCs for clean energy development. Among them are loans, grants, guarantees, equities, and debt financing. Sources of funding continue to expand as donors volunteer their resources, partnerships are forged, and new capital markets such as the green bonds are developed. ADB promotes synergy within the bank and directs everyone's energy toward inclusive and sustainable development, which includes advancing climate mitigation and adaptation and fostering environmental sustainability.

ADB will need to continue engaging its DMCs in projects and investments that promote clean energy. Prospects for clean energy financing include promoting clean energy uptake through multisector approach; providing modern energy access to all including cooking, cooling, and heating; promoting energy efficiency alongside the use of renewable energy resources; utilizing the appropriate business models to make clean energy more viable and affordable; advancing high technology to improve energy efficiency; and strengthening infrastructures and equipment (T&D and energy storage) for better renewable energy reliability and resilience.

The potential for a clean energy market in Asia and the Pacific is huge, which means a lot still needs to be done to achieve the commitments set in the Sustainable Development Goals (SDGs) and Paris Agreement. The COVID-19 outbreak also presents opportunities for clean energy finance to support the collective action to overcome the pandemic. ADB could help overcome the lack of adequate financing mechanisms, absence of enabling policy framework, and low awareness of technologies and business models through the combined expertise and knowledge across its organization, and partnership with the governments, private sector, other multilateral financial institutions, nongovernment organizations, communities, and other stakeholders.

Appendixes

Table A1: Accounting of Clean Energy Investments and Climate Finance, Comparison of Previous (until 2015) and Current (from 2016) Scope and Methodology

	Clean Energy Investments	Climate Finance
Period	Up to 2015	From 2016
Governing Procedure	Manual for Calculating Energy Output Indicators, February 2011	Guidance Note on Counting Climate Finance in Energy, January 2017
Guidance Base	ADB Methodology	ADB Methodology based on the Joint MDB Approach
Scope and Coverage	• Clean energy components of energy and non-energy projects • Energy efficiency • Renewable energy • Fuel switching • ADB resources (Asian Development Fund, concessional ordinary capital resources lending, and ordinary capital resources) • Cofinancing administered by ADB	• Energy sector operations • Climate adaptation and mitigation activities • Fuel switching • ADB resources (Asian Development Fund, concessional ordinary capital resources lending, and ordinary capital resources) only
Exclusions	Projects that will not bring about reduction of greenhouse gas emissions	Greenfield fossil fuel-based power generation including gas-fired power projects

ADB = Asian Development Bank, MDB = multilateral development bank.

Source: ADB. 2020. Review of the ADB Clean Energy Program. Manila.

Table A2: The ADB Financing Modalities

Public (Sovereign) Financing	Private (Nonsovereign) Financing
LIBOR-based loans	Loans and other debt instruments
Local currency loan product	Equity investments
Concessional OCR loans	Guarantees
Debt management products	B loan, lender of record, or loan syndication
Results-based lending	Technical assistance
Multitranche financing facility	
Project readiness financing	
Small expenditure financing facility	
Policy-based guarantee	
Guarantees in group A countries—those in need of greatest concession and are eligible for ADF grants	

ADF = Asian Development Fund, LIBOR = London Interbank Offered Rate, OCR = ordinary capital resources.

Sources: Asian Development Bank (ADB). Public Sector (Sovereign) Financing – Financial Products and Modalities; and ADB. Private Sector (Nonsovereign) Financing – Financial Products: Private Sector Financing.

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4 Enabling Private Sector Investments in Renewable Energy Development in the Pacific

Alix Burrell, Olly Norojono, Alexander Jett, and Fely Arriola

Introduction

Achieving energy security in Pacific island countries is difficult due both to their distance from economic hubs and their small economic bases, which work against them creating economies of scale. The remoteness of the region translates to higher costs of goods and services, including for the petroleum products that the majority of Pacific countries rely on for energy supply. Renewable energy is a viable option to complement fuel imports and increase energy security.

Most Asian Development Bank (ADB) Pacific developing member countries (P-DMCs) have set an ambitious target to transition to renewable energy between 2020 and 2030. While the political will is strong, the high investment required to develop renewable energy projects hinders their implementation. Commercial and public sector financing for grid-connected renewable energy projects are insufficient.

Private sector investment is crucial in bridging the investment gap in the power sector in the Pacific, but it is restricted due to several risk factors, such as uncertainties over foreign currency availability and convertibility, political risks, and a low capacity of governments and utilities to engage the market and prepare bankable power purchase agreements (PPAs).[1] Private developers depend on government guarantees to backstop the offtake obligations of the public power utilities to support the viability of their investments. In fact, ADB's private sector operations in the Pacific are quite modest. Since 2007, only one renewable energy project has been approved through private sector lending. The 4-megawatt (MW) solar project in Samoa, which was approved in 2017, is the only independent power producer (IPP) project to which private sector lending from ADB has been extended.

The Pacific Renewable Energy Program (PREP) was developed to encourage more private sector investments by offering financing instruments that minimize the risks in developing renewable energy projects in a fragile area like the Pacific. PREP is in line with the recently approved *Operational Plan for Private Sector Operations (2019–2024)*.[2] The operational plan directs ADB to increase its focus on highly innovative, smaller, and riskier projects in challenging markets while addressing climate change and increasing equality and support for women by identifying and implementing measures that benefit them. PREP uses an innovative approach to make renewable energy projects viable and create a substantial development impact to P-DMCs.

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1 ADB. 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Pacific Renewable Energy Program*. Manila.

2 ADB. 2019. *Operational Plan for Private Sector Operations, 2019–2024*. Manila. https://www.adb.org/sites/default/files/institutional-document/558661/op-private-sector-operations-2019-2024.pdf.

This chapter discusses the unique characteristics of P-DMCs and how PREP meets their energy and financing requirements. The salient features of PREP are also outlined, as well as its current status toward full implementation.

Economic Profile

ADB has 14 developing member countries (DMCs) located in the Pacific region. Samoa is an ADB founding member, while Niue is the latest addition, joining in 2019. With the exception of Fiji, Papua New Guinea (PNG), Solomon Islands, and Vanuatu, Pacific DMCs (P-DMCs) are geographically small, with the smallest, Tuvalu, having an area of 27 square kilometers (km^2). The largest Pacific member country in terms of both land area and population is PNG, which has a total land area of around 452,000 km^2 and a population of 9 million. Niue has the smallest population, with 1,700 people. The combined population of all P-DMCs excluding PNG is 2.5 million. Table 1 shows the profile of all P-DMCs.

Table 1: Profile of Pacific Developing Member Countries

Country	Population (persons)	Land Area (km^2)	GDP Per Capita (2019 $)	GDP Growth (%)	ADB Membership (year)
Cook Islands	19,203	237	19,139.6	5.3	1976
Fiji	895,003	18,333	6,134.2	0.7	1970
Kiribati	115,518	811	1,587.0	2.4	1974
Marshall Islands	54,774	181	4,198.7	3.8	1990
Micronesia, Federated States of	104,469	701	4,098.4	3.0	1990
Nauru	12,700	21	9,297.0	1.0	1991
Niue	1,738	259	15,197.0	6.5	2019
Palau	18,427	444	14,840.4	–3.1	2003
Papua New Guinea	9,287,988	462,840	2,677.5	4.8	1971
Samoa	201,000	2,934	4,231.3	3.5	1966
Solomon Islands	683,677	28,230	2,060.9	2.6	1973
Tonga	105,100	749	4,793.5	3.0	1972
Tuvalu	11,570	26	3,661.3	4.1	1993
Vanuatu	290,443	12,281	3,196.2	2.8	1981

ADB = Asian Development Bank, GDP = gross domestic product, km^2 = square kilometer.

Note: Estimates for population, GDP per capita, and GDP growth are for 2019 except for Niue (2018).

Sources:
ADB. 2020. *Asian Development Outlook: What Drives Innovation in Asia?*. Manila; Pacific developing member countries' statistics offices and central banks.
ADB. 2021. *Pacific Energy Update 2020*. Manila; ADB. 2019. ADB Operations in the Pacific. Manila; ADB. 2019. *Key Indicators for Asia and the Pacific: 50th edition*. Manila.

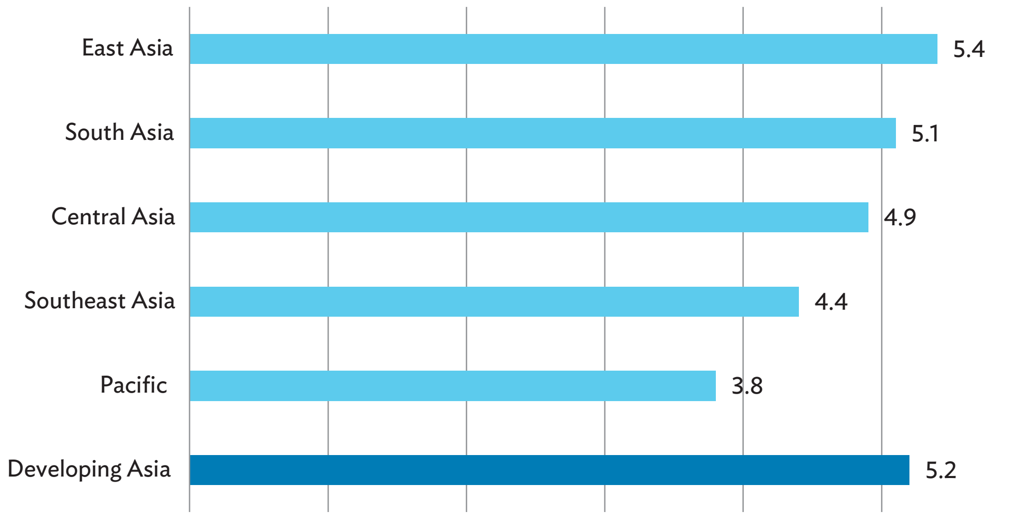
All P-DMCs are classified as small island developing states, a distinct group of developing countries facing social, economic, and environmental vulnerabilities. Five P-DMCs are included in the 15 countries with the highest disaster risk in the world. In order of facing most to least risk, they are Vanuatu, Tonga, Solomon Islands, PNG and Fiji. Vanuatu and Tonga rank first and third, respectively.[3]

[3] P. Mucke et al. 2019. *WorldRiskReport 2019*. Bündnis Entwicklung Hilft and Ruhr University Bochum–Institute for International Law of Peace and Armed Conflict (IFHV). `https://reliefweb.int/sites/reliefweb.int/files/resources/WorldRiskReport-2019_Online_english.pdf.

The vulnerability of P-DMCs to external shocks and climate change results in a high degree of economic volatility. The average gross domestic product (GDP) growth in the Pacific was estimated at 3.8% in 2019—a big leap from 0.4% in 2018. Growth in 2019, however, was still below developing Asia's average of 5.2% (Figure 1). The lower growth rate in 2018 was due to a major earthquake and tropical cyclones that hit the region in that year. The Cook Islands, PNG, and Niue grew above the regional average. Palau experienced negative growth rate of 3.1%, while Nauru and Fiji grew by 1% or below.

P-DMCs have varied income classifications. While most are lower and upper middle-income economies, goods and services are costly due to transport costs and smaller market sizes, so actual living standards are lower than statistics indicate, particularly in rural areas and outer islands. In terms of 2019 per capita GDP, the Cook Islands has the highest at $19,139, followed by Niue at $15,197. Kiribati has the lowest GDP per capita at $1,587 (Table 1). For comparison, New Zealand, a developed economy neighboring a number of P-DMCs, had a per capita GDP of $40,634.[4]

Figure 1: Gross Domestic Product Growth Rate by Subregion, 2019 (%)



GDP = gross domestic product.

Source: ADB. 2020. *Asian Development Outlook 2020 Update: Wellness in Worrying Times*. Manila.

Energy Sector Overview

Table 2 presents the energy profiles of the P-DMCs. Due to increasing electricity demand, total installed capacity grew at an average of 4.4% annually from 900 MW in 2000 to 1.7 gigawatts in 2019. Total annual electricity generation in 2019 amounted to around 4,000 gigawatt-hours, of which Fiji and PNG accounted for almost 80%.

[4] International Monetary Fund. 2019. New Zealand: Article IV Consultation—Press Release and Staff Report. *IMF Country Report No. 19/303*. Washington, DC. https://www.imf.org/en/Publications/CR/Issues/2019/09/20/New-Zealand-2019-Article-IV-Consultation-Press-Release-and-Staff-Report-48694.

Table 2: Energy Profiles of Pacific Developing Member Countries

Pacific Developing Member Country (P-DMC)	Total Installed Capacity (MW) 2019	Annual Electricity Generation (GWh) 2019	Access to Electricity (%) 2018	Access to Clean Cooking (%) 2017	Share of Fuel Imports to GDP (%) (2017–2018)	
Cook Islands	25	42	100	77	4.92	
Fiji	357	1,066	100	28	8.39	
Kiribati	9	29	100	5	5.89	
Marshall Islands	30	80	96	65	11.90	(2015)
Micronesia, Federated States of	29	63	82	8	8.71	
Nauru	18	51	100	90	9.60	(2015)
Niue	3	3	100	84	9.59	
Palau	33	85	100	95	12.90	(2015)
Papua New Guinea	1,037	2,136	59	8	1.18	
Samoa	60	154	100	35	8.28	
Solomon Islands	67	102	67	9	6.63	
Tonga	25	68	99	50	8.92	
Tuvalu	5	9	100	43	8.34	
Vanuatu	33	78	62	8	4.08	
P-DMC	**Total 1,731**	**Total 3,966**	**Average 90**	**Average 43**		

GDP = gross domestic product, GWh = gigawatt-hour, MW = megawatt, P-DMC = Pacific developing member countries.

Sources: International Renewable Energy Agency (IRENA). 2020. *IRENA Query Tool*. 2011–2020. https://www.irena.org/Statistics/Download-Data; The World Bank. 2020. *Tracking SDG 7: The Energy Progress Report 2020*. Washington, DC. https://trackingsdg7.esmap.org/data/files/download-documents/tracking_sdg_7_2020-full_report_-_web_0.pdf; ADB. 2019. *Pacific Energy Update 2019*. https://www.adb.org/sites/default/files/institutional-document/545686/pacific-energy-update-2019.pdf; F. Vukikomoala. 2019. *Status of and Matters Arising from Previous Communique and the Status of the Region's Energy Sector, 2019 Energy Transport Ministers' Meeting*. PowerPoint slides. Samoa. http://prdrse4all.spc.int/sites/default/files/e1-status_of_and_matters_arising_from_previous_communique.pdf.

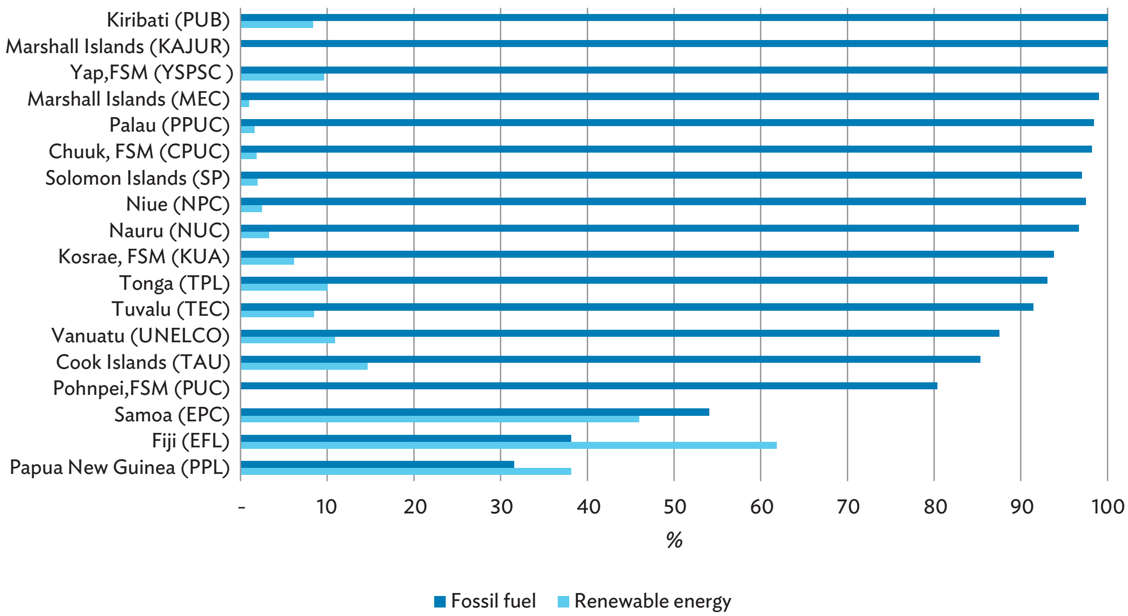
Dependence on Imported Fuels

Most power generation is from imported fuels, which translates to high and unstable energy costs. Figure 2 shows that only Fiji, PNG, and Samoa source a relatively larger portion of their power generation from renewable energy. Most of the islands are located far from a major oil refinery and are dependent on lengthy and complex fuel supply chains. On some islands, delivery of fuels is also constrained by a lack of modern port facilities. These challenges lead to higher fuel costs and exposure to price volatility and supply disruptions. For example, household electricity consumers in the Federated States of Micronesia, where around 90% of installed capacities are from fossil fuels, pay an average of $0.43 per kilowatt-hour (kWh).[5] This amount is almost four times higher than New Zealand, where consumers pay $0.11 per kWh. In reality, actual electricity production costs are most likely to be higher because some P-DMCs are provided with subsidies to lower the price paid by consumers, especially the poor. The Utilities Regulatory Authority of Vanuatu regularly conducts an annual electricity price comparison report to gather, compile, and disseminate current electricity pricing in the Pacific region. Its sixth Electricity Price Comparison report (2019)[6] reported

[5] World Bank. 2018. *Sustainable Development and Energy Access Project. Project Information Document*. Washington, DC.

[6] $1 = F$52.506 for Fiji, and $1 = T$48.405 for Tonga. See Utilities Regulatory of Vanuatu. 2019. *Pacific Region Electricity Bills Comparison Report*. Port Vila. http://ura.gov.vu/attachments/article/8/Feb%202019%20-%20Electricity%20Price%20Comparison%20Report%20-%20Pacific%20Area%20February%202019.pdf.

Figure 2: Renewable Energy and Fossil Fuels Contribution to the Grid



CPUC = Chuuk Public Utility Corporation, EPC = Electric Power Corporation, EFL = Energy Fiji Limited, FSM=Federated States of Micronesia, KAJUR = Kwajalein Atoll Joint Utilities Resources Inc, KUA = Kosrae Utilities Authority, MEC = Marshall Energy Company, NPC = Niue Power Corporation, NUC = Nauru Utilities Corporation, PPL = PNG Power Limited, PPUC = Palau Public Utilities Corporation,
PUB = Public Utilities Board, PUC = Pohnpei Utilities Corporation, RE = renewable energy, SP = Solomon Power, TAU = Te Aponga Uira O Tumu-Te-Varovaro, TEC = Tuvalu Electricity Corporation, TPL = Tonga Power Limited, UNELCO = UNELCO Vanuatu Limited, YSPSC = Yap State Public Service Corporation.

Sources: Pacific Power Association. 2019. *2018 Fiscal Year PPA Benchmarking Report*. Suva. https://www.ppa.org.fj/wp-content/uploads/2019/09/2018-FY-Benchmarking-Report_update_220719-FINAL.pdf, For Niue: Secretariat of the Pacific Community. 2015. Niue Energy Road Map for 2015–2025. Suva. https://niue-data.sprep.org/dataset/niue-strategic-energy-road-map-2015-2025/resource/c019970f-0b0c-446c-bef9-fe45c2469c61.

that monthly subsidies amounting to $9.54 and $15.14 are provided to domestic consumers using 60 kWh per month in Fiji and Tonga, respectively.

As a proportion of GDP (Table 2), imported fuel takes a noticeable share, with the Marshall Islands and Palau having a share of more than 10%. Despite rapid advances in renewable energy generation in practically all P-DMCs, the level of fuel imports in the region remain high. This is due to continuous growth in electricity demand, both by domestic consumers as countries provide access to their citizens and in the transport and industrial sectors.

Energy Efficiency

The Implementation of energy efficiency measures is critical for countries without fossil fuel resources such as P-DMCs. Efficiency improvements in energy usage can alleviate the financial burden of fuel imports and make the best use of existing power supply capacity to maintain and improve access to affordable electricity supplies. Any improvement in efficiency of fossil fuel usage may result in reduced investment needed for the expansion of electricity generation. Energy efficiency programs of a more universal nature that may be adopted by P-DMCs are demand-side measures, such as efficient lighting appliances, appliance labeling standards, and energy efficiency in buildings.

Energy efficiency is measured through the rate of primary energy intensity, which is the percentage decrease in the ratio of energy supply per year per unit of GDP. Average energy intensity in the Pacific was estimated at 5.66 megajoules per dollar (2011 purchasing power parity) in 2017, higher than the global primary energy intensity of 5.01 megajoules per dollar. This is most likely due to some P-DMCs failing to upgrade their power facilities compared with more developed economies.

The energy intensity improvements of P-DMCs are way below the targets set under the United Nation's Sustainable Development Goals (SDGs) for 2030. Between 2010 and 2017, the annual rate of improvements in P-DMCs' primary energy intensity was 0.9%, while the SDG target is 2.6%. Annual global improvement until 2030 will need to average more than 3% to meet the SDG target. As shown in Table 3, Nauru and Solomon Islands show improvement in their energy intensity at rates beyond the SDG target while Kiribati, the Marshall Islands, Palau, PNG, Tuvalu, and Vanuatu exhibit a rate of improvement below the region's average. Meanwhile, for the same period, Fiji, the Federated States of Micronesia, Samoa, and Tonga did not show any efficiency improvements at all.

Table 3: Energy Intensity, 2000, 2010, and 2017

Pacific Developing Member Countries	Energy Intensity, MJ/$ 2011 PPP			Compound Annual Growth Rate of Energy Intensity, %		
	2000	2010	2017	2000–2017	2000–2010	2010–2017
Cook Islands	No data					
Fiji	4.0	3.4	4.2	0.3	–1.6	2.1
Kiribati	5.5	7.4	6.3	0.8	3.0	–1.6
Marshall Islands	10.5	11.7	11.0	0.3	1.1	–0.6
Micronesia, Federated States of	5.8	4.5	6.1	0.3	–2.5	3.1
Nauru	17.1	8.8	3.5	–8.9	–6.4	–8.8
Niue	No data					
Palau	12.3	11.8	11.0	–0.7	–0.4	–0.7
Papua New Guinea	6.5	6.2	5.1	–1.4	–0.5	–1.9
Samoa	4.2	3.9	4.1	–0.1	–0.7	0.5
Solomon Islands	8.7	8.0	5.5	–2.7	–0.8	–3.7
Tonga	3.2	3.2	3.7	0.9	0.0	1.5
Tuvalu	3.4	3.9	3.7	0.5	1.4	–0.5
Vanuatu	4.0	3.9	3.7	–0.5	–0.3	–0.5
Average	7.1	6.4	5.7	–0.9	–0.6	–0.9

MJ = megajoule, PPP =purchasing power parity.

Source: The World Bank. 2020. *Tracking SDG 7: The Energy Progress Report 2020*. Washington, DC.

A number of energy efficiency projects have been implemented in recent years. The Government of Australia made some initiatives on appliance and labeling standards in a few countries in South Pacific.[7] ADB has supported a technical assistance project[8] to identify demand-side energy efficiency measures in the Cook Islands, PNG, Samoa, Tonga, and Vanuatu and assist in the preparation of follow-up energy efficiency projects. However, investments in energy efficiency are not gaining much traction, indicating a need to assess technical, commercial, and regulatory or other barriers. There are recent efforts from New Zealand and European partners to explore private sector participation in energy efficiency (footnote 8).

[7] ADB. 2020. Energizing Economies—ADB'S Pacific Energy Strategy, 2021–2025 (Draft report). Manila.

[8] ADB. 2011. *Regional: Promoting Energy Efficiency in the Pacific*. https://www.adb.org/projects/42078-012/main#project-pds.

Energy Access

More than half of P-DMCs have already attained 100% electricity access via both on-grid and off-grid sources. The Federated States of Micronesia, PNG, Solomon Islands, and Vanuatu have electricity access rates below the region's average of 90% (from lowest to highest, Table 2). The low electrification rate is predominantly due to the isolation of dispersed populations on small outer islands or in mountain villages, which results in high costs for connection to centralized power grids, high costs for installation and operation of localized power systems, and capacity constraints related to operation and maintenance.

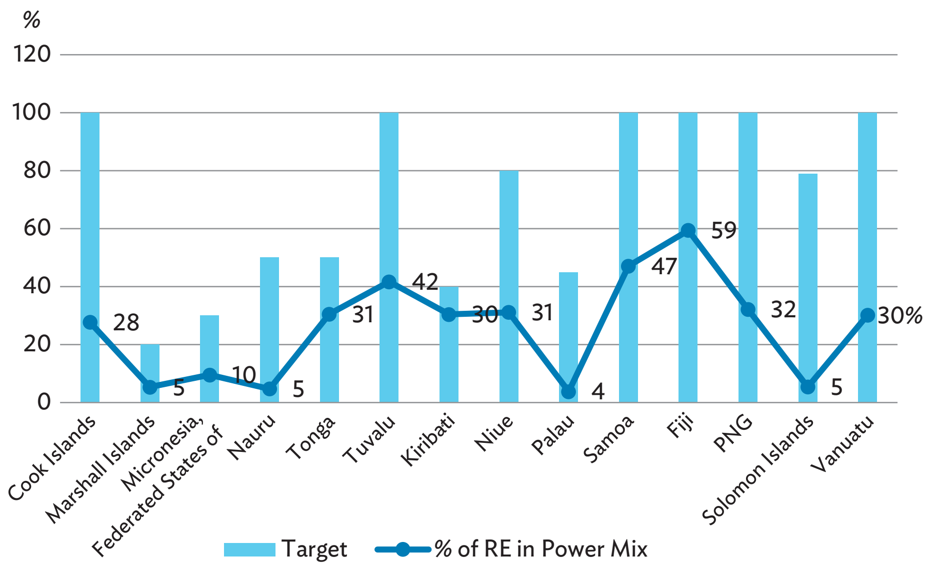
On average, 43% of the households in P-DMCs rely on the traditional use of biomass for cooking, though a majority of households in the Cook Islands, Nauru, Niue, and Palau already use clean energy cooking devices. Access to clean cooking is lower (less than 10%) in Kiribati, the Federated States of Micronesia, PNG, Solomon Islands, and Vanuatu (Table 2).

Renewable Energy Development

Deployment of Renewable Energy

As of 2021, renewable energy generation in the Pacific is limited but growing. The majority of current renewable energy installations are from historical hydropower investments in Fiji, PNG, and Samoa. In the past 5 years, all power utilities have installed some form of renewable energy systems, mainly solar and hydropower. Almost all countries have aggressive renewable energy targets. Future demand for renewable energy will be high as the region is still at an early stage in its structural conversion to this form of power.

Figure 3: Renewable Energy Targets vs. Actual Renewable Energy Installed Capacity[a]
(%)



PNG = Papua New Guinea, RE = renewable energy.

[a] Renewable energy investments taking place between 2017 and 2020 has most probably changed the renewable energy penetration profile.

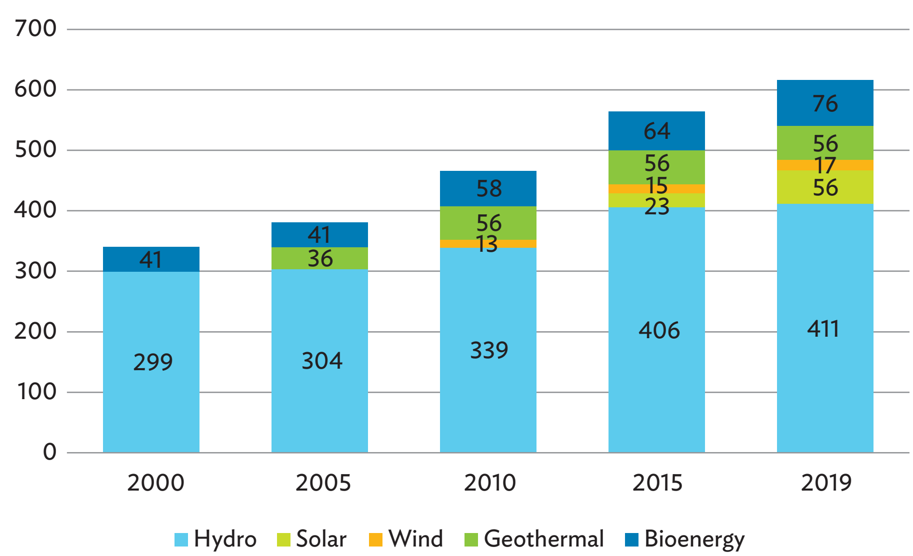
Sources: International Renewable Energy Agency (IRENA). 2020. *IRENA Query Tool*. 2011–2020. 2020. https://www.irena.org/Statistics/Download-Data; ADB. 2019. *2019 Pacific Energy Update*. Manila. https://www.adb.org/sites/default/files/institutional-document/545686/pacific-energy-update-2019.pdf; New Zealand Ministry of Foreign Affairs and Trade. 2016. *Pacific Energy Country Profiles*. New Zealand. https://apo.org.au/sites/default/files/resource-files/2016-06/apo-nid108461.pdf; Government of Nauru. 2018. *Nauru Energy Road Map: 2018–2020*. Nauru. http://prdrse4all.spc.int/sites/default/files/nerm_report_final.pdf; Government of Fiji. 2014. *Sustainable Energy for All: Rapid Assessment and Gap Analysis*. Fiji. https://policy.asiapacificenergy.org/sites/default/files/Fiji%20-%20SE4All%20Report.pdf.

Six P-DMCs have set an ambitious target of achieving 100% electricity generation from renewable energy by 2020–2030. Fiji and Samoa have already attained more than 40% of renewable energy penetration in their power generation mix. However, there are large gaps between targets and current renewable energy shares. For example, the Cook Islands and Tuvalu aimed for 100% renewable energy generation by 2020 but as of 2018, their renewable energy penetration to grid was only 14.6% and 8.4%, respectively. PNG and Vanuatu also have relatively lower renewable energy shares at 38.1% and 10.9%, respectively, but they still have sufficient time to work on more renewable energy initiatives as their target periods are within the next 5–10 years. Transitioning to renewable energy will require a significant scaling up of renewable energy technologies as well as access to finance.

Total renewable energy installed capacity in 2000 reached 340 MW, comprising only hydro and bioenergy (Figure 4). This increased to 466 MW in 2010 and 616 MW in 2019. The composition of renewable energy became more balanced from 2015, when all renewable energy sources were represented. Of installed clean energy capacity, solar is found across the region, with Fiji and Samoa having the largest installations at 14 MW and 10 MW, respectively. Other renewable energy sources, like geothermal, wind, bioenergy and hydro, are site specific and thus have been developed only in a few P-DMCs. For almost 2 decades, the largest capacity additions in clean energy have been in hydropower, with Fiji and PNG having a combined installed capacity of 396 MW.

These additions are still small compared to the increase in installed capacity of non-clean energy sources over the same time frame. Total installed capacity of nonrenewable energy in 2019 is estimated at 1,119 MW or around 65% of total installed capacity.[9] The higher share of nonrenewable energy is in part attributed to the need for reliable baseload power supply, low upfront capital costs, and relatively well-established supply chains.

Figure 4: Total Renewable Energy Installed Capacity by Technology (MW)



Source: 2011. International Renewable Energy Agency (IRENA). 2020. *IRENA Query Tool*. 2011–2020. https://www.irena.org/Statistics/Download-Data.

[9] International Renewable Energy Agency (IRENA). 2020. *IRENA Query Tool. 2011–2020*. https://www.irena.org/Statistics/Download-Data.

Barriers and Challenges

Transitioning to a low-carbon economy, specifically for power generation, would not only improve P-DMCs environmental outcomes but also help reduce expensive imports, reduce vulnerability to price volatility, and improve energy security. However, several hurdles need to be overcome to maximize the full potential of renewable energy in the region.

Technical Barriers

Due to the geographical layout of the region, not all renewable energy technologies are appropriate. The region is cyclone-prone and is located in highly corrosive environments. In addition, most P-DMCs consist of remote islands, which leads to a need to use lengthy supply chains.

The intermittency of renewable energy resources leaves the region with limited technical alternatives. Renewable energy sources such as wind, geothermal, and hydropower are site specific. Hydro is abundant in Fiji and PNG, and to some extent in Samoa and Vanuatu. Only PNG has a geothermal power plant, and this supplies power to the gold mining operations on the island. Development of geothermal and hydropower is costly and may not be cost-effective due to a limited market size and small project sizes. Wind has potential in limited areas, however, wind turbines must be specifically engineered to withstand strong typhoons and hurricanes, and are normally not cost-effective if required on a small scale. Solar photovoltaic is a proven technology and may be applicable elsewhere in the region, but integration could be difficult because some grids have already reached saturation levels. Crude coconut oil has been developed in some P-DMCs to blend with diesel for power generation. Tedious technical procedures like pre-heating and filtering occur, which may deter blending due to low capacity of power utilities. Crude coconut oil blending for vehicles has been unsuccessful due to technical complications.[10] A final major barrier to renewable energy development in the Pacific is land acquisition, particularly in Melanesia as land is owned mainly by local indigenous groups. Land issues are complicated due to the uncertainties about the nature of group ownership and uncertainty and division among landowners.[11]

Developing renewable energy projects in the region requires conducive policies and appropriate technical specifications to meet the specific geographies of each P-DMC.

Lack of Institutional Capacity and Policy Framework

The distribution utilities are important stakeholders in the power industry in the Pacific. Public utilities often perform vertically integrated functions, being in charge of the production, transmission (in some areas), and distribution of electric power. Various bilateral and multilateral development agencies have exerted efforts to improve the capabilities of utilities in providing electricity or other network services.

Public utilities face challenges in providing a quality service as they draw staff from a small pool of potential staff with required skills and knowledge, and face a drain of qualified personnel. Expertise in design and implementation of major projects needs to be enhanced to meet the growing demands of the power sector. Further, policy making and the coordination of donors, currently being handled by small government energy units, need to be strengthened and expanded to efficiently manage the sector and donors' support requirements. ADB lending in the power sector is almost 100% through national state-owned corporatized power utilities.

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[10] A. Maxwell. *Challenges for Renewable Energy in Asia and the Pacific [PowerPoint Slides]*. Training on Supporting Renewable Energy Deployment in Africa and Pacific Island Countries. 2014. Tokyo. https://www.mofa.go.jp/mofaj/files/000027960.pdf.

[11] S. Mecartney and J. Connell. 2017. Urban Melanesia: The Challenges of Managing Land, Modernity and Tradition. In S. McDonnell, M. G. Allen, and C. Filer, eds. *Kastrom Property and Ideology: Land Transformations in Melanesia*. Australia: Anu Press. https://press-files.anu.edu.au/downloads/press/n2414/pdf/book.pdf.

Building capability of utilities and energy units is critical. The energy sector is crowded by numerous donors and coordinated efforts are necessary to ensure that donor funding is used effectively. Capabilities should be strengthened particularly in managing multisource renewable energy generation, grid integration of intermittent generation from renewables, and in the conduct of regular operation and maintenance (footnote 12).

Regulatory and policy framework is often misaligned among P-DMCs, although to varying degrees. Most countries have broader renewable energy plans but lack regulatory processes to identify and prioritize renewable energy projects (footnote 12). Regulatory reform, therefore, is required. For example, larger countries have tariff setting regulation independent of utilities, while tariffs in smaller countries are typically set by the utilities. In most cases, customer bases and potential for market participant competition are so small that vertically integrated utilities are an acceptable model for the industry; sophisticated market regulation is not required. However, setting tariffs at a level that allows utilities to generate sufficient revenues to cover costs as well as invest in new infrastructure remains essential for sustainability.

Financing Gap

A big challenge the region is facing in shifting to cleaner fuel is financing. It is very expensive to move from the usual single diesel generation system to establishing new solar plants, hydropower, and even wind farms. While public sector financing can partly fill in the gap, national constraints and limitations on sovereign borrowing means that this option is not sufficient. Grant financing has played an important role in developing pilot projects but building large-scale renewable energy infrastructure requires more financial assistance. The need for private sector investment is crucial to augment the gap.

The participation of the private sector in investing in the region is relatively small but increasing along with a growing demand for IPPs. Investors are deterred by small project size, poor financial performance of power utilities, perceived political risk, as well as offtaker risk. In the last few years, several IPPs have invested in renewable energy projects but in just a handful of countries. P-DMCs need financing de-risking instruments, such as partial risk and political risk guarantees, to enable greater private sector participation in the uptake of clean energy projects. Market transformation will require a combination of these financial de-risking instruments, supplemented by direct financial and grant incentives in the initial years. This may help to widen and diversify the nature of investors interested in the P-DMCs and reduce the risk perceptions (and return requirements) from projects. Public–private partnership options, including joint ventures, may enable investments by the private sector in affordable energy solutions while addressing concerns around private sector ownership and long-term commitments.

Overcoming Barriers and Identifying Opportunities

While the region is faced with a daunting set of challenges, these could be overcome, with a number of opportunities existing to tap the full potential of renewable energy.

The continuous fluctuation in oil prices serves as a sharp reminder of the dangers of overdependence on fossil fuels. Renewable energy will allow P-DMCs to reduce reliance on diesel generation and move toward a more climate sustainable economy. The move toward greater use of renewable energy gives a natural advantage to P-DMCs, where local energy sources are abundant. Aside from solar, hydro resources exist in the Federated States of Micronesia, Fiji, PNG, Samoa, Solomon Islands, and Vanuatu. There is also potential for wind and biomass resources in some areas. There have been preliminary proposals to tap tidal currents in PNG, and there is a potential tidal resource in Tonga.[12] While renewable energy resources are site specific, there is a need to move a step further to assess specific "niches" that are a combination of renewable energy

[12] International Renewable Energy Agency (IRENA). 2013. *Pacific Lighthouses: Renewable Energy Opportunities and Challenges in the Pacific Islands Region*. Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/Pacific-Lighthouse-Roadmapping.pdf.

sources available, selection of appropriate technologies, and assessment of energy needs and technical capacities to meet their particular energy requirements.

Fuel costs in the P-DMCs are not only volatile, but they are among some of the world's highest. The share of expenditure on household energy ranged from about 10% to as high as 23%.[13] High electricity tariffs reduce household consumption and savings, reduce the competitiveness of an economy, and lead to significant government spending as they tend to be among the largest customers in the P-DMCs.

A lack of electricity access in some P-DMCs presents further opportunity to tap renewable energy for distributed generation. Deployment of mini-grids may be a viable option for some of the more remote islands. Smart mini-grid systems, either grid-connected or off the main grid, are appropriate to P-DMCs as they can optimally and intelligently manage the load and energy resources to maximize the use of renewable energy resources. Smart mini-grids have monitoring and control systems that can manage the operation remotely without physically going to remote islands. Further, while transitioning toward wider renewable energy use, hybridizing renewable energy with diesel may be a viable option. ADB has supported a number of mini-grid projects in the Federated States of Micronesia, Solomon Islands, Tonga, and Tuvalu.

The P-DMCs have realized some of the benefits of renewable energy and are demonstrating that a low-emissions pathway is well underway. They have committed to ambitious renewable energy targets in response to the Paris Agreement. Each P-DMC has developed an energy strategy, often called a National Energy Roadmap, to guide the required investments and to empower this transition. For instance, electricity supply in the Cook Islands is met mainly by diesel and the utilization of renewable energy sources has been negligible over the past years. ADB is helping the Cook Islands to reduce its heavy dependence on diesel fuel for electricity generation by establishing solar power plants on six islands in the country with a total capacity of 3 MW. The project is expected to increase the share of renewable energy for electricity generation in the country.[14]

ADB Energy Operations

P-DMCs face development constraints. ADB makes significant contributions to this region, with total financing increasing from $462 million in 2005 to $2.8 billion in 2018.[15] ADB's core areas of assistance are in the transport, energy, water and urban development, and public management sectors. Transport accounts for more than 50% of ADB financing.

ADB started to boost assistance to the energy sector in 2007. From 2007 to 2020, $945.3 million (including cofinancing) was extended to P-DMCs.[16] ADB's contribution alone amounted to $410.7 million, covering both loan and grant components at 59% and 41%, respectively (Figure 5). Solomon Islands received the highest assistance, of $249 million or 26% of the energy support accorded to the Pacific region. PNG used to have the lion's share of ADB assistance due to its relatively larger geographical coverage. However, with the approval of the Tina River Hydropower project in 2019, Solomon Islands has overtaken PNG. The project amounts to $222.57, which constitutes almost 90% of the total assistance extended to Solomon Islands. Solomon Islands was followed by PNG at $224 million. Samoa and Tonga came next at $136 million and $100 million, respectively. Others received ADB assistance below $100 million.

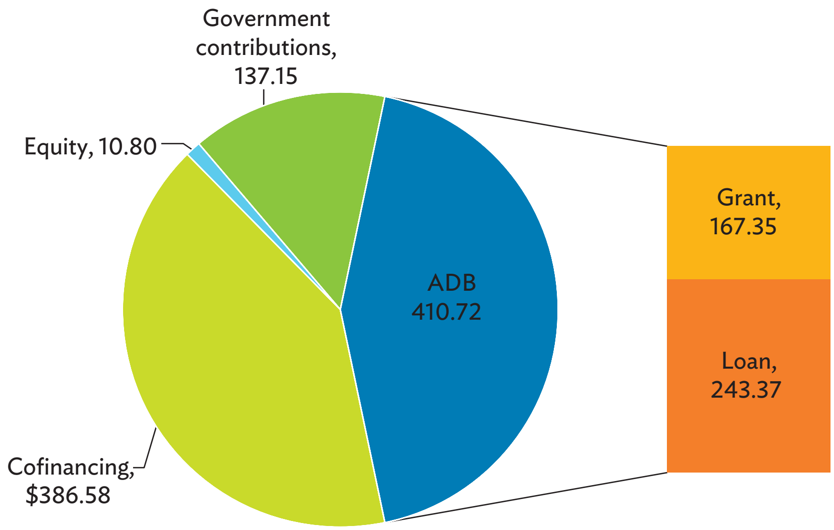
[13] ADB. 2020. Energizing Economies—ADB's Pacific Energy Strategy, 2021–2025. Draft Report. Manila.

[14] ADB. 2014. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant: Cook Islands: Renewable Energy Sector Project*. Manila.

[15] ADB. 2019. *ADB Operations in the Pacific*. Manila.

[16] ADB. 2021. *Pacific Energy Update 2020*. Manila.

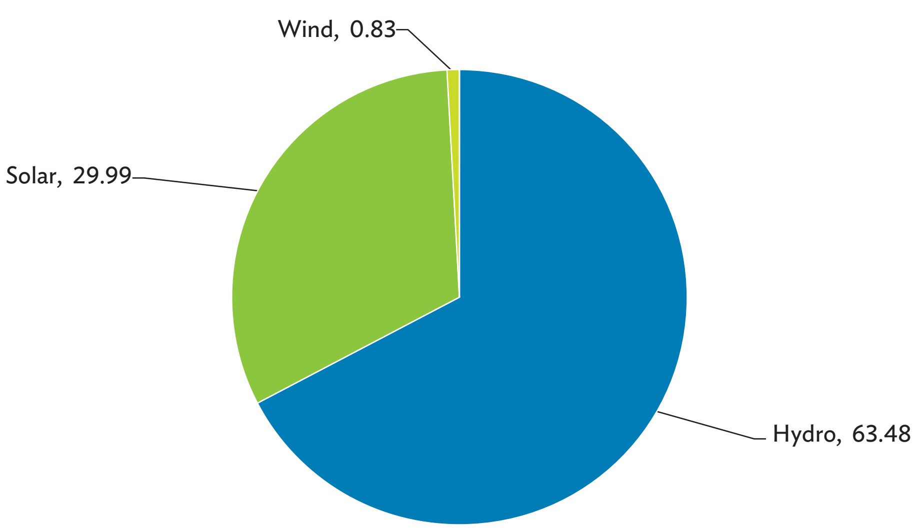
Figure 5: Total Energy Financing by Source, 2007–2020
($ million)



Source: ADB. 2021. *Pacific Energy Update 2020*. Manila.

From 2007–2020, renewable energy generation supported by ADB across P-DMCs reached a total of 94.3 MW. Hydro had the highest generation, at 63 MW, followed by solar at 30 MW (Figure 6). Aside from investment in clean energy generation, other energy projects have included the upgrading and expansion of transmission and distribution lines; improving energy access; and capacity building of distribution utilities, national agencies, and other energy stakeholders.

Figure 6: Total Installed Capacity in Pacific Developing Member Countries by Technology
(megawatts)



Source: ADB. 2021. *Pacific Energy Update 2020*. Manila.

From 2007 through to 2020, ADB's assistance to P-DMCs including cofinancing was able to achieve the following (footnote 18):

- extension of 2,890 kilometers of efficient transmission and distribution lines;
- provision of energy access to 25,431 households;
- construction of 102.5 MW of power generation systems, of which 92% came from renewable energy; and
- installation of 69.76 MWh of battery energy storage systems.

ADB's assistance in the Pacific is predominantly through the public sector. The Pacific Renewable Energy Investment Facility, which was approved in 2017, will finance renewable energy projects in the 11 smaller Pacific island countries. The facility will support these countries in transforming their power sectors from reliance on diesel to renewable energy sources. The facility will support regional approaches for energy sector reform, private sector development, and capacity building. One of the output indicators of the facility was the development of a donor-backed guarantee program to fill the financing gap caused by the lack of government guarantees for offtake obligations under private sector IPP contracts.

The Pacific Renewable Energy Program (PREP), a private sector financing facility of $100 million to encourage private sector investments in renewable energy for power generation, was created to address this gap. The program offers a credit enhancement mechanism to offset the risks inherent in power generation projects. It encourages private sector investment in the energy sector because public sector debt alone cannot address the ambitious renewable energy targets of the P-DMCs.

The Pacific Renewable Energy Program: An Innovative Approach Toward Greater Private Sector Participation in the Pacific

Due to the high and volatile prices of fossil fuels, the majority of P-DMCs have set an ambitious target of reaching up to 100% renewable electricity generation between 2020 and 2030. Transitioning to renewable energy is not simple, especially for P-DMCs. Most lack the technical capability required to make the switch because they have been operating with a single-source generation system. Running multiple renewable energy sources, which are intermittent in nature, poses challenges that require a more sophisticated grid operation management. Further, deploying renewable energy systems is expensive. P-DMCs need funding from both public and private sources to support investments, however, commercial bank financing is limited in the region and public funding is often not sufficient.

ADB has a number of financing products available for DMCs. Given the smaller size of P-DMCs, however, most of these are not appropriate for them. Table 4 provides a summary of the different ADB products and their suitability to P-DMCs.

Table 4: ADB Products and their Suitability to Pacific Developing Member Countries

Support Product	Description	Suitability
Public sector loan and/or grant	• The government and/or SOE develops and owns the renewable energy project • ADB extends public sector loan and/or grant to the government and/or SOE for the financing of the renewable energy project	• Constrained by the limits to borrow by governments and/or SOEs in some P-DMCs as a percentage of GDP
Private sector loan from PSOD	• A private sector entity develops and owns the renewable energy project • ADB provides a commercial loan to the project company	• Private sector loan may not be possible due to lack of bankability of PPA, lack of creditworthiness of power utilities and/or inability to convert local currency
PCG supporting commercial borrowing for government and/or SOE	• The government and/or SOE develops and owns the renewable energy project • The government and/or SOE obtains a loan from commercial banks to finance the renewable energy project • ADB provides a partial credit guarantee to the commercial bank that covers the repayment of the loan • ADB could also provide this PCG to a state-owned bank lending to an IPP	• PCG mitigates the nonpayment risk and encourages commercial loans at more competitive rates • Costs of PCGs may be expensive without donor funding
PCG supporting a letter of credit (LC)	• The government and/or SOE uses an LC to backstop its payment obligations to an IPP. The LC bank has a Partial Credit Guarantee from ADB and the LC is unfunded	• Mitigates the nonpayment risk of government and/or SOE and provides liquidity to project sponsors • Guaranteed LCs require counter indemnities from host governments, which are considered to be public sector liabilities • Governments in some P-DMCs are subject to fiscal constraints, which limit their ability to provide counter indemnities
PRG supporting commercial borrowing for the private sector	• A private sector entity develops and owns the renewable energy project • The private sector entity obtains a loan from commercial banks to finance the project • ADB provides a PRG guarantee that covers certain risks including war and civil disturbance, transferability, expropriation, and breach of contract	• PRGs reduce project risks, helping to attract private sector participation and facilitate debt raising • P-DMCs lack the capacity to guarantee key project documents, which typically is a condition for the provision of a PRG • PRGs may not address all the risks required to mobilize commercial loans in some P-DMCs • While a PRG would generally cover the termination risk due to a payment default, it would not cover the monthly payments due to keep the loan current until an arbitration award was received, which may take up to 18 months • Cost of PRGs may be expensive and require donor funding
TAs	• ADB provides the public sector with a technical assistance budget for the development of renewable energy projects	• ADB TAs may assist governments and/or SOEs with the preparation of IPPs (e.g., legal support in drafting of the tender process and PPA)

GDP = gross domestic product, IPP = independent power producer, LC = letter of credit, PCG = partial credit guarantee, PPA = power purchase agreement, PRG = partial risk guarantee, PSOD = Private Sector Operations Department, SOE = state-owned enterprise, TA = technical assistance.

Source: ADB. 2018. *Pacific Renewable Energy Guarantee Program: Supporting the Renewable Energy Transition in the Pacific Islands.* Manila.

Public financing through direct loans and partial guarantees faces a number of constraints, particularly the inability of governments to borrow. Partial risk guarantees (PRGs) supporting private sector investment can help mobilize commercial debt. However, due to fiscal constraints, governments lack the capacity to guarantee payment obligations under key project documents, which is typically required as a condition for the provision of a PRG. In addition, PRGs only pay out to lenders after an international award has not been honored. Until such payment has been made, lenders (and the project company) are exposed to liquidity risk.

PREP has been established through a combination of PRGs, direct loans, and technical assistance to address the above constraints, with an added component of a donor-backed letter of credit (LC) to cover short-term liquidity risks. PREP is introduced to utilities during project preparation and can reduce their costs because project developers may consider that it offers a better risk profile to the project and, therefore, requires a lower rate of return in their bid, which results in a lower proposed tariff. PREP's LC is a credit-enhancement tool that supports up to 24 months of power payments payable by the power utility under the PPA to address short-term liquidity issues that may arise during the course of the contract. The first 3 months is provided by the power utility as a first loss component, and the remaining 21 months would be cash collateralized by donors in lieu of a government guarantee. The technical assistance component may be used to assist the government in preparing the IPP tender process. Technical assistance can also help screen projects to lower risks. PREP is designed for smaller IPPs in the Pacific where ADB is lending up to $10 million to the project in a combination of loans and guarantees.

As an example, ADB's $3 million loan for a project in Tonga will support a private sector investment of $8.4 million for capital expenditure consisting of both debt and equity.

Alignment with ADB Strategy and Operations

In 2008, ADB approved Strategy 2020,[17] which reaffirms ADB's vision of an Asia and Pacific that is free of poverty, and supports the mission to help DMCs improve their living conditions and quality of life. To meet the objectives espoused in Strategy 2020, ADB developed the 2009 Energy Policy,[18] which serves as a guide to ADB's energy sector operations. The Energy Policy is anchored on the three operational pillars of promoting energy efficiency and renewable energy; maximizing access to energy for all; and promoting energy sector reform, capacity building, and governance. To adopt to the changing needs of the region, a new long-term corporate strategy, Strategy 2030,[19] was launched in 2018 to supersede Strategy 2020. It has an expanded vision of achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific through seven operational priorities as follows:

(i) addressing remaining poverty and reducing inequalities,
(ii) accelerating progress in gender equality,
(iii) tackling climate change and building disaster resilience,
(iv) making cities more livable,
(v) promoting rural development and food security,
(vi) strengthening governance and institutional capacity, and
(vii) fostering regional cooperation and integration.

17 ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila. https://www.adb.org/sites/default/files/institutional-document/32121/strategy2020-print.pdf.

18 ADB. 2009. *Energy Policy*. Manila. https://www.adb.org/sites/default/files/institutional-document/32032/energy-policy-2009.pdf.

19 ADB. 2018. *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*. Manila. https://www.adb.org/documents/strategy-2030-prosperous-inclusive-resilient-sustainable-asia-pacific.

The development objectives of PREP are aligned with the operational priorities of Strategy 2030 and the current Energy Policy. The ultimate objective of PREP is to provide a credit-enhancement mechanism to encourage private sector investment in renewable energy power generation projects. PREP will hedge against the key risks associated with these projects and is expected to achieve the following results:

(i) a lower cost of financing achieved by addressing key risks through guarantees and the LC structure;
(ii) longer tenors, which can translate to lower tariffs in competitive private sector tenders;
(iii) attract new investors and lenders to P-DMCs to increase competition and access to financing; and
(iv) increase the Private Sector Operations Department's (PSOD) focus on frontier markets.

The objectives of PREP are aligned with the operational priorities of Strategy 2030 in tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability.[20] By increasing renewable energy generation, PREP will contribute to decreasing carbon emissions in P-DMCs, and help reduce their reliance on fossil fuel imports. Further, it will lead to increasing energy access, which is one of the pillars of the current Energy Policy.

The PREP has been developed by PSOD and ADB's Pacific Department (PARD) under a One ADB Approach. ADB instituted a One ADB Approach to bring together knowledge and expertise across the organization to effectively implement Strategy 2030. This approach leverages PARD's close relationship with the Pacific power utilities. PSOD and PARD worked together to implement PREP and identify pipeline transactions. PSOD is responsible for processing guarantees and project financing for individual private sector projects. Debt financing terms and conditions to sponsors are determined on a project-by project-basis. PARD, PSOD, and ADB's Office of Public–Private Partnership (OPPP) manage technical assistance to develop upstream capacity and provide transaction advisory services where practical.

Program Design and Modalities

A maximum of $50 million is allocated for PSOD's nonsovereign operations (NSO) guarantee exposure (exclusive interest of guarantee fees). The Canadian Climate Fund for the Private Sector in Asia II may risk participate up to $20 million for projects that fall under PREP. The other $50 million is for PSOD NSO lending exposure. Both the Government of New Zealand and the Asia-Pacific Climate Finance Fund approved a contribution of $3 million and $4.5 million, respectively, to support the program through the letter of credit (LC) structure (Table 5).

Table 5: Program Financing Plan

Source	PRG ($ million)	LC ($ million)	NSO Loans ($ million)	Total ($ million)
PSOD NSO exposure for PRG	50.0	–	–	50.0
PSOD OCR for NSO loans or partial credit guarantees	–	–	50.0	50.0
Additional financing				
CFPS II (reimbursable capital)	20.0	–	–	20.0
New Zealand Grant	–	3.0	–	3.0
Asia-Pacific Climate Finance Fund		4.5		4.5

CFPS = Canadian Fund for the Climate Sector in Asia II, LC = letter of credit, OCR = ordinary capital resources, PRG = partial risk guarantee, PSOD = Private Sector Operations Department.

Source: ADB. 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Pacific Renewable Energy Program.* Manila.

[20] ADB. 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Pacific Renewable Energy Program.* Manila.

For a project to use PREP, it must:[21]

(i) be located in a P-DMC;
(ii) be a renewable energy generation project;
(iii) be economically viable;
(iv) have finance and project documents acceptable to ADB;
(v) satisfy ADB environmental and safeguards, and meet other due diligence requirements; and
(vi) comply with the risk criteria developed during due diligence.

In addition, P-DMCs availing of the LC structure under PREP must sign a memorandum of understanding to be acknowledged by the host's Ministry of Finance and Ministry of Energy as well as the local utility. The memorandum shall serve as an acknowledgement of the said stakeholders to the guarantee program. The utility will also be required to sign a cooperation agreement and/or direct agreement with ADB regarding the conduct of the project.

PREP consists of the following instruments (Figure 7):

Partial risk guarantee (PRG). This will be issued by ADB to commercial lenders to cover a wide array of risks relating to currency (inconvertibility and/or nontransferability), contractual obligations (breach of contract), and politics (expropriation, war, and civil disturbance). Currently, ADB has allocated $50 million for PRG and the Government of Canada may risk participate to the amount of $20 million.

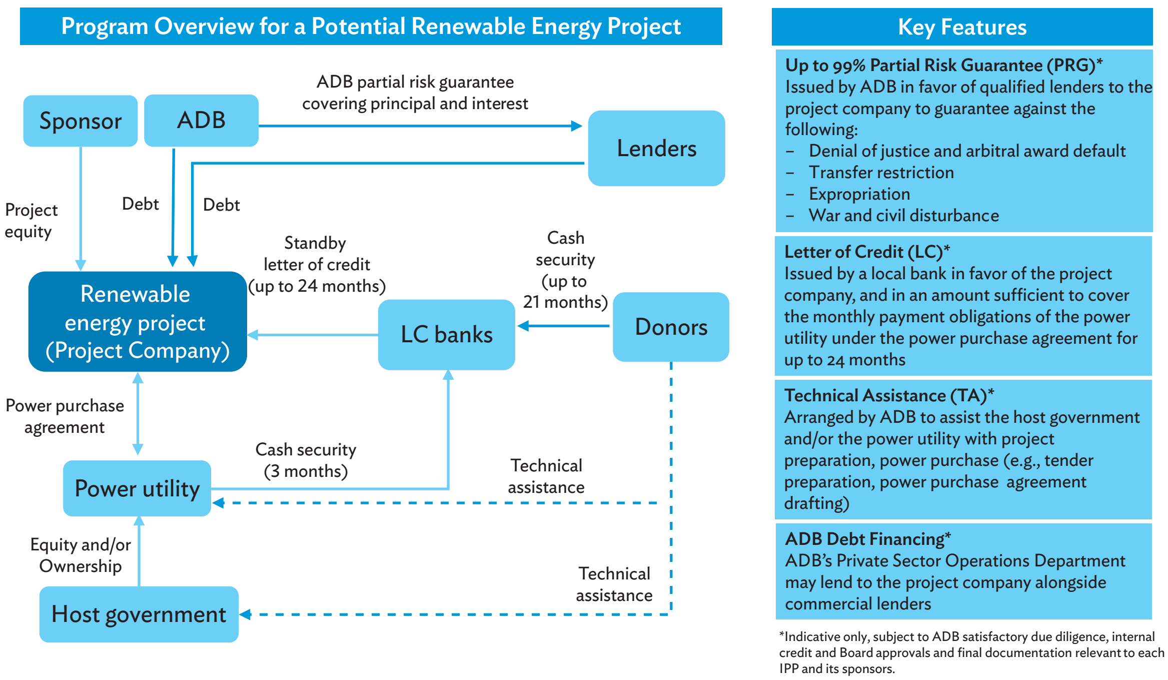
Direct loan. ADB will provide a direct loan of up to $50 million from its ordinary capital resources to support private sector investment in the P-DMCs. PREP is designed for a maximum of $10 million provided by ADB in any combination of loans and PRG. ADB will also mobilize cofinancing for the project and where appropriate, use third party concessional financing with ADB as lender of record. If ADB cannot finance a loan in local currency, a partial credit guarantee in favor of the local lender to the project may be made available. Donor funding may also be used to back up ADB's direct loan.

Letter of credit (LC). An irrevocable LC will be issued by the commercial bank to the project company to cover short-term liquidity risk in case the utility as an offtaker fails to make payment for the project under the terms of the PPA. The LC is a credit enhancement tool to support up to 24 months of power payments payable by the power utility under the PPA in the event that the power utility fails to pay. The first 3 months power payments in the LC are provided by the power utility as a first loss component, and the remaining months are cash backed by donors. The risk of default by the power utility as a result of the benefits offered by PREP is potentially a moral hazard since there is a possibility that the power utility will default as an option where terms of continuing under a PPA appear too onerous. The LC structure is provided to the project company in lieu of a government guarantee. The Government of New Zealand has approved a $3 million grant to support the LC structure. The Asia-Pacific Climate Finance Fund also approved a contribution of $4.5 million toward the LC component of the PREP on 2 December 2020.

Technical assistance (TA). TA is intended for transaction advisory support and to streamline processes to reduce high transaction costs of relatively smaller transaction sizes in the Pacific. TA will also support capacity building and be provided through the existing ADB TA and additional external funds, as required.

[21] ADB. 2018. *Pacific Renewable Energy Guarantee Program: Supporting the Renewable Energy Transition in the Pacific Islands.* Manila.

Figure 7: Program Overview and Key Features



IPP=independent power producer.

Source: Asian Development Bank.

Implementation Arrangements

Loans and guarantees under PREP must be processed during a period of 5 years, i.e., from April 2019 to April 2024. PREP aims to support five renewable energy investments within this period, with deadline for final approval set on 30 April 2024. A specific P-DMC can have more than one approved project and regional projects may be considered to cover countries within the Pacific. No financing cap is set for each country, but the country's exposure limits must be taken into consideration.

Loans and guarantees under PREP are expected to have a maximum tenor of 15 years, subject to ADB's internal risk assessment process. Each project is limited to a cost allocation of $10 million to cover both loans and PRG exposure. The individual transactions will be approved following due diligence and will be based on the financing parameters indicated under Operations Manual section D10 (Nonsovereign Operations).[22] The criteria include the following: (i) the project includes renewable energy generation and supports energy sector infrastructure, (ii) the project is located in a P-DMC, and (iii) the project does not fall under category A.[23]

[22] The Operations Manual collects ADB's operational policies known as Bank Policies, which are short, focused statements that follow from ADB's Charter, ADF, and OCR regulations; and policies adopted by the Board of Directors. Operations Manual D10 specifically looks at the procedural requirements and guidance on the implementation of policies specifically for nonsovereign operations. ADB. 2016. *Bank Policies and Procedures.* Operations Manual. Section D10. Manila.

[23] Category A is when a proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment, including an environmental management plan, is required.

Both ADB's PSOD and PARD will work with power utilities within the Pacific to identify possible transactions. Once a suitable transaction is identified, the utility may elect to use the transaction advisory services provided by OPPP and may be able to tap the Asia-Pacific Project Preparation Facility for TA support. PSOD will oversee PREP, be responsible for the management of the portfolio, and respond to any issues that arise in any project. ADB will charge donors an administration fee for managing donor funds for PREP.

Payment Default

In case of payment default by the utility, the project company with support from ADB will first seek an amicable resolution as set out in the PPA. If an amicable resolution does not work, and there is payment default, the company will initiate termination of the PPA and seek termination compensation. In some cases, this termination arrangement may be disputed, and an arbitration may be required to confirm the legitimacy of termination compensation. During this process, if the company continues to deliver power, it may draw from the LC for any unpaid undisputed invoices of the utility in accordance with the PPA to ensure that the company can continue its operations while arbitration is underway.

The combined value of the LC will cover up to 24 months of payments to ensure that it covers the duration required to negotiate resolution and if necessary, initiate the termination of the PPA, following payment default under the PPA. The time frame will take into account provisions of the PPA specifically relating to the default and cure period, dispute resolutions and termination, and governing law of the PPA and requirements from commercial lenders.

To the extent that the LC is not drawn, it can be renewed on a rolling basis until the end of the tenor of the project loans. The refund mechanism has the following principles: (i) if the LC is not drawn, it will be renewed; (ii) if LC is partially drawn and the utility has paid up the shortfall, the LC can be renewed with the same initial size; (iii) if LC is partially drawn, but the utility has not made any payments and the project continues, the LC can be renewed for the remaining undrawn amount; and (iv) if the LC is fully drawn and the utility has not made any payment and the project has initiated termination, the LC will not be renewed.

The progress of PREP will be reported annually by PSOD to the ADB Board of Directors. The first two annual reports covering the period March–December 2019 and covering the period January–December 2020 have already been submitted.[24] When 50% of the approval limit has been utilized, or prior to 30 September 2021 (whichever comes first), ADB will conduct a review of PREP and make a recommendation to the Board for any possible design modifications.

Status of Implementation

Pipeline of projects. A market sounding exercise was conducted to determine the potential of PREP by taking the views of relevant stakeholders on the development of renewable energy in P-DMCs. Interviews were conducted with the chief executive officers of various utilities, private sector developers, lenders active in the region, as well as representatives from utilities. Site visits in the Cook Islands, PNG, and Tonga were also made. The results revealed that a number of P-DMCs have potential for IPP operations. P-DMCs are grouped into three according to likelihood for IPP development: short- to medium-term, medium- to long-term, and limited potential. The diversity of potential is due to the P-DMCs differences in size, maturity of the power sector, and the demand for additional capacity. The Cook Islands, Fiji, PNG, Samoa, and Tonga are classified as having IPP potential within the short- to medium-term while Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Palau, and Solomon Islands are categorized as having potential in the medium- to long-term. Tuvalu and Vanuatu are considered to have limited potential.

[24] ADB. 2021. *Pacific Renewable Energy Program Annual Report: April–December 2020*. Manila. https://www.adb.org/sites/default/files/institutional-document/688406/prep-annual-report-2020.pdf.

Current status. PREP was signed in 23 August 2019, but no project has been signed yet. Nevertheless, the program is still on track with a 6 MW project in Tonga expected to achieve financial closure in the first quarter of 2021. The financial closure was expected to happen in 2019 but the investor sold its shares to a new investor resulting in a 7-month delay in the financing process. A wind project in Tonga and solar project in Fiji are also in advanced stage and are expected to be financed by PREP by 2023 (footnote 27).

The Asia-Pacific Climate Finance Fund has provided a direct charge of $200,000 of legal fees for the design of the template for the LC. PSOD presented PREP to power utilities and governments across the Pacific, and it was well received. Further promotions will be undertaken to raise awareness about PREP and its benefits (footnote 27).

The Case of Tonga

Tonga is a small island developing state with a total area of 749 km^2. It consists of 176 islands, of which 36 are inhabited. Tonga has four main island groups namely, Tongatapu, Ha'apai, Vava'u, and Niuas. Total population was estimated at 105,100 in 2019, of which 75% are residing in Tongatapu.

The 6 MW solar project in Tonga is considered the anchor project of PREP. Total installed capacity in Tonga is 25 MW, consisting of 18 MW of diesel and 6 MW of renewable energy, mainly solar photovoltaic and wind. Off-grid installation is estimated at around 250 kilowatts. Of the 6 MW of renewable energy installed, 2 MW is sourced from an IPP, China Singyes Solar Technologies Holdings Limited. Singyes installed a 2 MW solar farm in Tonga in September 2016 and signed a 25-year PPA with Tonga Power Limited (TPL). The generation tariff is estimated to be T$0.33 ($0.14) per kWh.[25] TPL owns a 10% equity stake in the project company consisting of in-kind contribution through technical studies, land, and interconnection facilities.

The Government of Tonga aims to attain 50% of its electricity generation from renewable energy by 2020 and 70% by 2030. To achieve the 2020 target, a total of 17.5 MW of renewable energy capacity is required in combination with storage of at least 20 MWh. TPL is on track to meet its 2030 goal through the current roll out of its renewable energy plan to introduce battery storage, solar, and wind projects to its asset base. In 2019, TPL signed a contract with Sunergise New Zealand to build, own, and operate a 6 MW solar IPP, which will be the largest solar power plant in the Pacific. In the first quarter of 2019, ADB approved the implementation of the Tonga Renewable Energy Project. This entails the installation of multiple battery energy storage systems with a total capacity of 10.1 MW solar power and 19.9 megawatt-hour (MWh) of battery storage in Tongatapu and several battery energy storage systems in the outer islands. A 4.5 MW wind energy project is also expected to be bid out to the private sector and installed as part of the overall renewable energy plan. As of March 2021, renewable energy penetration to the grid is only 12.8%.

The pilot project will create 60 jobs during construction and the project will achieve effective gender mainstreaming through technical training and managerial positions for women. The annual avoided emissions (using fuel efficiency based on TPL's actual data of the existing diesel generators in Tongatapu) is 6,126 tons per annum or 153,148 tons over the 25-year lifespan of the PPA. This project, along with the wind energy project in the pipeline, will significantly contribute to the goal of the country attaining 70% of renewable energy penetration to the grid by 2030.

[25] *Matangi Tonga Online*. 2017. King Commissions Tonga's Largest Solar Farm. 19 October. https://matangitonga.to/2017/10/19/king-commissions-tongas-largest-solar-farm.

Conclusion

The development of renewable energy in P-DMCs is being spurred on by a current high dependency on expensive fossil fuels, high tariff costs, lack of electricity access, and availability of local renewable energy sources, among other factors.

Private sector investment in renewable energy in the Pacific is quite modest. The 4 MW solar project in Samoa, which was approved in 2017, is the only IPP project to which private sector lending from ADB has been extended. Private sector investors who have explored project opportunities in the Pacific are often hesitant to take on the inherent risks of long-term renewable energy investment. This is compounded by the struggle to access long-term financing for these investments. The implementation of PREP is a remarkable way to diversify funding sources of P-DMCs toward more private sector investment. Further, this is also in line with the provisions in the Operational Plan for Private Sector Operations, 2019–2024, where ADB is mandated to further sharpen the focus of its private sectors operations, giving increasing attention to complex, highly innovative, and riskier projects while addressing climate change and providing support to women.

P-DMCs have set renewable energy targets to transition toward low-carbon economies. A number of them aim to attain 100% dependence on renewable energy generation by 2030. This presents an opportunity to attract more players in renewable energy development, particularly investors and lenders who can use loans and guarantees through PREP and an LC structure that offers credit enhancement of payment risk from the power utilities in lieu of a government guarantee. PREP can also serve as an avenue for countries to attain their renewable targets.

The Cook Islands, Fiji, Palau, PNG, Samoa, and Tonga, which are considered to have IPP potential, may be a good starting point to showcase private sector investment in a difficult region like the Pacific. The challenge is to identify other financing instruments that can cater to the energy requirements and financial capabilities of other P-DMCs.

PREP has demonstrated strong coordination among different departments within ADB. PARD, PSOD, and OPPP have worked together to initiate the implementation of PREP projects, with each having a role to play depending on their strengths and expertise. Outside ADB, it is also important to strengthen relationships among various institutions such as the host governments through their energy departments, IPP developers, and power utilities. The role of private sector investors and lenders in encouraging IPPs to provide renewable energy is critical in bridging the gap to provide a stable and sustainable supply of electricity. They can provide much-needed external financing and a transfer of technology and private sector efficiencies through competitive tendering. Governments, on the other hand, need to provide the necessary oversight.

The success of PREP cannot be ascertained at this time as no project has yet reached financial close. A more meaningful assessment can made after 5–10 years when IPPs have been financed and their projects are in operation.

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5 Financing Plus: Experience from the Green Financing Platform in the People's Republic of China

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Introduction

This chapter aims to explore the use of sovereign loans in bridging the financing gap for green enterprises and in channeling private capital into low-carbon fields. First, a general overview of the ADB-funded Green Financing Platform (GFP) Project is presented, with special attention given to the examination of its financing structure, products design, targeted clients, and current progress. Second, a detailed introduction of four typical subprojects financed by the GFP Project is given, followed by the characteristics of implementing approaches and implementation highlights in part three. The successful experience of GFP Project throughout the whole process is discussed in part four. The fifth part displays the overall trends of air quality in the Greater Beijing–Tianjin–Hebei (BTH) region during 2014–2020, and the sixth part discusses needs for further improvements. The professional know-how and successful experiences in conducting green financing projects is summarized at the end of this chapter.

Context

The greater BTH region is one of the country's most heavily polluted regions with major air pollutants including particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3), etc. Moreover, in 2016, the region alone contributed about 40% of the country's total carbon dioxide (CO_2) emissions. Beijing has a target of bringing the average concentration of PM2.5 to the national standard of 35 micrograms per cubic meter ($\mu g/m^3$).[1] Nonetheless, the number is still higher than 10 $\mu g/m^3$ recommended by the World Health Organization (WHO).[2] Therefore, further steps still need to be taken to improve and maintain the air quality of the greater BTH region.[3]

Another practical challenge faced by the government is the limited scale of private investment in green and low-carbon sectors. Since private capital tends to be risk averse and profit-driven, they are often reluctant to enter into environmental protection and low-carbon sectors for which potential returns are modest and perceived risks are high. Further, small and medium-sized enterprises (SMEs) still face

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1 Government of the People's Republic of China, Beijing Municipal Government. 2017. *Master Plan of Beijing City (2016–2035)*. Beijing: Beijing Municipal Government. http://www.beijing.gov.cn/gongkai/guihua/wngh/cqgh/201907/t20190701_100008.html.

2 WHO. 2006. *WHO Air Quality Guidelines for Particular Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide*. Geneva: WHO.

3 In 2015, the region's annual average PM2.5 concentration was 73 $\mu g/m^3$. Exposure to high levels of PM2.5 contributes to about 1 million premature deaths annually in the PRC, with a disproportionate number of these in the BTH region. The cost of premature mortality to the national economy is estimated as approximately 7.5% of the gross domestic product. Reference: World Bank and Institute for Health Metrics and Evaluation. 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action*. Washington, DC.

challenges in accessing cheap and long-term finance in the People's Republic of China (PRC),[4] with a bank-dominant financial system. World Bank estimated that the financing gap for formal Chinese micro, small, and medium-sized enterprises is $1.89 trillion as of 2016, which is equivalent to 17% of the country's gross domestic product (GDP).[5]

According to the PRC's Clean Air Alliance, a total investment of over CNY1.8 trillion is required to reach the target as stipulated in the Action Plan on Prevention and Control of Air Pollution (2013–2017), of which CNY250 billion will be needed in the BTH region. In face of this situation, together with the help of both the Ministry of Finance (MoF) and the National Development and Reform Commission (NDRC), China National Investment and Guaranty Corporation (I&G) worked closely with ADB and launched the GFP Project, where a multi-province, multisectoral GFP is established to unlock green investment and channel financing into low-carbon sectors.

The GFP Project is part of the broader BTH regional air quality management program initiated by ADB, which envisions to provide of up to $2.8 billion in loan funding from ADB, and to mobilize investment at scale in air quality management in the greater BTH region. The BTH program is a series of investment operations using different financing modalities and financing instruments with discrete projects approved each year over 6 years. The investment operations, which have been approved to date and proposed potential expansion are summarized in Table 1. The GFP Project is the second loan.

Table 1: Summary of Beijing–Tianjin–Hebei Program Investments

Project (Year of Approval)	Amount and Modality	Notes
Loan 3356-PRC: Beijing–Tianjin–Hebei Air Quality Improvement–Hebei Policy Reforms Program (2015)	$300 million policy-based loan	First ADB policy-based loan for air quality management in the PRC.
Loan 3504-PRC: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—China National Investment and Guaranty Corporation's Green Financing Platform Project (2016)	€458 million ($499.6 million equivalent) financial intermediation loan	First financial intermediation loan for air quality management in the PRC, and one of the first investment operations to establish a green financing platform. Some emphasis on support for small and medium-sized enterprises.
Loan 3629-PRC: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Regional Emission-Reduction and Pollution-Control Facility (2017)	€428 million ($499 million equivalent) financial intermediation loan	Second financial intermediation loan. Emphasis on innovative and high-level technology for industrial cleaner production and sustainable infrastructure.
Loan 3765-PRC: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Shandong Clean Heating and Cooling Project (2018)	€350 million ($399.91 million equivalent) project loan	Some emphasis on clean and renewable energy technologies for district and distributed heating and cooling systems in Shandong Province.
Loan 3879-PRC: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Henan Cleaner Fuel Switch Investment Program (2019)	$300 million results-based lending	First use of results-based lending for air quality management in the PRC. Emphasis on fuel switching from coal to natural gas and biogas.

continued on next page

[4] Commercial banks, as the major sources of financing, generally consider SME transactions highly risky and require good credit ratings or high levels of collateral, which many SMEs cannot provide. In the PRC, SMEs are categorized as companies employing less than 1,000 persons or with an annual turnover up to CNY400 million, according to the National Bureau of Statistics, which is relatively larger than firms in other Asian countries. 80% of Chinese financial system consisted of bank loans. Reference: ADBI. 2018. *The Role of SMEs in Asia and Their Difficulties in Accessing Finance*. Tokyo: ADBI.

[5] International Finance Corporation. 2017. *MSME Finance Gap*. Washington, DC.

Table 1 *continued*

Project (Year of Approval)	Amount and Modality	Notes
Loan 3999-PRC: Bank of Xingtai Green Finance Development Project (2020)	€170 million ($199 million equivalent) financial intermediation loan	First financial intermediation loan provided to a local city commercial bank with emphasis on strengthening its institutional capacity in green finance policy.
PRC (51033): Proposed Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Green Financing Scale Up Project (I&G's Green Financing Platform Project Phase II) (2020)	$150 million	Scale up of original loan, approved by ADB in December 2020.

ADB = Asian Development Bank, PRC = People's Republic of China.
Source: Asian Development Bank.

Green Financing Platform's Design and Its Practice

Green Financing Platform Financing Structure and Products Design

The GFP Project was approved by ADB on 12 December 2016. The loan became effective in August 2017, with a total amount of €458 million ($499.6 million equivalent) and a term of 15 years. It aims to provide better access to finance, especially for small and medium-sized enterprises to scale up investments in pollution-reduction projects.[6]

I&G, a holding subsidiary of the State Development & Investment Corporation (SDIC), acts as the executing and implementing agency of the GFP Project. With the ADB sovereign loan, I&G uses the financial intermediation loan modality to establish a GFP. Through the financing platform, various financial instruments and tools are introduced to mobilize domestic financing and scale up investments in air-quality improvements and public health improvement in the greater BTH region. The GFP offers four complementary financial products: (i) credit guarantees to enable commercial financing from banks and financial institutions, (ii) debt financing through entrusted loans,[7] (iii) financial leasing for purchasing energy-efficient industrial equipment and other goods to obviate the need for large capital for SMEs and energy service companies (ESCOs), and (iv) equity investments in qualified early-stage technology companies.[8]

The Geographic Coverage and Targeted Clients

The GFP aims to provide financial services for the projects primarily in clean energy, energy saving and emissions reduction, green transportation, and waste to energy. The targeted geographical location includes Beijing and Tianjin municipalities; Hebei, Henan, Liaoning, Shandong, and Shanxi provinces; and Inner Mongolia (or Nei Mongol) Autonomous Region (IMAR). The region generates more than 34% of the PRC's GDP and is the home to more than 30% of the country's population. The region also has a rich endowment of energy and mineral resources such as about 64% of the country's iron ore reserves, and 69% of coal, which have led to high concentration of energy-intensive industries in the region. Enterprises in such industries

[6] SMEs are key economic players in the BTH region, accounting for about 60% of industrial pollution.
[7] An entrusted loan refers to the extension of credit by a bank as an agent of entrusted funds from the GFP. The bank will administer the debt but assumes no credit risk.
[8] ADB provided project preparatory technical assistance for the original loan: TA 8975-PRC: Beijing–Tianjin–Hebei Regional Air Pollution Control.

tend to have large financing needs for energy saving and emission reduction. Nevertheless, due to wide technical scope, high professional threshold, and volatile returns, the enterprises often face difficulties in accessing commercial credit. The GFP endeavors to address current issues and channel funds to green enterprises in need. Its target clients mainly include environmental protection companies, ESCOs, financial leasing companies, green SMEs, and early-stage, low-carbon technological start-ups.

Subproject Selection Criteria

Subprojects financed under the GFP must meet the technical, financial, economic, environmental, and social criteria developed by I&G and ADB. All subprojects must be in the greater BTH region and address air pollution issues. They must not result in an increase in energy consumption and emissions—including CO_2, SO_2, NOx, and airborne particulate matter (PM)—where they are located. All subprojects are required to be financially viable and the total economic benefits must exceed the total economic costs. Each subproject must be designed, constructed, and operated in accordance with relevant national and provincial social and environmental laws and regulations. The subprojects must also meet standards of the Environmental and Social Management System (ESMS) developed for the GFP.

These criteria ensure that the selected subprojects lead to air quality improvement, energy efficiency improvements and emissions reduction, and promote low-carbon development in the greater BTH region. The subprojects must adopt the advanced clean and low-carbon technology, with adequate financial returns, and provide substantial benefits to the economy, society, and environment. The detailed subproject selection criteria are presented in Appendix 1 and 2.

Progress and Achievement

As of 31 December 2020, the GFP Project has approved CNY2.33 billion (€301.48 million) in entrusted loans and equity investments to finance 39 eligible subprojects and provided CNY584 million (€75.56 million) of guaranty to two qualified subprojects, leveraging more than CNY8 billion (€1.04 billion) of green investments in total. In terms of regional distribution, nine subprojects have been implemented in Beijing; five each in Hebei and Henan; three in Tianjin; two each in Liaoning and IMAR; one in Shanxi and 14 in Shandong. After completion, these subprojects are expected to reduce annual coal consumption by approximately 1,140,000 tons and annual gasoline consumption by 310,000 tons, contributing to annual emissions reductions of CO_2 by 2,710,000 tons, SO_2 by 30,000 tons, PM by 70,000 tons, and NO_X by 7,000 tons. In addition, 343 bid bonds have been provided for over 130 SMEs through the Xinyijia E-bond Platform of I&G, facilitating their investment in green subprojects in the greater BTH region with a transaction cost reduction up to CNY44 million.

So far, the subprojects have covered comprehensively eight provinces and municipalities in the greater BTH region, and the beneficiaries have reached 400 million. A sustainable GFP has been formed and some preliminary results have appeared in social welfare improvements as well. As of 31 December 2020, the Project Management Office (PMO) of I&G has organized and participated in more than 50 domestic and international forums, sharing actively their experiences and practices in developing green finance. Under the direction of ADB, the PMO has also delivered seven trainings so far on energy efficiency and environmental and social safeguards, with over 300 people (including more than 120 from SMEs) trained in energy-saving and emission reduction technologies, environmental evaluation, financial assessment, and post-loan management. By continually focusing on the promotion of green investment and strengthening the capacity building of financial institutions and investors involved, the GFP allows the public to participate in and benefit from the projects, thereby raising their awareness of green life and green production.

Showcase of Typical Subprojects

SDIC Tieling Biofuel Ethanol Subproject

Biofuel ethanol is a form of green and renewable energy. Its utilization is of great significance in alleviating energy crisis and environmental protection. In October 2017, SDIC Biotech Investment Company initiated a biofuel ethanol subproject with an annual output of 300,000 tons in Tieling, Liaoning Province. Liaoning Province has a continuous harvest of grain during recent years, which has led to increasing stocks and consequently a serious storage problem for unsold grain. Thus, it faces an arduous task of consuming aged and rotten corns. The subproject plans to produce 306,000 tons of biofuel ethanol; 276,300 tons of distiller's dried grains with soluble; and 20,000 tons of corn oil per year and consumes, correspondingly, about 1 million tons of aged and rotten corns. CNY300 million (€38.82 million) was financed by the GFP Project in July 2018. The construction of the subproject was completed at the end of 2018 and has since been progressing well. It will help reduce annual CO_2 emissions by 250,000 tons, and CO emissions by 18,000 tons. Meanwhile, it will consume around 950,000 tons of aged and rotten corn each year, which will help solve associated storage problems in the local and surrounding regions and result in more stable agricultural production. Moreover, the subproject will provide suitable job opportunities for local surplus labor force. Upon completion, it will play a positive role in releasing local employment pressure in local communities and increase farmers' incomes.

Shandong Wudi 60-MW Centralized Solar Photovoltaic Power Generation and Poverty Alleviation Subproject

The 60-megawatt (MW) centralized solar photovoltaic (PV) power station, situated in Xixiaowang Town, Wudi County of Shandong Province, was financed CNY100 million (€12.94 million) through financial leasing in the second half of 2018. It is in a less-developed rural region, covering an area of 133.3 hectares, and serves as a typical poverty alleviation subproject, with a combination of power generation and cash crops growing under the PV modules (agriphotovoltaic). The combination of power generation and plant growth leads to an annual emission reduction of CO_2 by 61,200 tons and SO_2 by 40 tons. In addition to the environmental benefits, the subproject has also achieved sound economic and social benefits primarily by avoiding conflict over land use and enhancing income for rural residents. The subproject provides financial benefits to more than 1,600 poor households with annual incomes of CNY3,000 (€388) per household.

Pingyi County Waste-to-Energy Plant Subproject

During recent years, the PRC government has stepped up its garbage segregation campaign. Following the ongoing trend, I&G continued its efforts to support enterprises in waste sorting and utilization sectors. In December 2019, I&G granted an entrusted loan of CNY180 million (€23.29 million) through the GFP Project to Pingyi Tianying Waste-to-Energy Subproject, one of the fourth batch of public–private partnership demonstration projects of the MoF. With a daily garbage disposal capacity of 600 tons, the completion of the subproject will significantly enhance local garbage disposal capacity and help solve the environmental problem caused by landfill. The subproject total investment is CNY310 million (€40.11 million) and it is expected to reduce annual CO_2 emissions by about 52,000 tons.

Towatt Charging Station Construction Subproject

In December 2019, the GFP Project issued a loan of CNY9 million (€1.16 million) to Beijing Duodatong Energy Technology Co., Ltd. to finance the construction of two charging stations in Beijing. The total investment is about CNY21.6 million (€2.79 million), for installation of 70 direct current fast-charging piles and 15 box-type transformers. Moreover, with easy access to the parking system, the subprojects aim to create intelligent and convenient parking and charging places, which will further enhance user experiences. After completion by 2021, the subprojects are expected to reduce CO_2 by 28,000 tons and SO_2 by 1.7 tons per year through gasoline substitution. As Beijing Duodatong Energy Technology Co., Ltd. is an SME in Beijing, the subproject demonstrates I&G's determination and efforts in supporting green SMEs.

Characteristics of Implementing Approaches

Enhancing Cofinancing to Scale Up Investments in Green and Low-Carbon Initiatives

Air pollution control is an arduous systemic task that requires participation from all walks of life and sustained financial support. I&G has developed close partnerships with commercial banks to leverage more financing in air quality improvement efforts. In December 2018, I&G signed a memorandum of understanding of $600 million collaborative cofinancing with Huaxia Bank, Bank of Beijing Zhongguancun Branch, and ADB under the GFP Project. I&G will further cooperate with more financial institutions to scale up investments in improving energy efficiency and pollution-reduction projects.

Tailoring Financial Products for Diverse Financial Demands at Different Levels

Taking Advantage of Rich Experience and Brand Effect to Promote Guaranty Business

The GFP Project has played a leveraging role by setting a guaranty loss reserve and introducing a guaranty mechanism. In December 2018, a guaranty subproject was approved for Sound Group, in which I&G would provide a CNY584 million (€75.56 million) guaranty service to facilitate the issuance of a "Sound Green Asset-Backed Security" (ABS). The funds raised through the ABS from the capital market will be used for odor control of two sewage treatment plants in Fatou and Wulituo of Beijing to improve air quality and sanitary conditions in the surrounding areas.

Providing Targeted Services to Specific Customers and Expanding the Scope of Support through Financial Leasing

Considering the heavy investments of fixed assets in green fields, the GFP Project introduces a financial leasing modality to provide loans to companies in need of fixed-assets procurement such as machines or equipment. This modality, on one hand, can extend the depth of subprojects' implementation and facilitate their sustainable development. On the other hand, it can cater to the specific needs of targeted customers. The GFP Project has granted CNY700 million (€90.57 million) to the subborrowers through three financial leasing companies, leveraging cofinancing of CNY595 million (€76.99 million) with a total investment of CNY2.56 billion (€331.24 million).

Supporting the Development and Capacity Building of Green SMEs

Green SMEs are important in terms of low-carbon development. However, they are often confronted with difficulties in accessing affordable financing due to their imperfect corporate governance, informal financial management systems, and volatile financial returns. To incentivize SMEs and promote their contributions to environmental protection, the GFP Project has worked hard on approaching SMEs and strengthening their capacity to access financing, with capacity building initiatives on energy-saving and emission-reduction technologies, environmental safeguards, financial assessment, and post-loan management. In addition to capacity-building support, the GFP Project has also endeavored to provide tailored financing services to green SMEs in a practical and timely manner. For instance, in 2019, I&G initiated a cooperative framework, in which a comprehensive CNY100 million (€12.94 million) credit line is given to Beijing Chengxinjia Guaranty Company, which is committed to providing guarantees for local green SMEs to help them acquire financing from the GFP Project. Under this framework, two subprojects were granted CNY9 million (€1.16 million) to construct two charging stations in Beijing. By constantly innovating and finding new ways of supporting green SMEs, the GFP Project aims to ease their financing pressure and pave the way to their sustainable development. As of 31 December 2020, a total of ten SMEs have passed the comprehensive assessment of ADB and I&G for total financial support of CNY 209 million (€27.04 million).

Innovative Approaches to Promote Commercial and Sustainable Development of Green and Low-Carbon Business

Green and low-carbon business tends to follow strict requirements in terms of both technical feasibility and environmental and social compliance. Meanwhile, they also contain certain features of public goods, such as higher capital cost, remarkable social effects, and spillover effects. Public finance and subsidy have played dominant roles in many of low-carbon areas. However, this mode cannot sustain low-carbon investment at scale. There is a need to innovate business models. Therefore, I&G has worked with Langfang City and Zhangjiakou City governments in Hebei Province on innovative mechanism and cooperation models using commercial funds as a basis, government funding as supplement, with policy support. Such a mechanism and cooperation model can reduce risks and financing cost of green projects for enterprises.

Successful Experiences

Establishing Clear Green Criteria and Financial Criteria for Selecting Subprojects

The GFP Project has set up specific selection criteria for potential subprojects. During the project appraisal process, I&G screens, assesses, and selects potential subprojects to mitigate the technical and financial risks, and applies an ESMS in accordance with ADB's Safeguard Policy Statement (2009). By setting up clear selection criteria for subprojects, I&G, as the implementing agency, can effectively and efficiently choose eligible subprojects. Moreover, by requiring subprojects to meet the ESMS standards, it may help domestic enterprises to benchmark international standards and enhance continuously their capacity for green and sustainable development.

Building an Efficient and Professional Project Team

A highly efficient and professional team is essential for the successful implementation of the project. I&G has long practiced and promoted the green development concept and established an ADB Program Center (i.e., PMO), comprising 22 professional with engineering, finance, legal affairs, and English skills, including two environmental and social safeguards managers. In addition, a think tank consisting of experts on foreign exchange management and environmental assessment has also been set up to provide comprehensive support to the project implementation. PMO staff received a series of skill trainings, including two English sessions at the Beijing Foreign Studies University, and participated in business exchanges and more than 30 learning tours in-country and abroad. More than 20 special research reports covering sectors such as energy saving, green transportation, and PV power generation have been prepared by the PMO. I&G has also undertaken a study funded by the United States Energy Foundation on the control of raw coal. Through learning, doing, and sharing, the project team's business and management capacity has been improved gradually, laying a solid foundation for efficient and high-quality project implementation and maximizing the implementation effects.[9]

9 Lessons learned include: (i) capacity of the financial intermediary is crucial; (ii) credit risks were borne by provinces or industrial entities in previous financial intermediation loans, which led to a risk-averse approach in appraising transactions; and (iii) more rigorous due diligence can avoid high attrition rate among borrowers.

Leverage Effect

To give full play to the role of ADB loans and leveraged capitals for all walks of life to invest in the green and low-carbon sectors to the maximum extent, I&G has been actively partnering with commercial banks, energy conservation associations, local financial platforms, and financial leasing companies. Various financing modalities such as cofinancing, guaranties, and intermediary loans have attracted more capital to flow into energy conservation and environmental protection areas. Currently, the GFP Project has successfully mobilized more than CNY8 billion (€1.04 billion) in investments to support green and low-carbon subprojects by offering entrusted loans, guaranty services and equity investments, realizing the leverage and demonstration effect.

Emphasis and Development of Tailored Financial Services

In line with the specific features of the low-carbon business and varying needs of customers, the GFP Project has focused on providing customized services to develop more targeted and practical financial products for customers in diverse circumstances with full consideration of risk control. Cooperating with local partners provides I&G with efficient and effective exposures to high quality SMEs' projects and helps improve project implementation. Under the GFP Project, I&G has signed a cooperative framework agreement with Shanxi Provincial Financing Re-guaranty Company, which has enabled I&G to communicate with potential green SMEs in Shanxi Province in advance and provide comprehensive credits. As a result, once their projects are initiated, the SMEs can receive loans easily and in a timely manner, and quickly proceed to implementation.

Application of Financial Technology

Financial technology (fintech), due to online operations, has been proven to have plenty of advantages in terms of convenience, efficiency, and cost savings. For instance, the application of big data and digital technology allows companies to quickly screen, evaluate, and monitor clients' risk profiles, which greatly facilitates credit rating and risk control. I&G has been actively exploring the application of fintech and has recently approved a PV power station guaranty subproject. The subproject adopted financing-guarantee linkage mode, in which I&G provides guarantee services for farmers to obtain loans from internet financial sectors to install distributed rooftop PV power stations. The cash flow generated from the stations will help cover borrowing costs and subsidize housekeeping expenses. This subproject also introduced private cooperative partners, whose core strengths lie in industrial experiences in fintech. By getting access to the cooperative partners' industrial internet platform and utilizing big data, I&G will not only improve its risk control ability but also channel more financial support to vast rural areas in the PRC.

Air Quality Trends

Looking at the big picture, $PM_{2.5}$ remains the number one pollutant in most of the cities in the PRC. The annual average concentrations of $PM_{2.5}$ in major cities of the greater BTH region displays a declining trend (Table 2) and the number of days with air quality index (AQI)[10] below 100 also shows improvements (Table 3). The greater BTH region demonstrates accelerated progress and the gap with the national average level is narrowing down. Although the target of 80% of days with AQI below 100 has not yet been met, the overall trends shown in Tables 2 and 3 are consistent with the objectives of the GFP Project.

[10] AQI is a common measure of the quality of air and its potential health impacts. AQI includes consideration of six atmospheric pollutants: sulfur dioxide, nitrogen oxide, PM2.5, carbon monoxide, ozone, and particulate matter 10 micrometers or less in diameter. In the PRC, the AQI is categorized from 50 (excellent) to 500 (severe pollution).

Table 2: Annual Average $PM_{2.5}$ Concentrations in the Greater Beijing–Tianjin–Hebei Region (microgram per cubic meter, μg/m³)

Location	2014	2015	2016	2017	2018	2019	2020 target
Beijing	86	81	73	58	51	42	66
Tianjin	83	70	69	62	52	51	57
Hebei Province	95	77	70	65	56	50	
Shijiazhuang	126	89	99	86	72	67	73
Baoding	129	107	93	84	67	58	88
Henan Province	83*	80	73	66	61	59	
Zhengzhou	88	96	78	66	63	58	79
Anyang	95	91	86	79	74	71	75
Shandong Province	82	76	66	57	49	50	
Jinan	90	87	73	63	52	46	71
Jining	92	82	73	56	52	54	67
Shanxi Province	64	56	60	59	55		
Taiyuan	68	62	66	66	59		51
Changzhi	67	65	69	60	54	55	53
Liaoning Province	58	55	46	44	38	40	
Shenyang	71	72	54	51	41	43	59
Jinzhou	63	60	55	48	46	47	49
IMAR	44	41	35***	32***	31***	28***	
Hohhot	44	43	41	44	39	38	35
Wuhai		55	46	44	36	32***	45
The Greater BTH Average	64	67	62	55	49	40	
PRC Average 338 Cities	62**	50	47	43	39	36	
PRC Standard	35***						

AQI = air quality index, BTH = Beijing–Tianjin–Hebei, IMAR= Inner Mongolia Autonomous Region, PM2.5 = particulate matter less than 2.5 microns in diameter, PRC = People's Republic China.

* Average of seven major cities. Greenpeace. 2014. 190 Cities PM2.5 Ranking. https://m.thepaper.cn/api_prom.jsp?contid=1296446&from=.

** The 2014 data covers 161 cities.

*** Regions in the corresponding year that meet the PRC standard for annual average PM2.5 concentrations (35 μg/m³).

Source: Ministry of Ecology and Environment of the PRC, Local Department of Ecology and Environment, and Greenpeace.

Table 3: Number of Days per Year with Air Quality Index≤100 in the Greater Beijing–Tianjin–Hebei Region

Location	2014	2015	2016	2017	2018	2019
Beijing	172	186	198	226	227	240
Tianjin	175	220	226	209	207	219
Hebei Province	152	190	207	202	208	226
Shijiazhuang	99	180	172	151	151	174
Baoding	84	127	155	159	159	194

continued on next page

Table 3 *continued*

Location	2014	2015	2016	2017	2018	2019
Henan Province	183	183	196	200+	206	241
Zhengzhou	163	138	159	166	168	177
Anyang	136	166	180	185	160	150
Shandong Province		181	206	214	220	218
Jinan	96	141	162	185	203	182
Jining	148	152	192	201	212	206
Shanxi Province	236	253	249	200	207	
Taiyuan	197	230	232	176	170	
Changzhi	235	242	219	195	213	
Liaoning Province		260	283	277	296**	295**
Shenyang	191	207	249	256	285	284
Jinzhou	238	243	246	255	276	286
IMAR	251	295**	313**	311**	305**	327**
Hohhot	240	276	283	255	272	292**
Wuhai		228	275	268	251	296**
BTH 13 cities	156	201	204			
BTH 2+26				180	184	194
The Greater BTH Average	195	221	235	234	235	252
PRC Average 338 Cities		280	287	284	288	287
PRC 80% Target by 2020	292**					

AQI = air quality index, BTH = Beijing–Tianjin–Hebei, IMAR= Inner Mongolia Autonomous Region, PM2.5 = particulate matter less than 2.5 microns in diameter, PRC = People's Republic China.

* Average of four major cities.

** Regions in the corresponding year that meet the PRC target for numbers of days per year with AQI ≤100 (292 days).

Source: Ministry of Ecology and Environment of PRC, and Local Department of Ecology and Environment.

Further Improvements

Foreign Exchange Rate Risks

Since I&G borrows euros from ADB and the loan funds will usually be converted to renminbi before transferring to qualified subprojects, there exists potential risks of foreign exchange rate fluctuation. Over the years, EUR to CNY exchange rate continues to fluctuate. More specifically, it reached a historical high of 11.2 in 2005 and fell to a record low of 6.6 in 2015. As of 31 December 2020, the figure was 8.025 and the equilibrium exchange rate of the GFP is 7.7286. So far, the exchange loss has reached CNY100.00 million (€12.94 million).

In the future, I&G will continue to focus on the foreign exchange fluctuation and in due course, make proper use of foreign exchange derivatives such as foreign exchange options, foreign exchange swaps, foreign exchange forward transactions, and so forth, to hedge the forex risks.

Minimizing Adverse Impacts of Coronavirus Disease 2019

The adverse impacts triggered by the coronavirus disease (COVID-19) pandemic, especially its economic shock, bring new challenges to the development of new subprojects and increase the risk and uncertainty of ongoing subprojects. To be more specific, the lockdown and travel restriction disrupted projects on-site due diligence and operation. Meanwhile, falling interest rates further narrowed credit spreads. As a result, some subprojects applied for pre-repayment or interest rate reduction, increasing reinvestment pressure. Last but not least, due to the COVID-19 crisis, enterprises, especially private enterprises and SMEs face cash flow restraints. Some subprojects cannot operate at full capacity, which in turn leads to slower repayment and higher default rates.

Since the beginning of the COVID-19 outbreak, by conducting online services, I&G has been quick and flexible in its response to meet subborrower's needs. By reducing interest rates, waiving evaluation fees, and helping to appease investors, I&G has provided crucial support for enterprises affected by the crisis. Meanwhile, according to ADB's instructions, I&G has conducted subproject-level risk assessments, examined the potential impacts of COVID-19, and gave relevant, timely feedback.

Strengthening the Development of Guarantee Business

The GFP has set up goals for the provision of guarantee services and will withdraw from guarantee loss reserve in phases according to the aggregate amount of guarantees provided. So far, CNY386 million (€50 million) of guarantee loss reserve has been withdrawn. The next withdrawal will be made when I&G ensures that no less than CNY1,103 million (€140 million) of guarantees has been provided to the qualified subprojects. The PMO are trying their best to develop guarantee subprojects. Nevertheless, the complex external environment, combined with high project risks triggered by the COVID-19 crisis, brings new challenges to the provision of guarantee services.

In the face of the current situation, I&G put forward an innovative financing modality by combining loans with guarantees, utilizing both domestic and international funds to achieve diversified cofinancing. Meanwhile, I&G has strengthened business cooperation with relevant institutions in green field to give full play to its brand advantage in credit enhancement. It has also been actively reaching to local governments' financing platforms, seeking potential business opportunities to provide guarantee services for green bonds. In addition, I&G is exploring the use of fintech to extend the reach of financial instruments adopted, aiming to provide tailored guarantee services for customers.

Summary

The GFP Project has performed well overall. As envisioned at the conception of the BTH program (Table 1), up to $2.8 billion in ADB financing was envisioned, and to date, ADB has committed investments of approximately $2.0 billion. Air pollution in the greater BTH region remains a challenge and additional funds are needed to continue the efforts made. With this backdrop, the government and ADB have agreed to further scale up the GFP Project by increasing the ADB funding inputs by $150 million (approved by ADB in December 2020). The Green Financing Scale Up Project targets the greater BTH region and also expands to the Yangtze River Delta Region, which comprises Shanghai municipality, and Anhui, Jiangsu, and Zhejiang provinces. The Scale Up Project will mainly focus on the promotion of renewable energy, energy storage, and the reduction of greenhouse gas emissions. It will also target the elimination and substitution of coal and continue supporting the subprojects on waste-to-energy, green transportation, energy saving and emission reduction, and follow-up treatment of coal-to-electricity and coal-to-gas in rural areas. ADB will continue to support the PRC government with financial and technical assistance to achieve the long-term environmental and social development objectives.

Appendix 1: Selection Criteria For Entrusted Loans, Guarantees, and Financial Leases

The subprojects supported by entrusted loans including credit lines to energy service companies and financial leasing companies, guarantees, and financial leases, must meet technical, financial, economic, environmental, and social criteria. These criteria will ensure that the selected subprojects lead and demonstrate air quality improvement, low-carbon development, energy efficiency, and emission reduction work in Greater Beijing–Tianjin–Hebei (BTH) region with advanced technology, adequate financial returns, and provide substantial benefits to the economy, society, and environment. The following criteria will apply to the subprojects that are financed under the green financing platform.

Subproject Technical Criteria

All subprojects must meet the following criteria, in particular:

(i) All subprojects must not result in an increase in energy consumption and emissions comparing to the current situation in the facility where the subprojects are located, including carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxide (NOx), and airborne particulate matter (PM), or others may be approved by the Asian Development Bank (ADB).
(ii) Baseline for energy consumption and emissions shall be established before the subprojects are being implemented.
(iii) Energy consumption and emissions produced by the subprojects after implementation shall be monitored and recorded.
(iv) All subprojects must use proven technologies with reliable, measurable, and verifiable emission reduction that will contribute to the achievement of the Action Plan on Prevention and Control of Air Pollution (2013–2017), and the Thirteenth Five-Year Plan of the People's Republic of China (PRC).
(v) The proposed technologies to be used shall be the best available technologies, where feasible.
(vi) All subprojects shall comply with the ADB's Energy Policy and the industry policies of where the subproject is located. Normally, the subproject should belong to the encouraged and prioritized sectors, local key supported projects, or piloting project.
(vii) All subprojects shall contribute to at least one of the indicators set in the design and monitoring framework.
(viii) All subprojects must be located in the geographic areas listed under greater BTH region and must address air pollution issues.

Subproject Financial Criteria

All subprojects must be financially viable. The financial analysis should be prepared in accordance with ADB Financial Management and Analysis of Projects guidelines. In particular:

(i) The estimated subproject investment and operations costs, as well as cash inflows, must be clearly presented and must be reasonable.
(ii) The financial internal rate of return (FIRR) shall be greater than the weighted average cost of capital.
(iii) The FIRR must be robust under various sensitivity scenarios.
(iv) The payback period of subprojects shall match the repayment period of subloans.
(v) The average debt service coverage ratio shall be at least 1.2. If any subproject has debt service coverage ratio less than 1.2, China National Investment and Guaranty Corporation (I&G) will require the subborrower to provide additional credit enhancement measures.

Subproject Economic Criteria

For all the proposed subprojects, the total economic benefits must exceed the total economic costs. The economic internal rate of return of the subproject must be greater than the discount rate of 12% and must be viable under adverse sensitivity scenarios. The economic benefits include CO_2 savings valued at $35.2/ton with 2% annual increase.

Subproject Social and Environmental Safeguards Criteria

All subprojects must meet the following criteria, in particular:

(i) The subprojects must not involve any land acquisition or housing demolition.
(ii) The subproject must not have any impacts on ethnic minorities.
(iii) The subprojects must not be located in any designated environmental protection zone and cultural heritage site.
(iv) The subprojects must not support enterprises that have activities involving commercial development of cultural resources of indigenous peoples without their consent for the commercialization of such resources.
(v) Each subproject must be designed, constructed, and operated in accordance with relevant national and provincial social and environmental laws and regulations.
(vi) Subproject must meet requirements of the environmental and social management system developed for the loan project.
(vii) Initial Poverty and Social Assessment and Summary Poverty Reduction and Social Strategy shall be prepared for all subprojects.
(viii) Each subproject must acquire proper approvals from proper national and provincial authorities in-charge.
(ix) The subprojects shall not result in labor retrenchment and labor redundancies.

Subborrower Selection Criteria

All subborrowers must meet the following criteria, in particular:

(i) All subborrowers must be financially creditworthy and not have a poor credit record, as recorded in the People's Bank of China credit history database.
(ii) The subborrowers must be capable to contribute a minimum of 20% of the total subproject investment cost as counterpart financing.
(iii) The subborrowers shall commit to enhance capacities in project planning, financing, implementing, and monitoring during the subproject preparation and implementation periods.
(iv) The subborrowers must have complied with all relevant domestic environmental regulations and must acquire relevant environment permits with respect to the existing facilities.
(v) The subborrowers must be in compliance with relevant domestic occupational health and safety standards.

In the event that a subproject has good energy savings and emission reduction potential, but does not meet some of these criteria, I&G may consider and recommend to ADB, ADB will review and approve.

Appendix 2: Selection Criteria For Early Stage Investment

1. **Sector coverage.** The investment in early stage technology will focus on the introduction of innovative low-emission technologies in same targeted areas as specified for the overall loan project, including clean energy, energy efficiency, emission reduction, green transport, and other related low-emission technologies.

2. **Number of positions and investment size.** Targeting companies must be in the early to early-growth stages. Early stage refers to typically pre-revenue, with business model in trial, while early-growth stage refers to typically early revenue, pre- or post-profit with existing business model.

3. **Return objective.** The return is expected to be greater than 10%.

4. **Investment criteria.**

    (a) China National Investment and Guaranty Corporation will inject capital to the low-carbon technology investee, which are operating in the selected industries and fields mentioned in para. 1;
    (b) The investee must conduct businesses with environmental–social return, which can generate enhanced financial return;
    (c) The investee must possess patent(s), proprietary technology, and/or technical know-how in the sectors mentioned in para. 1;
    (d) The investee must have good growth potential with feasible technology;
    (e) The investee should be ready for initial commercialization or further scale-up;
    (f) The investee must be registered within 8 years; and
    (g) It will be a strong plus if other investment institutions have already invested to the investee.

5. **Geographic location.** The investee must be located in the Greater Beijing–Tianjin–Hebei region.

6. **Social and environmental safeguards criteria.** The subprojects supported by the investment in early stage technology must meet the following criteria:

    (a) The subprojects must not involve any land acquisition or housing demolition. The subproject proposal will be screened through an involuntary resettlement impact screening checklist in accordance with procedures contained in the project's environmental and social management system (ESMS) which is included as Appendix 7 of the ESMS. The checklist will be submitted to the Asian Development Bank (ADB) for approval to confirm that no land acquisition or house demolition will be required;
    (b) The subproject must not have any impacts on ethnic minorities. The subproject proposal will be screened through an ethnic minorities impact screening checklist. The checklist will be submitted to ADB for approval to confirm that there are no impacts on ethnic minorities;
    (c) The subprojects must not be located in any designated environmental protection zone and cultural heritage site;
    (d) Each subproject must be designed, constructed, and operated in accordance with relevant national and provincial social and environmental laws and regulations;
    (e) Subproject must meet requirements of the ESMS developed for the project;

(f) Initial Poverty and Social Assessment and Summary Poverty Reduction and Social Strategy shall be prepared for all subprojects;

(g) Each subproject must acquire proper approvals from proper national and provincial authorities in-charge;

(h) The investees must have complied with all relevant domestic environmental regulations and must acquire relevant environment permits with respect to the existing facilities;

(i) The investees must be in compliance with relevant domestic occupational health and safety standard; and

(j) The subprojects should not result in labor retrenchment and labor redundancies.

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PART 3

Clean Energy Development in Selected Subregions and Countries: Financing Approaches, Business Models, and Policies

6 Clean Energy Finance in the Countries of the Association of Southeast Asian Nations

Shobhakar Dhakal and Subina Shrestha

Introduction

Rapid economic growth and development across the Association of Southeast Asian Nations (ASEAN) has presented several energy challenges in the region. There is a growing need to significantly increase the region's investments in clean energy and energy efficiency.

The ASEAN region is witnessing rapid economic growth and development, combined with an increase in population as well as urbanization. By 2018, ASEAN was fifth among the world's largest economies, contributing to 3.5% of the global economy, with an estimated regional gross domestic product (GDP) of $3.0 trillion, an increase of more than 50% of its 2010 level.[1] Countries in the region are also undergoing structural transformations, underpinned by the shift from agriculture to service and industry-oriented economy, and the regional economy has grown at over 5% per year in 2000–2018—among one of the highest rates globally. ASEAN's economic development and industrial growth is underpinned on the increased use of fossil fuels, which meets over 80% of the region's energy demand.[2] The region's reliance on coal alone is expected to further grow by around a third over the next 5 years. ASEAN's impressive economic growth trajectory is, therefore, being met with energy challenges, which raises concerns over environmental sustainability.[3]

ASEAN's energy challenges are several folds: first, about 45 million ASEAN residents still do not have access to electricity.[4] This, coupled with the region's continued increase in population and socioeconomic growth will accelerate energy demand, raising concerns over access to reliable and affordable energy. Second, meeting ASEAN's rising energy demands with fossil fuels will boost carbon dioxide (CO_2) emissions and exacerbate local air pollution. Regional external costs of fossil-fuel associated air pollution is likely to increase by 35%, from $167 billion annually in 2014 to $225 billion in 2025.[5] Third, as the region's fossil fuel reserves continue to deplete, ASEAN is on its way toward becoming a net importer of fossil fuels,[6] which has important energy security implications. Fourth, all ASEAN nations have national commitments to reduce energy-related greenhouse gas (GHG) emissions.

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1 ASEAN Secretariat. 2019. *ASEAN Key Figures 2019*.
2 International Energy Agency (IEA). 2019. *Southeast Asia Energy Outlook 2019 – Analysis*.
3 R. Clark, N. Zucker, and J. Urpelainen. 2020. The Future of Coal-Fired Power Generation in Southeast Asia. *Renewable and Sustainable Energy Reviews*. 121.
4 IEA. 2019a. *ASEAN Renewable Energy Integration Analysis*.
5 International Renewable Energy Agency (IRENA) and ASEAN Centre for Energy (ACE). 2016. *REmap – Renewable Energy Outlook for ASEAN*.
6 IEA (2019), p. 7.

Fulfilling these national commitments for emission reduction while addressing ASEAN's energy security issues in a sustainable manner calls for significantly increasing the region's investments in clean energy and energy efficiency. ASEAN's clean energy transition will rely on how effectively diverse financing sources and instruments will be used across countries to leverage the region as a hub for both international and domestic investments in renewable energy as well as energy efficiency and conservation.

In this context, this chapter provides a picture of current status of clean energy and its targets in the ASEAN region, including the financing gaps and investment needs, prevailing sources of flows of finance, and an outlook on the regional cooperation in energy financing in the region. It elaborates on the policy and financial instruments of financing in ASEAN and draws on the success stories of ASEAN states that could be of great interest within and outside the region. Insights on the challenges and barriers for clean energy financing are also provided in this chapter, which has important policy implications.

Status and Targets of Renewable Energy Development

Renewable energy currently accounts for about 15% of the region's energy demand; 2025 regional target comprises 23% renewable energy in its total primary energy supply (TPES) and a 30% reduction in energy intensity based on 2005 levels by 2025.

Energy demand in ASEAN has grown by more than 80% since 2000–2019.[7] Eighty-five percent of this growth has been met by a doubling in fossil fuel use, led by oil. The rising demand for oil already exceeds the region's production potential. Oil accounts for more than one-third of ASEAN's primary energy mix, followed by coal (20%) and gas (19%). Despite having enormous potential in renewables in the ASEAN countries, renewable energy currently accounts for less than one-fourth of the region's energy demand. Current trends already reveal a growing imbalance between rising demand and stagnant or falling production. For instance, Viet Nam is expected to import almost half of its total commercial primary energy demands over the next decade, while Malaysia is already beginning to import oils.[8] This is gradually pushing ASEAN toward becoming a net importer of fossil fuels, which has important energy security implications.[9] This presents an opportunity to meet the region's growing energy security concerns with clean energy and tap into the region's renewable potential.

At the same time, the coronavirus disease (COVID-19) pandemic has affected investments in clean energy, as ASEAN governments redirect funds to emergency relief programs. Financing gaps for clean energy projects in the region could widen owing to the pandemic, as these are likely to be perceived with higher risk and lower revenues. ASEAN's post-COVID-19 economy offers pathways to incorporate green recovery and catalyze finance flows into clean energy. This presents an opportunity to mobilize both public and finance into renewable energy as well as energy efficiency.[10] The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 "seeks an opportunity to ensure the sustainable energy supplies by committing on 23% renewable energy contributions in its total primary energy supply and a 30% reduction in energy intensity based on 2005 levels by 2025." Similarly, countries across ASEAN have their respective targets for both energy efficiency and renewable energy, as shown in Table 1.

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7 Footnote 6.

8 S. Senderov and S. Vorobev. 2018. Ensuring Energy Security in ASEAN Countries: Current Trends and Major Challenges. *E3S Web of Conferences*.

9 Footnote 6.

10 ASEAN Catalytic Green Finance Facility and Asian Development Bank (ACGF and ADB). 2020. *Green Finance Strategies for Post-COVID Economic Recovery in Southeast Asia*.

Table 1: ASEAN Member State Renewable Energy and Energy Efficiency Targets, based on National Energy Targets/Road Map

ASEAN Member State	Targets for Renewable Energy	Targets for Energy Efficiency
ASEAN	• By 2025, the proportion of renewable energy is 23% of the primary energy mix	• By 2025: Energy intensity levels are reduced by 30% (based on 2005 level)
Brunei Darussalam	• 10% renewable energy capacity share in power generation mix (installed capacity)	• Reduce total energy consumption by 63% by 2035 compared to a business-as-usual (BAU) scenario • A reduction of 45% in energy intensity by 2035 compared to 2005 level
Cambodia	• No specific renewable energy target except hydropower • By 2020: 2,241 megawatt (MW) large hydro (approximately 80% of the total installed capacity) • 55% of hydro, 10% of other renewable energy in power generation mix by 2030	• A total of 10% energy reduction in all sectors compared to the BAU by 2030 • Achieve less than 8% transmission and distribution losses • 15% of energy intensity reduction in industry sector by 2030 • 15% increase of bus engine efficiency by 2030
Indonesia	• By 2025: 23% renewable energy share of total primary energy supply (TPES) • By 2050: 31% renewable energy share of TPES • Renewable energy installed capacity of 45 gigawatts (GW) by 2025 and 168 GW by 2050 • Implementation of B30 (30% biodiesel blending) by 2025	• Energy elasticity < 1 by 2025 • 1% of energy intensity reduction per annum of up to 2025
Lao People's Democratic Republic	• By 2025: 30% renewable energy share of Total Final Energy Consumption (TFEC) (excluding large hydro)	• 10% of total final energy consumption reduction by 2030, compared to BAU • 20% of total final energy consumption reduction by 2040, compared to BAU
Malaysia	• By 2030, the total electricity mix from renewable energy is targeted to reach 11% of total electricity generated • Implementation of B10 (10% biodiesel blending) by 2020	• 8% of demand growth reduction by 2025, equivalent to a total of 233 gigawatt-hours (GWh) of electricity savings over a 10-year period from 2016–2025
Philippines	• 20 GW of installed capacity from renewable energy by 2040	• 3% of reduction in energy intensity across key economic sectors • At least 10% of energy saving on electricity from all sectors by 2040, based on 2016 BAU
Singapore	• Solar target of at least 2 gigawatt-peak by 2030 • Energy storage deployment target of 200 MW beyond 2025	• Energy intensity reduction by 35% in 2030, compared to 2005 level

continued on next page

Table 1 *continued*

ASEAN Member State	Targets for Renewable Energy	Targets for Energy Efficiency
Thailand	• By 2036: 30% renewable energy share in TFEC, in: ° Electricity (20.11% in generation, approximately 19,684 MW) ° Heat (36.67% of heat production, approximately 25,088 kilotons of oil equivalent [ktoe]) ° Biofuels (25.04% in transportation sector, approximately 8,712 ktoe)	• 30% reduction in energy intensity by 2036, compared to 2010
Viet Nam	• Renewable energy share in total primary energy consumption (approx.): 31% in 2020, 32.3% in 2030, and 44% in 2050 • Share of renewable energy-based electricity in the total national production: 38% in 2020, 32% in 2030, and 43% in 2050 • Share of biofuels in transportation fuel demand: 5% in 2020, 13% in 2030, and 25% in 2050	• 5%–7% of energy saving in the period of 2019–2025 • 8%–10% of energy saving in the period of 2019–2030 • Reduce power loss to: ° less than 6.5% by 2025 ° less than 6% by 2030

ASEAN = Association of Southeast Asian Nations.

Source: Liu, Sheng, and Azhgaliyeva (2019).

Clean Energy Financing in ASEAN: Clarifying the Picture

An estimated $290 billion and $11 billion needed in investment to reach regional targets of renewable energy and energy efficiency, respectively, by 2025.

The current clean energy financing landscape is prominent in the power sector. Several ASEAN countries have long invested into large-scale hydro and geothermal power plants, owing to their cost competitiveness. The recent trend of declining costs of solar and wind have attributed to an increase in their adoption rates, albeit they are only beginning to be tapped. However, clean energy financing trends in the region vary among countries. Cambodia saw a remarkable increase in its investment with a leap to $568 million in 2019, from almost nothing the previous year (due to financing of a photovoltaic [PV] facility of 135 MW). Other countries, however, saw a decline in investments compared to 2018. Thailand's renewable investment in 2019 was $229 million, the Philippines had little more than $100 million committed to renewables, $359 million in Indonesia, $250 million in Malaysia, and $2.6 billion in Viet Nam.[11]

Meeting the region's future growing energy demands with clean energy needs a sizeable increase in and substantial redirection of investments. Clean energy financing in ASEAN has met with difficulties to keep up the necessary rate of transition required to meet regional and national targets set by member nations. How the national and regional commitments for clean energy will translate across investment decisions remains ambiguous. Public funding (through national subsidies and export credit guarantees) is still steered toward fossil fuels, as export credit agencies from countries such as Japan and the Republic of Korea

[11] Frankfurt School – UNEP Centre and BNEF. 2020. *Global Trends Renewable Energy Investment 2020*.

continue to invest into coal power plants in the region.[12] Furthermore, utilities in the region are state owned with monopoly positions in power distribution and transmission, which effectively restricts renewable energy development and support due to government's preferential treatment of fossil fuels and large centralized power plants.[13] There are pertinent challenges arising from general scarcity of investor capital (debt and equity) in many ASEAN countries, and investors' limited information and track record in renewable energy. How the region's financial market evolves to enable private sector investment and make use of innovative financing instruments is crucial for meeting financing gaps in ASEAN's clean energy transition. The proportion of renewable energy would only slightly increase from the current 15% to just under 17% by 2025 under a business-as-usual scenario.[14] Reaching the 2025 goal, therefore, requires targeted efforts to accelerate and scale up renewable energy deployment, and exploiting the rapidly evolving market landscape, and ultimately make fossil fuel and clean energy investments cost-competitive.[15]

Investment Needs and Clean Energy Financing Gaps: Renewable Energy

In 2017, investment in renewable energy stood at about $2.4 billion.[16] To reach the regional target of increasing the share of renewable sources to 23% of primary energy by 2025, an estimated regional investment of $290 billion in renewable energy capacity for 2014–2025 or an estimated investment of $27 billion annually, is needed.[17] To close the gap, an additional $14 billion annually will be required on top of existing government plans, of which $5 billion annually can be redirected from investments in fossil fuels. However, an additional $9 billion will be needed, and the current landscape of government financing schemes is not able to match the investment costs required for scaling-up renewable energy projects.[18] Strategies that meet the 2025 target for renewable energy are expected to further increase their share to 28.7% of TPES in 2040. This would require an additional estimated investment of $281 billion from 2026–2040 in renewables.[19] Closing this gap will require more concerted efforts to scale up renewable energy projects.

Investment Needs and Clean Energy Financing Gaps: Energy Efficiency

ASEAN's investment in energy efficiency stood at $1.83 billion, accounting for a mere 5% of the region's energy investment.[20] This has been attributed to inadequate progress in expanding appropriate policies and measures. Demand-side investment in ASEAN's energy sector is expected to account to approximately one-fourth of the total energy sector investments to 2040. A large portion of these will be focused on energy-efficient technologies.[21] Meeting the region's energy efficiency targets by 2025 is estimated to require about $11 billion.[22] Energy efficiency investments in ASEAN are seen predominantly in road transport and the buildings sector, as incentive schemes such as tax rebates for more fuel-efficient vehicles and soft loans for efficiency measures in buildings are in place. However, highly subsidized energy sector across the region disincentivizes investments to improve energy efficiency, thereby creating a gap.[23]

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12 P. du Pont, C. Gueguenteil, and O. Johnson. 2020. *Perceptions of Climate-related Investment Risk in Southeast Asia's Power Sector.*

13 ASEAN Centre for Energy (ACE) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). 2019. *Renewable Energy Financing in Cambodia, Lao PDR and Myanmar.*

14 IRENA and ACE (2016), p. 10.

15 Footnote 14, pp. 13–14.

16 United Nations Economic and Social Commission for Asia and the Pacific. 2017. *Regional Cooperation for Sustainable Energy in Asia and the Pacific.*

17 Footnote 14, p. 18.

18 IRENA. 2018. *Renewable Energy Market Analysis: Southeast Asia.*

19 ACE. 2020. *Asean Energy Outlook 2017–2040.* Jakarta.

20 Footnote 18.

21 Footnote 2 in IRENA. 2018. *Renewable Energy Market Analysis: Southeast Asia.* p. 78.

22 ACE. 2019. *Mapping of Energy Efficiency Financing in ASEAN.* Jakarta.

23 Copenhagen Centre on Energy Efficiency (C2E2). 2015. *Accelerating Energy Efficiency: Initiatives and Opportunities – Southeast Asia.* Copenhagen.

Inadequate financing in clean energy hinders ASEAN's ability to meet its clean energy investment target.[24] Thus, it becomes important to assess the drivers of this financing gap across ASEAN, propose appropriate ways to channel adequate capital into the renewable energy sector.[25]

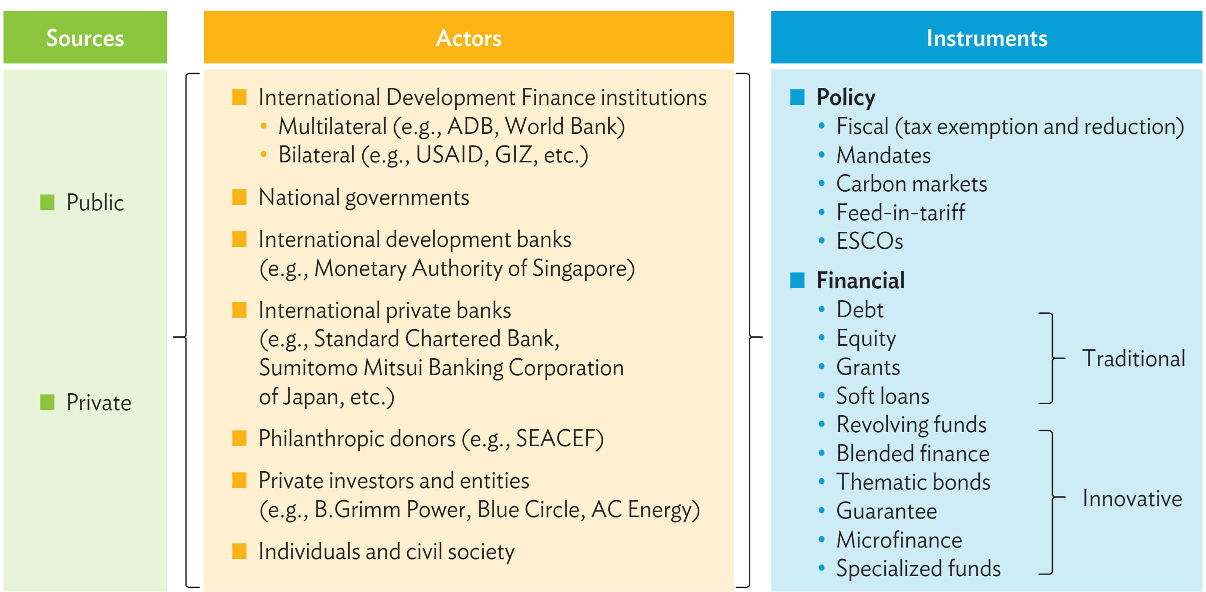
While the deployment of renewables and energy conservation is occurring at a relatively higher rate in many countries with different innovative financing schemes already in place, the investments are still not at par to meet these targets. As the number and scale of clean energy projects increase, public sources and traditional investments alone will not be able to finance them.[26]

Prevailing Financing Sources and Flows

Private financing sources for clean energy in ASEAN dominate utility-scale solar PV and wind technologies, whereas domestic financing for clean energy within the region is still in its infancy.

The energy market in ASEAN is changing, as the region emphasizes on renewable energy development. Investment needs are significant. The mix of available financing sources for renewable energy comprises domestic and international, as well as public and private (Figure 1). Current investments in clean energy are dominated by public finance, accounting for two-thirds of infrastructure investments. However, future investment needs cannot be fulfilled by public sources alone, and must be complemented by a sustained as well as balanced access to different private financing sources.[27]

Figure 1: Prevailing Sources and Flows of Clean Energy Financing



ADB = Asian Development Bank, ESCO = energy service company, GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit, SEACEF = Southeast Asia Clean Energy Facility, USAID = United States Agency for International Development.

Source: Adapted from The New Climate Economy (2016).

[24] T. Ekholm et al. 2013. The Effect of Financial Constraints on Energy-Climate Scenarios. *Energy Policy*.
[25] T. H. Ng and J. Y. Tao. 2016. Bond Financing for Renewable Energy in Asia. *Energy Policy*.
[26] P. Yatim, S. L. Ngan, and H. L. Lam. 2017. Financing Green Growth in Malaysia: Enabling Conditions and Challenges. *Chemical Engineering Transactions* 61.
[27] IEA (2019), pp. 17–20.

Public Finance Institutions

Both national and institutional financing institutions play a major role in financing clean energy in ASEAN. Public financing in ASEAN has been concentrated in large-scale renewables such as hydropower and geothermal, that typically have large upfront capital needs. Public sources accounted for over 60% of the financing share in these technologies in the region over 2014–2018.[28]

International Public Finance Institutions

In the early phases of renewable energy development in ASEAN, development finance institutions (DFIs), both bilateral and multilateral, were the most dominant investors. However, their roles in the region have decreased over time, as utility-scale solar PV and wind projects became more affordable, and private sector investments increased. Nevertheless, the role of DFIs is still important in the Lower Mekong countries and Indonesia albeit their roles have evolved over the years. They now work on several areas, including capacity building, awareness generation, conducting feasibility studies, as well as technical cooperation with other donor-funded public agencies. The ASEAN–German Energy Programme (AGEP), which was jointly implemented by the ASEAN Centre for Energy (ACE) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), aims to "improve regional coordination for the promotion of renewable energy and energy efficiency toward sustainable energy for all. AGEP is being implemented in regional contexts in all ASEAN Member States."

Box 1: Green Climate Fund and Clean Energy Financing in ASEAN

The Green Climate Fund (GCF) provided $86.3 million in financing to Viet Nam through its guarantee instrument for technical assistance and capacity building activities. Additionally, GCF also provided a dedicated credit line to scale up investments in energy efficiency in Viet Nam's industrial sector.

In Indonesia, GCF has financed $100 million in the Geothermal Resource Risk Mitigation Project to "help the Government of Indonesia scale up geothermal energy development by introducing a well-designed upstream risk mitigation mechanism and by promoting a conducive regulatory environment. Under this project, both public and private sector geothermal developers will have access to funds to help mitigate early-stage development risks. The geothermal resource risk mitigation facility will provide contingent financing and soft loans for resource confirmation drilling."

ASEAN = Association of Southeast Asian Nations.

Source: Green Climate Fund.

DFIs financed over $9 billion in clean energy in ASEAN region over 2011–2020.[29] The top three investors comprise the World Bank, the Asian Development Bank (ADB), and Japan Bank for International Cooperation as each bank has invested over $1 billion during 2009–2016 (Table 2). Financing by development banks in ASEAN have been prominent in geothermal and hydropower sectors historically (Figure 2), which collectively attracted 70% of investments from 2009–2016.[30] However, strides are now being made in other technologies. The World Bank has committed $640 million for the Pumped Storage Technical Assistance Project in Indonesia. Energy efficiency projects are also increasingly financed. ADB has mobilized more than $400 million to energy efficiency and conservation projects in the ASEAN region by providing grants and technical assistance to the governments of Indonesia, the Philippines, Thailand, and Viet Nam.

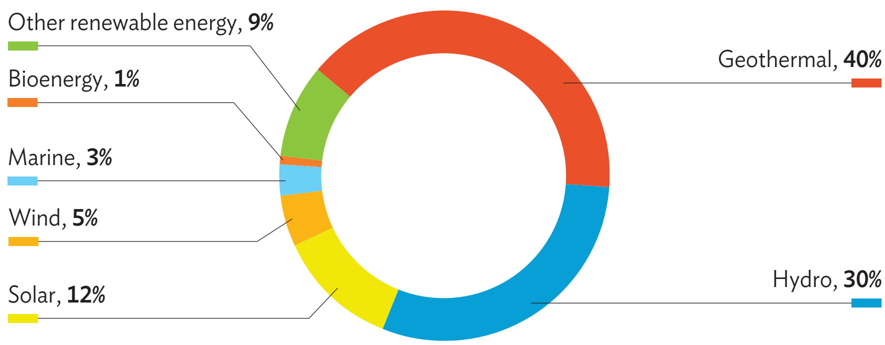
[28] World Bank. 2020. Private Participation in Infrastructure (Database) (accessed 20 December 2020).
[29] Footnote 28.
[30] IRENA (2018), pp. 116–117.

Table 2: Clean Energy Financing Provided by International Development (World Bank 2020)

Development Finance Institution	Clean Energy Financing ($ million)
Asian Development Bank	3,834.02
International Finance Corporation	1,684.28
Japan Bank of International Cooperation	1,672.00
Bank of Tokyo	1,575.03
Bank of China	244.80
Export–Import Bank of Korea	191.00
Sumitomo Bank	64.00
Asian Infrastructure Investment Bank	20.00

Source: World Bank. Private Participation in Infrastructure (Database) (accessed 20 December 2020).

Figure 2: Development Banks' Investments in Renewable Energy by Technology, 2009–2016



Source: International Renewable Energy Agency 2017.

Some of ADB's key interventions include replacing 100,000 gasoline-burning tricycles in the Philippines for electric ones, supporting green urban infrastructure in Viet Nam, and providing technical assistance to mainstream energy efficiency measures in Thailand.[31] Likewise, ADB financed $7.64 million for a 100 megawatt (MW) National Solar Park in Cambodia, and also provided technical assistance for the same. DFIs are now shifting focus toward blended investment structures to increase and encourage the role of private sector in the region's clean energy development.

Domestic Public Finance Institutions

Domestic public financing for clean energy in ASEAN is still in its infancy, as countries are only beginning to develop national financing vehicles and green banks in order to access international climate finance. Such national vehicles have dual roles: channeling funds from donor organizations as well as acting as the implementing agencies on behalf of the investor. Such dedicated agencies aim to develop a pipeline of bankable projects, including the clean energy sector. The maturity of these institutions varies according to country. Table 3 shows some of the domestic financial institutions in ASEAN countries that dedicate to clean energy.

[31] ACE and GIZ (2019), p. 16.

Table 3: Examples of Current Domestic Financial Institutions by Country that Dedicate to Clean Energy Financing or Green Finance/Climate Finance

Country	Domestic Financial Institutions in Clean Energy Financing	
Indonesia	PT Sarana Multi Insfrastruktur (SMI), Financial Service Authority (OJK)	PT SMI is a special mission vehicle under Indonesia's Ministry of Finance and an accredited member in the Green Climate Fund. It supports renewable energy projects mostly through PPP schemes. PT SMI also issued Indonesia's first green bonds, worth Rp500 billion (approx. $35.4 million) in 2018 for two mini hydro projects and one Light Rail Transit project. Green finance was promoted by the central bank, Bank Indonesia, until 2013, after which it was promoted by Financial Service Authority (OJK).
Malaysia	Bank Negara Malaysia, CIMB Bank Berhad, Bank Pembangunan Malaysia, RHB Bank Berhad	Malaysia's central bank, Bank Negara Malaysia, initiated the Green Sukuk, which is under the bank's Malaysia Green Finance Program. The program aims to encourage investments in green or sustainable projects through the development of green Islamic finance markets initially in Malaysia, and subsequently, in the ASEAN region. RHB Bank Berhad committed RM5 billion (about $1.23 million) in support of green financing by 2025, which includes renewable energy and green buildings.
Philippines	BDO Unibank, Bank of the Philippine Islands, Development Bank of the Philippines, Philippine National Bank, Rizal Commercial Banking Corporation	The Philippines' commercial banks use a number of instruments to finance renewable energy projects. For example, BDO has been able to use over $500 million in the Philippines' clean energy sector. The bank's renewable energy financing portfolio includes loans for renewable energy and energy efficiency projects, as well as bonds. Other commercial banks/entities also issue green bonds to support clean energy projects. For example, AC Energy issued a $60 million green bond for renewable energy in 2020 and has issued over $800 million between 2019–2020 in green bonds for energy. AP Renewables issued $225 million in green bonds for the Tiwi–MakBan geothermal complex, with the support of the Asian Development Bank.
Singapore	Monetary Authority of Singapore (MAS), United Overseas Bank (UOB), Development Bank of Singapore Limited	MAS has formed a network with seven other central banks in the world called the "Central Banks and Supervisors Network for Greening Financial System." MAS has also established a "Green Bond Grant Scheme" to promote and ensure the issuance of green bonds in Singapore. In 2017, UOB lent $15 million to Sunseap Group for a series of solar projects in Singapore.
Thailand	Kasikorn Bank, Siam Commercial Bank, Bangkok Bank	Kasikorn Bank's "*Energy and environmental project financing*" includes loans to support the installation of clean energy such as solar rooftop PVs, as well as energy conservation in buildings. As of 2019, the bank has approved more than B2.0 billion ($65.98 million) of loans under this. Other domestic banks have been financing renewable energy projects, e.g., SCB has financed most of the wind power projects in Thailand, including $1.14 billion for the 450-megawatt project by the Wind Energy Holding in 2017. These banks also finance renewable energy projects in other countries in the ASEAN region.
Viet Nam	State Bank of Vietnam (SBV), Vietnam Development Bank	Commercial banks in Viet Nam provide debt financing to renewable energy projects, e.g., the SBV developed a directive on "Promoting Green Credit Growth" in 2015, followed by the "Action Plan of Banking Sector" to implement its national "Green Growth Strategy" until 2020. The Vietnam Development Bank financed a 40.7 MW small hydropower project with Asiatic Holdings Group.

ASEAN = Association of Southeast Asian Nations, PPP = public–private partnership, PV = photovoltaic.

Sources: IRENA (2018), ADB (2019), and Chang (2019).

Private Finance Institutions

As clean energy is becoming increasingly attractive, private sector is also investing in this sector in ASEAN. Private sector investment is dominant in utility-scale solar PV and wind, driven by the cost-competitiveness of these technologies.[32]

Debt Financing

Both domestic as well as international commercial banks are investing in the region's clean energy sector. Some of the initial investors in the region comprised international banks such as Standard Chartered Bank, Rabobank, Sumitomo Mitsui Banking Corporation of Japan, among others. Domestic financial institutions have already begun financing clean energy technology projects in ASEAN, although the levels vary across countries. In Malaysia, the Philippines, Singapore, and Thailand, local banks are well familiar with financing clean energy projects, pioneered by Thai banks. In relatively new markets, such as Indonesia and Viet Nam, however, financial institutions have traditionally lent to large-scale fossil-fuel power plants and therefore lack the necessary technical know-how needed to finance renewable energy projects.

Equity Financing

Equity financing is another important source of investment in ASEAN. Private equity investors from within ASEAN and beyond are investing in clean energy projects in the region. Thailand's B.Grimm Power's renewable energy share in its portfolio is expected to rise from 10% to 30% by 2022,[33] and is increasing its portfolio of overseas renewable power projects. The Blue Circle identifies, develops, finances, owns, and operates large-scale wind energy projects across Southeast Asia, particularly. Similarly, Sindicatum Renewable Energy Company develops, owns, and operates clean energy projects across the Philippines and Thailand.

Regional Cooperation in Energy Financing in ASEAN

Regional cooperation in energy financing in ASEAN thus far is concentrated in the power sector and its infrastructure. ASEAN Catalytic Green Finance Facility (ACGF) specifically targets financing for green and climate-friendly projects.

Enabling energy security in the region requires regional cooperation in clean energy financing among member states. The ASEAN member states (AMS) have the long-term goal of regional integration of their power grids via a common ASEAN Power Grid (APG). To date, APG's development has been geared toward cross-border infrastructure development and bilateral power trading. Integrating the ASEAN power market further could boost renewable energy generation and diversify the regional energy mix. Total power sector requirements for APG is estimated to reach $618 billion in generation and $690 billion in transmission and distribution sectors between 2015–2040. Financing APG through public spending will not suffice for the timely development of the envisaged electricity infrastructure.[34] The Greater Mekong Subregion (GMS) Economic Cooperation Program's cooperation in the energy sector is working toward "a competitive and integrated regional market that will develop, in a sustainable manner, the rich energy resources of the GMS, improving the subregion's energy security, and the people's access to modern and affordable energy supplies." One of the key focus areas of the program is exploiting the hydropower potential in GMS, especially the Lao People's Democratic Republic (Lao PDR).[35]

Large-scale integration of renewable energy into ASEAN's regional power sector, however, will require additional investments. Adding 13 GW of cross-border interconnectors is estimated to require about $18 billion, and result in an integration of up to 25% variable renewable energy share in the region.[36]

[32] World Bank (2020).
[33] ADB. 2018. *ADB, B.Grimm Power Expand Support for Renewable Energy in ASEAN.* News release. 23 February.
[34] OECD/IEA. 2015. *Southeast Asia Energy Outlook – World Energy Outlook Special Report 2015*. Paris.
[35] IRENA (2018), p. 57.
[36] IEA (2019a), pp. 19–21.

Box 2: The Role of the Asian Development Bank in Clean Energy Financing in ASEAN

The Asian Development Bank (ADB) has been financing clean energy projects through its Clean Energy Financing Partnership Facility (CEFPF). In 2017, ADB provided $1 million through CEFPF in technical assistance to help the Government of Indonesia scale up energy efficiency programs and investments. Project components include (i) the development of a minimum energy performance standards and labeling program for several household appliances, (ii) the accreditation of government testing laboratories for the identified appliances, and (iii) the development of the regulatory basis for energy service companies to serve the needs of government facilities.

In 2018, the CEFPF provided $11 million as concessional financing to support one of the first private sector, internationally financed, utility-scale solar power projects in Viet Nam, the first floating solar project in the country, and one of the largest floating solar projects (47.5 megawatt [MW] capacity) in the world.

In 2018, ADB invested $155 million in B.Grimm Power Public Company Limited's first 5-year and 7-year climate bond issuances. The proceeds from these bonds have been allocated to a total of 16 solar power plants (nine operational with total capacity of 67.7 MW and seven under construction with total capacity of 30.8 MW).

Source: ADB. https://www.adb.org/what-we-do/funds/clean-energy-financing-partnership-facility (accessed 19 December 2020).

This would particularly facilitate the integration of solar and wind into the regional grid, while enhancing the flexibility of the region's power market.

The ASEAN Infrastructure Fund (AIF) is a dedicated financing initiative established by the ASEAN member states and ADB in 2011 to address the region's infrastructure development needs. The fund financed $200 million for Indonesia's sustainable and inclusive energy program (subprograms 1 and 2), and $100 million for Viet Nam's power transmission development projects, as well as provided support for technical assistance project structuring, among others. To date, the AIF has committed over $500 million to 11 projects, with a portfolio size of over $4 billion. The ACGF created under the AIF more specifically targets financing for green and climate-friendly projects.

The Southeast Asia Clean Energy Facility (SEACEF), which has been financially backed by several philanthropic donors, aims to trigger an investment of $2.5 billion into ASEAN's clean energy. It is managed by Singapore-based Clime Capital. The facility has an initial investment of $10 million and is looking to invest into new projects in Indonesia, the Philippines, and Viet Nam. In addition to this, SEACEF also targets attracting another $40 million in capital from other institutions.[37]

Policy Instruments and Financing Mechanisms in ASEAN

A mix of policy and financing instruments available across the region for financing clean energy at varying levels. Indonesia, Malaysia, Singapore, and Thailand are among the member states that have been frontrunners in adopting a diverse mix of these instruments. Use of innovative financing instruments, however, are still nascent across the region.

Several instruments are utilized in the region to promote investments in clean energy. Different policy support instruments are used in combination across the countries to steer clean energy market development. Similarly, a number of financial instruments are also available in the region. Traditional instruments such as debt financing, loans, credit guarantees, grants, funds and equity ventures, and revolving fund models are well established in ASEAN, and innovative instruments such as green bonds, results-based financing, energy savings insurance, crowdfunding, and microfinancing are also being increasingly used.

[37] *Reuters*. 2019. Southeast Asia Launches $1-billion Facility for Green Infrastructure. 4 April.

Policy Support Instruments to Create Clean Energy Market

Fiscal Instruments

Fiscal incentives have been commonly used in the region to make investments more attractive to project developers and investors and develop clean energy markets. Indonesia, for example, offers incentives that include income tax exemption and reduction for 5–6 years, tax deduction for 6 years, and exemptions on value-added tax (VAT) and import duty fees. The Philippines offers a 7-year income tax holiday, zero-percent VAT rate and 10-year duty free renewable energy equipment and materials, as well as accelerated depreciation. Singapore also provides tax and non-tax incentives for investors. The Singapore Productivity and Innovation Credit offers tax deduction and/or cash incentives to encourage research and development in green technology. The Government of Viet Nam offers incentives in the form of a preferential tax rate of 10% (the normal tax rate is 20%), tax exemption for the first 4 years, and tax reduction for the subsequent years as well as exemptions on import duty fees. Such fiscal instruments are well established in Malaysia and Thailand also. However, member states with newly opened markets in renewable energy, such as Cambodia and the Lao PDR, have yet to develop their renewable energy policy support mechanisms.

Among all the member nations, Singapore is the only one with a carbon tax. It introduced a tax on carbon dioxide emissions from 2019, as a measure to increase its mitigation efforts under its Climate Action Plan. The initial tax rate has been set at S$5 per ton of greenhouse gas during the transition phase of 2019–2023. It is going to be subsequently increased to S$10–S$15 per ton in 2023, following an impact assessment.[38]

Carbon Markets

AMSs have been involved in carbon markets, including Clean Development Mechanism (CDM) and Joint Credit Mechanism (JCM). Under the CDM, $470 million was invested in emission reducing projects in ASEAN-6 (Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam) between 2008–2012.[39] In Malaysia, 102 projects on clean energy and energy efficiency were registered under CDM between 2006–2012, which resulted in an estimated carbon financing of $0.3 billion to $1 billion by earning the carbon credits.[40] Similarly, Viet Nam has had 255 CDM projects registered in the CDM executive board by 2019, 59 projects of which are from energy sector.[41]

Indonesia, Thailand, and Viet Nam are preparing themselves for the implementation of carbon market initiatives, including emissions trading scheme (ETS) and crediting mechanisms in the coming years. Thailand piloted a Voluntary Emission Trading Scheme to develop operational rules as well as test its monitoring, reporting, and verification (MRV) system. The pilot phase of the system (2015), was designed to work with 15 factories. Indonesia, the Philippines, and Viet Nam are also considering developing emissions trading.[42] Indonesia developed its own voluntary carbon market “Nusantara Carbon Scheme.” However, the pace of the carbon market development in the region is very slow compared to East Asia, North America, and Europe with wait-and-see approach to the Article 6.2 of Paris Agreement on Climate Change.

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38 National Climate Change Secretariat. 2021. Carbon Tax. Singapore.

39 S. Olz and M. Beerpoot. 2010. Deploying Renewables in Southeast Asia – Trends and Potentials.

40 X. Lim, W. H. Lam, and A. H. Shamsuddin. 2013. Carbon Credit of Renewable Energy Projects in Malaysia. *IOP Conference Series: Earth and Environmental Science* 16; X. Lim and W. H. Lam. 2014. Review on Clean Development Mechanism (CDM) Implementation in Malaysia. *Renewable and Sustainable Energy Reviews* 29.

41 O. Massman. 2019. Vietnam: Vietnamese Clean Development Mechanism CDM Market – The Perspective of an Emission Certificate Buyer. *Mondaq*. 10 July.

42 J. Aleluia. 2019. Carbon Pricing in Southeast Asia – Current Status and Future Perspectives. *Technical Workshop on Climate Finance in ASEAN*. Manila. 29 October.

Feed-in Tariff

Feed-in tariff (FiT) is seen as an effective scheme to create the market in the beginning phase since it incentivizes renewable energy generation to be cost-competitive with other conventional generation. FiT promotes renewable energy projects by offering long-term power purchase agreements (PPAs) for the sale of renewable electricity. The PPA typically provides a specific rate for every unit of electricity generated based on the renewable energy technology, size, and location of project for a specific contract period. FiT in ASEAN is developed since 2007 with Thailand being the first to introduce it in the form of adder scheme. Then it was followed by Indonesia in 2008 for geothermal power and Viet Nam for small-hydropower as well as Malaysia and the Philippines in 2011. The FiT in each ASEAN member states have been adjusted several times, taking both technological advancements as well as cost reductions in RE technologies into account. FiT scheme is yet to be developed in other countries of the region, where RE market maturity is relatively lower. The details of the FiT scheme in ASEAN region are described in Table 3.

Table 3: Feed-in Tariff in the ASEAN Region as of 2018 (ACE and CREEI 2018)

ASEAN Member State	Feed-in Tariff Status
Indonesia	• Feed-in Tariff (FiT) have been provided for hydropower, solar photovoltaic (PV), wind, geothermal, waste to energy (WtE), biomass, biogas, and tidal, but replaced by new incentive scheme (comparing LPCE & NPCE) since 2017 • Source of fund for FiT: State budget (taxpayers)
Malaysia	• FiT is provided for solar PV, biogas, biomass, small hydro, and geothermal • FiT is specified by renewable energy technology and capacity which is set with degression rates annually • Source of fund for FiT: (i) RM300 million of national treasury, (ii) 16% surcharge from electricity bill • FiT rates range from \$0.07–\$0.17/kilowatt-hour (kWh)
Philippines	• FiT is provided for run-off river hydro, solar PV, biomass, and wind • FiT is specified by renewable energy technology in fixed rate without range for specific region or different capacity • Source of fund for FiT: rate payers (electricity consumer) through FiT Allowance • FiT rates range from \$0.11–\$0.17/kWh
Thailand	• FiT is provided for natural renewable energy (solar PV, hydro, wind) and bioenergy (biogas, biomass, MSW) • FiT is provided for different renewable energy technologies, capacity, and region • Source of fund for FiT: uniform fee to all its electricity consumers • FiT rates range from \$0.12–\$0.22/kWh
Viet Nam	• FiT is provided for solar PV, wind, biomass, and waste • FiT is specified by renewable energy technology with a fixed rate • Source of fund for FiT: Vietnam Environment Protection Fund and budget from Vietnam Electricity Group • FiT rates range from \$0.06–\$0.17/kWh

ACE = ASEAN Centre for Energy, ASEAN = Association of Southeast Asian Nations, CREEI = China Renewable Energy Engineering Institute, LPCE = Local Production Cost of Electricity, MSW = municipal solid waste, NPCE = National Production Cost of Electricity.

Note: In May 2019, Thailand announced FiT rate of B1.68/kWh for residential rooftop PV electricity with a target of 100 megawatts every year. Owing to less appeal, the National Energy Policy Council (NEPC) raised it to B2.20 effective from 1 January 2021.

Sources: IRENA (2018), ADB (2019), and Chang (2019).

Introduction of FiT has resulted in a clear growth in investment in solar and wind power. Since 2010, financing deals worth at least $8.3 billion have been made in solar power projects. Compared to wind power projects, investment in solar projects in Southeast Asia was 1.5 times higher (a total of $892 million) in 2016.[43] These clearly indicate the growing foothold of solar power across the region. It is also worth noting that despite the COVID-19 pandemic, Viet Nam has shown a remarkable increase in its renewable investments, particularly solar. As Viet Nam introduced phase 2 of FiT in April 2020, it resulted in a boom in the country's rooftop solar PV installations. Over 8.5 gigawatt-peak rooftop solar capacity was added between June and December 2020. By June 2020, domestic banks in Viet Nam provided up to $3.6 billion in loans to renewable energy projects.[44]

Despite Viet Nam's remarkable success, overall, FiT implementation faces several challenges in the region, including unclear and long process of PPA permitting process, oversubscription, and unclear grid interconnection guidelines, which have impacted investments.[45]

Mandates

Blending mandates have been commonly used to promote biofuel use in ASEAN's transportation sector. Such mandates incentivize the domestic production of biofuels and increase the proportion of renewable energy in transport sector, given the growing demand of transport fuel. Indonesia, as a major palm oil producer introduced a 20% biodiesel mandate in 2008, as a part of the National Energy Policy to increase the share of biofuel in Indonesia's final energy consumption. As a result of this, the government invested around $1.4 billion between 2015–2017 for the program.[46] Other countries have also followed suit, with ethanol as well as biodiesel mandates in Malaysia, the Philippines, Thailand, and Viet Nam.[47] Biofuel mandates have successfully driven investment in the biofuel industry.

Energy Service Company

An energy service company (ESCO) is a company that "provides an array of energy solution including the design and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management." The spread of ESCOs in the ASEAN region began from the World Bank-supported project, Promotion of Electricity Energy Efficiency, in Thailand. This was developed to remove the barriers often found in project financing and/or investment in Thailand. ESCOs have become well adopted in ASEAN, partly due to the national energy efficiency targets. ESCOs typically use performance-based contracting models, which could include either (i) guarantee savings (guarantees of energy savings); or (ii) shared savings (provision of an equal amount of energy service at a lower cost, where the remuneration is proportional to the energy savings achieved).[48] Both models are common across ASEAN.

Malaysia, Singapore, and Thailand are the top three countries in the region that have actively adopted ESCOs to drive their energy efficiency efforts.[49] There are 205 registered ESCOs in Malaysia, 69 in Thailand, and 21 in Singapore. Thailand's ESCO market is backed by a dedicated ESCO fund. The cumulative investment with EPCs from 2009–2017 amounted to B19,836.80 million (~$555 million), realized by a total of 466 EPCs.

43 IRENA (2018), p. 93.

44 T. Vu. 2021. Vietnam's Extraordinary Rooftop Solar Success Deals Another Blow to the Remaining Coal Pipeline. *Institute for Energy Economics and Financial Analysis*. 12 January.

45 ACE and CREEI. 2018. *ASEAN Feed-in-Tariff Mechanism Report*. Jakarta. 26 June.

46 USDA Foreign Agricultural Service. 2018. *Indonesia Biofuels Annual 2018*.

47 IRENA (2018), pp. 105–107.

48 K. Hofer, D. Limaye, and J. Singh. 2016. Fostering the Development of ESCO Markets for Energy Efficiency. Washington, DC.

49 C. Murakoshi. 2009. Current State of ESCO Activities in Asia: ESCO Industry Development Programs and Future Tasks in Asian Countries. *Energy*.

Malaysia's Green Technology Financing Scheme (GTFS) was set up to implement ESCO projects, and between 2016–2017, 228 projects had secured a total of RM2.617 billion ($532.2 million) worth of financing assistance from 26 banks and/or financial institutions from GTFS.[50] On the contrary, Indonesia and Viet Nam's ESCO market face a poor enabling environment. The ESCO markets here are in infancy, has a weak asset base and is unlikely to develop without sustained government support.[51]

Financing Mechanism and Instruments

Several financing instruments have been used by institutions to finance clean energy in ASEAN. The major financing instrument used by development banks in the region is in the form of loans. Traditional as well as innovative instruments used in the region are described here.

Traditional Instruments

Debt Financing, Including Soft Loans

Debt financing is one of the most common instruments used for financing by banks, including the International Finance Corporation. Historically, up to 73% of financing by development banks for renewable energy is in the form of loans.[52] For example, ADB committed $17.6 million loan for the installation of 47.5 MW of floating solar PV power generation panels in Viet Nam, ING Bank issued a green loan of approximately $37.4 million loan for developing 50 MW portfolio of rooftop solar projects in Singapore.

In addition to commercial loans, soft loans are also widely used for financing clean energy. Soft loans have lower interest rates, more flexible time frame, and "softer" terms for repayment. Concessional loans amounted to about $611 million from 2009–2016 in ASEAN.[53]

Equity

Equity investors in ASEAN comprise utilities as well as power developers, as companies in the region are looking to diversify their energy mix and are already investing in renewables. Major business conglomerates have also invested in renewables in the region via partnerships, especially in the Philippines, while business giants in Thailand are investing in renewable energy in Cambodia, the Lao PDR, and Viet Nam region in solar and wind farms. Malaysia's national utility company, Tenaga Nasional Berhad (TNB), has a renewable energy subsidiary to grow the renewable energy business for TNB. Thailand's Global Power Synergy Public Company Limited has approximately 11% of its equity capacity in renewables. Among the ASEAN countries, Singapore has attracted several large public placements and stands out as the regional hub. Moreover, plans are underway to attract further investors and renewable energy developers.

Specialist private equity funds are mandated to "develop and invest in economically viable renewable energy-related businesses" in ASEAN. The typical equity invested by such funds lies in the range $5 million–$20 million for a "minority stake." Additionally, such investors can also gain higher stakes by either cooperating with other investors, or providing mezzanine or convertible debt funding. The Armstrong South East Asia Clean Energy Fund ($164 million) has invested in several clean energy projects in the ASEAN region, including both utility-scale renewable energy and resource efficiency projects. Renewable Energy Asia Fund I ($112 million) and Renewable Energy Asia Fund II ($250 million) make equity investments in on-grid solar, wind, waste-to-energy and hydropower projects of between 5 MW and 100 MW in the Philippines and Indonesia. The SEACEF, which has an initial investment of $10 million from leading international climate foundations focuses on clean energy projects associated with relatively higher risks, with an initial focus on Indonesia, the Philippines, and Viet Nam.

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50 ACE. 2017. *The 5th ASEAN Energy Outlook 2015–2040*. Jakarta.
51 N. D. A. Thi. 2013. Opportunities and Challenges to ESCO Model in Vietnam. Slide presentation. 14 January.
52 IRENA (2018), p. 113.
53 Murakoshi (2009).

Grants

Grants have been used as traditional financing instruments for clean energy in ASEAN. The World Bank approved two grants (equaling $67 million) to increase access of remote and isolated areas to solar energy in the Philippines. DFIs also finance clean energy through grants. The United Kingdom granted $16.3 million to finance Indonesia's Low Carbon Development Initiative. Similarly, Cambodia's National Solar Park Project received a $3 million grant from the Strategic Climate Fund.

Revolving Funds

Revolving funds have been successfully used to finance energy efficiency and clean energy projects in ASEAN. These funds comprise of an initial capital to fund internal efficiency projects. The savings generated from the projects that have been invested in are then used to replenish the fund. Thailand's Energy Efficiency Revolving Fund (EERF), which was initiated in 2013, utilized revenues from a petroleum tax facilitated participation of 11 commercial banks for subsequent investment in energy efficiency projects.[54] The EERF successfully funded 294 energy efficiency projects, realizing savings of 0.98 metric tons of CO_2/year, and successfully leveraged private sector investment in energy efficiency projects with a 3:1 ratio.[55] Similarly, the Clean Energy Revolving Fund (CERF) program provides uncollateralized loans to small agricultural farms in Cambodia for switching to cleaner forms of energy technologies. CERF has already provided 15 loans amounting to $10,000–$15,000 per loan. Indonesia plans to develop a $36.7 million energy efficiency revolving fund. However, it is yet to materialize.[56]

Innovative Instruments

Guarantees

Malaysia's Green Technology Financing Scheme (GTFS) operates through a loan guarantee scheme that offers an annual rebate of 2% on interest or profit rates charged by financial institutions, as well as a government guarantee of 60% on financing provided by financial institutions. GTFS reported that by the end of 2017, the GTFS has supported more than 319 projects out of 620 applications with a total cost of around $1.7 billion. Eighty-one percent of these were on renewable energy, and 5% on energy efficiency.

Microfinance

Microfinance institutions (MFIs) provide financial services, mainly loans, on a fully or largely financially sustainable basis. MFIs typically charge an interest rate that enables them to recover their costs and remain operational. Dedicated MFIs have been successfully used to fund sustainable start-up companies in emerging markets.

Scaling up the microfinance markets in ASEAN markets such as Cambodia and the Philippines has been supported by multilateral development banks (MDBs). SNV's solar microfinance program in Cambodia is using MFIs for promoting small solar homes systems. The project has disbursed $355,524 through solar loans from MFIs to 1,387 households in rural Cambodia.[57]

Bonds

Thematic bonds, such as green, sustainability, and social bonds, have garnered investor interest as a financing instrument. These bonds emerged from the growth of green bonds post Paris Agreement in 2015.[58]

[54] S. Gubbi et al. 2015. Fostering the Development of ESCO Markets for Energy Efficiency. Washington, DC.
[55] Retallack et al. 2018. *Energy Efficiency Finance Programs: Best Practices to Leverage Private Green Finance.*
[56] ACE (2019), p. 41.
[57] Alliance for Rural Electrification. SNV – Solar Microfinance Program (Cambodia).
[58] ADB. 2021. *Green, Sustainability and Social Bonds for COVID-19 Recovery: A Thematic Bonds Primer. Mobilizing Financial Markets for Achieving Net Zero Economies.* Manila.

Green bonds represent an innovative scheme of clean energy financing in the ASEAN region, with multiple issuances from financial and nonfinancial corporates across several core markets. The ASEAN green bond market is still in its infancy, pioneered by Malaysia and Singapore in 2017. Later it expanded to Indonesia, Thailand, and the Philippines. ADB has supported ASEAN countries in the issuance of green bonds. In 2018, ADB invested $155 million in B.Grimm Power Public Company for solar projects in Thailand. ADB has also contributed to a total issue volume of $410 million in green bonds (as an anchor investor in AC Energy's green bond), which will finance renewable energy projects in Indonesia, the Philippines, and Viet Nam.[59] As of 2019, a total of $13.4 billion has been issued in green bonds in ASEAN, of which 1% has been for clean energy. The green bond markets total $549 million for Singapore, $200 million for the Philippines, $58 million for Malaysia, and $92 million for Thailand. However, green bond issuance in clean energy, thus far, is driven by Indonesia, the Philippines, and Thailand. Majority of the ASEAN green bonds proceeds have been used for green buildings, compared to the global trend of using these bonds for energy.[60]

Green bonds are driven by different instruments in the region. Indonesia's green bonds issuance is driven by the government, which accounts for 99% of all green bonds issued in the country. On the contrary, the private sector is responsible for driving the issuance of green bonds in Malaysia and Singapore. However, the respective governments incentivize green bond issuance via green bond grant schemes and tax incentives.[61]

Along with the development of the ASEAN green bonds market, the ASEAN Green Bond Standards were also developed in 2017 in collaboration with the International Capital Market Association. These are based on the internationally recognized and commonly used "Green Bond Principles (GBP)."[62]

Transition bonds are an emerging category of bonds that aim to "help companies in industries with high GHG emissions (known as brown industries) raise capital specifically to finance decarbonization."[63] Indonesia's state-owned utility PLN and ADB aim to issue PLN's first ever transition bonds in 2021 to improve PLN's green energy portfolio.[64]

Blended Finance

Blended finance uses the power of development finance for decreasing risks to encourage private capital. The most widely used forms of blended finance for clean energy in ASEAN include private sector capital deployment, credit enhancement and public–private partnerships.

The USAID's regional Private Financing Advisory Network-Asia (USAID PFAN-Asia) program assists the private sector and governments to attract clean energy investments across Asia, including seven of the ASEAN countries. Since 2013, the program has helped obtain more than $500 million for a total of 38 clean energy projects in renewable energy as well as energy efficiency.[65] For example: PFAN-Asia helped obtain $700,000 in equity financing for bio-digesters in Cambodia.

Blended finance also utilizes public finance to mobilize private investment through "risk mitigation" or "credit enhancement." This has been employed by Indonesia's Tropical Landscapes Finance Facility (TLFF) and the Credit Guarantee Investment Facility. These provide private sector with technical support and facilitate access to funding, and develop bankable projects. In clean energy, TLFF focuses on scaling up investment in renewable energy capacity and electricity access for marginalized, off-grid communities.[66]

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59 ADB. 2020. *Green, Social, and Sustainability Bonds for Asia and the Pacific*. Manila.
60 D. Azhgaliyeva, A. Kapoor, and Y. Liu. 2020. *Green Bonds for Financing Renewable Energy and Energy Efficiency in Southeast Asia: A Review of Policies*. January.
61 ACE (2019), pp. 13–16.
62 ASEAN Capital Markets Forum (ACMF). 2018. *ASEAN Green Bond Standards*. Bangkok.
63 Gubbi et al. (2015), p. 3.
64 N. Harsono. 2020. ADB, PLN to pilot issuance of energy transition bonds in 2021. *The Jakarta Post*. 3 November.
65 United States Agency for International Development (USAID). 2018. *Private Financing Advisory Network – Asia*.
66 Tropical Landscapes Finance Facility. A Blended Finance Facility for Indonesia.

Similarly, GuarantCo's B425 million ($13.5 million) guarantee facility is supporting Thai Biogas Energy Company's four wastewater-to-biogas plants in rural Thailand.[67]

Initiatives by ADB such as the Southeast Asia Department Innovation Hub also recognize the need to leverage public finance to catalyze private sector investments. The hub's objective is to use "innovative finance" approaches, based on leveraging a minimum of 1:1 public finance for private funds, and up to 1:6 ratios, to develop green and bankable/innovative finance (or "GIF") projects across different sectors.[68] The Hub's key thrust areas include capacity and knowledge development, development of innovative finance concepts and pilot projects, de-risking funds, and rapid response.

Another form of blended finance is public–private partnerships (PPPs), which can converge the skills and resources of public and private sectors to facilitate risk sharing and help develop larger projects, while improving how stakeholders understand various technical solutions and the associated risks. The use of PPP across Southeast Asia has been increasing, albeit at different rates, and is promoted widely in Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam, where PPP typically contributes to less than 1% of GDP.[69] For example, the government of the Philippines uses PPP through its PPP center financed several large-scale hydropower and geothermal projects. The $83 million Bakun Hydroelectric Power Project (70 MW) was financed via the PPP center.[70] Similarly, solar PPP investments have improved overall awareness and capacity in Cambodia. For Cambodia's National Solar Park Project, ADB's technical assistance helped obtain the lowest bid of $0.04/kWh for a solar project in Southeast Asia.[71] This also helped increase private sector investments in solar PVs by demonstrating the ability of large-scale solar parks to improve the electricity supply and their bankability.[72] Similarly, PPP was also used to finance a 10 MW solar facility project in Cambodia, where a private company (Sunseap) entered a 20-year solar PPA, Cambodia's state-run utility, to which the ADB agreed to lend $9.2 million.[73] However, the role of PPP is much lower in countries, such as Brunei Darussalam and Singapore, where the role of public funds and/or public institutions is dominant.

Specialized Funds

Specialized green funds aim to generate capital for financing those companies and/or projects which are environmentally beneficial, including clean energy projects.

The ACGF was created under the AIF (refer back to discussion on regional funds), and will direct close to $1.5 billion from the AIF, ADB, and other development partners including KfW, the European Investment Bank, and Agence Française de Développement to accelerate the development of green infrastructure across the region. The ACGF helps in preparing and sourcing public and private finance as well as technical assistance for environmentally sustainable and climate-friendly infrastructure projects.

ADB also established the Leading Private Infrastructure Fund (2016) to catalyze such projects in Asia; the fund has equity capital of $1.5 billion from the Japan International Cooperation Agency.

67 IRENA (2018), p. 123.
68 A. Mehta et al. 2017. *Catalyzing Green Finance: A Concept for Leveraging Blended Finance for Green Development*. Asian Development Bank. Manila; ADB. 2018. *Green and Innovative Finance Initiative for Scaling Up Southeast Asian Infrastructure*. Manila.
69 F. Zen. 2018. *Public–Private Partnership Development in Southeast Asia*. August.
70 Government of the Philippines, Public–Private Partnership Center. Bakun A/B and C Hydroelectric Power Plant.
71 ADB. 2019. ADB-Supported Solar Project in Cambodia Achieves Lowest-Ever Tariff in ASEAN. 5 September.
72 ADB. Cambodia: National Solar Park Project.
73 Footnote 67.

Box 3: The ASEAN Catalytic Green Finance Facility

The Association of Southeast Asian Nations (ASEAN) Catalytic Green Finance Facility (ACGF), an Asian Infrastructure Fund initiative, is an innovative financing initiative designed to "scale up the development of green infrastructure projects in Southeast Asia, in support of climate change and environmental sustainability goals of ASEAN member states." ACGF, to date, is the only regionally owned green finance initiative whose focus is to develop as well as scale up pro-climate initiatives in the ASEAN region. The ACGF supports ASEAN governments in the following ways:

- Funding for de-risking green infrastructure projects: The ACGF will direct financing to bridge the viability gap for green projects. Flexibility will be used to determine how loans for ACGF projects can improve bankability on a project-by-project basis. The most likely use of funds will be to cover a portion of the capital or operational costs of a project. New products can be developed to meet the needs of projects. Three projects, amounting to close to $1.4 billion in total have been approved already for formal pipeline.
- Project structuring and origination: Technical assistance supported by a dedicated structuring team will identify, originate, design, and structure projects. The team will develop new financing structures and support individual projects to develop targets and performance measures. As of January 2021, 22 projects are being supported through technical assistance.
- Building knowledge and awareness: Through a multi-partner platform, ACGF will build awareness on green finance and innovative finance in ASEAN countries with the aim of developing project pipelines and building capacity to better identify project opportunities.

Source: ADB (2020).

The Clean Technology Fund (CTF), within the Climate Investment Funds, provides emerging economies with scaled-up financing for the demonstration, deployment, and transfer of low-carbon technologies that have a significant potential for curbing GHG emissions in the long-term. In 2019, CTF financed renewable energy and energy efficiency projects with funds amounting to $138.28 million in the Philippines, $110.85 million in Thailand, and $179.94 million in Viet Nam.[74] Similarly, Indonesia has developed a $400 million investment plan for geothermal development under the CTF. CTF has financed $35 million in Indonesia's geothermal power generation project to commission an additional 110 MW of geothermal electricity generating capacity of a state-owned geothermal company.

The Scaling up Renewable Energy Projects (SREP), which is funded by the Strategic Climate Fund, aims to "scale up the deployment of renewable energy solutions and expand renewable markets in low-income countries." SREP is financing $30 million in Cambodia's renewable energy projects, that include In, multi-scale solar energy development program, and a biomass power project. Additionally, this is also used for supporting policy making and awareness generation. In 2019, $14 million was been approved under the fund for financing Cambodia's National Solar Park Project.

Key Lessons from the ASEAN Experience

The degree of success of clean energy financing in ASEAN region varies among the member states. Indonesia, Malaysia, the Philippines, and Thailand have been particularly successful. The renewable energy markets in these countries are reasonably developed, and investments are incentivized through several renewable energy policy and financial support mechanisms that encourage the involvement of private actors and financial institutions in renewable energy project development. As clean energy market in ASEAN becomes more mature, it is likely that ASEAN will strengthen the use of market-based instruments. However, other ASEAN member states, such as CLM have not seen much private sector investments into renewable energy and are just starting to open their markets to new incentives and models for renewable energy deployment. CLM can replicate successful measures looking to their own contexts.

[74] World Bank. 2019. Climate Investment Funds – Clean Technology Fund (CTF) results data (accessed 19 December 2020).

FiT has been successful in driving private investments in solar and wind power plants in the region. Viet Nam's first solar PV FiT program and PPA template gained a significant amount of applications from both domestic and regional project developers and investors. Cambodia, with the support of ADB, signed its first PPA for a large-scale solar (10 MW) project and within months announced competitive tendering (with ADB assistance) for a 100 MW solar park. Increasing Thailand's FiT support from 10 years to 25 years has also encouraged investments in the sector. The increasing cost competitiveness of solar energy, combined with local production of solar modules and attractive FiT rates have successfully increased investments in these technologies, particularly private sector.

ESCOs have also been instrumental in driving the financing of energy efficiency projects, especially in buildings. Specific regulatory support for ESCO, coupled with financial incentives fostered ESCO development in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. Piloted initially through energy efficiency programs in government buildings, a number of instruments such as ESCO fund, concessional loans, and partial guarantees are now available for ESCOs in these countries.

Cambodia's CERF has been successful in giving loans to Cambodian agribusiness units to assist them in reducing their carbon usage.[75]

Green bonds are still relatively new in the ASEAN region, and has been issued only in selected countries. However, the issuance of green bonds has observed remarkable growth since the first bond was issued in 2017. A cumulative issuance of $13.4 billion has occurred in ASEAN's green bonds, 1% of which has been used for renewable energy, mainly geothermal and solar. Green bonds standards have helped foster this and can be replicated in other regions as well.

Such success stories, however, are common in countries with well-developed renewable energy markets. CLM can learn important lessons from other countries in the region to encourage clean energy financing by expanding and strengthening their current policy and financial instruments.

Challenges and Barriers

Currently, ASEAN's need for investors is not matched by the number of bankable projects in clean energy.[76] Clean energy financing faces several institutional and regulatory gaps, which have attributed to the investment hurdles in ASEAN. At a regional level, the main renewable energy development challenges in ASEAN are mostly related to the power market, grid transmission, and limited financing options. However, the challenges vary across countries and depend on their respective domestic environments. A lack of diverse financial sources is a major contributing factor to the investment needs. Clean energy in ASEAN is financed majorly by public sector and banks, and still lack private sector financing.[77] Therefore, concerted efforts that address investment barriers will be required to scale clean energy investments.

Regulatory

A clear regulatory framework that governs clean energy investments is the cornerstone of promoting renewable energy financing. ASEAN member states, which have had clear and consistent legal, administrative, and institutional frameworks are the ones that have attracted the highest investments. Unclear legal and regulatory frameworks, including non-bankable PPAs and weak FiT pricing, are major

[75] Y. Liu, Z. Sheng, and D. Azhgaliyeva. 2019. Toward Energy Security in ASEAN: Impacts of Regional Integration, Renewables and Energy Efficiency. *Asian Development Bank Institute Working Paper.* No. 1041. November. Tokyo.

[76] H. Koh. 2017. Half of Southeast Asia's Renewable Energy Projects are Unbankable. *Eco-Business.* November.

[77] Ekholm et al. (2013).

barriers in this context.[78] For instance, Cambodia faces insufficient regulatory framework to accelerate renewable energy deployment, as the government has not yet set official targets for renewable energy apart from hydropower.[79]

Administrative barriers include the unclear and long process of PPAs including permitting process. The processing of PPAs are typically cumbersome, occurring on a case-by-case basis, and without warranting transparency.[80] In ASEAN states of Cambodia, Indonesia, and the Philippines, unclear guidelines of grid interconnection from renewable energy power plant also poses a barrier.[81] The access to grid in nearly all ASEAN countries is controlled by the respective state-owned utilities. This is a major setback for deregulating the region's power market.[82]

The rules and procedures associated with land-use rights in ASEAN are complicated, non-transparent and uncertain. This also makes and access for renewable energy projects difficult.[83]

Financial and Market

Markets for renewable energy in Malaysia, the Philippines, Singapore, and Thailand are mature and promote clean energy investments. In Indonesia, Viet Nam, and particularly in the CLM countries, the domestic markets are not yet mature, with smaller markets, few financial instruments, high perceived risk associated with renewable energy projects, and lack appropriate vehicles for accessing international finance and mitigating risks and investment criteria.[84]

A prominent barrier is the limited private sector equity funding. An estimated 55% of the current clean energy projects still rely on public sector to ensure bankability, making it especially challenging for private investors to accumulate a portfolio of commercially viable renewable energy projects.[85]

While ASEAN employs a number of traditional financial and policy instruments to support clean energy financing and markets, it is yet to fully employ new and innovative schemes. For example, green bond markets in ASEAN are small and in infancy stage—only 1% of total green bonds in the region has been issued for clean energy compared to global share of 4%.[86] As a result, a lack of know-how regarding technical solutions, and a lack of potential for and trust in renewable energy bonds among developers, local banks and finance institutions exists.[87]

The high capital costs associated with renewable energy, which vary among the region, is another barrier. For example, the average cost per megawatt of solar PV capacity in Indonesia is 10% higher than in Thailand.[88] Similarly, currency inconvertibility risk is also a barrier. This is especially significant when PPAs occur in local currencies, and banks hesitate to carry the associated exchange risks or provide competitively priced hedging.

[78] IRENA (2018), pp. 125–126.
[79] ACE and GIZ (2019), pp. 50–52.
[80] IRENA (2018), pp. 105–107.
[81] ADB. Cambodia: National Solar Park Project.
[82] A. Sen, R. Nepal, and T. Jamasb. 2018. Have Model, Will Reform? Assessing the Outcome of Electricity Reforms in Non-OECD Asia. *The Energy Journal* 39.
[83] ADB (2019).
[84] Ng and Tao (2016).
[85] Koh (2017); ACE (2019), p. 6.
[86] ACE (2019), p. 10.
[87] Footnote 83.
[88] IEA. 2020. *Attracting Private Investment to Fund Sustainable Recoveries: The Case of Indonesia's Power Sector.*

Capacity Gaps

Financial structures in ASEAN that are typically familiar with handling conventional energy projects are inadequately equipped to handle renewable energy projects. With the exception of mature renewable energy markets in ASEAN, local banks in other countries often lack the capacity to access finance for clean energy, due to inadequate technical awareness and due to less experience in dealing with renewable energy.[89] For example, domestic banks in Viet Nam have inadequate capacity for processing green credit appraisals. Therefore, green energy lending deals therefore have often only been successful with the involvement of international financial institutes.[90]

Several financial institutions across the ASEAN region still do not fully understand the green investment market and credit risk, especially for clean energy.[91] As a result, domestic commercial banks have not been investing in renewable energy technologies beyond solar and wind. Limited local benchmarks and reference projects also hinder the commercial banks' ability to invest.[92] Many local developers in Southeast Asia are also not well equipped to independently deal with the complex requirements of the IFIs and DFIs.

Concluding Remarks

Energy security is a growing concern in the region and clean energy is an opportunity. ASEAN's energy demand has grown by 80% over the last 20 years owing to rapid economic growth and will continue to grow. About 85% of this growing energy demand has been met by fossil fuels. As the ASEAN region is endowed with various renewable energy sources, and has a target of increasing the share of renewable energy in primary energy mix to 23%, and reduce energy intensity by 30% by 2030 (based on 2005 level), clean energy sources can meet the challenges of energy security and the region's targets. Therefore, the region must use this opportunity to invest in clean energy.

Meeting clean energy targets will require substantial new investments and investment gaps are stark. According to the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025, investment of around $11 billion would be required to achieve the goal of reducing energy intensity by 20% in 2020 and by 30% in 2025. Similarly, meeting the renewable energy target would require an annual investment of over $27 billion. Investment requirements for clean energy are huge in the region.

Clean energy investments are dominated by public financing. Currently, public finance in ASEAN region accounts for two-thirds of infrastructure investments. However, future investment needs cannot be fulfilled by public sources alone and must be complemented by sustained and balanced access to international and regional sources of private finance. Several institutional and regulatory gaps, and lack of bankable projects in clean energy have attributed to the investment hurdles in ASEAN, limiting private sector investment. CLM countries are still lacking in terms of using innovative financing instruments for encouraging large-scale private investments in both renewable energy and energy efficiency projects. This calls for leveraging public finance better to de-risk or better structure these projects to catalyze private finance.

[89] ADB (2019).

[90] Nguyen, Phuong Anh & Abbott, Malcolm & Nguyen, Thanh Loan T. 2019. The development and cost of renewable energy resources in Vietnam. *Utilities Policy*.

[91] ACE (2019), pp. 2–4.

[92] Footnote 89.

The ASEAN region has a reasonable level of experiences in clean energy finance, but it must overcome key challenges to upscale clean energy finance. The member states have been using several policy and financial instruments to promote clean energy financing, albeit the level of penetration of these instruments vary among countries. Challenges in ASEAN are mostly related to the power market, grid transmission, unclear legal and regulatory frameworks, and lack of financing from the private sector. These challenges are particularly pronounced in the CLM nations, which still struggle with nascent renewable energy markets, undiversified financial instrument types, and a high perceived risk associated with renewable energy projects. Additionally, capacity gaps at the institutional level to access finance for clean energy hinder upscaling clean energy financing in the region, which also indicate a clear need for MDBs/DFIs to support by providing capacity building efforts. Reaching the 2025 energy goals necessitates targeted efforts to accelerate and scale up the rapidly evolving market landscape. ASEAN's clean energy transition will rely on how effectively diverse financing sources and instruments will be used across countries.

Innovative instruments are necessary for promoting private investment. A conducive environment to encourage private sector investments in ASEAN's clean energy calls for mobilizing innovative instruments. IFIs have already successfully leveraged public funds to catalyze private investments across the region. National governments and domestic finance institutions could also adopt this to de-risk clean energy projects and make them more bankable.

COVID-related green economic recovery can be instrumental. The energy challenges in ASEAN have been exacerbated by the COVID pandemic. Although funds have been redirected, a green recovery road map could encourage investments into clean energy. This is already evident in the case of Viet Nam, where the introduction of phase 2 of its FiT policy demonstrated a staggering boom in the country's solar rooftop PVs during the pandemic.

Regional support is imperative to meet targets. Meeting the 2025 targets calls for regional collaboration among member countries, including multilateral power trading, which could provide an opportunity for integrating variable renewable energy into the region's power supply. Intraregional investment in infrastructures as well as a collective and/or collaborative push for green infrastructure could open opportunities for countries with nascent markets to ramp clean energy investments. An interconnected power system could improve and integrate the region's variable renewable power generation capacity, contributing to ASEAN's energy security.[93]

[93] IEA. 2015. *Development Prospects of the ASEAN Power Sector: Towards an Integrated Electricity Market*. Paris.

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7 Crowding in Private Capital to Enable Cambodia's Clean Energy Evolution

Pradeep Tharakan, Diana Connett, Grace Yeneza, Ferran Vila Planas, and Kapil Thukral

This chapter explores Cambodia's ongoing clean energy evolution and showcases the well-planned and successful integration of a large-scale variable renewable energy project into the country's power system. The Cambodia Solar Park marks an important breakthrough for the country and serves as a model for multifaceted innovations in the energy sector in developing countries, and the infrastructure sector at large. The chapter includes a brief discussion on the country and sector contexts, a summary of the country's approach to transitioning away from fossil fuel-based power, and details ADB's multifaceted support to facilitate clean energy finance, including use of concessional climate finance for the Cambodia National Solar Park Project. The chapter highlights scale-up and replication opportunities within Cambodia and the region, and closes with summary observations and lessons learned. This project may serve as a model for countries, regardless of their resource base, to enhance energy security, meet their climate commitments, and crowd in private sector capital to build energy and other much-needed basic infrastructure.

Overview of Cambodia's Power Sector

Cambodia achieved lower middle-income status in 2015. During 1998–2018, gross domestic product (GDP) growth averaged 8% annually. However, even with these impressive growth rates, Cambodia's GDP per capita, estimated at $1,643 in 2019,[1] remains among the lowest in Southeast Asia. Further, in 2019, 5 million Cambodians lacked access to electricity, while high dependence on imported fossil fuels for power generation meant that electricity tariffs were high, constraining economic competitiveness. While the novel coronavirus disease (COVID-19) pandemic has adversely impacted the country's economy, with GDP expected to contract by about 4.0% in 2020, it is expected that economic growth will recover in the near term.[2]

Sector Structure

Electricité du Cambodge (EDC) is a state-owned and vertically integrated monopoly responsible for Cambodia's generation, transmission, and distribution of electricity. It is owned jointly by the Ministry of Mines and Energy (MME) and the Ministry of Economy and Finance. Generation in Cambodia is private sector-driven, and EDC buys power from independent power producers, which are predominantly joint ventures between Cambodian and foreign investors. EDC is also responsible for power imports, and

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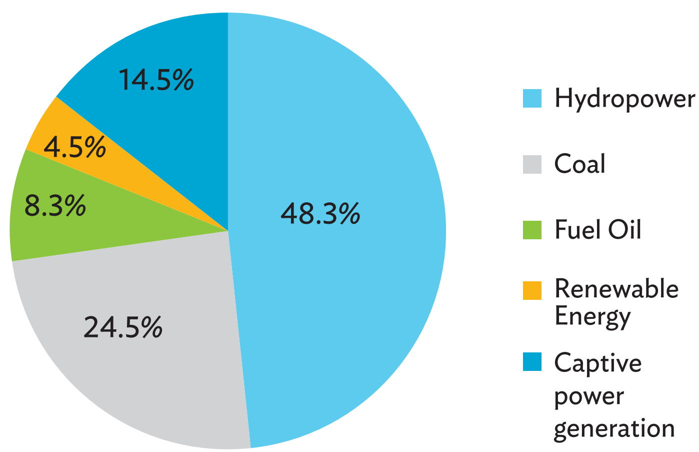
1 World Bank. The World Bank | data. http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=KH (accessed 26 February 2021).

2 ADB. 2020. Asian Development Outlook 2020 Update: Wellness in Worrying Times. Manila. p. 220. https://www.adb.org/sites/default/files/publication/635666/ado2020-update.pdf.

distributes electricity to urban areas and a large part of rural Cambodia. Some remote parts of the country are served by small, privately owned rural electricity enterprises, which operate as licensees, buying power from EDC and selling power into local distribution networks. MME develops the sector policies and plans, and the sector regulator is the Electricity Authority of Cambodia (EAC), an autonomous body responsible for setting tariffs and awarding licenses.

Since 2010, the government has made significant progress in developing the country's power network and diversifying the generation mix. By the end of 2019, Cambodia had an installed capacity of 2,756 megawatts (MW), predominantly comprised of hydropower (1,323 MW), coal-fired plants (675 MW), and oil-fired generators (227 MW). The remaining capacity consisted primarily of renewable energy (124 MW of biomass and solar) as well as captive capacity installed by licensees (400 MW).[3] Figure 1 shows the generating capacity mix at the end of 2019.

Figure 1: Cambodia Power Generation Capacity in 2019



Total Capacity: 2,756 megawatts

Source: Electricity Authority of Cambodia.

By 2019, Cambodia's national grid had connected 21 of its 25 provinces, with plans to extend coverage to the remaining provinces in the coming years (footnote 3). With the expansion of the high-voltage transmission system in recent years, an increasing number of rural electricity enterprise licensees have connected to the main grid. The transmission system is also interconnected with the neighboring power systems of the Lao People's Democratic Republic (Lao PDR), Thailand, and Viet Nam.

Sector Issues and Strategic Priorities

Until 2015, EDC had relied on procuring large hydropower projects and coal-fired power plants through bilateral negotiations with independent power producers as the primary strategy for expanding generation capacity and reducing reliance on expensive power imports, along with diesel power plants. Coal power plants, however, were reliant on imported coal, and large hydropower plants, owing to their negative

[3] Electricity Authority of Cambodia. 2020. Salient Features of Power Development in Kingdom of Cambodia Until December 2019. https://www.eac.gov.kh/uploads/salient_feature/english/salient_feature_2019_en.pdf.

environmental impacts, faced increasing public opposition. Together, these factors continued to constrain the security, affordability and sustainability of the sector.[4] Around the same time, solar photovoltaic (PV) prices were falling drastically globally, and awareness grew within Cambodia about the potential opportunities to tap their abundant domestic solar resources. Solar energy was seen as a potential source of reliable and affordable electricity.

The National Strategic Development Plan 2014 highlighted the need to build more low-cost generation capacity and transmission and distribution networks.[5] The Rectangular Strategy, Phase IV (2018–2023) underscored increased investment in solar energy to reduce electricity costs and ensure long-term energy security, using the private sector to maximize social benefit and minimize environmental degradation.[6] Further, the government's Industrial Development Policy called for reduced electricity prices, expanded transmission coverage, and improved supply reliability.[7] Meanwhile, the government's international commitments included reducing greenhouse gas emissions by 16% by 2030[8] and, along with fellow member countries of the Association of Southeast Asian Nations (ASEAN),[9] to obtain 23% of their primary energy from modern, sustainable, and renewable sources by 2025.[10] These strategies were also aligned with the government's goal to provide electricity to all villages by 2020. Thus, the focus among policy makers started to shift from what Cambodia needed toward how to achieve its needs.

Transitioning to Renewable Energy

The government's efforts began in earnest in 2013, when a technical study supported by ADB investigated the scope for developing a 100 MW solar power plant.[11] In 2015, the United States Agency for International Development funded a study to explore the viability of solar energy in various applications to enhance Cambodia's energy security.[12] In February 2016, when global solar PV prices had shown a discernible decline, the government issued its first large-scale tender for a 10 MW solar PV plant at Bavet in Svay Rieng Province. The tender resulted in a competitive tariff of 9.1 US cents/kilowatt-hour (kWh), just below EDC's average cost of supply (9.5 US cents/kWh in 2015). The project received debt financing from ADB's Private Sector Operations Department (PSOD) and concessional climate financing from an ADB-administered trust fund supported by the Government of Canada. The project was commissioned in mid-2017.[13]

The Bavet Solar Project proved that renewable energy could be a significant contributor to meeting Cambodia's growing energy demand, while also improving energy security and reducing environmental impacts compared to competing generation technologies. Ensuing cost reductions would further strengthen the business case for adding more solar PV capacity.

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4 ADB. 2018. *Cambodia Energy Sector Assessment, Strategy and Roadmap*. Manila. https://www.adb.org/sites/default/files/institutional-document/479941/cambodia-energy-assessment-road-map.pdf.

5 Government of Cambodia. 2014. National Strategic Development Plan 2014–2018. Phnom Penh.

6 Government of Cambodia. 2018. *Rectangular Strategy for Growth, Employment, Equity and Efficiency: Building the Foundation Toward Realizing the Cambodia Vision 2050, Phase IV of the Royal Government of Cambodia of the Sixth Legislature of the National Assembly*. Phnom Penh.

7 Government of Cambodia. 2015. *Cambodia Industrial Development Policy 2015–2025: Market Orientation and Enabling Environment for Industrial Development*. Phnom Penh.

8 Government of Cambodia. 2015. Cambodia's Intended Nationally Determined Contribution. Phnom Penh.

9 ASEAN is a regional grouping, established on 8 August 1967, that promotes economic, political, and security cooperation among its 10 members states: Brunei Darussalam, Cambodia, Indonesia, the Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.

10 UNESCAP, ADB, World Bank, and IRENA. 2020. The Policy Brief 2020: Advancing SDG 7 in Asia and the Pacific. https://www.unescap.org/resources/policy-brief-2020-advancing-sdg7-asia-and-pacific.

11 Korea Photovoltaic Industry Association, KC Cottrell Co., Ltd. and Sun Business Development (for ADB and the Government of the Republic of Korea, Ministry of Trade, Industry, and Energy). 2013. *Pre-feasibility Study in the Kingdom of Cambodia: Identification of Feasible Sites and Conditions for the Development of 100 MW Photovoltaic Power Project*. Unpublished.

12 R. de Ferranti et al. 2016. *Switching On: Cambodia's Energy Security in a Dynamic Technology Cost Environment*. Phnom Penh: Mekong Strategic Partners.

13 ADB. 2016. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Loan to Sunseap Asset Co. Ltd. for the Cambodia Solar Power Project*. Manila. https://www.adb.org/projects/documents/cambodia-solar-power-project-rrp.

Globally, the lifetime cost of generating electricity from solar PV has continued to decline since 2016.[14] However, the levelized cost of solar PV generation in Southeast Asia remains significantly higher than average, at about $0.10/kWh.[15]

ADB's Role and Sector Assistance

ADB is Cambodia's largest multilateral development partner, having committed $3.8 billion, including $331.9 million in cofinancing, to government and private sector development between 1966 and 2019. Of the commitments, $2.23 billion have been disbursed. During this time period, ADB committed $194.17 million to support the energy sector, accounting for just over 5% of total commitments.[16]

Building on the initial success of the Bavet Solar Project, in 2018, ADB with EDC developed a national solar PV grid integration study and roadmap through to the year 2030. The roadmap identified viable locations for solar development that included Phnom Penh, Battambang, Bavet, East Siem Reap, Kampong Cham, Kratie, Kampong Chhnang, Pursat, Suong surrounds, Takeo, and Svay Antor.[17] As part of the roadmap, four scenarios were developed for varying levels of utility-scale solar integration, i.e. business as usual, low, medium, and high solar uptake. When matched with the high demand growth scenario from 2015, the feasible utility scale solar plants in 2030 were estimated to increase from only 10 MW in 2019 to 450 MW in the low-solar case, 1,050 MW in the medium-solar case, and 1,570 MW in the high-solar case by 2030. In the medium- and high-solar scenarios, the planned additions to hydropower, coal-fired, and other thermal power plant capacities were deferred.

Based on the scenarios and available technologies, it was found that 150 MW of solar energy generation could be added to the grid by 2020 (100 MW in Phnom Penh and 50 MW elsewhere in the country) without any significant impact on the grid or need for technical upgrades to the existing transmission system. In late 2019, however, the government announced the planned addition of 415 MW of solar capacity by 2022, including what would be ASEAN's first solar park with a capacity of 100 MW to be developed with ADB's support. All of this 415 MW of capacity was being targeted in locations identified in the 2018 roadmap. Figure 2 illustrates how closely the locations of the pipeline of solar PV projects match the locations identified in the ADB-supported roadmap.

In February 2020, the government approved an update to its Power Development Plan (PDP), which shows that solar capacity of more than 1.8 gigawatts (GW) could be installed by 2030.[18] As of mid-2020, ADB is supporting a further update of the PDP through a technical assistance project, which will also address issues related to grid integration of variable renewable energy at high penetration levels.[19]

14 Frankfurt School-UNEP Centre/BNEF. 2020. *Global Trends in Renewable Energy Investment 2020*. (Frankfurt am Main). https://www.fs-unep-centre.org/global-trends-in-renewable-energy-investment-2020/.

15 IRENA (2018). *Renewable Energy Market Analysis: Southeast Asia*. Abu Dhabi. https://www.irena.org/publications/2018/Jan/Renewable-Energy-Market-Analysis-Southeast-Asia.

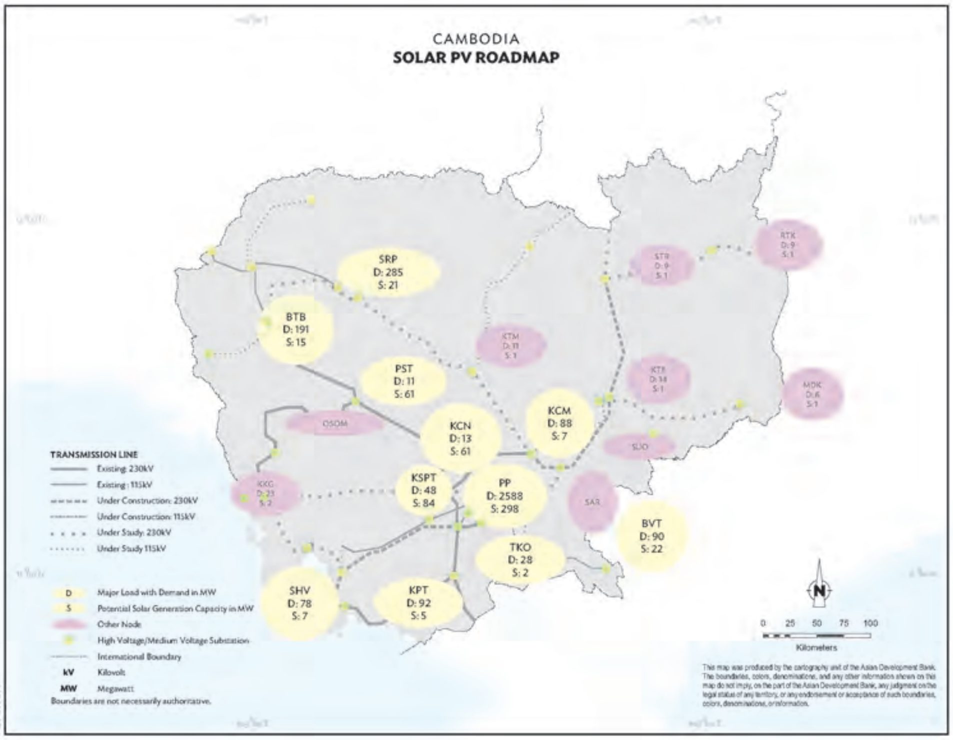
16 ADB. 2020. *Cambodia: Asian Development Bank Member Factsheet*. Manila. https://www.adb.org/sites/default/files/publication/27757/cam-2019.pdf.

17 Intelligent Energy Systems. 2018. Cambodia Solar Masterplan: Study on Large-scale Integration in Cambodia's Power System. Unpublished report. Funded under ADB TA 8105: Regional Demonstration of An Assisted Broker Model for Transfer of Low Carbon Technologies to Asia and the Pacific (Subproject 2).

18 The Chugoku Electric Power Co., Inc. 2020. *Revision of Cambodia Power Development Master Plan 2019 (Final Report)*. Phnom Penh.

19 ADB. 2019. *Technical Assistance for Support for Innovation and Technology Partnerships in Asia and the Pacific; Energy Sector High-Level Technology Application (Subproject 2)*. Manila. https://www.adb.org/projects/country/cam/sector/energy-1059.

Figure 2: Solar PV Roadmap, 2018 and Solar PV Project Pipeline, 2020



BMC = Banteay Meanchey, BTB = Battambang, BVT = Bavet, KCM = Kampong Cham, KCN = Kampong Chhnang, KKG = Koh Kong, KPT =Kampot, KSPT = Kampong Speu, KTE = Kratie, KTM = Kampong Thom, MDK = Mondul Kiri, OSOM = Osoem, PP = Phnom Penh, PST = Pursat, PV = photovoltaic, SAR = Svay Antor, SHV = Stueng Hav District, SRP = Siem Reap, STR = Stung Treng, SUO = Suong, RKT = Ratanak Kiri, TKO = Takeo.

Sources: ADB and Climate Investment Fund Presentation, 2020.

The Cambodia National Solar Park Project

Project Background

Cambodia has vast solar resource potential. However, in 2017, as mentioned above, only a singular 10 MW solar power plant had been built. ADB and other development community partners recognized the compelling case for utility-scale solar, and jointly prepared an investment plan for the Climate Investment Funds (CIF), which introduced concessional and grant financing to incentivize investment. The concessional and grant financing was to come from the Scaling-Up Renewable Energy Program in Low Income Countries window of the Strategic Climate Fund (SCF) in the CIF. In 2017, in partnership with ADB, the CIF revised the investment plan and added provisions for a National Solar Park Program that was intended to increase renewable energy supplies across all customer categories, and in the process, kickstart investment in large-scale solar projects in Cambodia.

Multiple conditions had to converge to move the National Solar Park Program forward. The government had recognized that transparency in transactions and regulatory reforms, particularly for pricing, were necessary to ensure investor confidence. The government also appreciated the need to better understand the trade-offs between bilateral contracting and a competitive selection process. With these foundations, the government embarked, with ADB support, on a strong capacity development campaign, which fostered discernment for the trade-offs between the two procurement processes, particularly regarding the pace at which contracting arrangements could be finalized and ensuing project costs. In addition, EDC and the government recognized grid stability as a necessary precondition to allow high penetration of intermittent solar PV plants.

Recognizing stepwise progress, ADB's roadmap recommended a set of sequenced actions to help the country prepare its power system for increased solar uptake, which served as the basis for the Cambodia National Solar Park proposal. ADB next provided technical assistance for a feasibility study and a bankable solar resource assessment for the National Solar Park Project. As requested by the government, ADB then financed this project and helped facilitate access to cofinancing through a combination of concessional loan and grant resources from the Scaling-Up Renewable Energy Program in Low-Income Countries window of the SCF.

Project Rationale and Objectives

The Cambodia National Solar Park Project is the first large-scale solar park in Southeast Asia employing government and private sector participation. It built upon lessons learned from the ADB PSOD's financing of the 10 MW Bavet Solar Project, and also drew upon ADB's experience with two solar park models supported in India.[20]

The project demonstrates the ability of large-scale solar parks to improve the electricity supply in Cambodia, while also providing technical benefits (i.e., ancillary services) to the national grid.[21] The project further serves to substitute or defer investment in planned fossil fuel projects, and could complement hydropower generation in coming years. In summary, the project intends to expand low-cost power generation, diversify the power generation mix with an increase in the share of clean energy, and encourage the use of competitive tenders and other global best practices.[22]

[20] In Charanka (Gujarat State) and Bhadia (Rajasthan State).

[21] Technical or ancillary benefits include voltage support during peak loading periods, reduction of loading levels on transformers, and reduction of the amount of power that needs to be generated from distant sources (hydro and coal, in particular), and therefore reduction of losses in the transmission system.

[22] ADB. 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Loan, Grant, and Technical Assistance Grant to the Kingdom of Cambodia for National Solar Park Project*. Manila. https://www.adb.org/sites/default/files/project-documents/51182/51182-001-rrp-en.pdf.

The project will also help to lower the cost of electricity in Cambodia and is expected to increase private sector investments in solar PV plants. Additionally, the project has helped to build EDC's capacities to design, construct, and operate solar PV plants and solar parks, including the management of environmental and social safeguards issues, and procure solar PV generation capacity from the private sector through competitive bidding.

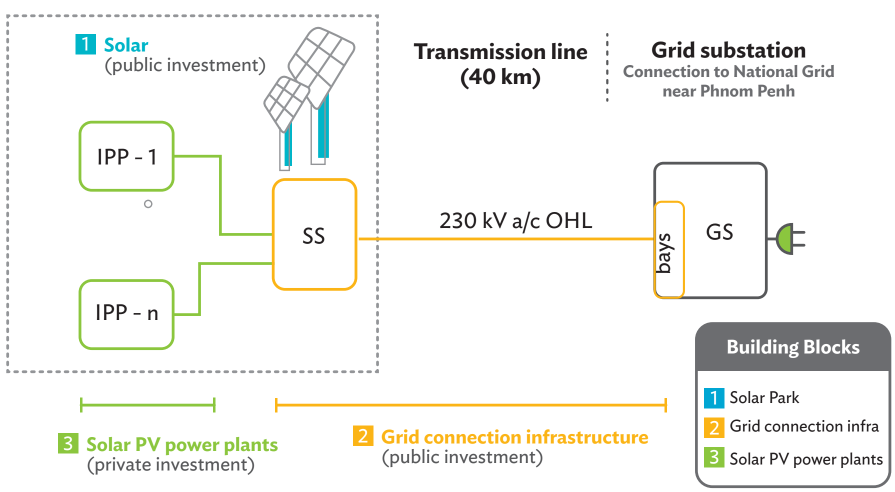
Project Description

The project has supported EDC to construct a solar power park near Phnom Penh in an area spread across Kampong Speu and Kampong Chhnang Provinces as well as a transmission interconnection system to EDC's nearest grid substation (grid substation 6 [GS6]). As of early 2021, the park area of approximately 150 hectares of land was being fenced and developed with drainage, roads, and plant buildings to accommodate at least 100 MW of solar PV plant capacity. The transmission interconnection system expansion to be constructed includes:

(i) a 100 MW capacity pooling substation at the park with two 50 megavolt-ampere transformers with space for two additional transformers in the future, switchgear, an ancillary system and controls;
(ii) a supervisory control and data acquisition system, advanced forecasting tools, and expanded information and communication technology applications;
(iii) a dedicated 40-kilometer, 230-kilovolt double circuit overhead transmission line between the park and GS6; and
(iv) two new bays with switchgear at GS6.[23]

The solar PV installations are being developed under a public–private partnership (PPP) arrangement. Figure 3 shows the assets in the National Solar Park and its links to the main transmission system.

Figure 3: Solar Park Overview



a/c = alternating current, GS = grid substation, km = kilometer, kV = kilovolt, IPP = independent power producer, OHL = overhead line, PV = photovoltaic, SS = substation.

Source: Climate Investment Fund Presentation, 2020.

[23] CIF-Global Delivery Initiative. June 2020. *Delivery Challenge Case Study: From Carbon to Competition: Cambodia's Transition to a Clean Energy Development Pathway: Electrification Via Clean and Affordable Energy Generation.* Washington,DC. https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/cif_gdi_case_ study_cambodia_national_solar_park.pdf.

Approach, Instruments, and Mechanisms

ADB is providing end-to-end support to the government and EDC with financial and technical assistance throughout development and construction phases of the project in multiple ways, as shown in Figure 4.

ADB's sovereign loan financing was used to build the park and transmission infrastructure, which helped reduce private investment risk. ADB's Office of Public–Private Partnership (OPPP) further supported EDC to design and conduct a competitive tender for procuring the first 60 MW (of the 100 MW) power plant from the private sector within the park. This transaction advisory supported project due diligence including legal, technical, financial, environmental, and social aspects; pre-feasibility and feasibility studies; support for the development of tender documents and long-term power purchase agreements (PPAs); and the tender review and selection processes.

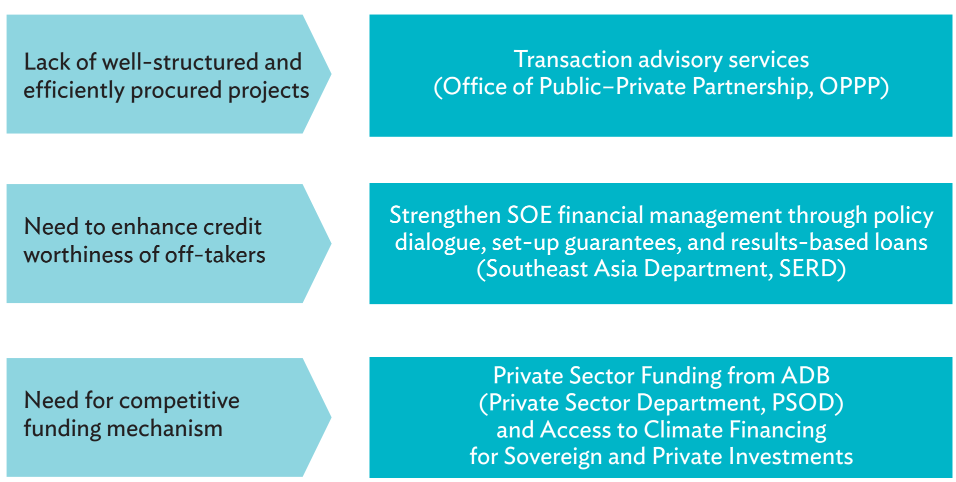
In addition to sovereign financing and transaction advisory services, ADB's PSOD is, in a consortium with other lenders, providing debt for the first 60 MW solar plant in the park.

Consultative and participatory process. The project employed a multi-stakeholder engagement approach through local consultations and dialogues at the earliest possible stage. During the design stage, ADB engaged with the project's primary stakeholders: MME, EDC, EAC, as well as Kampong Chhnang and Kampong Speu administration offices, associated districts, communes, and villages within the project site. ADB also engaged with private sector firms potentially interested, who later participated in the bidding process, as well as households that would be impacted by the construction and operation of the park and transmission line.

EDC and MME defined the project as a PPP concession, and EDC was ultimately responsible for selecting the project site. To select a suitable site, they consulted with local government officials as well as local households, which had a voice in site selection and land sale negotiations. Affected households were able to sell, exchange their land for other land, or exchange for some other type of support.

The strong participatory approach has reduced the likelihood of conflicts with affected people and other stakeholders. ADB's involuntary resettlement and indigenous peoples due diligence was conducted, and related safeguards and instruments were prepared.

Figure 4: ADB's End-to-End Support for Renewables in Southeast Asia



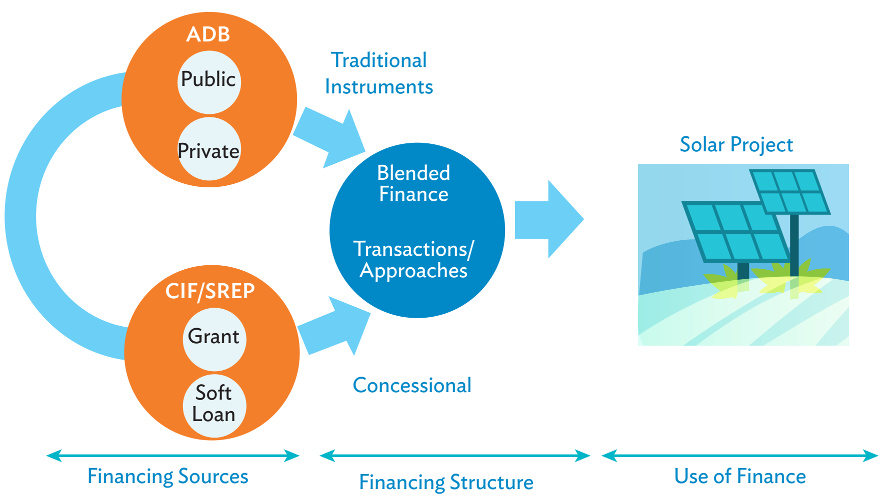
ADB = Asian Development Bank, SOE = state-owned enterprise.
Source: Climate Investment Fund Presentation, 2020.

Implementation arrangements. EDC executed and implemented the project by establishing a project management office responsible for overall coordination and implementation within the established budget and timeline. A project implementation consultant, engaged since mid-2020, is supervising and overseeing project implementation and ensuring (among other things) that ADB's procurement and financial management policies and procedures are followed for the development and construction of the park infrastructure, the transmission link with the national grid, and the solar PV installations. EDC has hired a contractor for the engineering, procurement, and construction of the park's civil works, substation, and transmission line. EDC has also been responsible for the entirety of the bidding process, from preparation of bidding documents to award of the contract.

Project cost and financing. At appraisal, the capital cost for the solar park infrastructure plus the transmission link with the main grid was estimated at $26.71 million.[24] The project demonstrated a bankable financial structure model using traditional instruments and concessional funds (including climate finance) for blended finance. This financing model and structure is shown in Figure 5.

The government requested, and ADB provided, a concessional loan of $7.64 million from ADB's ordinary capital resources to help finance the National Solar Park, including the transmission link to the main grid.[25] The SCF provided loan cofinancing of $11.00 million and grant cofinancing of $3.00 million, administered by ADB.[26] The interest during construction of the ADB loan and the service charge of the SCF loan were capitalized. The ADB and SCF loans were re-lent by the Ministry of Economy and Finance to EDC under a subsidiary agreement.[27] The government provided counterpart financing of $2.94 million to finance taxes

Figure 5: Financing Sources and Structure



ADB = Asian Development Bank, CIF = Climate Investment Funds, SREP = Scaling-Up Renewable Energy Program in Low Income Countries.

Source: Climate Investment Fund Presentation, 2020.

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24 The transmission line will be rated at 230 kilovolts, but will be initially operated at 115 kilovolts.

25 The loan has a 32-year term, including a grace period of 8 years; an interest rate of 1.0% per year during the grace period and 1.5% per year thereafter; and other terms and conditions set forth in the draft loan and project agreements.

26 The SCF loan has a 40-year term, including a 10-year grace period, and a service charge of 0.1% per year on the disbursed and outstanding loan amounts.

27 In addition to the interest rate and service charge, the subsidiary loans included an onlending margin of 0.65% for the ADB loan and 1.05% for the SCF loan.

and duties through exemptions, and EDC provided financing of $2.13 million for land acquisition and resettlement costs.

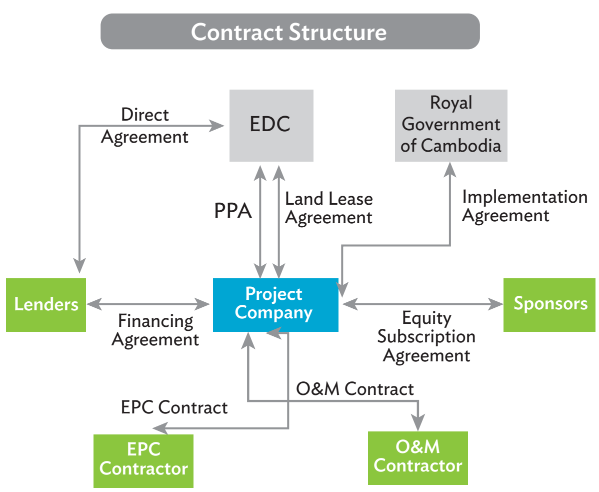
The climate change mitigation component is estimated at $25.54 million, about 25% of which will be financed by ADB. ADB is also financing 100% of the adaptation costs; the climate change adaptation measures were integrated within the main civil works contract costs, and the related costs were about $1.17 million. Financing sources and structure are summarized in Figure 5.

Developing a bankable contractual structure. To significantly de-risk the project in critical areas, ADB employed a business model that combined a public-funded solar park with a PPP modality to procure a solar plant. To assure the sustainability of the project, ADB also helped develop a bankable contractual structure which incorporated a judicious risk allocation framework for sharing obligations and responsibilities across various stakeholders.

The government took on country-specific risks that would have otherwise deterred new investor interest. EDC assumed the responsibility of providing grid connectivity, land, and other ancillary services. This, in turn, reduced execution-related risks borne by the private solar PV plant developer. This arrangement made the project's risk–reward profile substantially more attractive to the private sector and spurred investor interest, including from international players with limited or no exposure to the Cambodian market.

To build confidence among local and international bidders as well as foster a climate of transparency, ADB worked with EDC to prepare and deploy standardized and best-practice transaction documents, including project agreements as well as technical and financial tender documents. This helped improve the PPAs by clarifying the terms and conditions, particularly those pertaining to technical requirements, payment regime, default and termination, as well as change in law protection and dispute resolution. Additionally, operating procedures and responsibilities of EDC and the power producer were formally defined, thereby reducing risks of incongruence in expectations. The contractual structure and risk allocation framework are shown in Figure 6.

Figure 6: Contract Structure and Risk Allocation Framework



The risk of providing the grid connectivity, land, and other ancillary services borne by EDC; thereby reducing the execution risk allocation to the developer for the solar PV power plant.

Risk Allocation Framework

Key Risk	Primary Risk Allocation	
	Project Company	EDC
Delay in Financial Closure	✔	✘
Design Risk	✔	✘
Construction Risk	✔	✘
Project Cost Overrun	✔	✘
Operation Risk	✔	✘
Change in Law/Political Risk	✘	✔
Off-taker Risk Even	✘	✔
Solar Irradiation Risk	✔	✘
Obtaining and Maintaining Permits	✔	✘
Access to Grid	✘	✔
Provision of Land	✘	✔

Risk allocated appropriately to party best suited to manage that risk which ensures bankability of project.

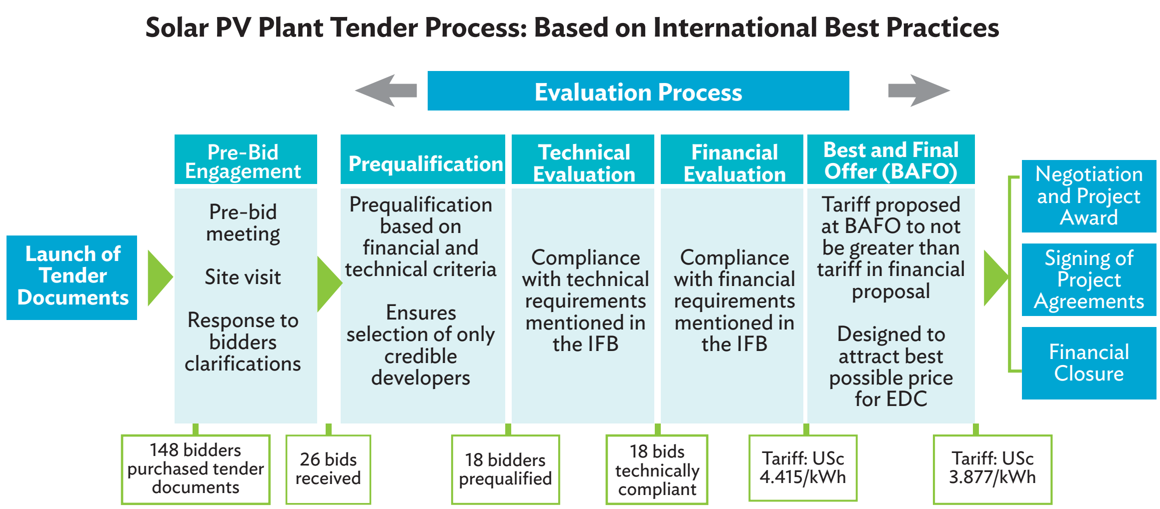
EDC = Electricité du Cambodge, EPC = engineering, procurement, and construction, O&M = operation and maintenance, PPA = power purchase agreement, PV = photovoltaic.

Source: Climate Investment Fund Presentation, 2020.

Competitive procurement. To enhance Cambodia's prospects for securing the lowest possible price, ADB worked closely with EDC and the government to implement a highly effective two-step reverse-auction. It was an iterative bidding process, allowing for a first-round selection of choice candidates, signaling priorities, followed by a second round of bidding that helped eliminate all but one of the previously selected candidates. This candidate was invited for negotiations and awarded the contract.

Bolstered by robust market and technical analyses, efforts to ignite international investor interest met with success. Over 150 firms attended a bidders' conference convened in Phnom Penh in early 2019. Of these, 148 purchased the bid documents, and 26 submitted expressions of interest. Further on, 18 firms from 11 countries were prequalified and invited to submit final bids. All 18 of them submitted bids, and all were found to be technically compliant. Negotiations with the preferred bidder yielded a price of just under US cent 3.877/kWh. Each step in the process enhanced competitive tensions to drive down the price (footnote 23). Figure 7 shows the tendering process for the solar PV plant.

Figure 7: Solar PV Plant Tender Process



BAFO = best and final offer, EDC = Electricité du Cambodge, IFB = invitation for bid, kWh = kilowatt-hour, PV = photovoltaic, USc = United States cents.

Source: Climate Investment Fund Presentation, 2020.

Status of Implementation

As of early 2021, Cambodia's first national solar park was being developed following more than 4 years of concerted foundational work, which included a study on grid integration of large-scale solar and other variable renewable energy plants, the development of a national solar PV master plan, and the creation of measures to present a transparent and reliable investment environment to the private sector. The park can accommodate up to 100 MW of solar PV capacity. An engineering, procurement, and construction contract incorporating good international practices was signed in March 2020. Construction is expected to be completed by early 2022.

Additionally, a PPA for the first 60 MW solar PV installation in the park was signed in June 2020. ADB's PSOD will also provide financial assistance for this 60 MW capacity. Commercial operations are scheduled to begin by June 2022. ADB's OPPP is currently supporting EDC to tender the remaining 40 MW.

To limit curtailment and congestion on the power network from the variable/intermittent generation from the 60 MW solar PV installation, ADB approved $6.7 million in September 2020 to procure Cambodia's first utility-scale battery energy storage system. The battery system will be able to store 16 megawatt-hours and help smooth the output from the solar park. It will also provide about 0.5 hours of curtailment reserve to address daily power shortages, primary frequency control, as well as congestion relief, thus allowing EDC to defer upgrades of its transformers at the GS6 near the National Solar Park.[28]

Potential for Scale Up and Replication

The agreed PPA tariff with the winning bidder, which is significantly lower than any previous tariff in Cambodia, is creating ripples within and beyond Cambodia.

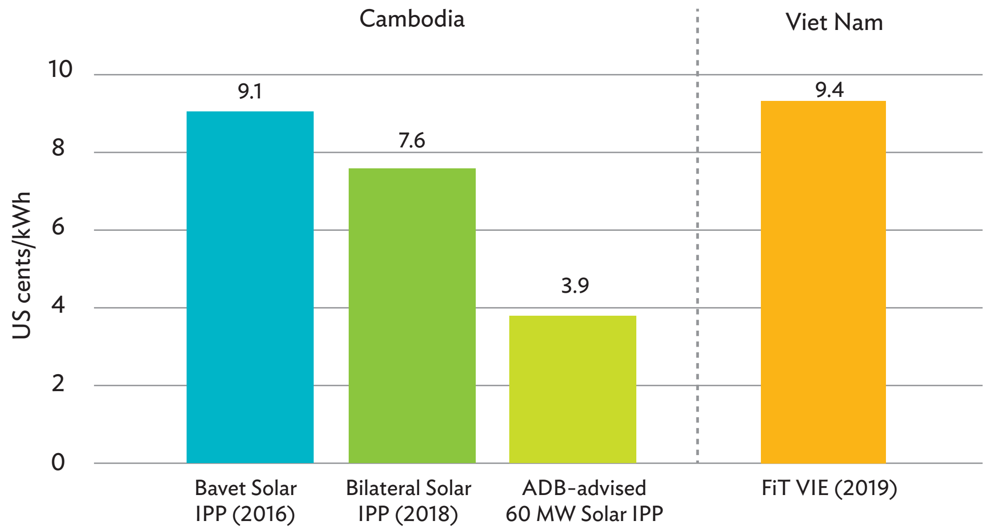
Solar Energy in Cambodia in the Post-COVID-19 Scenario

Given the massive solar energy potential in the country, the solar roadmap highlighted multiple pathways to deepen solar PV penetration by 2030, and also identified several locations for siting the PV capacity. Preparatory and development work for the National Solar Park Project occurred during a period of globally falling PV prices, and increasing private sector interest in new opportunities. During this time, the government's appreciation for solar PV's value proposition grew, and employing traditional procurement methods, the government negotiated bilateral PPAs with interested private parties. To the government's credit, the tariffs reached were US cents 7.60/kWh in 2018, which is lower than the US cents 9.10/kWh tariff for the ADB-supported solar plant at Bavet in 2016, but significantly higher than the transparent, competitive two-step auction process could yield, as shown in Figure 8. The tariff reached and the experience gained through the transparent two-step auction have inspired EDC and the government to consider replicating the process for the remaining 40 MW solar PV plant in the park.

Building on this success, Cambodia's Power Development Plan (PDP) (2020–2040) identifies pathways to reduce reliance on coal and other fossil fuel power generation; increase penetration of variable renewable energy, i.e., solar and wind; and incorporate other technologies, such as biomass, waste-to-energy, and large hydropower. Options for improving grid flexibility are also being considered, such as battery energy storage systems and internal combustion engine capacity for peaking demand profiles and frequency regulation. Such facilities would also help avoid curtailment from solar and wind installations in a high variable renewable energy penetration situation. ADB, which is supporting the current PDP update, is helping the government to balance climate change-related commitments with obligations under contractually signed PPAs.

[28] ADB. 2020. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grants to the Kingdom of Cambodia for the Grid Reinforcement Project.* Manila. https://www.adb.org/sites/default/files/project-documents/53324/53324-001-rrp-en.pdf.

Figure 8: Price Comparison



ADB = Asian Development Bank, FiT = feed-in tariff, IPP = independent power producer, kWh = kilowatt-hour, MW = megawatt, US = United States, VIE = Viet Nam.

Source: CIF, 2020.

As with the rest of the world, Cambodia and Southeast Asian nations are experiencing economic downturns amid the global pandemic. Likewise, the COVID-19 pandemic has decelerated the electricity demand growth trajectory in Cambodia. Electricity demand had increased significantly in the past decade, rising from 2,515 gigawatt-hours in 2010 to 12,015 gigawatt-hours in 2019. Growth averaged 18% per annum from 2015 to 2019. Following significant reduction in demand growth in 2020, electricity demand growth is now projected at about 12% per year to 2025 under a medium-growth scenario.[29]

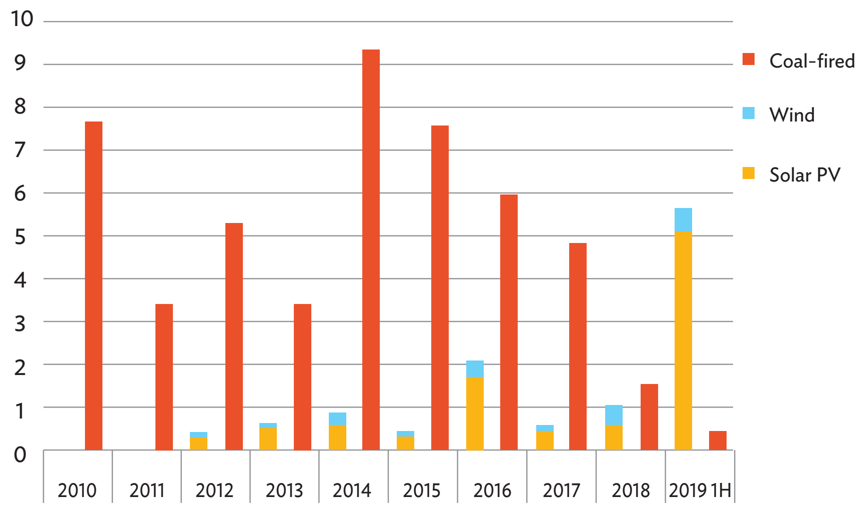
While COVID-19 has slowed economic and electricity demand growth, the demonstrated impact of the National Solar Park Project and the interest of the larger private sector community in setting up more solar PV capacity are potentially useful guideposts for the country's continued transition to renewable energy in the post-COVID-19 era.

Regional Spillover Effect

By the first half of 2019, there were clear signs of a shift in new capacity additions in Southeast Asia, when new solar PV approvals far exceeded new coal-fired capacity approvals (Figure 9). This was also around the time when the international competitive auction for Cambodia's National Solar Park Project—the first of its kind in Southeast Asia—began. Until then, only Malaysia had a competitive bidding program for large-scale

[29] ADB. 2020. *Power Development Master Plan (2020–2040) Demand Forecasts (June 2020)*. Unpublished. This study is being conducted under TA 9600-REG: Southeast Asia Energy Sector Development, Investment Planning and Capacity Building Facility.

Figure 9: Approved Coal, Solar PV, and Wind Capacity Additions in Southeast Asia, 2010–2019



1H = first half, PV = photovoltaic.
Source: IEA, 2019.

solar.[30] Cambodia's experience has sparked the interest of other ASEAN member countries to pursue competitive international solar auctions as well.

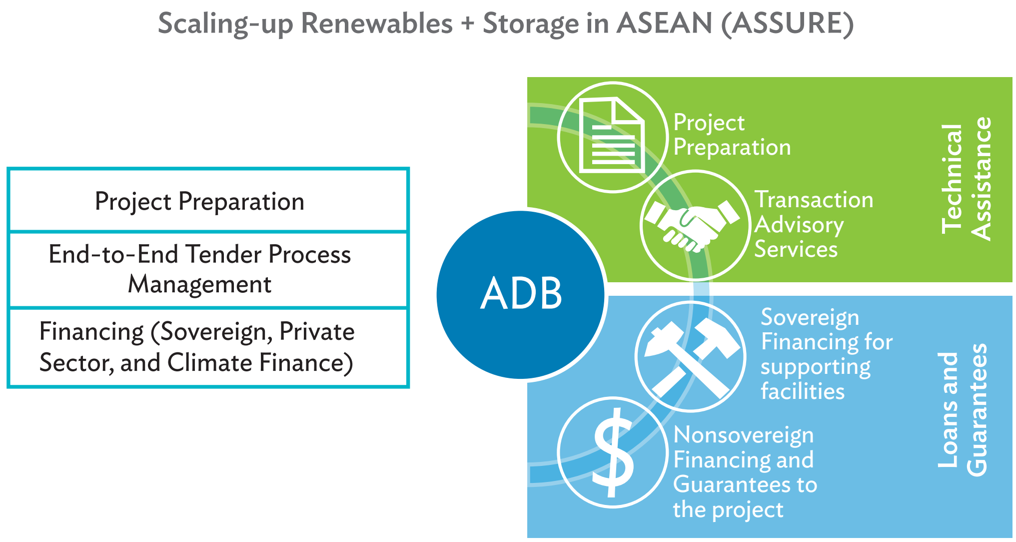
To meet increased interest, ADB has initiated the Scaling up Renewables Plus Storage in ASEAN (ASSURE) program.[31] This program works with ASEAN member countries to deploy renewable energy on a large scale by supporting project development and facilitating private sector participation. This program could be an important tool, among many others, to accelerate the region's transition to green energy. Viet Nam has signed a mandate for ADB support in developing a floating solar auction, and ADB is also in discussions with officials in Indonesia and Thailand, among other ASEAN countries, to undertake similar activities.

The key components of the ASSURE program include technical assistance for preparation and planning, transaction advisory services, and financing. As shown in Figure 10, the ASSURE program encompasses upstream and downstream support areas, from project preparation through to tendering and financial close. The support is tailored to meet countries' needs and experience. The project preparation process may include the development of energy master plans, resourcing studies, site suitability analyses, regulatory assessments, as well as feasibility studies and transaction advisory support. The end-to-end tendering process may include ADB support for drafting tender documents, organizing and conducting the auction process, as well as conducting market outreach. To reach financial close, ADB may provide or facilitate

[30] For its latest fourth round of bidding for 1 GW of solar PV capacity announced in mid-2020, the Government of Malaysia has aimed only at Malaysian firms. Some 500 MW is earmarked for projects of 10–30 MW capacity, and 500 MW for projects of 30–50 MW capacity each. This is done with the objective of accelerating development of the national renewable energy industry and help in economic recovery following the COVID-19 pandemic. The lowest bid price received in the third round of bidding in 2019 was US cents 4.20/kWh (see https://www.pv-magazine.com/2020/01/09/five-bidders-set-to-secure-490-mw-in-malaysias-third-solar-auction/); and some point out that the levelized cost of energy from solar PV would be US cents 8.86/kWh (see https://www.pv-tech.org/news/malaysia-eyes-pandemic-recovery-with-1gw-new-solar-tender).

[31] ACGF and ADB. January 2021. *ASEAN CATALYTIC GREEN FINANCE FACILITY 2019-2020 Accelerating Green Finance in Southeast Asia*, https://www.adb.org/sites/default/files/institutional-document/670821/asean-catalytic-green-finance-facility-2019-2020.pdf and ACGF and ADB. October 2020. GREEN FINANCE STRATEGIES FOR POST-COVID-19 ECONOMIC RECOVERY IN SOUTHEAST ASIA Recoveries for People and Planet https://www.adb.org/sites/default/files/publication/639141/green-finance-post-covid-19-southeast-asia.pdf.

Figure 10: The ASSURE Program



ADB = Asian Development Bank, ASEAN = Association of Southeast Asian Nations.

Source: Asian Development Bank.

project funding through grants and loans from ADB's sovereign and private sector windows, as well as funds managed by ADB, climate finance, cofinancing from other development partners, and financing from commercial sources.

Concluding Observations and Lessons

By competitively auctioning a 60 MW plant and finalizing a PPA tariff of US cents 3.877/kWh, the National Solar Park Project has laid the foundation for an energy transition in Cambodia. Once completed, it will have helped lower the average cost of electricity in the country; increased private investment in solar PV plants; and improved energy security, affordability, and sustainability. The project is also helping to steer the country away from polluting and greenhouse gas-emitting coal-fired power plants, a double win for combating climate change.

The private sector has traditionally played a greater role in the financing of variable renewable energy projects in Southeast Asia, while the public sector has focused on fossil fuel power plants and transmission and distribution infrastructure.[32] If the region is to accelerate the transition to clean energy, then this situation needs to change. Public resources need to be shifted to focus on large pioneering renewable energy projects and to leverage private capital by de-risking of projects. And the National Solar Park Project provides evidence of how this can be done. For lower middle-income countries finding it difficult to attract private participation for large-scale energy projects, the Cambodia experience with competitive bidding may help provide a playbook. Key findings and lessons that can be drawn from this experience are presented below.

(i) **Aligning objectives with stakeholders and collaboratively developing strategies is a cornerstone for project success.** By working alongside the government and other stakeholders from the

[32] IEA. October 2019. *Southeast Asia Energy Outlook* 2019. https://www.iea.org/reports/southeast-asia-energy-outlook-2019.

beginning, long-term strategies for creating sustainable and replicable outcomes that consider government priorities, constraints, and timeframes, can be implemented.

(ii) **A well-managed competitive bidding process can drive down project costs, and significantly reduce PPA tariffs.** In addition to strong planning and collaboration, a robust and competitive bidding process can drive down costs at each successive stage. Internationally, competitive auctions are often viewed as the gold standard in delivering transparency and price competitiveness. The result in Cambodia was a PPA tariff approximately 60% lower than the only existing solar PV installation in the country, and about 50% lower than the agreed PPA tariffs of bilaterally awarded solar PV projects. A transparent and professionally managed bidding process includes deployment of best practices, due diligence, and clear financial structuring to optimize outcomes from complex constraints. However, competitive bidding may not be the appropriate choice for all contexts and at all times. This procurement modality is best deployed when projects are already at scale and can attract international investor interest. Competitive bidding often entails longer lead-times owing to the additional steps and disclosure processes that support a transparent bidding process. Thus, in contexts where rapid scale up of clean generation capacity is a priority, countries may want to consider a strategy where competitive bidding and bilateral award of projects can work in concert. Periodic auctions can help provide important benchmarks for tariff levels, technology choices, investor appetite and financial structure. And this information can then be used to inform bilateral contracts negotiations, which can be speedily executed to support rapid scale-up.

(iii) **Concessional climate finance can enhance a project's financial viability and commercial attractiveness.** As demonstrated in Cambodia, concessional climate finance can lower the cost of funds and enhance the financial returns to private investors. Concessional and climate finance offer important "carrots" to attract increasing market interest in solar PV and other renewable energy projects.

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8 Distributed Renewable Energy Systems for Energy Access in Asia and the Pacific

Kee-Yung Nam, Lyndree Malang, and Grace Yeneza

Introduction

Despite years of extending electricity grids, some islands and mountainous areas across Asia and the Pacific remain unconnected and unserved. In some cases, it is neither feasible technically nor economically to extend the national grid to remote islands or to route transmission lines through mountainous areas. Since population density and the number of households to be connected are low, and connection cost per household unreasonably high, stakeholders, including governments, utilities, and the private sector, do not prioritize extending the grid to these regions. Distributed renewable energy systems (DRES) may play an important role in providing sustainable energy to these last mile areas, and achieving inclusive, low-carbon growth.

This chapter presents available technologies and business models for DRES in Asia and the Pacific based on pilot projects that the Asian Development Bank (ADB) supported in its developing member countries (DMCs). In particular, it will share lessons learned from a hybrid solar photovoltaic (PV) mini-grid pilot project on Malalison Island, the Philippines, which ADB helped implement in 2019. This case study shows the successful installation of a DRES on the back of strong commitment and collective action by the community, government, and private sector. This multistakeholder collaboration is referred to in this chapter as the public–private–people partnership. Importantly, it contributes to climate mitigation as it replaced a purely fossil fuel-based distributed energy system.

Role of Distributed Renewable Energy Systems in Achieving Universal Energy Access

The Asia and Pacific region has made great strides in improving electricity access in recent years, with the electrification rate reaching 95.6% of the total regional population in 2018, up from 87.3% in 2010. This equates to around 665 million additional people being given access to electricity during the period, so that 4.35 billion people in total had access by 2018. But gaps remain between urban electrification, estimated at 99.7%, and rural electrification, which lies at only 92.2%.[1] Among those left behind are people in remote

[1] Data from United Nations Economic and Social Commission for Asia and the Pacific. 2020. *Accelerating SDG7 Achievement in the Time of COVID-19: Policy Briefs in Support of the High-Level Political Forum 2020*. https://www.unescap.org/sites/default/files/2020SDG7-POLICY-BRIEF-ASIA-PACIFIC.pdf.

and isolated areas where extending the national grid is neither technically nor economically feasible. These energy access gaps can be bridged with mini-grids using renewable energy sources, otherwise known as DRES.

Asia and the Pacific has more than 16,000 installed mini-grid projects, which is about 85% of the total globally, and majority (61%) of them are installed in three countries—Afghanistan (4,980), Myanmar (3,988), and India (2,800).[2] This estimate, however, accounts for all mini-grids, including power generation using fossil fuels. Meanwhile, the number of people connected to off-grid technologies using renewable energy reached 133 million people in 2016, with at least 9 million connected to renewable mini-grids, and 124 million using solar lighting solutions and solar home systems.[3] The challenges that mini-grids often have to face include low demand and low population densities, affordability of the electricity consumed, inapt technical skills, remote location, limited resources, access to financing, and a lack of regulatory and institutional support.

To improve the viability and sustainability of mini-grids, locally available renewable energy sources are being used in power generation, and innovative business models promote productive and income-generating uses. As the load and customer ability to pay are developed, the community becomes prepared for the eventual arrival of the main grid, or an upgrade of the system.[4] By 2030, renewable energy is expected to be the source for more than 60% of new access globally, and the growing application of digital and mobile technologies in business models will encourage the use of mini-grid and off-grid systems estimated to provide nearly half of new access.[5]

Distributed Renewable Energy Technologies

Demand for energy and availability of resources are primary considerations in selecting the technology for deploying DRES. In planning, knowledge and in-depth analysis of the off-grid site is necessary, and one of the tools used to analyze the energy situation is geospatial maps. Regions, villages, and clusters of villages without access to electricity can be identified. A multitier approach to measuring energy access can also be employed to have a deeper understanding of the demand and supply in an area, which could result in comprehensive energy access assessments and energy demand maps. Such information are useful for planning off-grids and integrating them in the national electrification plans.

A multitier framework for defining and measuring energy access—a tool for tracking Sustainable Development Goal 7 and informing policy and investment decisions—redefines energy access from the traditional binary count (access and no access) to a multidimensional definition across six tiers and eight attributes of energy.[6] The tiers range from Tier 0 (no access) to Tier 5 (highest level of access), while the attributes of energy cover capacity, duration and availability, reliability, quality, affordability, legality, convenience, and health and safety. Under this new, broader definition, electricity connection does not equate to electricity access (Table 1).

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[2] Energy Sector Management Assistance Program (ESMAP). 2019. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers. *ESMAP Technical Report 014/19*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/31926.

[3] International Renewable Energy Agency. 2018. *Policies and Regulations for Renewable Energy Mini-Grids*. November. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Oct/IRENA_mini-grid_policies_2018.pdf.

[4] Footnote 2.

[5] International Energy Agency (IEA). 2017. *Energy Access Outlook 2017: From Poverty to Prosperity*. Paris: International Energy Agency. https://doi.org/10.1787/9789264285569-en.

[6] Angelou, N. and M. Bhatia. 2014. Capturing the Multi-Dimensionality of Energy Access. *Live Wire Knowledge Note Series No. 2014/16*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/937711468320944879/Capturing-the-multi-dimensionality-of-energy-access.

ADB has experience in pilot testing and supporting distributed renewable energy generation technologies in remote and isolated areas in Bangladesh, Bhutan, Myanmar, Nepal, and the Philippines.[7] It also leads the Energy for All Partnership, a collaboration among various stakeholders including civil societies, governments, and the private sector to build capacity, share knowledge, and develop projects, including DRES.[8]

Table 1: A Multitier Framework for Measuring Access to Electricity

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
		Less than 12 Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting, air circulation, television, phone charging are possible			
Availability	Daily availability	Less than 4 hours	At least 4 hours		At least 8 hours	At least 16 hours	At least 23 hours
	Evening availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week, or at most 3 disruptions per week with total duration of more than 2 hours	(> 3 to 14 disruptions per week) or ≤ 3 disruptions per week with > 2 hours of outage	At most 3 disruptions per week with total duration of less than 2 hours
Quality		Household experiences voltage problems that damage appliances				Voltage problems do not affect the use of desired appliances	
Affordability		Cost of a standard consumption package of 365 kWh per year is more than 5% of household income			Cost of a standard consumption package of 365 kWh per year is less than 5% of household income		
Formality		No bill payments made for the use of electricity				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

hr = hour, kW = kilowatt, kWh = kilowatt-hour, lmhr = lumen-hour, W = watt, Wh = watt-hour.

Source: Multi-Tier Framework. Electricity - Multi-Tier Framework for Measuring Access to Electricity. https://mtfenergyaccess.esmap.org/methodology/electricity (accessed 30 March 2021); and M. Bhatia and N. Angelou. 2015. *Beyond Connections - Energy Access Redefined: Technical Report 008/15*. Energy Sector Management Assistance Program. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/650971468180259602/Beyond-connections-energy-access-redefined-technical-report.

[7] This section on Distributed Renewable Energy Technologies is referenced from ADB. 2019. Guidebook for Deploying Distributed Renewable Energy Systems: A Case Study on the Cobrador Hybrid Solar PV Mini-Grid. http://dx.doi.org/10.22617/TIM190342-2.

[8] List of projects, https://energyforall.asia/projects.

The common renewable energy sources used in mini-grid and off-grid systems include biomass, hydro, solar, and wind. Many distributed power generations employ solar technology, which are set up in various ways, including lighting utilities, solar home systems, stand-alone and mini-grid solar PV systems, and swarm electrification. Hybrids of technologies are also popular such as solar-PV diesel hybrid mini-grids, and wind–solar hybrid systems. Aside from these, ADB has also pilot-tested a couple of projects using run-of-river mini-hydropower. The following is a sample of distributed renewable energy technologies, and some pilot projects, mostly under the Energy for All Initiative, on which ADB tested and financed DRES technologies to support the rural electrification programs of DMCs.

Biomass-Based System. Applications of biomass energy ranges from household cooking to large projects feeding power into the grid. While many biomass technologies exist, direct combustion and gasification are the most relevant for mini-grids. The appropriate technology to adopt depends on the alternative fuel cost, availability and cost of biomass, offtake, project size, and scale of operation.[9] In Myanmar, biomass gasifiers are used to power small-scale rice mills and for village electrification.[10]

Lighting Utility (up to Tier 2). Solar PV panels generate direct current (DC) electricity that is distributed to households for basic lighting and mobile phone charging. The size of the community may not exceed a 1-kilometer radius to avoid significant distribution losses,

Solar Home System (larger system can provide up to Tier 3). A solar home system is a modular energy generation system that is designed to power a single location. It comes with a solar PV panel, battery and wiring to connect light-emitting diode (LED) lights, liquid crystal display (LCD) screens or other low-wattage electronics. Solar home systems normally range between 5 and 200 watt-peak. The larger systems can provide Tier 3 level of electricity, and those with an inverter can provide alternating current (AC) or DC electricity. Among the ADB projects that involved solar home systems is the installation of 1,389 new and rehabilitation of 2,543 existing solar systems in Bhutan.[11] ADB also provided financial assistance to the Solar Home System Program of Bangladesh.[12]

Solar PV System (up to Tier 4). Solar PV systems may be rooftop or ground mounted. The DC electricity is converted to AC with an inverter and may directly feed to the end user or to a distribution grid. A pilot was done in Nepal to test the viability of using solar PV systems on community-owned lodgings that were sources of livelihood for the local residents.

Swarm Electrification (up to Tier 3). A micro-grid among households is created for them to use surplus electricity from solar home systems to power other households. To monitor the “trading” of electricity among households, a smart meter is used. ADB provided financial assistance for the implementation of swarm electrification in Bangladesh, which has the private sector as a proponent, and involved peer-to-peer trading platforms.[13]

Solar PV-Diesel Hybrid Mini-Grid (up to Tier 5). Solar PV panels are integrated with diesel generator sets to generate electricity round-the-clock daily. An isolated distribution grid transmits electricity from the generation assets to households and microenterprises. Pilot projects were tested in two isolated and remote islands in the Philippines, Cobrador Island and Malalison Island. The case study of Malalison is discussed in Section IV.

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9 ADB. 2017a. *Developing Renewable Energy Mini-Grids in Myanmar*. https://www.adb.org/sites/default/files/institutional-document/391606/developing-renewable-mini-grids-myanmar-guidebook.pdf.

10 D. Vaghela. 2019. Community Enterprise-based Hydro and Biomass Projects in Myanmar. Presentation at the Asia Clean Energy Forum 2019. 19 June. http://asiacleanenergyforum.pi.bypronto.com/2/wp-content/uploads/sites/2/2019/06/3-DiptiVaghela_CommunityEnergySystemsinMyanmar_18JUNE2019.pdf.

11 ADB. 2020. *Bhutan Rural Renewable Energy Development Project (Project Number 42252-022) Completion Report*. https://www.adb.org/sites/default/files/project-documents/42252/42252-022-pcr-en.pdf.

12 ADB. 2018. *Bangladesh: Public–Private Infrastructure Development Facility (Project Numbers 40517-013 and 40517-042) Completion Report*. https://www.adb.org/sites/default/files/project-documents/40517/40517-013-40517-042-pcr-en.pdf.

13 SOLShare is a company involved in renewable energy-based peer-to-peer trading platforms.

Run-of-River Micro-Hydropower (up to Tier 5). Community level micro-hydropower plants in the Energy for All Initiative ranged from 180 kilowatts (kW) to 1.5 megawatts (MW). ADB conducted pilot-testing of two community-owned off-grid micro-hydropower plants in the Philippines at the towns of Getsemane in the province of Agusan del Sur and Dalupan in the province of Davao del Sur. The Dalupan micro-hydropower plant is now connected to the primary grid with a net-metering arrangement. Another ADB-supported project is the 30-kW Dhostekhor Khola Micro Hydropower Pilot Project in Nepal. This was implemented as a model for expanding access to clean electricity and enhancing economic development of rural and remote areas in Nepal through ecotourism and productive use applications.

Wind–Solar Hybrid System (up to Tier 3). Generations from wind mills and solar energy panels are combined, and their capacities are often low ranging from 1 kW to 10 kW. Higher capacity is possible depending on available resources. ADB provided assistance to install the first wind–solar hybrid system in Nepal, a pilot project that provided electricity services to 46 households in Dhaubadi village of Nawalparasi district.[14] ADB further supported Nepal in its commitment to scale up decentralized off-grid for rural energy, and helped finance a bigger wind–solar hybrid system that provided electricity services to 83 households in the Hariharpurgadi village of Sindhuli district.[15]

Business Models for Distributed Renewable Energy Systems

The traditional and most common classification of business models for DRES is based on the proponent of the project: community, private sector, utility, and multiparty or hybrid.[16] Knowledge of these basic business models is essential before developing the more complex business models that will suit a renewable energy mini-grid project. A set of criteria will later be presented in this chapter, with the aim of providing a reference in choosing and designing the appropriate business model.[17]

Common Types of Business Models

Community-led business model. Community-led business model is where a local community owns, operates, manages, and maintains the mini-grid system and provides all services for the benefit of its members.[18] A community-led business model could take the form of a legal entity representing a community, a village electrification or energy committee, or an electric cooperative. Financing is largely grant-based with some

[14] ADB. 2014. ADB Hands Over Nepal's First Wind-Solar Hybrid System to AEPC. News release. 9 June. https://www.adb.org/news/adb-hands-over-nepals-first-wind-solar-hybrid-system-aepc.

[15] ADB. 2017b. Nepal's Largest Wind-Solar Hybrid Power System Switched On to Connect a Small Village to the World. News release. 12 December. https://www.adb.org/news/nepals-largest-wind-solar-hybrid-power-system-switched-connect-small-village-world.

[16] Literatures that have the four basic or traditional business models are (a) World Bank. 2008. Designing Sustainable Off-grid Rural Electrification Projects: Principles and Practices. *Operational Guidance for World Bank Group Staff*. November. http://siteresources.worldbank.org/EXTENERGY2/Resources/OffgridGuidelines.pdf; (b) Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf; (c) Alliance for Rural Electrification. 2014. *Hybrid Mini-grids for Rural Electrification: Lessons Learned*. Brussels. https://www.ruralelec.org/sites/default/files/hybrid_mini-grids_for_rural_electrification_2014.pdf; (d) C. Oji and O. Weber. 2017. Beyond the Grid: Examining Business Models for Delivering Community-based REPs in Developing Countries. *Center for International Governance Innovation Papers* No. 130. May. Ontario: Center for International Governance Innovation. https://www.cigionline.org/sites/default/files/documents/Paper%20no.130.pdf; and (e) USAID. What Ownership Models are Used for Mini-Grids? https://www.usaid.gov/energy/mini-grids/ownership/models/.

[17] This section on Business Models for Distributed Renewable Energy Systems is referenced from a draft ADB publication titled Designing Business Models for Distributed Renewable Energy Systems.

[18] Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

community financial or in-kind contributions. Local ownership and sustainability are relatively assured, but management risks are also relatively high.

In developing countries where the interest of private sector and public utilities to provide rural electrification is limited—in areas that are remote and of low population density—the community-led business model has become the alternative. The limited financial and technical capacity of rural communities, however, makes access to finance and implementation difficult, hence projects typically require grants and technical assistance. Community contributions could be in the form of land, materials, and low-cost or free labor. If the community is the sole owner of a project, generating profits is not a priority but tariffs will have to cover operational, maintenance, and replacement costs for equipment components.[19] Such community-based projects provide employment opportunities to locals who are trained in operating, maintaining, and doing minor repairs on the systems.[20] External service providers are hired for major repairs.

To ensure local ownership of a community-based project, a thorough community participatory process is a crucial step before project implementation. Highly dependent on the local circumstances, this initial phase of community interaction, information, and self-organization may take more than a year before the actual construction of the energy system starts. This initial phase instills a sense of ownership into the beneficiary community, especially if the funding comes primarily from grants or subsidies. Crucial also is the identification of an "internal activator," such as a village leader or reputable local personality, who can communicate and inform the community about the project, work towards community consensus, gain the trust of the community, and ensure support for the project.[21]

The community as project owner and operator needs to be organized in a community-based organization, such as a village electrification or energy committee, that ensures effective decision-making and management, or an organizational entity, such as an electric cooperative, that has the legal power to own and operate distributed renewable energy systems (Figure 1). The committee or electric cooperative will be responsible for the management of the system, which includes setting and collecting tariffs, ensuring the availability of funds for maintenance and repairs, and deciding on investments relating to the energy system.[22]

ADB has tested several pilot projects demonstrating community-led business models. One is a micro-hydropower in Dhostekhor Khola, Nepal where villages were represented in the micro-hydro users' committee. Another was the hybrid solar PV mini-grid in Cobrador Island, the Philippines, where the community was represented by an electric cooperative.

Private sector-led business model. Private sector-led is where a private entity plans, builds, manages, and operates the mini-grid system. Depending on the nature of business of the private sector, and regulations surrounding the establishment of a renewable energy mini-grid, a special purpose vehicle (SPV) may be necessary as a conduit to accomplish its role as an energy company (Figure 2). SPVs are designed to allow independent ownership, management, and funding, as well as to manage financial risk.[23]

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19 African Development Bank. 2016. Green Mini-Grids in Sub-Saharan Africa: Analysis of Barriers to Growth and the Potential Role of the African Development Bank in Supporting the Sector. *Green Mini-Grid Market Development Program Document Series No. 1*. December. https://www.energy4impact.org/file/1818/download?token=j67HKZEy.

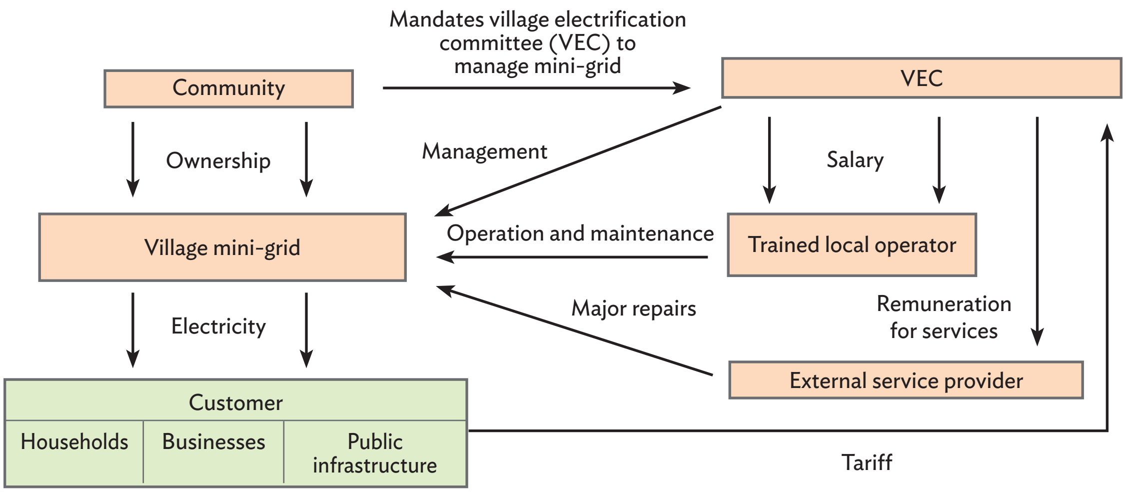
20 Krithika, P. R. and D. Palit. 2013. Participatory Business Models for Off-Grid Electrification. In S. Bhattacharyya, ed. *Rural Electrification Through Decentralized Off-grid Systems in Developing Countries*. London: Springer. pp. 187–225. https://www.researchgate.net/publication/261946063.

21 Institut Bisnis dan Ekonomi Kerakyatan. 2019. Ensuring the Sustainability of Community Energy Systems. Presentation of Tri Mumpuni Iskandar, agriculture engineer from IBEKA (which translates to People Centered Business and Economic Institute), at the 2019 Asia Clean Energy Forum. 19 June. Manila. http://asiacleanenergyforum.pi.bypronto.com/2/wp-content/uploads/sites/2/2019/06/2-Tri-Mumpuni_Asia-Clean-Energy-Manila-19-June-2019.pdf.

22 Gollwitzer, L. 2014. Community-based Micro Grids: A Common Property Resource Problem. *Social, Technological, and Environmental Pathways to Sustainability (STEPS) Working Paper No. 68*. STEPS Centre. https://steps-centre.org/wp-content/uploads/Rural-Electrification.pdf; and P. R. Krithika and D. Palit. 2013. Participatory Business Models for Off-Grid Electrification. In S. Bhattacharyya, ed. *Rural Electrification Through Decentralized Off-grid Systems in Developing Countries*. London: Springer. pp. 187–225.

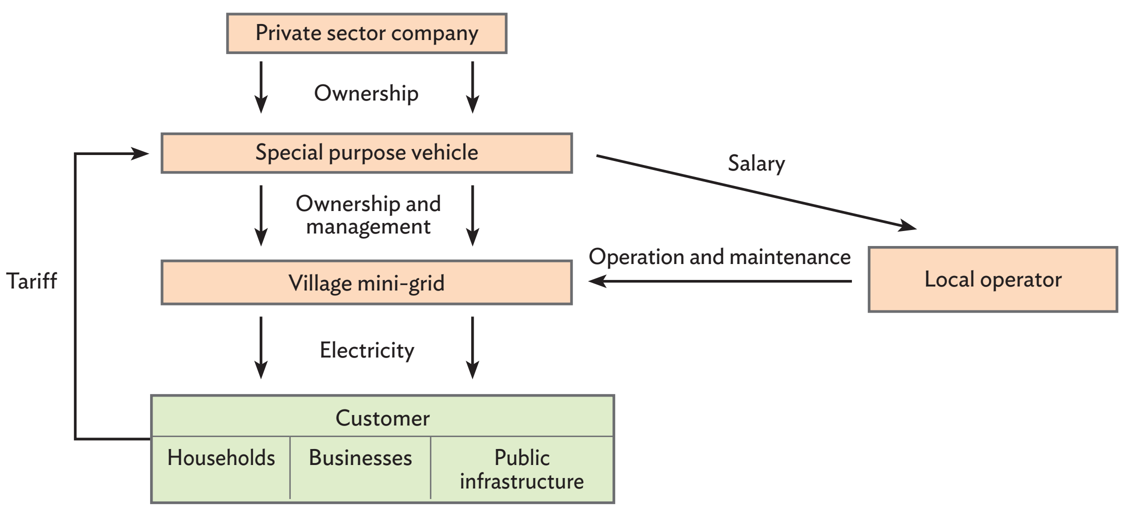
23 Chen, J. 2020. Special Purpose Vehicle. Investopedia. 29 June. https://www.investopedia.com/terms/s/spv.asp.

Figure 1: Community-Led Business Model



Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript, last modified 14 December 2020. Microsoft Word file.

Figure 2: Private Sector-Led Business Model



Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript, last modified 14 December 2020. Microsoft Word file.

A private sector-led business model has high potential for scaling up, attracting private investments, and mobilizing know-how. It requires, however, a supportive enabling environment, wherein the government supports mini-grid energy development; licensing procedures are simple; credit, financing, and subsidies are available and accessible; and governments and donors give technical assistance.[24] Private sector players tend to implement and provide energy services more efficiently and have a strong interest in sustaining continuous operations and achieving steady cash flows for them to recover their investments and make

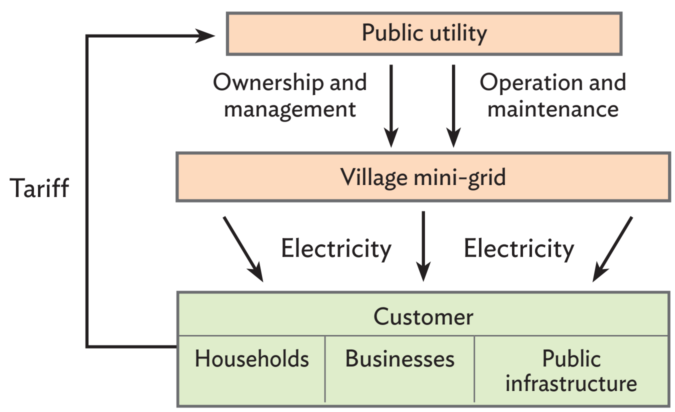
[24] USAIDc. What Ownership Models are Used for Mini-Grids? https://www.usaid.gov/energy/mini-grids/ownership/models/.

profit. Private companies that can show a track record of profitable mini-grid projects can more easily access commercial lending and private investment for expansion and scale up of successful operations.[25] ADB supported a private sector-led project in Bangladesh wherein the private company implemented a swarm electrification.

Under the private sector-led model, three common approaches exist. First, the anchor load approach, or the anchor–business–community approach, is where the developer or grid operator secures an anchor customer (e.g., a telecommunication tower company, a factory, lodges) with predictable and guaranteed energy demand to supplement the beneficiary community. Demand could further be increased by connecting local businesses such as shops, petrol stations, and agro-processing units. The bulk of the electricity is supplied to the anchor customer and businesses, and the rest is sold to the community. Second, the clustering approach clusters villages of comparable socioeconomic requirements—being adjacent or neighboring villages is not required—to allow sharing of one management structure. Third, the local entrepreneurship approach hinges on the presence of a local entrepreneur with a well-established social network, which is essential in reducing costs for security, customer relationship management, and money collection. The local entrepreneur is ideally engaged in productive industries, and alongside operates the electricity system and owns parts of the generation and distribution assets.[26]

Utility-led business model. The utility-led model refers to cases wherein the national or regional electricity utility installs, owns, operates, and maintains the mini-grid and is responsible for payment collection (Figure 3). Utility-led is often funded by the national treasury or government, and may be prone to political interference and procurement problems due to bureaucracy. If public funding is available, this model can easily be scaled up. But due to the liberalization of energy markets in many developing countries, utilities have adopted market-driven priorities, and rural low-revenue mini-grids rank low in their priorities. If a government directs utilities to undertake mini-grids, utilities may cross-subsidize tariffs of mini-grid with grid-connected customers.[27]

Figure 3: Utility-Led Business Model



Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript, last modified 14 December 2020. Microsoft Word file.

[25] USAIDb. What are the Pros and Cons of Each Ownership Model? https://www.usaid.gov/energy/mini-grids/ownership/considerations.

[26] Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

[27] Alliance for Rural Electrification. 2014. *Hybrid Mini-grids for Rural Electrification: Lessons Learned*. Brussels. https://www.ruralelec.org/sites/default/files/hybrid_mini-grids_for_rural_electrification_2014.pdf; and Africa-European Union Renewable Energy Cooperation Program. 2014. Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

In the traditional public utility business model, vertically integrated utilities are responsible for generation, transmission, and distribution. Public utilities traditionally serviced rural areas with power from the central grid. Still, considerable portions of the population in remote and rural areas of developing Asia are not served due to the difficulty of extending the grid and the related prohibitive costs. Some public utilities deploy distributed energy solutions such as mini-grids powered by diesel generators in areas that are remote or on islands that cannot be reached by the national grid. The major activity of public utilities has been the extension of the national grid, while deployment of distributed electrification solutions and use of renewable energy resources are recent developments. Still, public utilities are sometimes hesitant to explore this new field of business. Expectations of low revenues from mini-grids, the need to acquire knowledge and new skills in renewable energy generation and distribution, as well as complex, costly and time-consuming maintenance in remote areas makes it less attractive for them to get involved.

Hybrid or multiparty business model. Hybrid combines different aspects of the three aforementioned models. It is relatively hard to establish, but presents a good compromise for mini-grids. Ideally, the strengths of each business model are combined and maximized, and weaknesses avoided or at the least tempered. In a hybrid business model, the possibilities are unlimited, but are of course governed by the rule of law. Setting up a hybrid business model requires extensive knowledge of the legal and regulatory framework as the different players, utility or public sector, private sector, community, and development partners collaborate and negotiate the terms of ownership, financing, operation and maintenance, and profit-sharing.

Four contractual arrangements under a hybrid business model have been suggested.[28] First, the public–private partnership (PPP) approach, where a contract between a public party and private party is forged to provide various aspects of the DRES. The PPP approach usually takes the form of build–own–operate–transfer, build–own–operate, or build–own–transfer.[29] Second, the Renewable Energy Service Company approach is a fee-for-service setup, wherein the company operates and maintains the systems, and collects fees from the users, while the government purchases and owns the systems. Third, the concession approach is where a private company provides electricity services to the rural communities under beneficial terms such as an electric supply monopoly, preferential market access for a certain period, or a special tariff for the area. Fourth, the power purchase agreement is where generation and distribution assets are owned by various entities; for instance, an agreement wherein a public utility owns the distribution assets and buys the electricity from private players who generate the electricity. Figures 4a and 4b depict possible hybrid models between a community and government agency, and between a community and private sector.

With the participation of the concerned communities in any of the business models adopted, ADB sees the emergence of another multiparty business model, the public–private–people partnership. This model is vital to successfully attain so-called “last-mile electrification” in Asia and the Pacific and sustain the upkeep of installed DRES. The participation and commitment of communities are essential to nurture a sense of ownership among the people. With the people’s support, along with the public sector’s provision of a conducive business environment, and the private sector’s technical expertise, the success and sustainability of a DRES project are assured.

ADB tested several pilot projects that employ hybrid business models. One is a combination of private sector-led and community-led to run a solar micro-grid in Khotang and Okhaldhunga, Nepal. An SPV was established, which comprised the private company and local investors. This project also used clustering and anchor–business–community approaches. Another project that employed a hybrid business model is the

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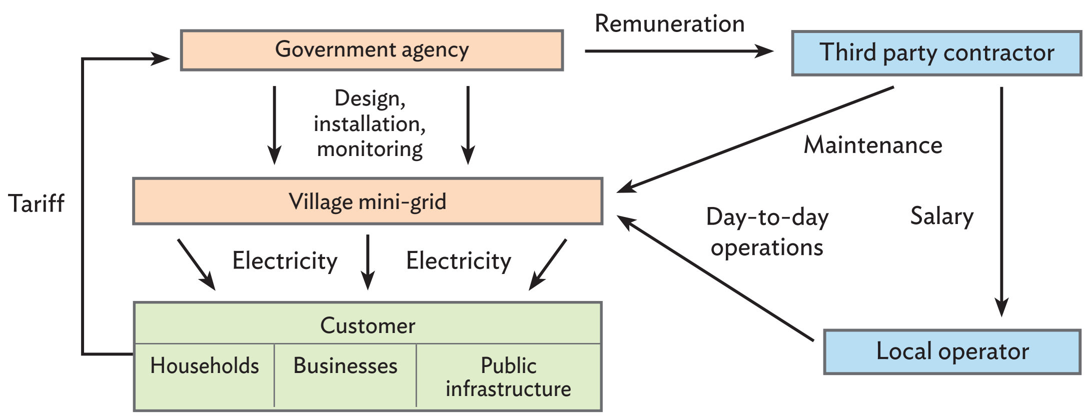
[28] Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

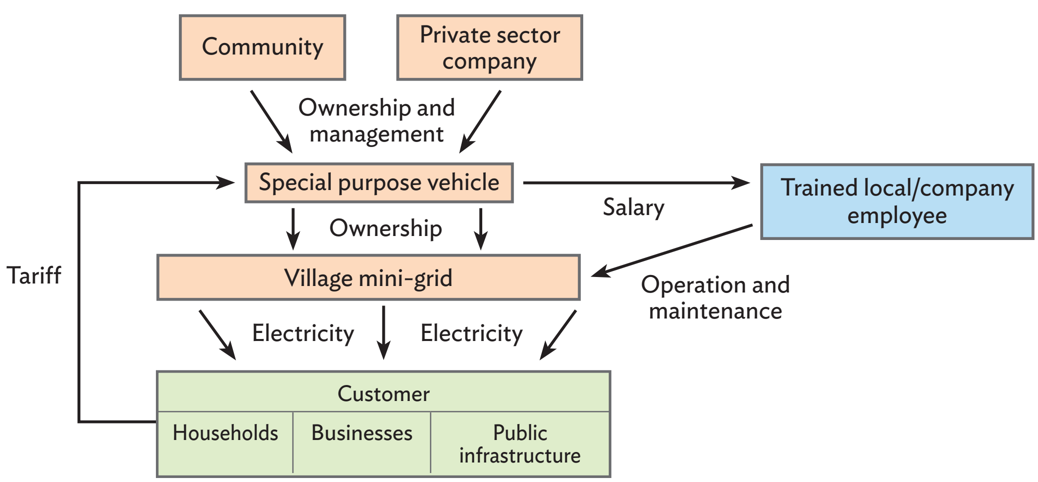
[29] ADB. 2015. *Business Models to Realize the Potential of Renewable Energy and Energy Efficiency in the Greater Mekong Subregion*. http://hdl.handle.net/11540/5053; and C. Oji and O. Weber. 2017. Beyond the Grid: Examining Business Models for Delivering Community-based REPs in Developing Countries. *Center for International Governance Innovation Papers No. 130*. May. Ontario: Center for International Governance Innovation. https://www.cigionline.org/sites/default/files/documents/Paper%20no.130.pdf.

Figure 4a: Hybrid Model between a Community and Government



Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript last modified 14 December 2020. Microsoft Word file.

Figure 4b: Hybrid Model Between a Community and Private Sector



Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript, last modified 14 December 2020. Microsoft Word file.

hybrid solar PV mini-grid in Malalison Island, the Philippines. A public–private–people partnership facilitates this DRES. Table 2 summarizes ADB pilot projects that were conducted in Bangladesh, Nepal, and the Philippines, and shows the key players—proponents, owners, and financiers—for each.

Table 2: Key Players in ADB Pilot Projects on Distributed Renewable Energy Systems

	Business Model	Technology	Proponent	Owner	Financier
1	**Community-led**				
1.1	Users' committee	Micro-hydropower (Dhostekhor Khola, Nepal)	A champion – social entrepreneur Mahabir Pun	Community through the users' committee	A combination of loans, grants, and financial contributions (from ADB, community-owned lodges, District Development Committee, National Trust for Nature Conservation under Annapurna Conservation Area Project, Nepal Tourism Board, Huguenin Rallapalli Foundation of the United States, NMB Bank [loan to the users' committee], Nangi and Swanta village local cooperatives [loans to the users' committee]).
1.2	Electric cooperative	Hybrid solar PV mini-grid (Cobrador Island, Philippines)	Electric cooperative – Romblon Electric Cooperative	Electric cooperative	Grants from international government source (KEA) and international financial institution (ADB), and funds from electric cooperative.
2	**Private sector-led**	Solar home system – swarm electrification (Shariatpur, Bangladesh)	Private company, – SOLshare, in collaboration with a local NGO, Upokulio Biddutayan O Mohila Unnayan Samity	Private company	A mix of grants, prize money, and convertible notes from international financial institutions, a government-owned nonbank financial institution, and a mix of individuals and social impact funds.
3	**Hybrid**				
3.1	SPV among private company and local investors – clustering and anchor–business–community approaches	Solar micro-grid (Khotang and Okhaldhunga, Nepal)	Private company – Gham Power	SPV comprising of a private company, and local investors. Ownership of the assets will be transferred to the community after 10 years.	Local community investors, private company (Gham Power), local commercial bank (NMB Bank), and a partial grant from ADB
3.2	Public–private–people partnership	Hybrid solar PV mini-grid (Malalison Island, Philippines)	Electric cooperative – Antique Electric Cooperative	SPV comprising of a private company, and an electric cooperative	A grant from ADB for the solar system and prepaid metering system, and remaining funds for solar generation from the electric cooperative and private company.

ADB = Asian Development Bank, KEA = Korea Energy Agency, NGO = nongovernment organization, PV = photovoltaic, SPV = special purpose vehicle.

Source: Asian Development Bank (ADB). "Designing Business Models for Distributed Renewable Energy Systems: ADB Experience and Lessons Learned in Pilot Projects." Unpublished manuscript, last modified 14 December 2020. Microsoft Word file.

Through the years, the business models employed have become more sophisticated as they increasingly cater to the unique needs of each location. More variations of the hybrid models are coming up as project developments respond to last-mile electrification.

Considerations in Choosing a Business Model

Aside from the characteristics of the traditional business model types, factors to consider in choosing and designing a business model that best fits a project are important. Using available literature, together with ADB's experience in various renewable energy mini-grid projects, a set of fundamental criteria to consider in designing the appropriate business models for each location or project can be suggested. The criteria consider regulation, institutions, demand, revenue, system location and scale, operation and maintenance, and financing. Since the hybrid model ideally combines the strengths and circumvents the weaknesses of the other three models, the discussion on the criteria or factors to consider concentrates on the three models: utility-led, community-led, and private sector-led. Combining certain aspects of these three models, a hybrid model could be designed according to the needs of a location or project.

Regulation. A major determinant of the business model that will work best is the set of regulations governing mini-grids. Where regulations exist, players have to be comply with rules and standards, which include permits, quality, technology, and taxes. Compliance could be expensive especially where regulations are poorly designed and enforced. If transaction costs are too high, private sector would be discouraged from investing and partaking in the mini-grid development.[30]

Supportive policies and simple licensing procedures will encourage private sector participation. In countries with effective deregulation for mini-grids, minimal and reasonable transaction costs can make projects financially viable. Private companies can negotiate profitable cost-reflective tariffs, although the absence of subsidies means a higher user tariff. The total lack of regulation, however, risks having the private sector maneuver through unofficial arrangements. They must learn the ropes on their own, which could be costly given the incomplete or asymmetric information. Such deregulation could have adverse health and environment repercussions, and compromise general safety.[31]

In cases of highly regulated markets, utility-led is the suggested model. With their rich experience in the industry and access to financing, they are best equipped and financially able to navigate bureaucracy. Their adoption of ingenious commercial strategies, however, is key to their successful endeavor into mini-grid development.[32]

Institutions. If institutional structures and governance are weak, private sector-led and community-led are the suggested business models because utilities, especially public utilities, are prone to political interference and political problems.[33] The private sector, which tends to be more resourceful, will have more room for creativity and innovation, and may be better able to navigate political interference.[34] On the other hand, a community-led model, if backed by good results-oriented leadership, a participative community, and working social and decision-making structures, has better chances of providing electricity to an area than a utility-led model.[35]

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30 USAIDa. Mini-Grids Support Toolkit. https://www.usaid.gov/energy/mini-grids.

31 Ibid.

32 Alliance for Rural Electrification. 2014. *Hybrid Mini-grids for Rural Electrification: Lessons Learned*. Brussels. https://www.ruralelec.org/sites/default/files/hybrid_mini-grids_for_rural_electrification_2014.pdf.

33 Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

34 Footnote 34.

35 Footnote 35.

If a country has a mini-grid energy development plan and strategy, as well as supportive policies and simple licensing procedures, a private sector-led business model would thrive well. If the mini-grids are part of the national electrification strategy, a utility-led business model would be practical given eventual connection to the main grid.[36] But this decision would depend on how long and far out the eventual grid connection of a location or community lies.

Demand. The most important question is for whom the mini-grid is being built. In rural, remote, and isolated areas, most often, demand for electricity is low. Community-led business models, such as cooperatives, are the usual proponents. Communities that have a semblance of organizational structure and are led by an influential, visionary, and systematic leader are likely to succeed in establishing a community-led mini-grid. For locations that are closer to the grid, or have a foreseeable connection to the grid, a utility-led model may be the better option. Utilities may opt to implement cross-subsidization among customers, with grid-connected customers subsidizing the cost of off-grid customers.

Revenue. Revenue generation concerns are more prominent in remote and isolated areas given low demand and limited incomes. Introduction of an anchor customer or customers, and promotion of productive uses of electricity, are the workaround to increase revenue generation. Private sector participation is likely with better revenue prospects. A not-for-profit, community-led business model will also thrive amid low revenue generation but would need large grants and public support. Utilities, however, may pass over the opportunity as they would prefer to focus on their core business, which is grid electrification.

The availability of a subsidy, which would help tide the business over in case of low revenue, will increase the feasibility and success of private sector- and community-led business models. For utilities, mini-grids may not be their core business, but they have the fallback of cross-subsidizing the tariffs with their grid customers when they do undertake mini-grids.

System location and system scale. If the location is close to the grid, or grid connection is anticipated in the foreseeable future, it is best to pursue a utility-led business model. On the other hand, if the location is considerably far from the grid, and the community or the government will give the land to the project developer, the private sector may become interested to invest in the area.

Smaller mini-grids are more often relegated to private sector than utilities.[37] While economies of scope and scale are entrenched in utilities, ingenious rather than traditional approaches are what lead to success in developing mini-grids.[38] The advantage of the private sector lies on the different approaches it may employ: franchise, anchor–business–community, or clustering. In a franchise approach, overhead costs such as management-related could be bundled at the franchiser level, freeing up resources for the franchisees. The anchor–business–community approach leverages on the presence of anchor customers, businesses in the local area, and customers with direct power supply. The clustering approach bundles the operations and management of several nearby but non-interconnected mini-grids to save on overhead, labor, travel, and transport costs.[39] If, however, a mini-grid can neither hook to any business nor connect to a productive use, a community-led model may be the best option.

Operation and maintenance. Efficient operation and maintenance are most often associated with private sector-led model. Rigorous planning, formal structures, and consistent monitoring of performance indicators often characterize private sector-led management. Being profit-oriented, not only would a private organization ensure it has the technical capacity to carry out and sustain its operations, it will also be on the lookout for business opportunities that could go with providing electric power services. It is also likely that

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36 USAIDc. What Ownership Models are Used for Mini-Grids? https://www.usaid.gov/energy/mini-grids/ownership/models/.

37 Africa-European Union Renewable Energy Cooperation Program. 2014. *Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-outs*. Eschborn: European Union Energy Initiative Partnership Dialogue Facility. http://www.euei-pdf.org/sites/default/files/field_publication_file/RECP_MiniGrid_Policy_Toolkit_1pageview_%28pdf%2C_17.6MB%2C_EN_0.pdf.

38 Footnote 34.

39 Footnote 39.

a private sector would have an existing business interest in the area, hence, would have added incentives to make the mini-grid run smoothly.[40]

Financing. A project would be conducive for a private sector-led business model amid readily available financing. This could be in the form of grants from the government and multilateral financial institutions, and microcredit from micro-financial institutions. Community and utility-led business models are the better options in the absence of financing, with the former backed by heavy grants and public support, and the latter with better access to financing.

The Malalison Island Hybrid Solar Photovoltaic Pilot Project

Malalison (known as Mararison in the local language) is a 55-hectare island that is about a 20-minute boat ride from the mainland municipality of Culasi, Antique Province, the Philippines. Its population of about 800 mainly rely on fishing and local tourism as a means of livelihood.[41] The lack of a continuous and reliable power supply has curtailed the island's economic growth and constrained the improvement of people's lives. A 25 kW diesel generator was providing only 4 hours of electricity from 6 p.m. to 10 p.m. daily. Being vulnerable to typhoons and drastic changes in weather conditions, which can disrupt transport and prices of diesel, Malalison has to find an innovative solution that will provide sustainable, reliable, and continuous power to the island.

Technical Solution Adopted

A pilot project using solar PV with an energy storage system was introduced to hybridize the existing diesel generation on the island. The solar hybrid micro-grid power plant consists of a 52-kilowatts-peak (kWp) PV system with a set of 274 kilowatt-hour (kWh) lithium-ion batteries, and 55 kW backup diesel generator.[42] Solar power was selected because of the abundance of sunlight in the Philippines. The capacity was calculated to supply the current and future needs of approximately 800 people or 200 households, and commercial establishments catering to local tourism on the island. The power plant is equipped with an energy management system that would allow for automatic switching to the diesel generation as needed. The system provides real-time data on the operation of the power plant, which can be monitored remotely.

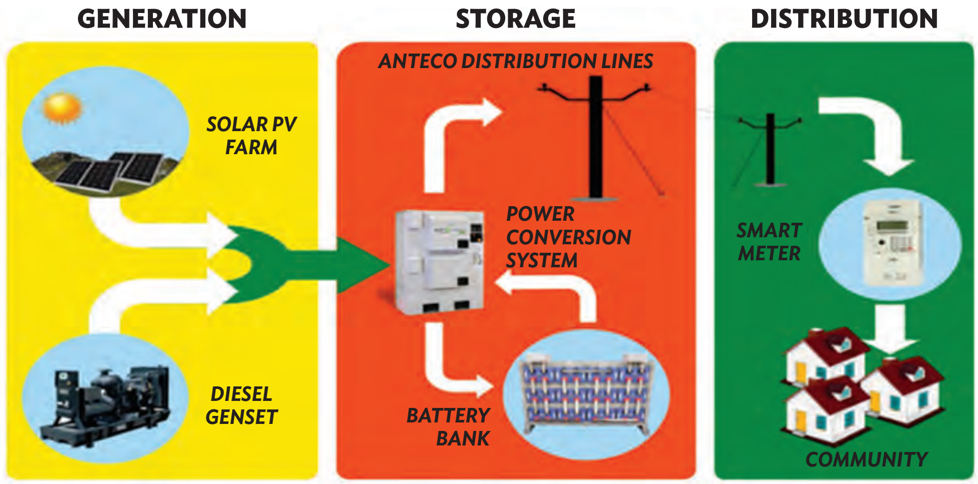
Power is principally generated by the solar PV system, stored in the batteries, and delivered to households using the transmission and distribution lines of the Antique Electric Cooperative (ANTECO), the island's power provider (Figure 5). The diesel generator supplies any shortfall from solar production. This technical solution is expected to: (i) provide reliable round-the-clock power supply using environment-friendly local resources, (ii) allow inclusive access to electricity, and (iii) spur the island's economic development.

[40] Alliance for Rural Electrification. 2014. *Hybrid Mini-grids for Rural Electrification: Lessons Learned. Brussels*. https://www.ruralelec.org/sites/default/files/hybrid_mini-grids_for_rural_electrification_2014.pdf.

[41] As of 2019. Data from Municipal Government of Culasi.

[42] Specifications from AO Power, Inc.

Figure 5: Distributed Renewable Energy System of Malalison Island



PV = photovoltaic.

Source: Case Study Report from AO Power, Inc.

Innovative Business Model

The project's hybrid business model features a public–private–people partnership whose participation and contribution were critical to the success of the project. The public, represented by the local government of Culasi, contributed free use of land and provided local permits and approvals for the project. The private company, One Renewable Enterprise, Inc. (OREEi)—a solar integrator that focuses on on-grid and off-grid installation of rooftop solar systems, and solar pumps for agriculture projects of the government—co-invested capital and performs managerial and technical tasks to ensure the operational integrity and sustainability of the project. The people are represented by ANTECO and the local community. The project proponent ANTECO is a non-stock, nonprofit electric cooperative that is owned by the people (member-consumers), serves the 16 municipalities of the province of Antique, and holds the electric distribution franchise for Malalison Island. ANTECO provided capital and manpower to build, construct, and operate the project. The local community provided logistical support and labor during construction of the project. The active participation of community leaders helped in generating social acceptance and cooperation among the local population. ADB provided a partial grant to get the project off the ground and provided advisory and technical assistance.

Operationally, ANTECO is the sole (100%) offtaker of the power generated by the solar PV hybrid plant and distributed to its member-consumers. To assure affordability, ANTECO adopted a blended tariff setting formula. This blends the cost of power generation and distribution in Malalison with the tariff of ANTECO's franchise, resulting in the same rate for electricity sold on Malalison Island as on the mainland.

The use of a prepaid metering system enhanced the affordability, inclusivity, and sustainability of the pilot project. This allowed 100% connection of all Malalison households, as the prepaid metering system enabled households to monitor and manage their power usage based on what they need and can pay. This prepaid metering system is very useful not only for the households who mostly have no fixed incomes, but also for ANTECO's operational efficiencies. Meter reading, billing, collection, disconnection, and reconnection have been made easier. Bad debts from consumers are averted, and returns on investment are more certain.

A joint venture company, known as ANTECO–OREEi Power, Inc. (AO Power), was initially set up with a 55%–45% ownership stake in favor of ANTECO. ANTECO and OREEi independently raised funds, which they contributed as equity to the joint venture. Initially, AO Power invested in the project (supported with a partial grant from ADB) and owned the solar power plant. The joint venture agreement provided for an exit provision that gave ANTECO the option to buy out OREEi's share of the assets. Today, ANTECO has full ownership of the power plant, while AO Power continues to provide operation and maintenance services to ensure the project's sustainable operation. The total cost of the solar hybrid generating facility, excluding the prepaid metering system, amounted to P22,735,502 million ($421,072), of which ADB contributed $100,000 for the energy storage system. ADB contributed another $100,000 for the prepaid metering system.

A public–private–people partnership is suitable for this project as ANTECO's experience in dealing with regulations is valuable given the nascent institutions and intricate mini-grid development in the Philippines. Demand is low, which is conducive for a community-led model, but productive uses of electricity are existing and promising, which make the project also compatible to use a private sector-led model. The island is far from the grid and unlikely to be connected in the foreseeable future, and the system scale needed is small. All of these scenarios are preconditions of either a community-led business or a private sector-led business model. ANTECO has the government's mandate and the people's trust. Active involvement of the government was evident in its donation of land, and timely issuance of permits and assistance. Financing of the project was through the contributions of ANTECO and OREEi, and a grant from ADB.

Initial Project Outcome

The solar PV hybrid power plant was commissioned in January 2019. It improved the electricity service provided to the community of 200 households from 4 hours per day to round-the-clock. Since Filipinos are familiar with the use of a prepaid system—most are already using prepared mobile phone services for communication—the residents easily adapted to the prepaid metering system of their electricity service provider and appreciated the ability to monitor their usage.

AO Power reported that the power plant was able to achieve the designed solar penetration of 80% (full year average) peaking at about 8,000 kWh during the summer months (March–May) and dropping to about 5,000 kWh during the rainy months of July and August (Figure 6). Estimated carbon dioxide emissions avoided for 2019 totaled 77.5 tons, exceeding the target of 73 tons for a 52-kWp system.

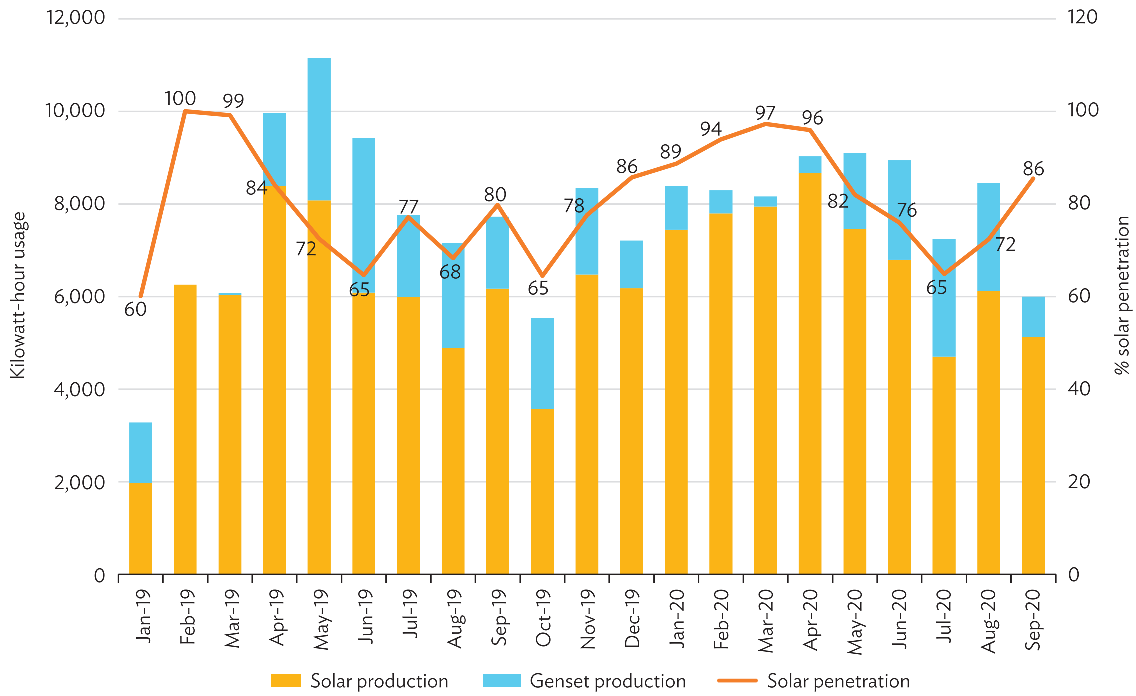
Figure 6 shows that during the first 3 months of operations, the solar power plant was able to supply 100% of the power needs of the residents on a round-the-clock basis. However, starting April, a sharp increase in demand required supplemental supply from the diesel generator. The increase in power demand may be attributed to two factors: the reduction of the tariff from P30.15/kWh ($0.60) to P10.65/kWh ($0.21) (Lim 2019), and the inclusion of households that were previously not connected to the diesel mini-grid. Other than dips in solar production, particularly in October 2019 and July 2020 mainly due to parts that had to be replaced from the Republic of Korea, the power plant has operated reliably with relatively high solar ratios.

In terms of consumer usage, users with low (1–30 kWh per month) and medium (and 31–50 kWh per month) consumption had a low degree of variability month on month, while users with average consumption of >51 kWh had a greater degree of variability and drove total consumption (Figure 7). The current demand level was not significantly affected by the COVID-19 lockdown. Consumers continue to purchase load regularly and manage their consumption according to their needs and budget. It is also noteworthy that after just the first year of operations, the average blended consumption per user reached 37 kWh per month, or 125% of the 30 kWh per month demand projected by year 3.

Low usage consumers make up 54% of the base but consume only 16% of total power demand. The drivers of demand are the high usage consumers who comprise 26% of the base but consume 65% of power.[43]

[43] AO Power, Inc monitors the data presented on this section on Initial Project Outcome.

Figure 6: Malalison Island Energy Production



Source: AO Power, Inc.

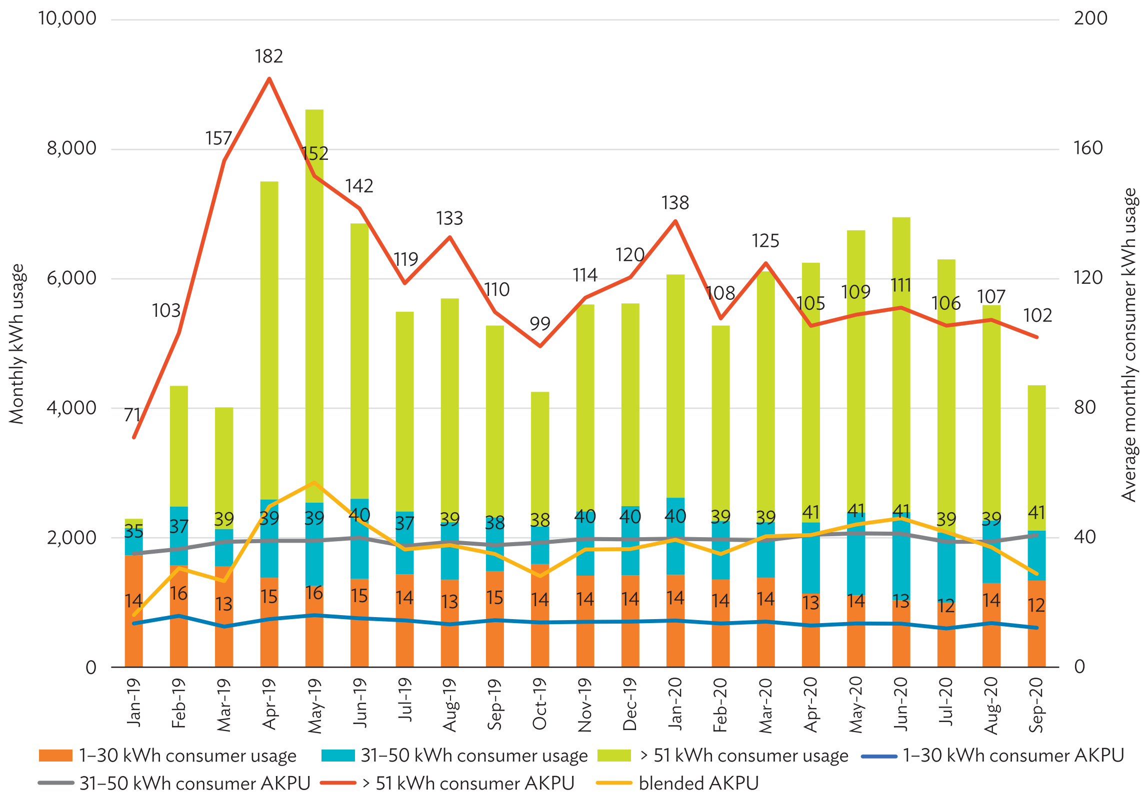
These are residents who have purchased appliances such as refrigerators, freezers, and air conditioners to support their homestay businesses and small convenience stores. With refrigerators and freezers, ice is now being produced on the island and fishermen have the choice of either selling their catch right away or preserving them for better prices.

Lessons Learned

The project successfully provided reliable, affordable, and modern energy access to all residents of Malalison Island, improved the sustainability of their energy source, and raised the living standards, especially of women and children. The people of Malalison benefited from the: (i) provision of round-the-clock electricity; (ii) reduction in tariff, which improved affordability, and use of prepaid metering system, which allowed marginal households to access electricity; (iii) availability and reliability of power supply resulting in enhanced economic development (particularly in the case of the tourism and fishing industries), and additional income generating and productive use applications (such as ice making and food processing); and (iv) improved living standards, especially for women and children. For example, the acquisition of electrical appliances, such as rice cookers, reduces the burden for women, and round-the-clock availability of electricity enables children to study at night without exposure to pollutive gases from kerosene lamps. Effectively, the project achieved its objectives, which were to provide reliable, round-the-clock, and inclusive energy access; improve the sustainability of the island's energy source with the use of solar PVs; and enhance economic development on the island.

The public–private–people partnership built among stakeholders was key to the successful implementation of the project and increased the chances of long-term success that can be replicated in other off-grid areas. Partnership between the electric cooperative and private sector contributed to the long-term sustainability of the project. The reliable local presence of the electric cooperative with its mandate to provide power to residents ensured long-term engagement and trust while the private sector was able to provide both the necessary financing as well as the management and technical expertise for

Figure 7: Malalison Island Usage Trends



AKPU = average kilowatt-hour per user, kWh = kilowatt-hour.

Source: AO Power, Inc.

the project's operation. The people's involvement from the start of the project went a long way in earning trust and generating acceptance and cooperation for the project. The early involvement of local government officials allowed the project to benefit from the free use of land, and timely approvals of permits and the accomplishment of other local regulatory requirements.

Involvement of players from the public and private sectors, and the people, ensured that all aspects of the project were covered. Of particular importance was the early involvement of the people, which nurtured local ownership and hinted at the long-term success of the project. Opportunities for replicating a public–private–people run DRES are vast as the Asia and Pacific region struggles with the last mile electrification of isolated and remote rural areas. In the Philippines alone, the National Electrification Administration has identified about 1,700 islands that are still either unserved or underserved.[44]

The project showed that grant support from ADB can help in catalyzing private sector financing in remote and isolated areas. The ADB grant, as well as ADB technical assistance and lessons learned from previous pilot projects, assisted in getting the Malalison hybrid solar PV mini-grid project off the ground, which to date has good progress and is reaping the benefits of cleaner and reliable electricity access for all. The grant helped in catalyzing private sector investment, which is scarce in remote locations with low market demand. Well-crafted incentives and enabling support for islands, and mountainous and remote areas, certainly help in attracting investments.

[44] These islands are within the franchise area of the 42-member Association of Isolated Electric Cooperatives (AIEC) and could benefit from the experiences and lessons learned of this pilot project. Encouraged by the success of the Malalison Island project, some investors have already started working with the AIEC to take up these electrification challenges.

Conclusion

No one solution exists in choosing the right business model for a DRES. Several criteria—existing regulations and institutions, current and forecasted demand, revenue prospects, system location and scale, operation and maintenance, and financing availability—presented in this chapter serve to help assess and determine the most compatible business model.

Understanding the off-grid sites and level of electricity services—both current and aspired—is essential for planning and designing a DRES. Available local resources and existing nearby infrastructure could be drawn from geospatial mapping to estimate the potential for off-grid investments. The current level of electricity services available could be measured and assessed using the multitier framework of energy access. The same framework can be used in planning for the desired level of electricity services and determining possible renewable energy technologies.

In planning for a DRES, however, the most important step is to get to know the community or villages, and find the nuances that make them unique, such as the possible presence of champions, sources of livelihood, local traditions and practices, and activities that bind them together. Understanding how the community thinks, and having a sense of their collective pulse, will be the foundation in designing the business model to power a DRES that is suitable for them.

Among the pilot projects ADB conducted to test the viability of DRES in remote and isolated areas, the resources used were hydro, solar, and wind. Technologies that were tested included solar home system, solar PV system, solar PV-diesel hybrid, run-of-river micro-hydropower, and wind–solar hybrid. Meanwhile, business models that were employed included community-led, private-sector-led, and hybrids of community–private and public–private–people partnerships. All of them received grants from ADB.

In ADB's experience, grant support helped catalyze private sector investments, which are scarce in remote and isolated areas with low demand. In the Malalison Island case study, technical and financial assistance from ADB helped in bringing together the local people and government who provided in-kind contributions, an electric cooperative that has the government's mandate and local residents' trust, and a private company that provided technical know-how and additional financing. Early participation of all the stakeholders ensured acceptance and ownership of the project, important for a DRES longevity.

Contributing to the financial viability of DRES is the use of digital and mobile technologies. Prepaid metering enables newly connected households to monitor their balance and consumption, and adjust their electricity use accordingly. Prospects for incorporating more information and digital technology into a DRES could enhance remote monitoring to assist with operation and maintenance.

Energy access through DRES has resulted in improved living standards. Access to more electric appliances, such as refrigerators and rice cookers, allows households to store food, enhances food safety, and even opens the opportunity of starting small-scale food businesses. This access mostly benefits women, who bear most of the burden of household management. Children meanwhile benefit from improved electricity access as they are able to study comfortably through the evening, and access more information and communicate through computers, mobile phones, radio, and televisions. Healthcare services are improved with round-the-clock electricity that allows cooling and storage of medicines, performance of medical procedures any time of the day, and with the aid of electric-powered medical equipment. Other livelihoods where greater level of electricity access has helped people prosper include tourism, fishing, lodging, food processing, and handicrafts.

DRES play a vital role in reaching out to remote and isolated areas to realize the last mile electrification. Availability of more affordable, reliable, and sustainable electricity supply helps with social and economic developments. Grants may be necessary for certain remote and isolated areas to get a DRES off the ground, and where private sector involvement is not feasible, the business model would have to cover the operation and maintenance of the DRES at the least. As ADB experience shows, DRES are a powerful tool for achieving inclusive low-carbon development and energy security.

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9 Clean Energy Investment Policies in the People's Republic of China

Lingshui Mo

Introduction

Clean energy investment in the People's Republic of China (PRC) grew rapidly by an average annual rate of 44% from 2005 to 2019, contributing to about 24% of global clean energy investment by 2019.[1]

This surge in clean energy investments contributed to the country's increase in renewable energy capacity, which as of 2019 reached 771 gigawatts (GW), with an average annual addition of 44 GW since 2005. The PRC now has the largest installed capacity of both wind power and solar power in the world, accounting for 34% and 35%, respectively, in 2019.[2]

In 2019, the PRC generated about 1,994 terawatt-hours (TWh), accounting for 27.5% of the total power generation, with an addition of 16.1% from 2005. Not including hydropower generation, renewable energy's share in the PRC's power generation mix increased by 10.1 % from 2005. The country has also made significant achievements in energy efficiency since 2000 using 20% less energy in 2018 against the business-as-usual scenario, avoiding greenhouse gas (GHG) emissions of nearly 2.1 gigatonnes carbon dioxide equivalent (Gt CO_2e).[3] The PRC is also a global leader in the renewable energy equipment manufacturing industry.

This chapter elaborates on the PRC's clean energy policies and measures over the last decade and its impacts on investment, shares experience and lessons in building an enabling policy environment for driving clean energy investment, and recommends how to meet the challenges to carbon neutrality.

Through six main sections, this chapter will discuss the government-led policy model that characterized the policies implemented before 2016 and the market-driven model under New Normal Era (from 2016), and assess the performance of clean energy policies and its impact on investment, lessons learned, and how to meet the challenges to carbon neutrality. The last section concludes.

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Clean Energy Policy Before 2016: Government-Push Model

Before 2016, clean energy development relied heavily on government push. The objectives of policies were to overcome key barriers to clean energy and create market demand.

Renewable Energy Policy Framework

The systematic renewable energy policy framework had not been established until the Renewable Energy Law was put in place in January 2006. The Renewable Energy Law mandated formulating supporting policies to address the key barriers to renewable energy development.

Renewable Energy Law and Regulation Renewable Energy Law

Renewable energy was raised as a solution to address growing challenges in energy security and environment pollution, climate change since the 11th Five-Year Plan (2006–2010). The PRC promogulated the Renewable Energy Law in 2006 (revised in 2009) to promise large-scale renewable energy development.

The Renewable Energy Law lays a legal foundation on the role of renewable energy and the renewable energy policy framework. The law confirms renewable energy as an energy strategy to ensure energy security and sustainable development. The Renewable Energy Law mandates establishing a systematic renewable energy policy framework, including a renewable energy target system and renewable energy planning, renewable energy manufacturing industry, and renewable energy production and utilization; a mandatory grid-connection system; a categorized electricity price regime and subsidy mechanism; a cost-sharing system; and economic incentives including tax credits, concessional loan, and a special fund. In 2009, the amended Renewable Energy Law included provisions of a "guarantee mechanism for purchasing of the full amount of renewable power" and establishing a "renewable energy development fund."

Regulation on Renewable Energy Electricity Price and Source of Subsidy

To address cost and incentivize investment in renewable energy, a specific regulation attached to the law was promulgated in 2006 to detail the methods for pricing electricity, cost sharing, and subsidy source for renewable energy. The renewable energy on-grid tariffs were determined through two methods: government-guided pricing through competitive tendering (auction mechanism), and government-fixed pricing (feed-in-tariff [FiT]).

The government-guided price is set by a public tendering and is applicable to wind power projects and biomass projects that its investors and/or developers determined through tendering. Government-fixed pricing was a FiT regime used for biomass power, solar power, and other renewable energy power projects. FiT was determined based on the principle of cost-plus reasonable profits of renewable energy projects.

The tariff of renewable energy power above the benchmark on-grid tariff of local desulfurization coal-fired generators shall be burdened by the provincial and the state power grid companies. The government levies a surcharge on the use of electricity and raised funding is used as subsidy to renewable energy power tariff.

Development Plan and Targets of Renewable Energy

The government promulgated the Renewable Energy Mid- and Long-Term Development Plan (2006–2020) that serves as the development roadmap for renewable energy. This plan targeted to achieve 15% renewable energy share in total energy consumption by 2020. It underscored to push domestic renewable energy technologies and manufacturing industry through the construction of renewable energy projects at scale.

The 5-year renewable energy development plan is formulated to implement the Renewable Energy Mid- and Long-Term Development Plan. The 5-year plan outlines the targets and key issues to be address, prioritizing technologies for support, and necessary policy and measures to achieve the targets.

Table 1 provides an overview of targets in the 5-year plan for renewable energy development from 2006 to 2020.

Table 1: Renewable Energy Targets in the 5-Year Plan

Plan	Goal	Target for Specific Renewable Energy Technology
11th Five-Year Plan for Renewable Energy Development (2006–2010)	**By 2010:** • 10% share in energy consumption • Provide electricity access for 11.5 million people • Initially establish a renewable energy technology innovation system and achieve locally manufactured renewable energy equipment.	**By 2010:** • Hydropower: 190 gigawatts (GW) • On-grid wind power: 10 GW • Solar photovoltaic (PV): 0.1 GW • Biomass power: 5.5 GW
12th Five-Year Plan for Renewable Energy Development (2011–2015)	**By 2015:** • 11.4% non-fossil fuels share in energy consumption	**By 2015:** • Hydropower: 260 GW • Pumped hydro: 30 GW • Onshore wind power: 100 GW, offshore wind 5 GW • Solar PV: 21 GW • CSP: 1 GW • Biomass: 13 GW
13th Five-Year Plan for Renewable Energy Development (2016–2020)	**By 2020:** • More than 31% non-fossil fuels share of the total power generation • 39% non-fossil fuels share of total installed capacity • 15% non-fossil fuels share of total energy consumption	**By 2020** • Hydropower: 340 GW • Pumped hydro: 40 GW • On-grid wind: 210 GW, including offshore wind 10 GW • Solar PV: 105 GW • Concentrated Solar PV(CSP): 5 GW • Biomass: 15 GW
Energy Strategy for Energy Production and Consumption Revolution (2016–2030)	**By 2030:** • 20% non-fossil fuels share in energy consumption • New addition of energy consumption to be met by clean energy	

Source: China National Energy Administration.

The first renewable energy five-year plan, the 11th Five-Year Plan (2006–2010) for Renewable Energy Development, aims to achieve 10% of non-fossil fuels share in total energy consumption. Hydropower, solar thermal utilization, biogas, and other renewable energy with mature technology and market competitiveness were taken as development priorities.

In the Copenhagen Climate Summit, the PRC was committed to reduce its carbon dioxide (CO_2) emissions per unit gross domestic product (GDP) by 40%–45% in 2020 compared to 2005 and 15% of non-fossil fuels energy share in total energy consumption. Renewable energy was as a major measure to address climate change in the 12th Five-Year Plan (2011–2015) for renewable energy development. Main tasks were to speed up expansion to significantly increase the renewable energy proportion in energy consumption and establish a competitive renewable energy industry. Renewable energy targets were very ambitious in this period, with total installed renewable energy capacity of 430 GW (Table 1), two times of that in the 11th Five-Year Plan. Wind power expansion was the priority, and its installed capacity represented the most addition.

During the 13th Five-Year Plan period, non-fossil fuels share in total energy consumption was raised to 20%, with total renewable energy installed capacity of 725 GW. Renewable energy development priority shifted to solar and offshore wind. Of which, solar installed capacity showed the most ambitious expansion in this period, with an addition of 105 GW against the 12th Five-Year Plan.

Subsidizing On-Grid Tariff

Providing subsidy to renewable energy on-grid tariff has been a major policy instrument to promote investment in renewable energy. The PRC adopted a concession bidding scheme (CBS) to determine the subsidy level to renewable energy tariff rate before starting with the FiT policy.

Concession Bidding Scheme

The CBS was used to determine subsidizing tariff under the government-guided price. Under the CBS, the selecting investors and developers of renewable energy projects and on-grid tariff were determined through a competitive bidding process. Price played a decisive role in determining successful bidders. The successful bidders enter a long-term power purchase agreement for power sales. A subsidized price was offered for the first 30,000 hours and a market price for the rest hours of operation period. Seventy percent local content of equipment was required for concessional bidding projects. CBS served as basis for setting reasonable FiT level of the next step and promoted the domestic power equipment manufacturing industry.

The CBS was first applied to determine the tariffs of wind power in 2003. Between 2003 and 2007, the National Development and Reform Commission (NDRC) initiated five rounds of concession bids for wind power projects. The CBS for solar PV started in 2009 and ended in 2010 as the categorized FiT policy was applicable to solar PV from 2011.

Categorizing Feed-in Tariffs

Categorizing FiTs were set for each individual source of renewable energy power from 2006. It is set based on following factors:

(i) Cost performance of different renewable energy technologies.
(ii) Geographic location.
(iii) Availability of renewable energy resources.
(iv) The FiTs declined over time to reflect renewable energy cost reduction.

In 2009, the government shifted the CBS to a categorized FiT policy for new onshore wind projects. Wind tariffs are composed of four categories based on wind resources endowment. Table 2 shows six adjustments to the categorized FiTs since 2009 to reflect declining wind power cost. As for 2020, the FiTs declined by about 41% compared to 2009. The FiTs were adopted for offshore wind power projects from 2015.

Table 2: Changes in Categorized Feed-in Tariffs for Wind Power Projects

Year	Onshore Wind Power				Offshore Wind Power	
	Category I (yuan/kWh)	Category II (yuan/kWh)	Category III (yuan/kWh)	Category IV (yuan/kWh)	Offshore wind power (yuan/kWh)	Intertidal wind power (yuan/kWh)
2009–2014	0.51	0.54	0.58	0.61		
2015	0.49	0.53	0.56	0.61	0.85	0.75
2016–2017	0.47	0.50	0.54	0.60	0.85	0.75
2018	0.44	0.47	0.51	0.58	0.85	0.75
2019	0.34	0.39	0.43	0.52	0.85	0.75
2020	0.29	0.34	0.38	0.47	0.85	0.75

kWh = kilowatt-hour
Source: National Development and Reform Commission.

FiT was standardized for solar PV projects in 2011. The standardized FiTs were offered to the solar PV projects a fixed FiT for 20 years, starting from projects' operation. From 2013, the standardized FiT was replaced by a categorized FiT policy. Solar PV FiTs are divided into four categories and each category includes two levels of FiTs—FiT for conventional solar PV projects, and a higher FiT for poverty reduction solar PV projects. As expansion of solar PV and declining cost, the government adjusted FiTs of each category every year (Table 3).

Table 3: Changes in Feed-in Tariffs for Solar Photovoltaic Projects and Subsidy for Distributed Solar Photovoltaic

Period	Categorized Benchmark FiTs for Solar Photovoltaic						Subsidy for Distributed Solar Photovoltaic	
	Category I (yuan/kWh)		Category II (yuan/kWh)		Category III (yuan/kWh)		Poverty Reduction Project (yuan/kWh)	Conventional Project (yuan/kWh)
	Conventional Project	Poverty Reduction Project	Conventional Project	Poverty Reduction Project	Conventional Project	Poverty Reduction Project		
Before 1 July 2011	1.15		1.15		1.15			
After 1 July 2011	1.00		1.00		1.00			
2013	0.90		0.95		1.00			0.42
2016	0.80		0.88		0.98			0.42
2017	0.65		0.75		0.85		0.42	0.42
January–May 2018	0.55	0.65	0.65	0.75	0.75	0.85	0.42	0.37
June–December 2018	0.5	0.65	0.6	0.75	0.7	0.85	0.42	0.32
2019	0.4	0.65	0.45	0.75	0.55	0.85	0.42	0.1-0.18

FiT = feed-in tariff, kWh = kilowatt-hour.
Source: National Development and Reform Commission

A fixed subsidy is used for its full power generation of distributed solar PV projects, since 2013, with a gradual decline (Table 3). The higher fixed subsidy is offered to distributed solar PV projects linking to poverty reduction.

Financial Support to Renewable Energy Technology Development

The government provided financial support to the research and development (R&D) of renewable energy technologies and its industrialization, as well as demonstration and application of renewable energy technology in the early stages.

Research and Development of Renewable Energy Technology

Since 2000, the government has consistently been providing financial support to R&D of renewable energy technology through three major government-funded science and technology programs: (i) High-Tech Research and Development Plan (referred to as the 863 Program), (ii) National Key Basic Research and Development Program (referred to as the 973 Program), and (iii) National Science and Technology Research Program (referred to as the Key Research Program). During the 10th Five-Year Plan, the government funding for R&D in renewable energy technology through these three programs amounted to CNY679 million, more than 15% share of total allocated funding for all R&D projects. The 973 Program exceeded 50% of its total funding to R&D of renewable energy technology.[4]

Demonstration and Application of Renewable Energy Technology

Financial support was provided to demonstration projects of renewable energy technologies. In 2000, the PRC implemented the National Bonds Wind Power Program using government-backed bonds to construct four wind power demonstration projects equipping with domestic wind turbines. The upfront investment grants and subsidized interests of the loan were provided to the wind power demonstration projects.

Two national solar PV subsidy programs were initiated to promote deployment of the domestic solar energy technology:

(i) An upfront subsidy for building-integrated PV (BIPV) systems and a 50% subsidy of the bidding price for the supply of critical components are provided to BIPV projects. The subsidy declined to reflect the cost reduction of PV energy. By 2012, the subsidy rate fell to CNY9/watt (W) for BIPV from CNY20/W in 2009, and CNY7.5/W for rooftop systems from CNY15/W in 2009;

(ii) From 2009 to 2011, the Government of the PRC implemented the Golden Sun Demonstration Programme that subsidized 50% of the total cost for on-grid solar PV projects, and 70% of total cost for off-grid solar PV projects located in rural areas.

Renewable Energy Projects to Connect to Power Grid

The subsidy was also provided to transmission lines investment for grid-connection of renewable energy power projects, with CNY0.01/kWh for transmission lines within 50 kilometers (km), CNY0.02/kWh for transmission between 50 km–100 km, and CNY0.03/kWh for transmission lines above 100 km.

Purchase of Full Amount of Renewable Energy Electricity

To ensure that the renewable energy power projects connect to the power grid, in 2007, the government mandated grid companies to sign grid connection agreements with renewable energy power generation companies. These companies obtained permits or government approvals for renewable energy power generation and purchased the full amount of on-grid electricity from renewable energy projects within the coverage of their grids. However, this policy did not assign specific targets to individual power grid companies.

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[4] J. Su et al. 2008. Government Funded Renewable energy technology innovation in China. *Journal China Soft Science* (J) 2008:11. ISSN1002-9753 (2008).

Policies to Promote the Domestic Renewable Energy Manufacturing Industry

The PRC launched the "Ride Wind Program" in 1996 to promote domestically made large-sized wind turbines. The government encouraged foreign enterprise to invest in wind power plants and subsidized 2% of loan interest. China Development Bank (CDB) provided concessional loans to the wind turbine manufacturers. The government prioritized grid connection for wind projects using domestically made equipment. Meanwhile, demonstration projects of wind power were required to use a homemade wind turbine.

Set Local Content Rate of Equipment for Renewable Energy Projects

To promote the localization of renewable energy equipment manufacturing, in 2005, the government set a minimum of 70% for the local content of equipment for newly built wind power plants. The government also mandated large wind power bases to use domestically made wind turbines.

Funding and Financing Policy for Renewable Energy

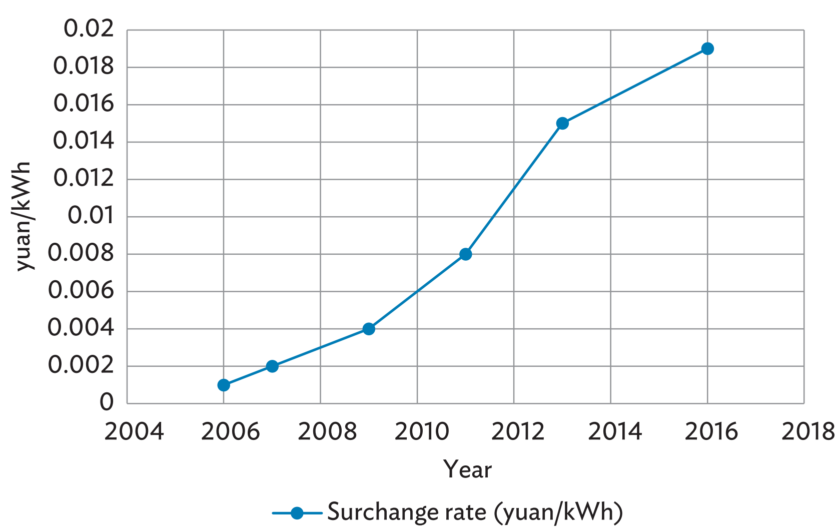
To achieve the objectives of renewable energy policies, the government used public financing tools to support their implementation.

Renewable Energy Development Fund

In 2006, the government set up the Renewable Energy Development Special Fund from the central government budget to support R&D and the application of renewable energy technologies and renewable energy utilization. The special fund provided grant and concession loan to R&D of renewable energy technologies and demonstration projects.

The government has imposed a surcharge on the use of electricity since 2006. This surcharge is used as a tariff subsidy to renewable energy power projects. The electricity surcharge was adjusted 6 times, increasing from CNY0.001/kWh to CNY0.019/kWh following the expansion of demand for subsidies (Figure 1).

Figure 1: Trend of Surcharge Rate



kWh = kilowatt-hour.

Source: National Development and Reform Commission.

In 2011, the government established the Renewable Energy Development Fund in response to the rising demand for subsidy. The fund merges two funding sources: renewable energy special funds (sourced from the national fiscal public budget), and electricity surcharge on electricity consumption. The Ministry of Finance distributes the funding through the renewable energy fund to R&D, demonstration projects, and subsidy to on-grid tariff of renewable energy projects.

National Development Finance Institutions

The PRC uses its national development finance institutions to provide a concessional loan to projects and to the manufacturing industry in renewable energy. CDB, a policy bank, provides low-interest loan and credit lines or credit enhancement to renewable energy projects and enterprises. From 2010–2017, CDB provided cumulative lending of over CNY310 billion to new energy.[5] In 2010, CDB provided $30 billion in low-cost loans to the top five solar PV manufacturers. Solar PV manufacturers are eligible for additional financial support for R&D and for export credits at preferential rates from the Import–Export Bank of China, as well as export guarantees and insurance through the China Export and Credit Insurance Corporation.[6]

Financing Policy

The PRC introduced green finance policies in its 12th Five-Year Plan. In 2012, it launched specific green lending policies including guidelines on green lending, the green lending statistical system, and key evaluation indicators for the implementation of green lending policies. The policies require commercial banks to develop green lending to support green projects and green activities. In late 2015, the government introduced guidelines on the issuance of green bonds and a catalog of projects supported by green bonds. The proceeds of green bonds are dedicated to green investment activities including clean energy.

In 2011, seven pilot emission trading schemes (ETS) were initiated in Shenzhen, Beijing, Tianjin, Shanghai, Chongqing, Guangdong, and Hubei. These pilot ETS cover the power sector, with a total market size of 1.2 billion tons of CO_2 emissions.

The green lending scale increased substantially as green financing policies were being implemented. The green lending of 21 major domestic banks was CNY7.01 trillion, an increase of 44% from June 2013 to 2015. The outstanding balance of green lending in total lending portfolio increased from 8.7%, to 9.7% between 2013 and 2015. In 2014, the China Guangdong Nuclear Power Co., Ltd. issued the first domestic carbon bond. In 2015, Goldwind Technology Co., Ltd. issued $300 million in green bonds overseas through the Bank of China. The Agricultural Bank of China issued $995 million and CNY600 million in dual-currency green bonds in London, and 55% of the proceeds were invested in clean energy.[7]

Energy-Saving Policy Mix

Since 2006, the PRC has adopted four major approaches to push energy saving: adjusting the industrial structure, raising the technological level, implementing comprehensive economic and fiscal measures, and strengthening energy management.

Energy Conservation Law

With increasing energy security and environmental pollution, in 1998, the Energy Conservation Law was released. The law defined resources-saving as one of the PRC's basic national policies and energy development strategy. It emphasized that conservation and development were equally important, and puts conservation as first priority. The law was furthered amended in 2007 and 2016 to strengthen energy-saving

[5] New energy includes renewable energy and nuclear energy.

[6] S. Zhang et al. 2013. Interactions between renewable energy policy and renewable energy industrial policy: A critical analysis of China's policy approach to renewable energies. August 2013. *Energy Policy* 2013:(62). pp. 342–353.

[7] M. Jun, Z. Yueqiu, and Y. Hong. 2016. *Case Studies on China Green Finance Development*. China Financial Publishing House.

in all areas and refine the energy-saving policy framework. The Energy Conservation Law was the basis of an energy-saving policy framework. It covers six aspects:

(i) Establishing a basic energy-saving system: incorporating energy-saving into medium- to long-term plans and the annual plan, and implementing an energy-saving target responsibility system.
(ii) Building up energy-saving supervision and management systems.
(iii) Carrying out energy management in key energy users.
(iv) Establishing the key areas of energy-saving: industry, construction, transportation, and the public sector.
(v) Promoting energy-saving technology and its application.
(vi) Implementing an energy-saving incentive policy.

Energy-Saving Plans and Binding Targets

The PRC formulated a roadmap for energy-saving in 2004—the Medium and Long-term Special Plan for Energy Conservation (2004–2020)—and defined long-term energy-saving goals by 2020. It stressed achieving energy saving by adjusting the industrial structure, technological progress, and advancing the energy management level. The 5-year plan for energy-saving establishes the energy saving targets, priorities, and necessary policies and measures to achieve targets. The first five-year plan—10th Five-Year Plan (2001–2005) for Energy Conservation and Comprehensive Utilization of Resources—set out a target of reducing energy intensity (non-binding target) by 22.5%. The emphasis of energy-saving was in the industry (including energy), buildings sector, and demonstration projects of energy service.

The 11th Five-Year Plan, 12th Five-Year Plan, and 13th Five-Year Plan set the binding targets of reducing GDP energy intensity by 20%, 16%, and 15%, respectively. These binding targets are used as indicators to assess the performance of central and local governments. In addition, the PRC formulated energy-saving plans for the industrial, transport, and building sectors.

Binding energy-saving targets are allocated to 31 provinces and cities. The local governments assign detailed targets to individual enterprises and monitor their progress. The local governments implement the policies to achieve energy-saving targets in the region, conduct mandatory energy audits, and even force companies to improve energy efficiency. The central government supports this action through training and capacity building, financial and economic incentives, etc.

Adjusting Industrial Structure

The PRC has adjusted its industrial sector by controlling the energy-intensive sector's expansion and phasing out inefficient production capacity while developing new and strategic industries with low-energy consumption.

The PRC implemented policies that require the early retirement of inefficient production capacity, substituting them with efficient, modern, large ones (called "large substituting small"). The central government established targets to eliminate inefficient production capacity in the five-year plan. From 2006–2015, entities with 101 GW of small-size coal-fired power generation, 213 million tons of iron, 165 million tons of steel, and 1 billion tons of cement capacities were shut down.

Meanwhile, the PRC cultivates strategic emerging industries. Energy conservation and environmental protection, new energy, new-energy vehicles,[8] generation of new information technology, new-material industries, and the service sector are prioritized as key fields to be promoted.

[8] New energy refers to nonconventional energy and includes non-hydro renewable energy, and nuclear, hydrogen energy. New-energy vehicles include hybrid electric vehicles (HEV); pure electric vehicles (BEV, including solar vehicles); fuel cell electric vehicles (FCEV); and other new-energy vehicles (such as supercapacitors, flywheels and other high-efficiency energy storage) vehicles.

Adjusting industrial structure enables the PRC to shift from the industrial sector with high carbon intensity. In terms of GDP, the service sector overtook the industrial sector in 2013. Such a structural change largely reduced energy use in the PRC. The structural change helped reduce energy use in the PRC by 43% between 2000 and 2017 against a business-as-usual scenario.[9]

Promoting the Use of Energy-Saving Technology

The government has been pushing technological progress by issuing catalogs since 2008 to promote energy-saving technologies and low-carbon technologies. The catalog enables energy users to understand the availability of advanced energy-saving technologies, and energy-saving transformation methods in their sectors. They are able to better select the applicable technology and approach to implementing energy-saving technological modification based on their conditions. The catalog is updated from time to time as technology progresses.

The government also releases a catalog of energy-efficiency star products once a year to promote the use of energy-efficient household electric appliances, and to guide and help shift consumption patterns.

These catalogs play a big role in popularizing advanced and applicable energy-saving technologies and products. It is estimated that use of advanced energy-efficient technologies and equipment and products contributed to about 41.5% of total energy saving in the industry sector during the 12th Five-Year Plan.[10]

Regulatory Policy and Energy Management

The PRC enhances energy management through comprehensive use of energy-saving assessments; energy efficiency standards; and vital energy-saving programs for new projects, productions, and consumption.

Energy-Saving Assessments in New Projects

Since 2010, the PRC adopted an energy-saving assessment system in fixed-asset investment projects. It mandates energy-saving assessments to all new, renovated, or expanded fixed-asset investment projects. The government approves a project's construction based on its assessment report on energy-saving provided by the accredited assessment agencies. The mandatory policy aims to curb the expansion of energy-intensive sectors and ensures the new projects are equipped with energy efficiency technologies and measures.

Adoption of Energy Efficiency Standards and Codes

The government established minimum energy performance standards or codes for appliances, products, equipment, and buildings. These standards and codes stimulate demand for efficient products and equipment, requiring a more significant investment than corresponding inefficient options and increasing awareness in improving energy efficiency.

Since 2012, the PRC launched two phases of the "100 Energy Efficiency Standards Promotion Project." A total of 206 energy efficiency standards and energy consumption limit standards per unit of product were approved and issued, including 98 mandatory standards. Adoption of these standards is expected to save 200 million tonnes of standard coal (tce). In addition, 48 energy efficiency standards for energy-consuming products at the end-use of energy were adopted, which is expected to save 170 billion kWh of electricity. More than 300 national energy efficiency standards are in place.

[9] International Energy Agency (IEA). 2020. *Decomposition of Chinese final energy use, 2000-2017*. Paris: IEA.

[10] Ministry of Industry and Information Technology(MIIT). 2016. *Interpretation II of the Plan for Industrial Green Development (2016-2020): Vigorously promote the improvement of energy efficiency*. 12 August.

Energy-Efficiency Labeling System

Since 2005, the PRC introduced the mandatory energy-efficiency labeling system (EELS) to classify and label products' energy efficiency levels. The EELS was applied to 41 categories of energy-consuming products, including household appliances, office supplies, industrial equipment, lighting equipment, and other fields, involving 15,000 manufacturing enterprises and more than 1.9 million device models of products. The cumulative saving in power exceeded 500 terawatt-hours (TWh).[11] The EELS raised widespread attention to energy saving, and promoted the consumption of energy-saving products.

Government Procurement of Energy-Efficient Products

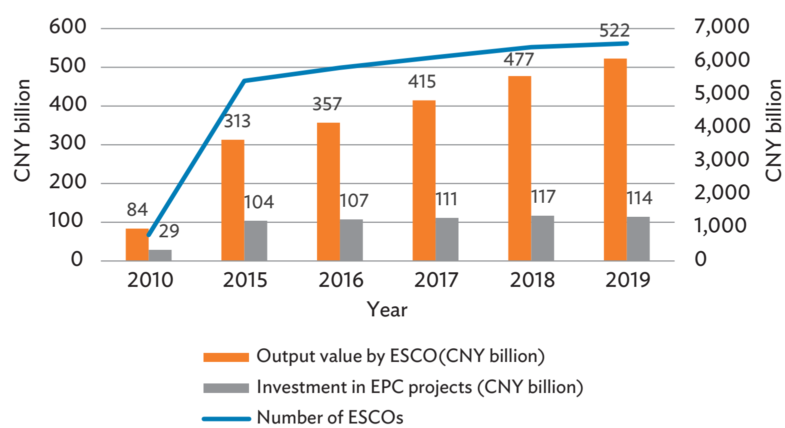
Government agencies take the lead in the use of energy-efficient products. From 2007, the PRC has mandated that all government agencies must purchase energy-saving products. The government releases a list of energy efficiency products in January and July every year to ensure the list meets the latest energy efficiency requirements.

Energy-Saving Performance Contracting

In 2008, the amended Energy Conservation Law included energy-saving performance contracting (EPC) as the market-based model to be promoted. In 2010, the government issued a wide range of policies to support energy-saving service companies (ESCOs) to implement the EPC model. The policies include subsidy to eligible ESCOs to implement EPC projects, of CNY240/tce for energy-saving by the central government and no less than CNY60/tce by the local government. ESCOs are exempted from value-added tax, sales tax, and corporate income tax for the first 3 years of their operation. Income tax is halved for the next 3 years of operation. The government allows the use of ESCO project assets, contracts, and revenues as mortgage

With the strong policy push, ESCOs and investment in EPC projects have been growing fast since 2010. From 2011 to 2015, the number of ESCOs grew by an average of 440%, output value by 465%, and investment in EPC projects by 560% per year.

Figure 2: ESCO Market and Energy-Saving Performance Contracting Investment, 2010–2019



CNY = yuan, ESCO = energy-saving service company, EPC = energy-saving performance contracting.

Source: National Development and Reform Commission, China Energy Conservation Association.

[11] National Development and Reform Commission (NDRC). 2020. *The National Development and Reform Commission and the State Administration for Market Regulation jointly issued the "Notice on the Product Catalogue of the People's Republic of China Implementing Energy Efficiency Labeling (Fifteenth Batch) and Related Implementation Rules*. 27 April.

Various financial instruments including loan, financial leasing, corporate bonds, and initial public offering provided financing to ESCOs exceeding CNY150 billion.[12]

Implementing Key Energy-Saving Projects and Programs

During the 11th and 12th five-year periods, the PRC implemented top energy-saving engineering projects. These are essential engineering measures to improve energy efficiency. During the 11th Five-Year period, about CNY30 billion was allocated to energy-saving projects equipped with energy-saving engineering measures through government budget and special fund, saving around 160 million tce.[13]

The central government signed contracts with the top 1,000 energy-consuming enterprises on energy-saving targets, which accounted for one-third of the PRC's total energy consumption. This program aimed to save 100 million tce by 2010. The contracted enterprises were required to speed up technological renovation and raise energy management level. The central government provided CNY105 billion ($15 billion) during 2007–2009, with additional funds from provincial governments, as incentives for energy efficiency improvement, and technology research and development. By 2010, these top 1,000 enterprises achieved energy savings of 150 million tce, exceeding the target of 100 million tce,[14] and contributing 24% of total national energy-saving during the 11th Five-Year Plan.

During the 12th Five-Year Plan, the government expanded the energy-saving action program to the top 10,000 energy-consuming enterprises. These 10,000 enterprises accounted for 60% of the PRC's total energy use. The program targeted to achieve energy savings of 250 million tce. From 2011 to 2014, the contracted enterprises achieved a cumulative energy saving of 309 million tce, or 121% of the established energy-saving target, and half of national energy-saving during the 12th Five-Year Plan.[15]

Economic and Fiscal Policy

Economic and fiscal policies have become an important part of the energy-saving policy framework during this period.

Financial Incentives

In 2007, the government provided subsidy to eligible energy-saving technological renovation projects with CNY240/tce for verified energy-saving in the Eastern Zone and CNY300/tce for the projects in the Western Zone.

In 2007, the government implemented a program that subsidized energy-efficient products including highly efficient lighting, energy-saving household appliances, energy-saving automobiles, and industrial products for 15 varieties and hundreds of thousands of models. By 2013, the central government has allocated a subsidy of more than CNY40 billion in total to the program.[16]

The implementation of this program built the consumer's energy-saving consumption concepts. In a survey, most respondents (95%) expressed that they would pay attention to the products' energy-saving performance when buying household appliances. Among them, most of the respondents would consider the energy-saving indicators of the products and buy higher energy-saving products.[17]

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[12] NDRC. 2017. *A Review of the development of energy-saving service industry during the Twelfth Five-Year Plan period*. July.

[13] NDRC. 2011. Eleventh Five-Year Review: Top Ten Energy-saving Projects Make Positive Progress. 29 September.

[14] NDRC. 2011. *Top-1000 energy-consuming enterprises have overachieved the energy-saving targets of the Eleventh Five-Year Plan–Review 6 of Eleventh Five-Year Energy Saving and Emission Reduction*. 14 March.

[15] NDRC. 2016. *The energy-saving of 10,000 enterprises exceeded the established energy-saving target of the 12th Five-Year Plan*.

[16] Ministry of Finance. 2013. The Project of Energy-saving Products for Benefits of People achieved remarkable results. July.

[17] Energy-saving subsidies promote the transformation of household appliances consumption to energy-saving products, Journal <Energy-saving and Environmental Protection>, 2013:7, Energy-saving subsidies promote the transformation of household appliances consumption to energy-saving products—<Energy Conservation and Environmental Protection>2013-07 (cnki.com.cn).

A lump-sum subsidy of CNY3,000 per car was provided to consumers buying energy-saving passenger cars with 1.6 liters and below. By July 2013, the central government allocated a total of CNY16.6 billion of subsidy to more than 5.84 million energy-saving vehicles.[18]

The government also provided financial incentives to carry out heat metering and energy-saving renovation of existing buildings and implemented energy-saving and emission reduction projects in the transport sector.

Differentiated Electricity Prices

The PRC applies lower electricity prices to highly efficient enterprises and higher electricity prices to enterprises with more inferior energy efficiency production technology. The "punitive electricity price" is implemented for enterprises whose energy consumption exceeds the prescribed limit.

Funding and Financing Policy for Energy Saving

From 2006 to 2015, the central government spent $73 billion on various energy-saving subsidies to implement energy-saving projects and programs.

The PRC takes advantage of financial policies to support energy-saving activities. In 2007, it issued the first lending policy specifically related to energy saving that requires banks to support energy-saving and emission reduction industries and projects. Simultaneously, they restricted lending to "two highs and one capital" (high-polluting, high energy-consuming, and capital intensive) industries. The lending policy also supports the enterprise to carry out technological renovation through "large substituting small projects."

Since 2004, the government has supported energy-saving enterprises to issue corporate bonds for financing its energy-saving and emission reduction projects. Meanwhile, discounted interest on medium- and short-term loans was provided to enterprises implementing technological upgrading and renovative projects. The government also required policy-based banks to support energy-saving and emission reduction technology R&D, industrialization demonstration and promotion, and energy management.

During 12 Five-Year Plan period, the PRC issued systematic green lending and green bond policies, and initiated pilot ETS to intensify energy-saving financing activities.

Clean Energy Policy in New Normal Era: Giving Full Play to the Market

Since 2012, as the domestic and international development environment changed, and because of issues arising from the implementation of clean energy policies, the PRC begun to adjust its clean energy policy.

Drivers of Changes in Clean Energy Policy

Key drivers of changes in the clean energy policy arise from domestic needs for ecological environment protection, international commitment to address climate change, and economic pressure.

[18] Ministry of Finance. 2013. The Project of Energy-saving Products for Benefits of People achieved remarkable results. July.

Ecological Civilization Construction

The PRC has sustained rapid economic growth over the past 3 decades. It is facing rising resource constraints, and ecological and environment deterioration. In 2012, the Government of the PRC regarded ecological civilization construction as the national development strategy. The 13th Five-Year Plan (2016–2020) underscores the establishment of the concept of green development.

Economic and Energy Sector "New Normal"

Since 2011, the PRC economy has entered into the "New Normal" stage which has the following characteristics:

(i) Economic growth shifts from high-speed to medium to low speed.
(ii) There is oversupply of production capacity in most industrial sectors.

The economic New Normal has a profound impact on the energy system. The energy sector also faces a New Normal: low demand for energy, oversupply of conventional energy, and lack of clean and efficient energy supply. Curtailment of renewable energy power has been intensified as increasing renewable energy installed capacity. The rising renewable energy subsidy increases pressure on the government fiscal budget. The energy sector must undergo profound changes to accommodate the New Normal.

Paris Agreement

In the Paris Agreement, the PRC committed to cut its CO_2 emissions per unit of GDP in 2030 by 60%–65% from the 2005 level, increase the share of non-fossil fuel energy in the primary energy consumption to 20%, achieve peak CO_2 emissions around 2030, and to strive to peak as early as possible. Scaling up renewable energy development and strengthening energy-saving are vital to achieve the PRC's commitment to addressing climate change.

Deepening Market-Oriented Economic Reform

The PRC seeks to deepen economic reform to build a sound economic system, mechanism, or institution for ecological civilization construction and economic growth. The core of this economic reform is to enable the market to play a decisive role in resource allocation, which requires market-based instruments to improve resource allocation efficiency.

Long-Term Goals for Clean Energy Development

The PRC established a roadmap, Strategy for Energy Production and Consumption Revolution (2016–2030), for long-term development of clean energy. It sets long-term clean energy goals, which include the following:

(i) By 2030, capping total energy consumption under 6 billion tce, attaining 20% non-fossil fuel share of total energy consumption, meeting additional energy demand through clean energy, and reducing CO_2 emissions per unit of GDP by 60%–65% against 2005.
(ii) By 2050, stabilizing the total energy consumption and non-fossil fuel energy share to more than half of total energy consumption.

These goals require intensifying energy-saving and scaling up renewable energy.

Changes in Renewable Energy Policy

The curtailment rate of renewable energy power generation became a barrier to its further development. Growing subsidy needs adds a burden to government budget as renewable energy generation expands. The objective of the renewable energy policy is to reduce subsidy and address the curtailment of renewable energy power. Related market-oriented policy instruments were introduced to address issues on electricity tariff, and increase the use of renewable energy.

Reducing Dependence on Subsidy

Tradable Green Electricity Scheme

In 2017, NDRC introduced the Tradable Energy Green Electricity Certificate Scheme (TGEC) to reduce the subsidy on renewable energy. The government issued the green electricity certificate for every megawatt-hour (MWh) of electricity generated by grid-connected non-hydro renewable energy sources. Power generators sell their Green Electricity Certificates (GECs) at negotiated prices between sellers and buyers or through auction, but the traded price shall not be higher than the subsidy level to renewable energy power.

Once the GECs are sold, the subsidy is no longer given to the sold renewable power. The GECs can be sold only once. By trading GECs, renewable power companies obtain income to cover the additional cost of renewable power generation, instead of relying on subsidy.

Unfortunately, given the lack of binding targets for power companies, the outcome of the scheme was unsatisfactory. By 20 September 2020, 30.84 million GECs were issued for wind and solar power, but only 38.9 were purchased.

Grid-Parity Tariff for Grid-Based Wind Power and Solar Photovoltaic Projects

In 2019, the government implemented 250 pilot grid-based wind power and solar PV power projects at a grid parity without subsidy. The pilot projects adopt the local reference tariff of coal-fired power. The power grids must guarantee their grid connection and purchase full power from pilot projects, while signing power purchase agreements with developers and/or investors of pilot projects at local reference tariff for at least 20 years.

The government canceled subsidies to all onshore wind projects from 2021. The government is gradually increasing solar power projects at grid parity, while lowering subsidy to individual solar PV projects.

Competitive Resource Allocation Model

In 2018, a competitive resource allocation model was applied to onshore wind power projects, which used a tendering method to determine projects developers/investors and on-grid tariff. Project plans and technological advancement, project readiness, and bidding on-grid tariff are key factors in selecting the project developer, investor, and project. The on-grid tariff promised by the developers and/or investors shall not be higher than the categorized FiTs for a wind power project in the project area. From 2019, this model was adopted in all onshore and offshore wind projects.

Guarantee Mechanism for Renewable Energy Consumption

In 2019, the government introduced a mechanism for guaranteeing renewable energy consumption called the Renewable Portfolio Standard to address the issue of rising curtailment.

The guarantee mechanism sets the minimum percentage of renewable energy and non-hydro renewable energy power in total energy consumption for each province. Each provincial quota is assigned to two types of market players: power vendors and large power consumers who directly purchase electricity through the wholesale electricity market and from companies with their captive power plants. The power vendors must meet the minimum percentage in total electricity sales. The large power consumers shall meet the minimum percentage in the total purchase of power. For total electricity sales, consumption related to agriculture and heating are exempted from the guarantee mechanism.

The participating market players may have two alternatives to meet their obligations:

(i) Purchase renewable energy power from other market players who have excess renewable power above the minimum renewable energy shares in total annual energy consumption.

(ii) Purchase the equivalent number of GECs to cover the deficit.

Market-Based Hybrid Scheme under the New Deal

Based on the experiment of the above policies, in January 2020, the government formally introduced the market-based hybrid approaches. The key messages of the hybrid scheme include:

(i) The total subsidy scale is determined by the scale of renewable energy development fund.

(ii) For a given annual subsidy amount, subsidized non-hydro renewable energy projects is determined by a competitive tendering, preferentially selecting projects with a low subsidy and advanced technology.

(iii) The subsidy to eligible projects is determined based on a reasonable operating hour of a project to reflect reasonable profit.

(iv) The approved projects voluntarily shifting to grid parity, are prioritized for payment of subsidy and supported for newly added capacity.

(v) The newly approved offshore wind power and solar thermal power projects are no longer subsidized.

(vi) Gradually decrease subsidies to industrial and commercial distributed solar PV projects to promote grid parity.

(vii) Fixed subsidy applies to household distributed PV projects.

(viii) From 1 January 2021, the government fully implements tradable GEC scheme under the renewable energy quota system (Renewable Portfolio Standard). The sales revenue from trading GECs replaces subsidies to renewable energy projects.

The market-based hybrid scheme makes the subsidies decline from CNY8.1 billion in 2019 to CNY5.67 billion in 2020.[19]

[19] Ministry of Finance. 2019. Notice of the Ministry of Finance on Issuing the Subsidy Budget of Renewable Energy Electricity Surcharge Fund 2019 (Caijian [2019] No. 275). 5 June 2019; Ministry of Finance. 2020, Notice of the Ministry of Finance on Issuing the Subsidy Budget of Renewable Energy Electricity Surcharge Fund 2020. (Caijian [2020] No. 208). 17 June 2020.

Building a Power Market

In late 2015, the PRC carried out a market-oriented reform in the power sector to create market-based power pricing mechanism, expand interprovincial and interregional transmission, and improve power planning. The two key components of power system reform relating to clean energy consumption include the following:

Developing a comprehensive power trading market system. This means gradually establishing a forward market and a spot market. The forward market carries out power transactions for medium- and long-term power contracts and ancillary service transactions such as interruptible load and voltage regulation. The spot market is designed for day-ahead, intra-day, and real-time power trading and auxiliary service trading such as reserve and frequency modulation. It also establishes regional and provincial (jurisdiction, municipal) power trading centers. The regional power trading center implements national plans and local government agreements on cross-provincial and cross-regional transmission. The provincial power centers serve as trading platforms for trading medium- and long-term contracting transactions and spot transactions.

Establishing a priority regime for power generation and power dispatching. The PRC seeks to gradually establish a power dispatch system based on an economically optimized merit order dispatch. The system prioritizes dispatching renewable energy power in national plan and renewable energy generation in local government agreements on inter-transmission cross-power grids. The annual prioritized renewable energy power generation plan shall not be lower than the previous year's actual level or the multiyear average level. The prioritized power generation contract can be transferable. Renewable energy power generators are encouraged to participate in power trading across provinces and regions.

The PRC established two regional power trading centers: the Beijing Power Exchange Center, and the Guangzhou Power Exchange Center. Meanwhile, 32 provincial-level power trading centers were established. Eight pilot power spot trading markets started to operate in 2020. The ancillary services markets are piloted in Northeast China and then extended to five other provinces.

The PRC's power transactions (including power generation rights transaction, excluding pumping power, and other special transaction power) increased to 42% of total power generation in 2019 from 19% in 2016. In 2019, cross-provincial and cross-regional power transmission increased above 40% against the 2016 level.[20]

Intensifying Energy-Saving Policies

Dual Binding Targets on Control of Energy Consumption

In the 13th Five-Year Plan, the government implemented "dual control" to maintain total energy consumption under 5 billion tce and reduce energy intensity per unit of GDP by 15% in 2020. Dual control targets are decomposed as binding targets to each province.

The following specific energy-saving targets are set for industrial, transport, and building sectors:

(i) Reduce the energy consumption per unit of industrial value-added by 18%, while striving to peak industrial energy consumption in 2020.

(ii) By 2020, increase the energy efficiency of newly built urban buildings by 20% against the 2015 level, and increase the number of green buildings in urban areas accounting for more than 50% of its newly built buildings, doubling the 2015 level.

(iii) By 2020, increase new-energy vehicles to 5 million.

[20] China Electricity Council (CEC). 2020. China Electricity Council Releases the report on 2019-2020 National Electricity Supply and Demand Situation Analysis and Forecast for 2020. January.

Incorporating Energy-Saving into Development

The PRC formulated a National Energy Conservation Action Plan in the 13th Five-Year Plan. The action plan further intensifies previous energy-saving policies and expands energy-saving into the production and consumption process, enterprises, and individuals, and public and private sectors. The key policies and measures include:

Implementing the Energy Efficiency Top-Runner Scheme

The PRC aims to double the consumption of energy-efficient products and equipment in 2020 against that of the 2015 level. The PRC introduced the Energy Efficiency Top-Runner Scheme on equipment and appliance at end-use from 2015. The government selects voluntarily participating manufacturers and their products, and establishes the higher energy efficiency targets. The government issues the list of products selected for the scheme every year. The scheme is first implemented in household appliances and consumer goods, and then gradually rolled out to energy-intensive industries and public buildings.

Building a Green Manufacturing System

The PRC established the Industrial Green Development Plan (2016–2020) with an overall goal of integrating green development into the entire process of the industrial production. To establish a green manufacturing system, the Green Manufacturing Engineering (2016–2020) was implemented.

The government targeted shaping a basic green manufacturing system by 2020, with building 100 green parks; 1,000 green factories; developing 10,000 green products; creating green supply chains; framing a green manufacturing standard system and evaluation mechanism; and setting up a green manufacturing service platform.

A special fund was set up for promoting green manufacturing projects, and CDB was committed to provide CNY300 billion of financing to establish the green manufacturing system.[21] The CDB provided financing of CNY200 billion to support building green manufacturing system by 2019.[22]

Raising Energy-Saving Standards

The government implemented the Action Plan for Energy-Saving and Green Standardization (2017–2019) to revise energy-saving and green standards, intensify their implementation, and establish an evaluation mechanism for enterprises' compliance with these standards. A total of 715 energy consumption standards were revised or are being revised.

The PRC adopted a technical standard for Nearly Zero Energy Consumption Buildings in 2019. This standard is expected to save 60%–70% of energy for the buildings with nearly zero energy consumption, and 100% of the energy for the buildings with zero energy consumption, compared to the 2016 standard used for buildings.

The PRC implemented the Action Plan for Upgrading and Renovating Coal-fired Power Plants (2014–2020) to achieve the average coal consumption for power supply below 310 grams of standard coal/kWh by 2020. The plan is part of the PRC's strategy to reduce emissions and pollution from coal-fired power generation. In 2019, the average coal consumption for power supply reached 307 grams of standard coal/kWh.[23]

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21 MIIT&CDB . 2019. Notice on Accelerating the Promotion of Industrial Energy Conservation and Green Development. 19 March. The General Office of the Ministry of Industry and Information Technology and the General Office of the China Development Bank Regarding Notice on Accelerating the Promotion of Industrial Energy Conservation and Green Development (miit.gov.cn)

22 MIIT. 2020. *Positive results have been achieved in energy conservation and green development of the industrial and communications industry*. 8 July.

23 China Electricity Council (CEC). 2019. China Electricity Council (CEC). 2019. *Statistics of China Power Industry 2019*. January.

Expanding Coverage of the Key Energy-Saving Program

In the 13th Five-Year Plan, the key energy-saving program is expanded to the top 100 energy consumers; 1,000 energy consumers with a second higher energy consumption level; and 16,000 other critical energy consumers to improve energy efficiency and meet energy-saving targets, with an energy-saving target of 250 million tce.

Enhancing Interaction between Energy Service Companies and Energy Consumers

The PRC aims to double the energy-saving service industry's output value against the 2015 level by 2020. The PRC is implementing the Action Plan for Industrial Energy Conservation Diagnostic Service to facilitate the interaction between energy-saving service companies (ESCOs) and industrial energy consumers in energy-intensive sectors. In 2019, 200 ESCOs proposed more than 7,900 energy-saving retrofit solutions to about 4,000 industrial enterprises, expecting to save 14 million tce and save about CNY11 billion in energy costs.[24]

As of 2019, the number of ESCOs reached 6,547, rising more than seven times against the 2010 level. The output value by ESCOs and investment in energy-saving performance contracting (EPC) projects were CNY522 billion and CNY114 billion in 2019, growing by six times and four times, respectively, compared to 2010. It is estimated that increasing the ESCO market and EPC investment resulted in an energy-saving of 276 million tce from 2011 to 2019.[25]

Introducing More Market-Based Instruments

Narrowing subsidy and a more market-oriented policy are the new directions of energy-saving policies.

Reducing Subsidy for Vehicles

Since 2014, the fiscal subsidy has driven the rapid growth of new-energy vehicles. In 2016, the government scheduled a gradual decline in subsidy to new-energy vehicles. Except for fuel cell vehicle, the subsidy levels for 2017–2018 was reduced by 20%, and in 2019–2020, by 40% from 2016. The subsidy level for 2020–2022 will be reduced by 10%, 20%, and 30%, respectively, from the previous year.

National Emission Trading Scheme

After the pilot of ETS, in 2017, the government launched an operational plan for building a national ETS and began operation from January 2021. The national ETS initially cover 2,225 participants in the power sector only, with total CO_2 emissions of 3.5 billion tCO_2e. It will later roll out to the petrochemical, chemical, building materials, iron and steel, nonferrous metals, papermaking, and aviation sectors. The national ETS currently does not set an overall ETS cap. The emission allowances are allocated to participating generation units for free, based on the sector benchmark and their outputs. Lack of an ETS cap may result in an oversupply of allowances and a low carbon price, which undermines the carbon market's role in promoting clean energy investment and controlling carbon emissions.

Pilots of Energy-Consuming Rights Trading Scheme

In parallel to the national ETS, the energy-consuming rights trading scheme was piloted in Zhejiang, Fujian, Henan, and Sichuan in 2017. Under the scheme, given total energy consumption, energy-consuming allowances are allocated to participating energy consumers. The energy-consuming allowances can be traded. Energy consumers sell extra energy-consuming allowances if they consume energy less than the given allowances. Energy consumers may buy energy-consuming allowances if they consume more energy than the given allowances. Four pilots have launched their schemes and began operation.

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[24] MIIT. 2020. *Positive results have been achieved in energy conservation and green development of the industrial and communications industry*. 8 July.

[25] The energy-savings for 2016, 2017, 2018 were estimated based on the energy-saving for 2019.

Fund and Financing Policy

Financing Policy: Green Finance

In 2016, the government released the Guidelines for Establishing the Green Financial System to promote green finance across the entire financial sector that provides financial services for the projects in environmental protection, energy savings, clean energy, green transportation, and green buildings.

Given the strong policy push, green finance has seen rapid growth. In 2019, green lending reached CNY10.22 trillion, rising by 97% compared to 2013. The issuance of green bonds amounted to CNY339 billion in 2019, compared to almost zero in 2015.[26] The PRC has become the second-largest country issuing green bonds.

National Green Investment Fund

The PRC established the first national green investment fund—the National Green Development Fund in 2020, with a registered capital of CNY88.5 billion. The fund aims to adopt a market-oriented approach to guide social capital to green investment in environmental protection and pollution prevention, ecological restoration, land and space greening, energy resource conservation and utilization, green transportation, and clean energy activities. The fund will invest in green activities in various vehicles including equity investment, project investment, and/or investment management.

Performance of Clean Energy Policy and its Impact on Investment and Financing

Effect of Renewable Energy Policies

Boosting Renewable Energy Investment

Categorizing FiTs has inspired renewable energy investment since 2006. The development of renewable energy—wind power, solar PV, biomass power—has entered the golden period.

Renewable energy-supporting policies triggered more than CNY6,477 billion of clean energy investment from 2006 to 2019, dominated by renewable energy (Figure 3).[27] Investment in renewable energy increased by an average of 30% from 2004 to 2018, surpassing that of the United States in 2009 and Europe in 2013.[28]

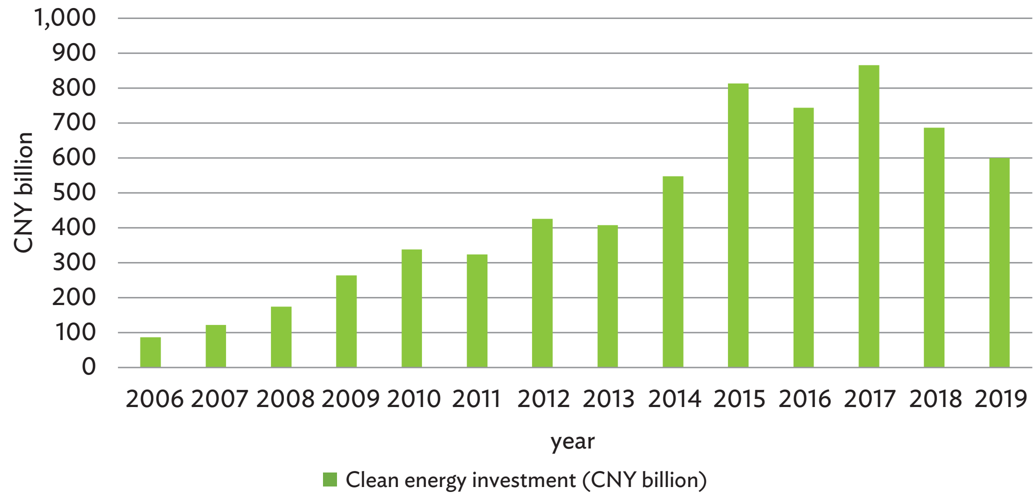
Clean energy dominates energy investment. Figure 4 indicates that the share of clean energy in energy investment has rapidly grown and overtook coal investment in 2014.

[26] Chongyang Institute for Financial Studies of Renmin University of China . 2020. *China Green Finance Development Report*. January, China Financial Publishing.

[27] Under clean energy investment scope defined by BNEF, excluding energy efficiency investment.

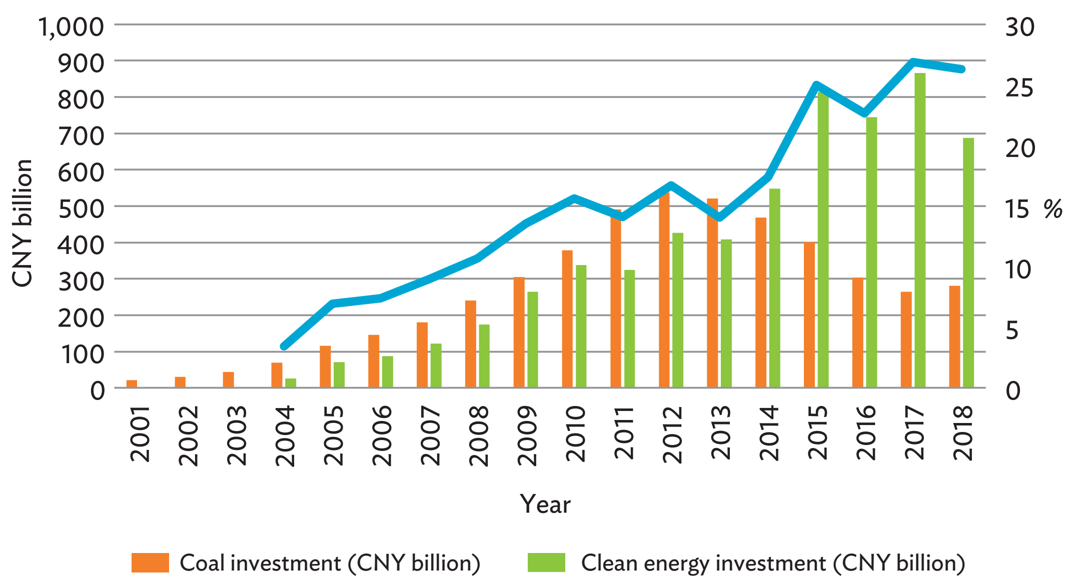
[28] *UNEP, Frankfurt School-UNEP Collaborating Centre/BNEF. 2019. Global Trends in Renewable Energy Investment 2019*. September 2019, GTR_2019.pdf (fs-unep-centre.org).

Figure 3: Clean Energy Investment, 2006–2019



CNY = yuan.
Source: Bloomberg New Energy Finance.

Figure 4: Clean Energy Investment vs. Coal Investment, 2006–2018



CNY = yuan.
Source: National Statistics Bureau and Bloomberg New Energy Finance.

Although clean energy investment slightly declined since 2016 due to renewable energy cost reduction and introduction of grid-parity policy to renewable energy, it did not change the rising renewable energy installed capacity (Figure 5).

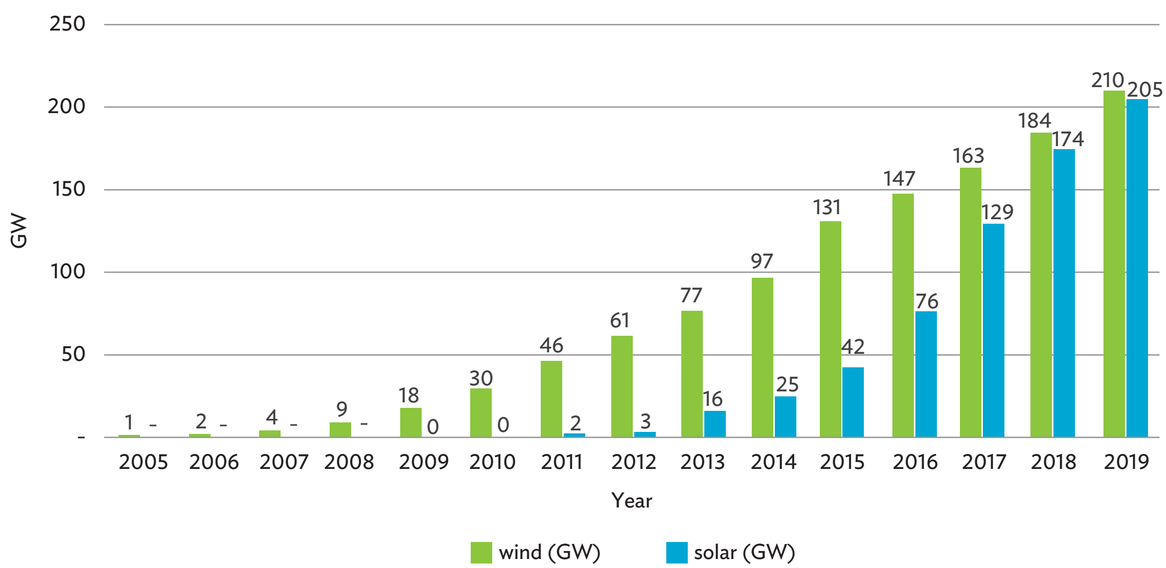
Overachieving Renewable Energy Targets

Rapidly growing investment in renewable energy enables the PRC to overachieve on renewable energy targets on supply and consumption established in its five-year plan.

By 2019, non-fossil fuels accounted for 31% of total power generation, 41% of installed capacity, and 5.3% of total energy consumption, 1 year ahead of the projected targets in the 13th Five-Year Plan (Table 1). The targets include renewable energy share of 27.5% of whole power generation and 38.4% of total installed capacity. Renewable energy installed capacity reached 771 GW in 2019, compared to the target of 725 GW by 2020.

The installed capacity of wind and solar power has seen the fastest growth over the last 10 years (2009–2019) (Figure 5). New additions of wind power installed capacity was 19 GW per year, and newly added solar power installed capacity was 16 GW each year. In 2019, wind generation capacity reached 210 GW, and power generation capacity reached 205 GW, 1 year ahead of projected targets in the 13th Five-Year Plan (Table 1).

Figure 5: Installed Capacity of Wind Power and Solar Power, 2006–2019



GW = gigawatt.

Source: China Electricity Council, Statistics of China Power Industry 2005–2019.

Localizing Power Equipment and Reducing Cost for Renewable Energy

The PRC established R&D for the domestic renewable energy technology and complete equipment manufacturing industry system. This provides a basis of underpinning the development of renewable energy at scale.

The PRC has fully achieved localization of wind power equipment manufacturing and has become a global leader in wind turbine manufacturing. By 2019, there were eight Chinese equipment manufacturers among the top 15 accounting for of wind machine manufacturers in the world, accounting for one-third of the global market.[29] Chinese wind turbines are exported to more than 28 countries and regions.

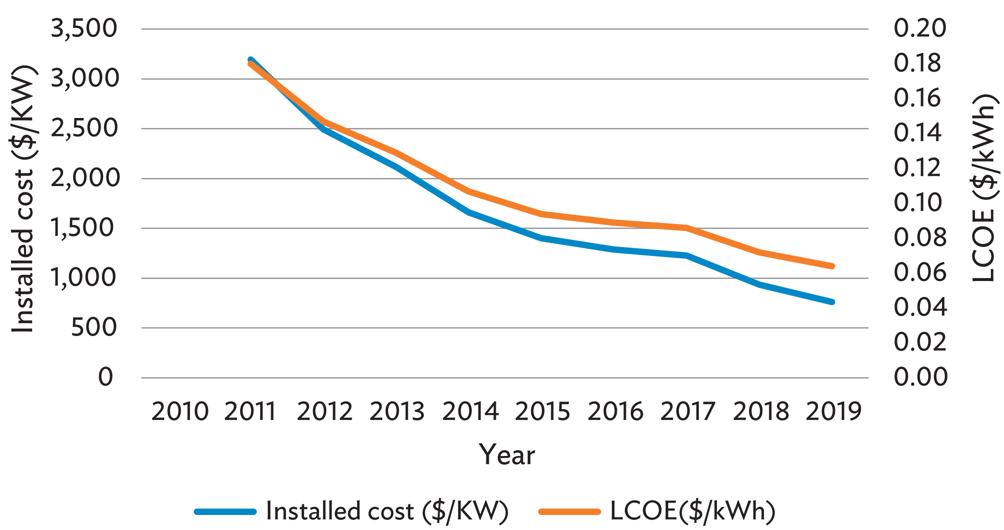
[29] Wind Energy Council. 2020. Global Off-shore Wind Report 2019. 5 August.

The PRC's wind turbine prices fell by 78% compared to the peak of $2480/kW in 1998, to $550/kW in 2019. The PRC has the most competitive weighted average installed costs for onshore wind projects at $1,223/kW in 2019, and levelized cost of electricity (LCOE) at $0.046/kWh.[30] Declining cost markedly improved wind power financial viability.[31]

The PRC has built a complete solar PV manufacturing industry chain that is up to international standards. The PRC accounts for about 40% of global polysilicon output and 71% of global photovoltaic module output. The entire industrial chain and the large-scale market promoted a decline in the price of PV modules by more than 60% during the 12th Five-Year Plan period (2010–2015).

The PRC also has the most competitive installed cost and LCOE for solar PV. Utility-scale solar PV weighted average cost of electricity dropped by 82% from 2010 to 2019. The installed cost and LCOE of electricity for commercial sector solar PV decreased by 76% and 64% from 2011 to 2019, with the lowest installed cost at $760/kW and the LCOE ranking second-lowest at $0.064/kWh (Figure 6).[32] Such significant cost reduction improves solar PV generation's financial viability.

Figure 6: Installed Cost and Levelized Cost of Electricity for Commercial Sector Solar Photovoltaic, 2011–2019



kWh = kilowatt-hour, LCOE = levelized cost of electricity.

Source: International Renewable Energy Agency.

Issues Arising from Renewable Energy Policies

The implementation of the FiT policy scaled up renewable energy projects. However, it also brings about the mounting subsidy. From 2012 to 2019, the subsidy to renewable energy power totaled about CNY450 billion.[33] The difference between subsidy's availability and needs for the subsidy has expanded year by year (Figure 7).

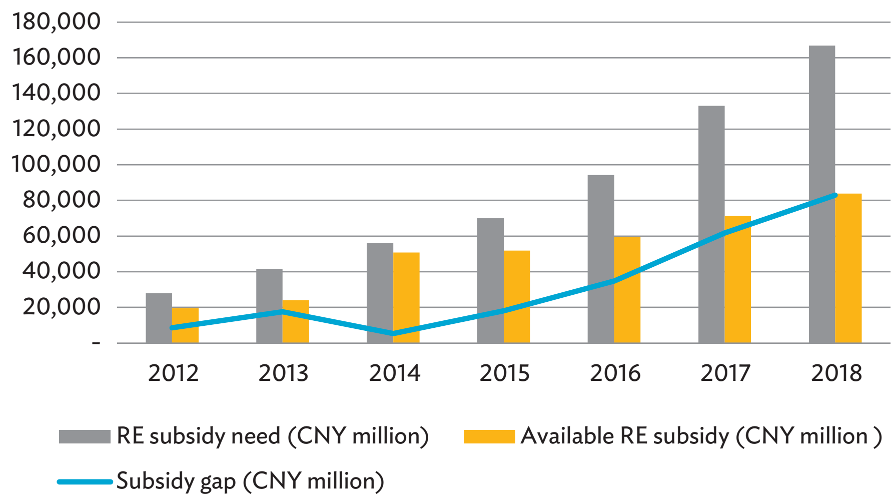
[30] IRENA. 2020. Renewable Power Generation Costs in 2019, International Renewable Energy Agency, Abu Dhabi.

[31] China Renewable Energy Engineering Institute. 2018. *The Achievements for new energy over past 40 years of reform and opening up and the Prospects for future development*. 8 November.

[32] *Ibid.*

[33] Ministry of Finance. 2020. *An Interpretation on Several Opinions on the Healthy Development of Non-hydro Renewable Energy Power Generation*. January.

Figure 7: Demand vs. Available Subsidy for Renewable Energy



CNY = yuan, RE = renewable energy.
Source: Ministry of Finance

Increasing the Curtailment of Renewable Energy Power Generation

Despite the central government implementing a policy of purchase of full amount of renewable energy in 2007, power grid companies did not have individual targets on their purchase of renewable energy power. Its intermittent nature makes power companies reluctant to take renewable energy power.

The power market system does not favor renewable energy power. The PRC's power system consists of six regional clusters (the north, northeast, northwest, central, east, and south regions). Each cluster covers several provinces. There are interconnection lines to facilitate trade within the regional clusters. Six regional grids and the provinces under them have considerable autonomy in dispatch and planning. This creates opportunities for local government's influence on grid operation. The local fiscal incentives generally prioritize and maximize local power production, instead of trade of power. It is estimated that the interprovincial barriers contributed to more than 40% of the total curtailment in the PRC.[34] The variability of renewable energy power interferes with the allocation of load hours and trading practices.

The transmission and dispatch system was designed to accommodate a baseload and a slowly varying coal power output. Renewable energy generators mismatching load center creates difficulty in transporting renewable energy power from generation centers to high consumption areas at the peak time of its generation.

The power transmission and power market structure, system balance lagging the renewable energy production, and the rapid expansion of the renewable energy power production resulted in the curtailment of renewable energy power generation. Wind and solar power curtailment rates had been above 10% until the policy of guaranteeing renewable energy operation hours was implemented in 2017. The curtailment rate

[34] J. Kehua. 2017. Shu Yinbiao: More than 40% of new energy curtailment is caused by inter-provincial barrier. *China Energy News*. 29 September.

of wind power reached 21% in 2016 and 16% in 2017.[35] The curtailment rate of wind in the five northwestern provinces was 33.3% in 2016. The curtailment rate of solar power was 19.8% in 2016 and 11% in 2017.[36]

Effect of Energy-Saving Policy

Sparking Investment in Energy Efficiency

Multipronged policies pulled rapid growth of energy efficiency investment in the PRC. From 2006 to 2015, the cumulative investment in energy efficiency reached CNY2.9 trillion, with the average annual growth rate of 38%. Of which, government funding totaled CNY462 billion and contributed to 16% of the total cumulative energy efficiency investment.[37]

The investment in energy efficiency is estimated at CNY1.682 trillion in the 13th Five-Year Plan.[38] Actual cumulated investment in energy efficiency amounted to CNY1.908 trillion from 2016 to 2019, exceeding predicated investment in energy efficiency in the 13th Five-Year Plan.[39] The average annual investment is CNY477 billion from 2016 to 2019, 66% higher than average annual investment in energy efficiency from 2006 to 2015.

Reducing Energy Intensity of Gross Domestic Product

The rapid growth of energy efficiency investment fueled improvement in energy efficiency and energy-saving. By 2019, the PRC's energy intensity per unit of GDP reduced by 42% compared to 2005 (constant price),[40] saving about 2.1 billion tce of energy.[41] Improving energy efficiency and increasing the use of renewable energy significantly cut carbon intensity by 48.1% against 2005,[42] surpassing the PRC's commitment to reducing its carbon intensity by 40%–45% below 2005 level by 2020.

Economic Growth and Energy Consumption

Energy consumption elasticity has been fluctuating. It sharply decreased from 2005 but bounced back from 2008 until 2011, and sloped between 2011 and 2015, and then bounced back again (Figure 8). The fluctuating trend indicates that the dependence of economic growth on energy-intensive sectors is not disconnected. The adoption of stronger energy-saving policies and measures to cap total energy consumption is essential for the PRC to embark on a low-carbon economic transformation.

[35] National Energy Administration (NEA). 2017. Grid-connected wind power in 2016 (nea.gov.cn); NEA. 2018. 2017 Grid-connected wind power in 2017 (nea.gov.cn), February.

[36] State Grid Corporation of China (SGCC). 2018. White Paper on Promoting the Development of New Energy. 1 April. https://news.solarbe.com/201804/01/285605.html.

[37] China Council for an Energy Efficient Economy (CCEEE). 2019. Energy Efficiency China 2018. January.

[38] IEA (2020), Energy Efficiency Market Report 2016: Energy Efficiency in China (Chinese). Paris: IEA.

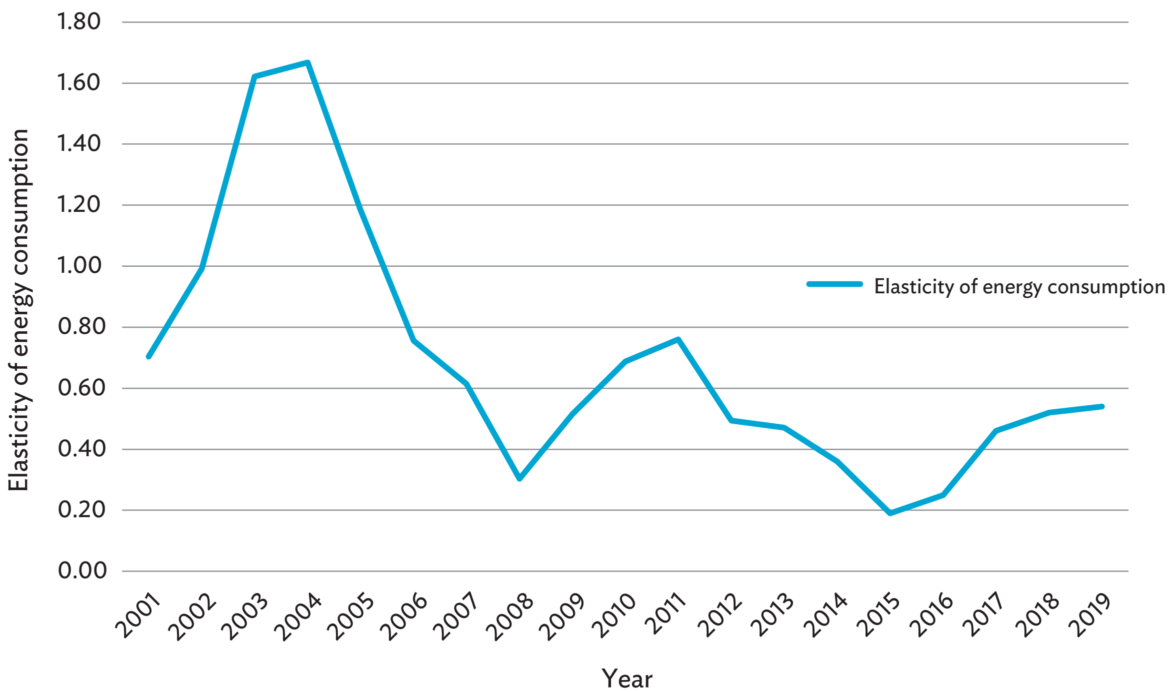
[39] Chongyang Institute for Financial Studies of Renmin University of China. 2020. *China Green Finance Development Report 2020, China Green Finance Development Report 2019, China Green Finance Development Report 2018, China Green Finance Development Report 2017* . China Financial Publishing House.

[40] National Statistics Bureau. National Database. Accessed 15 January 2021.

[41] NDRC. 2011. *Review of Eleventh Five-Year" Energy Conservation and Emission Reduction: Significant Results in Energy Conservation and Emission Reduction*. 11 March; Zhang Yong. 2020. *Improvement of energy efficiency pushes up the high-quality development*. 30 June.

[42] The State Council Information Office. 2020. The State Council Information Office held a press conference on the white paper "China's Energy Development in the New Era" Press Release (www.gov.cn).

Figure 8: Elasticity of Energy Consumption, 2005–2019



Source: National Bureau of Statistics. National Database. Accessed 15 January 2021.

Issues Associated with Energy-Saving Policies

The Effect of Industrial Restructuring

Since 2005, the government has curbed the energy-intensive sectors. However, the effect is not as expected. During the 11th Five-Year Plan, the tertiary industry's added value as a proportion of GDP was lower than the expected target. The proportion of heavy industry in the total industrial output rose from 68.1% to 70.9%. High-energy-consuming and high-emission industries grew too fast. The energy-savings goal was not achieved. The actual reduction of GDP energy intensity was only 19.1%, below the established target of 20%. Two key factors attributed to this unexpected outcome:

First, the phase-out of small and inefficient industrial production capacity neglected to control the overall scale of energy-intensive sectors. For example, the "large substituting small" policy was used in the thermal power sector that encouraged large and highly efficient production capacity. This policy stimulated energy-intensive sector growth and energy consumption.

Second, the stimulus package of CNY4 trillion ($585 billion) in response to the global financial crisis in 2008 stimulated energy-intensive industries. About 38%, of the stimulus package went directly to government-led infrastructure, consequently boosting energy-intensive sectors like iron and steel and cement, causing a sharp increase in energy demand. The stimulus package could result in additional energy consumption of 113 million tonnes of coal over the next 2 years, equivalent to 260 million tonnes of carbon. Around 5% of the package was spent on energy-saving, pollutant emissions reduction, and environmental projects. While this investment expected to save around 19 million tonnes of coal consumption per year, it could not offset additional energy consumption and emission brought by the energy-intensive sectors.[43]

Energy Price Policy vis-a-vis Energy-Saving

Although the central government imposes differentiated electricity prices on high-energy-consuming industries, energy price does not reflect the externality of energy use. Fossil fuels accounted for 84.7 % of the PRC's energy consumption in 2019, with coal accounting for 57.7%. The energy price has not accounted for carbon cost and environmental cost caused by burning fossil fuels.

Growing Green Finance

Since 2012, green finance has advanced in scale and financing product's diversity. First, green finance becomes an important business component of Chinese banks. The PRC's 21 major banks increase their investment in green credit. By 2020, the green credit balance of 21 major banks reached CNY11 trillion from CNY5.2 trillion in 2013. Second, the green bond market rapidly developed. A multi-level bond market consisting of financial and nonfinancial bonds was established to meet the financing needs of investment entities at different levels. The PRC's green bond issuance soared from almost zero before 2016 to 214 labeled green bonds in 2019, with an issuance amount of CNY339.06 billion, ranking second in the world. Third, green financial tools and financing service products are diversified. The number of green funds established in 2017 reached 209, an increase of 72.72% over 2016.[44] The pilot ETS innovated carbon-financing products and service models to meet low-carbon financing needs through carbon bonds, carbon asset management, CCER mortgage, etc. From 2012 to 2020, the cumulated traded volume of allowances amount to 430 million CO_2e in seven pilot ETS markets, with traded value of CNY10 billion.

Increasing green finance provides more clean energy financing and offers diversified financing instruments and products for clean energy. As of end-2019, renewable energy projects accounted for 25% of the green credit balance in 21 major banks, an increase of 5 percentage points from 2013. Among the PRC's labeled green bonds in 2019, 27% of the proceeds went to clean energy, ranking second among sectors. A total of 117 green funds were dedicated to clean energy investment, accounting for 56% of total number of green funds established in 2017 (footnote 44).

However, there is a mismatch between equity financing and debt financing. Ninety-five percent of green finance balance comes from green credits and 2% comes from green bonds. These two green debt financing account for 97% of the total green financing balance. Green equity financing from green securities and green funds accounted for only 3% of green finance.

As the green finance market is expanding rapidly, the inconsistent green finance standards hinder its further development. There are still differences between the PRC's green bond guidelines adopted for green financial bond, corporation bond, and enterprises bonds. The PRC green bond standards are also different from international guidelines. The differences exist not only on the definition of green projects, but also in the requirements for information disclosure of raised funds. Different standards could lead to funding to flow into non-green projects and activities.

[43] World Wildlife Fund. 2010. Climate and Energy Impacts of China's Stimulus Package.

[44] Institute for Financial Studies of Renmin University of China. 2020. *China Green Finance Development Report 2020, China Green Finance Development Report 2019, China Green Finance Development Report 2018, China Green Finance Development Report 2017*. China Financial Publishing House.

Experience and Lessons Learned

Experience

The PRC successfully overachieved on its clean energy goals. The experiences from the PRC's practice include:

Legislations, Planning and Target-Driven

Legislation is the foundation of clean energy policy instruments. The Renewable Energy Law and the Energy Conservation Law confirm their legal status in energy and sustainable development, which raises awareness and attention to renewable energy and energy-saving. The Renewable Energy Law establishes a target system, the mandatory grid connection, the FiTs/subsidy system, the cost-sharing system, and the renewable energy special fund. These mandates form a cornerstone of renewable energy policies to address the key issues relating to the incremental cost of renewable energy, source of subsidy, consumption, and enforcement mechanism. The law empowers policies to drive up renewable energy development on a large scale.

The Energy Conservation Law clarifies the essential energy-saving approaches, key fields of energy-saving, and enforcement mechanism of energy-saving (target system). It underpins a law-based energy-saving policy framework to ensure the policy's formulation and implementation.

The PRC's unique 5-year plans set up the binding, clean energy targets, needed investment, and required policies and measures to achieve the targets. These five-year plans ensure progress to achieve the long-term goals.

Subsidy Incentives and Supporting Financing Policy

Leveraging the Role of Subsidy and Stable Source of Subsidy

The FiT policy enabled renewable energy in the PRC to leapfrog. The subsidies to energy-saving activities incentivize industrial sectors to carry out technological retrofits and equip itself with advanced clean energy technologies. The subsidy is also seen as "seed funds" for energy-saving investment to direct private capital into energy efficiency and emission reduction.

The subsidy played a leveraging role in stimulating the investment in clean energy and mobilizing private capital. From 2006 to 2019, the subsidy to renewable energy through government funding was CNY462 billion, triggering more than CNY6,477 billion in clean energy investment.[45] The leveraging ratio of subsidy is around 1:13. The total subsidies for energy efficiency improvement are about CNY781 billion from 2006 to 2019.[46,47] This sparked a total cumulative energy efficiency investment of about CNY4.8 trillion.[48] The leveraging ratio of the subsidy is about 1:5.

The renewable energy development fund ensures stable sources of subsidy. Electricity surcharge not only raises energy consumers' attention to it but also promotes energy-saving behavior due to increasing power price.

[45] Under the clean energy investment scope defined by BNEF, excluding energy efficiency investment.
[46] Government funding from 2017 to 2019 is estimated based on average proportion of government funding in total energy efficiency investment from 2006 to 2016.
[47] China Council for an Energy Efficient Economy (CCEEE). 2019. Energy Efficiency China 2018. January 2019.
[48] Institute for Financial Studies of Renmin University of China. 2020. *China Green Finance Development Report 2020, China Green Finance Development Report 2019, China Green Finance Development Report 2018, China Green Finance Development Report 2017*. China Financial Publishing House.

Supporting Financing Policies

The PRC mobilizes its financial resources through funding and financial policy to support the implementation of clean energy policy, which ensures the financing needs of clean energy activities.

First, the PRC fully utilizes national policy-based banks to provide low-interest loan to clean energy activities. The policy-based banks assure funding needs and low-cost loans for clean energy activities to implement the national clean energy strategy. Policy-based banks have played a dominant role in financing clean energy projects. By 2016, the CDB has provided financing to more than 57 GW of new energy projects, accounting for 26% of total grid-connected installed capacity of wind power and solar PV nationwide in the same period.[49] In 2019, the green lending of CDB reached CNY2.1 trillion,[50] more than 20% of total green lending amount in the PRC.

Second, the government provides discounts on loans for clean energy projects. This policy reduces commercial banks' lending risks and incentivizes commercial banks to finance clean energy activities.

Third, the PRC implemented supporting financial policy to encourage financing to clean energy. The financial regulatory authority assesses financial institutions' performance by an indicator of reducing lending to inefficient enterprises or projects. This policy restricts the expansion of inefficient production capacity. Meanwhile, the government establishes a green finance system to direct financial resources into green enterprises and projects.

Interaction between Renewable Energy Production and Manufacturing Industry Policies

The PRC renewable energy production and renewable energy manufacturing industry followed a clear development route and complement each other. As a first step, the government provided significant support to R&D of renewable energy technology and implemented renewable energy demonstration projects using domestic renewable energy technology. The second step is to promote equipment localization through a minimum local content requirement for the renewable energy projects. The third step is to industrialize its production. The large scale of renewable energy production creates a market demand for the renewable energy equipment manufacturing industry and reduces costs, which also reduces the needs for subsidy. The interaction of production and manufacturing industry provides benefits for all involved stakeholders while contributes to the global renewable energy cost reduction.

Prioritizing Energy-Saving Actions and Mandatory Policy

Since the 11th Five-Year Plan, the PRC has been implementing key energy-saving engineering measures in energy-intensive sectors. On top of that, the government prioritizes energy-saving actions in top energy consumers of energy-intensive industrial sectors. The government imposes mandatory energy-saving policies on the top energy consumers, while providing them with funding support to implement the key energy-saving engineering measures. Such a carrot-and-stick policy approach improves top energy consumers' energy efficiency and significantly reduces energy consumption, ensuring the achievement of the PRC's energy-saving goals.

The comprehensive mandatory energy-saving policy and requirements for different stakeholders involved are unique and useful to achieve energy-saving goals. The PRC imposes a binding energy-saving target to local government and uses it as an indicator to assess its performance. Energy-saving assessment is required for all new investment projects. The government agencies are required for mandatory procurement of energy-efficient products. Mandatory energy efficiency policies and standards cover about 60% of final energy use, with the highest coverage of 68% in industry. Mandatory policies and measures enable the PRC to raise the energy efficiency level across sectors and reduce GDP energy intensity.

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49 H. Yaohui. 2017. *China Development Bank: Since 2010, a total of 310 billion loans have been issued to the new energy sector, with an average annual credit of over 75 billion yuan.*

50 China Development Bank (CDB). 2020. CDB Report on Sustainable Development 2019.

Lessons

Key lessons from the clean energy policy's implementation include:

Need for a Mandatory Renewable Energy Share System for Renewable Energy Consumption

Before 2016, the PRC required power grid companies to purchase the full amount of renewable energy power. However, there was a lack of a mandatory renewable energy's share system with no monitoring and compliance requirements for power grid companies. The grid companies had no incentive to purchase renewable energy power and caused increasing curtailment. The PRC introduced a guarantee mechanism for renewable energy consumption (RPS) in 2017, that assigns individual targets to power grid companies and top power consumers to ensure renewable energy consumption in their portfolio. As a result, wind curtailment rate fell from a peak of 17% in 2016 to 4% in 2019, while solar curtailment rate fell from 11% in 2015 to 2% in 2019.[51]

The coordination between the generation policy and consumption policy of renewable energy is essential to enhance their effectiveness and sustain development. When adopting FiT policy to incentivize renewable power generation, it also needs to establish a mandatory renewable energy share system (RPS) to ensure renewable energy power consumption matching the power generation.

Keeping Demand for Renewable Energy Expansion within Manageable Reach

The PRC's FiT policy stimulates the influx of investment in renewable energy. But it also brings about rapid market expansion to an unexpected level. The actual installed capacity far exceeds the established targets in the five-year plans.

Table 4: Actual Installed Capacity vs. Renewable Energy Targets in the 5-Year Plans

	11th Five-Year Plan		12th Five-Year Plan		13th Five-Year Plan	
	Target (GW)	Actual capacity (GW)	Target (GW)	Actual capacity (GW)	Target (GW)	Actual capacity by 2019 (GW)
Grid-based Wind	10	31	100	129	210	210
Grid-based Solar	0.3	0.8	21	43	105	163

GW = gigawatt.
Source: National Development Reform Commission.

Excessive market expansion creates dual challenges: increasing the subsidy deficit and rising curtailment rate of wind and solar power. Increasing the subsidy requirement significantly overshoots the government budget. The subsidy could not keep pace with demand. The cumulative subsidy deficit reached CNY327 billion by 2019.[52] The subsidy deficit causes delay of subsidy payment to the investors or developers, which influenced the cashflow and the internal rate of return of projects,[53] and endangered the sustainability of the business of the renewable energy enterprises.[54]

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[51] NEA. 2020. Grid-connected wind power in 2019 (chinapower.com.cn); NEA. 2020. Grid-connected solar power in 2019—National Energy Administration (nea.gov.cn).

[52] Y. Xiong. 2020. New Solutions to Address the Problems of Under-supply of Subsidies to New Energy—<Energy>020:8 (cnki.com.cn).

[53] G. Ge. 2019. "Delay payment of RE Subsidy is affecting private enterprises: In addition to selling power stations, how can new energy companies save themselves?." *The Economic Observer*. 26 August.

[54] J. Yao and L. Li. 2019. "The status of enterprises under long-term delay payment of national renewable energy subsidies exceeding 100 billion yuan." *China Energy News*. 24 December.

The PRC's lesson suggests that the open-end FiT policy speeds up market expansion and may also drive up the annual subsidy to levels beyond what the government expected and what the public budget afforded. The rapid expansion of the renewable energy power could also increase the pressure on the power grid system. It could cause negative outcome if the expansion significantly overshoots politically desired targets.

When supporting the FiT policy, governments need to manage the market expansion within the desired targets to control the explosion of subsidy demand and its consequences. The government could set an annual limit on supported new renewable energy capacity to avoid the subsidy deficit. Market monitoring is needed for timely adjusting subsidy level to preventing from demand exceeding the policy targets. Introduction of trading green electricity certificates scheme under RPS could appropriately share the subsidy burden arising from FiT policy.

Effective Power Market System to Adapt Renewable Energy Characteristics

With the rapidly increasing renewable energy production capacity, the PRC's power market system such as power transmission and dispatch pattern, and power pricing model cannot keep up with renewable energy development's needs. As analyzed in 2.1.9, the power market system that does not adapt to renewable energy development is one of the critical factors to curtail wind and solar power generation in the PRC.

When implementing the policies to promote investment in and power generation of renewable energy, equal attention should be given to building an effective power market system to increase renewable energy power consumption. The PRC's practice suggests that the considerations to be taken care of, among others: promote power transmissions and trading cross regions, establish different types of power markets (spot market and forward market), implement flexible electricity pricing mechanism, and improve a power dispatching regime that favors renewable energy.

Coordination of Policies

The PRC implements a few market-based instruments, including ETS, energy-consuming right trading scheme, and tradable GEC scheme. These schemes have synergic effects on reducing energy consumption and promoting emissions reduction. However, they may overlap on some fundamental elements. For example, both ETS and pilot energy-consuming right trading scheme cover the power sector. They may overlap on participants' coverage and allowance allocation. When the two schemes are implemented in parallel, it could result in multi-head management and dual compliances. Both ETS and GEC involve the same power sector. Emission reduction credits from renewable energy power are traded and used by participants in ETS. The GEC can also be traded and used by participants in the RPS. Simultaneously implementing ETS and GEC could cause the double counting of renewable energy power generation and its emission reductions. The overlap of the schemes reduces the effectiveness of policies.

When the policies with synergic effects are adopted in parallel, coordination is needed to avoid overlaps and its consequences. One solution is to define a specific range of each scheme to avoid covering the same participants. It is possible to consider the exchange and mutual recognition of trading products among the schemes to prevent double counting and double trading. Alternatively, when the schemes cover the same participants, a supplement policy is to give participants an option to participate in only one scheme's compliance and trading.

Meeting the Challenges of Carbon Neutrality

In 2020, the PRC announced successively raising its nationally determined contribution to reduce carbon intensity of GDP by 65% by 2030 compared to 2005, and non-fossil fuel energy would share 25% of primary energy by 2030 and the total installed capacity of wind power and solar power to reach more than 1.2 terawatts to peak carbon dioxide emissions before 2030; and strive to achieve carbon neutrality by 2060.

Carbon emissions peak and carbon neutrality require substantial reductions in energy-related carbon emissions. According to a study by Tsinghua University, to achieve carbon neutrality by 2060, the PRC will need to achieve net zero carbon emissions from the energy system by 2050. In doing that, non-fossil fuel energy will increase to more than 85% of primary energy consumption by 2050 from 15.3% in 2019. Coal consumption will be below 5%. Non-fossil fuel electricity will increase to 90% of total electricity by 2050 from 31% in 2019. Meanwhile total primary energy consumption will need to peak in 2025 and below 5 billion tce in 2050. Power will need to share more than 30% of final energy consumption in 2030, and it will reach more than 70% in 2050.[55]

Challenges to Carbon Neutrality

The challenge of turning the current energy system with 85% of fossil fuels into a zero-carbon energy system is unprecedented in history.

The energy transition speed needs to be tripled. The PRC's fossil fuel energy share is about 84.7% of its primary energy consumption with 57.6% coming from coal in 2019. A zero carbon emission energy system will require the PRC to increase non-fossil fuel energy sources in primary energy consumption by 2 percentage points every year, which is three times the average growth rate from 2005 to 2019. Non-fossil fuel electricity will increase by 1.9 percentage points per year, about two times of growth rate from 2005 to 2019. Undoubtedly, the PRC will face great challenges in the road toward a zero-carbon energy system.

Disconnection between energy consumption and GDP growth. The PRC is experiencing industrialization and rising urbanization. Energy consumption is still on the upward trend as the economy increases. The experience shreds of evidence that only when a country completes its industrialization and urbanization, energy consumption will reach its peak, and stabilize for 20 to 30 years or even longer, and then gradually decline. Achieving carbon neutrality before 2060 means that the PRC needs to complete a three-step process within 30 years, which is a challenge.

Huge investment and financing needs. Achieving carbon neutrality will need more than CNY138 trillion of low-carbon energy investment from 2020 to 2050, with an equivalent 2.5% of annual GDP (footnote 55). The average annual investment will be CNY5,000 billion, more than 10 times of current average annual clean energy and energy-saving investment over 2005 to 2019. Mobilizing financing for meeting huge low-carbon investment needs will be very challenging.

Toward Carbon Neutrality

Meeting the challenges to carbon neutrality, the PRC should carry out systematic carbon neutrality planning and deployment, and address the critical current policy, institutional and mechanism barriers to energy transition, innovating investment, and financing mechanism to accelerate energy transition.

[55] Institute of Climate Change and Sustainable Development, Tsinghua University. 2020. Comprehensive report on "China's long-term low-carbon development strategy and transformation path. *China Population, Resources and Environment* 30(11).

Establish Roadmap and Planning for Carbon Neutrality at Different Levels

First, it needs to establish a national energy development roadmap to carbon neutrality. This serves a top-level design and overall arrangement to guide local and departmental policy makers and investors to establish their strategies and take actions to carbon neutrality. The national roadmap should clarify a long-term zero-carbon goal and strategies, set phased targets and steps to achieve zero-carbon goal, and identify key mitigation technology alternatives and mitigation measures for high-carbon emission sectors.

Second, the five-year plans and investment plans at the national, local, and sector levels should link with both carbon emission peak and carbon neutrality goals. The binding renewable energy consumption targets and energy-saving targets in the five-year plan, mandatory targets for phasing out coal and oil, with policy measures and institutional or mechanism arrangements for the implementation of the plans, should be written into five-year plans to ensure achieving the targets. The binding targets should be decomposed and assigned into local governments and relating individual enterprises.

Address Critical Policy, Institutional, and Mechanism Issues to Energy Transition

Improve renewable energy power consumption guarantee mechanism. The prerequisite for large-scale electrification on the demand side is the used electricity coming from zero-carbon energy. The decarbonization of the power system requires improving the flexibility of the power system to increase renewable energy power consumption. There is an urgent need for taking comprehensive measures and multipronged approach to improve power system flexibility, including:

(i) Remove the barriers to cross-provincial and cross-regional transmission and trading, and increase investment in transmission lines, to help balance RE supply and demand promptly.

(ii) Improve power market operation mechanism favoring renewable energy power characteristics. Speed up the establishment of wholesale power markets for both mid-and long-term contracting trading and spot trading to adapt to renewable energy characteristics.

(iii) Establish dynamic power pricing mechanism to enable demand response and shift demand to match the power supply.

(iv) Establish economic cost-based power dispatching regime.

(v) Facilitate flexibility retrofit in thermal power generation units and equip with energy storage to support power grid flexibility.

Enhance coordination and connection between energy and climate policies. Coordination between energy and climate policies could ensure making progress in carbon reduction. For example, set clear phased targets (e.g., five-year plan target, 2030 target, and 2040 target) in reducing the carbon intensity of electricity to achieve zero carbon emissions by 2050. Establish a coordination and communication mechanism between the energy market and carbon emission trading market. A robust carbon market improves clean energy competitiveness and reduces the subsidy needs, and promotes energy-saving and emission reduction. The determination of energy price (including electricity, coal, oil, and gas prices) should consider reasonable carbon cost. Meanwhile, linking the GEC trading scheme with the energy-consuming right trading scheme and emission trading scheme can enhance the effectiveness of renewable energy, carbon market, and energy-saving policies, and avoid double counting in emission reductions.

Support the R&D of key negative and zero-carbon technologies. Fossil fuel shared more than 80% of energy consumption. In addition to continue pushing for clean energy technology progress to lower clean energy cost, the PRC should prioritize policies and financial support to R&D of alternative energy technologies of fossil fuels (e.g., hydrogen) and zero-carbon technologies, negative-carbon technologies, and promote fossil fuel-consuming sectors to deploy key zero-carbon technologies in production processes to avoid lock-in effects.

Innovating Green Investment and Financing Mechanism

Carbon neutrality will create huge clean energy investment potential. This will require mobilizing diverse financing to meet clean energy investment needs. Moving forward, to support energy system transition, it should address key issues facing green finance.

Establish common green standards and rating method for green investment activities. Defining green attributes and green ratings of investment activities to ensure capital and flow into real green activities. A unified definition and green rating methods are the prerequisites for trading green asset. The green finance standards should be aligned with goals of carbon peak and carbon neutrality. In particular, green finance standards should coordinate with climate investment and financing standards.

Improve carbon market mechanism and develop carbon finance. The national ETS should expand its coverage from power sector to other carbon-intensive sectors, and set the total cap and adopt auction method in the allocation allowances during the 14th Five-Year Plan. Setting a strict ETS cap can control total emissions and support reasonable carbon price. Auctioning allowances can not only impose a cost on carbon emission but can also collect revenue for further carbon mitigation actions. Expanding ETS coverage from power sector to iron and steel, cement, and petrochemical sectors will incentivize energy-saving and structural changes in energy saving sectors and expand carbon market scale.

Develop carbon finance to enhance the ability of carbon market in pooling capital. Carbon assets, either allowances or carbon credits, should be allowed to trade in the form of derivatives to attract more the financial sector and other investors, particularly private investors. Meanwhile, the PRC should improve the current carbon market structure. Only allow trading spot products in national ETS and pilot ETSs limits carbon assets' liquidity. In addition to spot market, the PRC should build a forward market to trade forward and future products to improve the liquidity of carbon assets and attract more private investment in carbon assets.

Improve the incentive mechanism and innovate the green financing products. The current incentive mechanism is directly provided to the clean energy investment and production activities (green finance demand side). Lack of incentives for financial institutions that provide funds to clean energy. Expanding green finance requires the interaction between the supply side and the demand side of financing. Establish a green credit risk compensation mechanism to share clean energy investment risks. Implement differentiated interest rates based on the degree of the greenness of investment activities to direct funds to projects and enterprises with the highest degree of greenness. Financial institutions are given financial incentives, tax reductions and exemptions for their financing of green activities.

Debt financing is the main financial instruments for clean energy financing. The size of other financial instruments suitable for clean energy is very small. Tap the potential of clean energy assets/ green assets in the financing, for example, developing green asset securitization products, green asset-backed bonds, and green income-backed securities and green collected debt products, to provide diverse financing products for different types of and sizes of clean energy projects and companies.

Promote diversified carbon financing products. At this stage, make full use of carbon asset mortgage, carbon bonds, carbon leases, carbon asset securitization, and carbon funds to finance clean energy, and gradually develop carbon financial derivatives such as carbon futures, carbon forwards, and carbon options to provide clean energy with diversified investment and financing products.

Conclusion

The Renewable Energy Law is the basis of the renewable energy policy and a trigger for rapid development of renewable energy in the PRC. The FiT policy sparks rapid expansion of investment in renewable energy while bringing about the risks in high subsidy cost and a challenging power grid system. The design of the FiT policy must take into consideration its potential impacts. The interaction between renewable energy production and the renewable energy manufacturing industry significantly lowered cost and helped expand both renewable energy and manufacturing industries in renewable energy. The power market system needs to be changed to favoring renewable energy characteristics to drive its consumption.

Adjusting the industrial structure, promoting energy-saving technologies, enhancing energy management, and implementing incentive economic and fiscal measures are major energy-saving approaches. Carrying out key energy-saving projects and programs for top energy consumers while equipping them with key energy-saving engineering measures play a significant role in achieving the PRC's energy conservation goals.

To meet the challenges to carbon neutrality, the PRC needs to address critical policy, institutional, and mechanism issues in the energy transition, enhance coordination between energy and climate policies; and innovate green investment and financing mechanisms to satisfy financing needs for the energy transition.

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PART 4

Financing Tomorrow's Clean Energy

10 Mobilizing Private Finance for Low-Carbon Energy Transition

Venkatachalam Anbumozhi

Introduction

Considerable progress has been made by Asia's developing countries toward achieving reliable and affordable energy in the last 3 decades. While many years of rapid economic growth increased power generation across the region, most demand was met by high-carbon fossil fuels. Without radical changes in its energy mix, the global warming greenhouse gas (GHG) emissions from energy use in Asia is estimated to reach an estimated 20 billion tons of carbon equivalent by 2030.[1]

After the successful conclusion of Paris Climate Agreement in 2016, research attention and policy debates shifted to how developing countries will realize their NDCs, the driving force of low-carbon energy transition. The physical infrastructure that supports high-carbon energy economies—power plants, urban transport infrastructure, buildings, individually owned vehicles—often have very long life spans, making a shift to low-carbon challenging.

For fast-growing Asia, which consumes nearly two-thirds of global energy, the required transformation of energy systems comprises three pillars. The first is energy efficiency or reducing the amount of energy required to meet consumer and industrial needs. The second is shifting energy production away from carbon-intensive fossil fuels toward renewable sources such as hydro, solar, wind, geothermal, and biomass. The third pillar is a transformational change to low-carbon sources in high-energy-consuming sectors such as transport, buildings, and manufacturing industry.

The Asian Development Bank (ADB) estimates that annual investment of at least $321 billion is required—$4.8 trillion from 2016 to 2030—in the energy sector alone in developing Asian countries to meet the change in power mix set out in NDCs.[2] The financing needs are enormous, complicated, and, in most of the countries, the required additional funding can only be mobilized through targeted collaboration between the public and private sectors. Nevertheless, the Paris Agreement appears to be having a positive impact on private sector investments. Increasingly, the private sector is looking for ways to invest in low-carbon solutions, because such investments offer competitive risk-return profiles.[3]

The question for policy makers is: to what extent is the private sector and financing community ready for a deep transition to a low-carbon economy? Private financial flows encompass equity market investments, credits, corporate finance, insurance solutions, and many other financial service intermediaries. A concise

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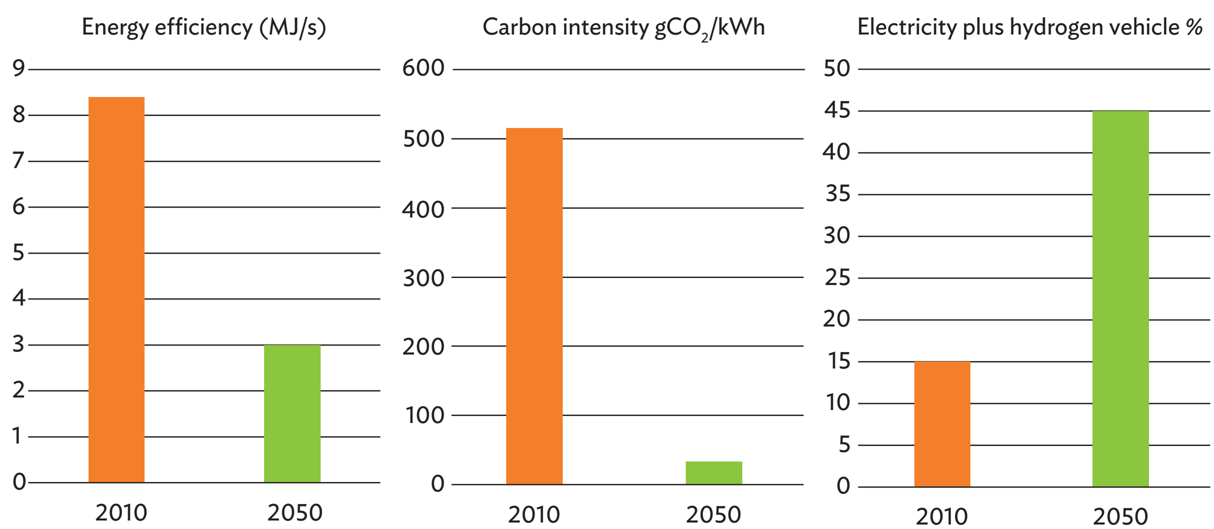
1 International Energy Agency. 2016. Energy and Climate Change. Paris.
2 ADB. 2017. *Meeting Asia's Infrastructure Needs*. Manila. p. 105.
3 M. Fulton and R. Caplino. 2014. *Investing in the Clean Trillion: Closing the Clean Energy Investment Gaps*. Boston: CERES.

overview of such instruments, and an analysis on their effectiveness in Asian developing countries, are missing. This chapter attempts to fill this gap by illustrating existing innovative private financial instruments necessary for a low-carbon transition in Association of Southeast Asian Nations (ASEAN) member countries and East Asia. By presenting recent developments in private financing and two stakeholder surveys, this chapter identifies barriers to upscaling of private investment for a low-carbon energy transition and proposes that regionally coordinated policy solutions could unleash the private financing potential required to support this transition.

The Dynamics of Energy Sector Investments and Financing the Low-Carbon Future

Developing and emerging economies of ASEAN, India and the People's Republic of China (PRC) are estimated to account for most of global low-carbon energy financing requirements in 2050. Over the past 30 years, considerable progress has been made in these countries in achieving universal, reliable, and affordable access to electricity, though supply is still dominated by fossil fuels. Figure 1 shows what the 16 countries of the East Asia Summit (EAS) must achieve in terms of doubling energy efficiency, making drastic changes in electricity production, supply, and consumption, as well as shifting almost completely to zero-emissions vehicles by 2050.[4] Financing this transformation is a daunting challenge without private sector participation, but benefits include meeting countries' NDC targets and United Nations Sustainable Development Goals (SDGs) by 2030.[5]

Figure 1: Transformational Changes Needed in Low-Carbon Energy Pillars



gCO_2 = gram carbon dioxide, kWh=kilowatt-hour, MJ/s = megajoules per second.

Source: Author, based on Energy Outlook and Energy Saving Potential, Economic Research Institute for ASEAN and East Asia (2017).

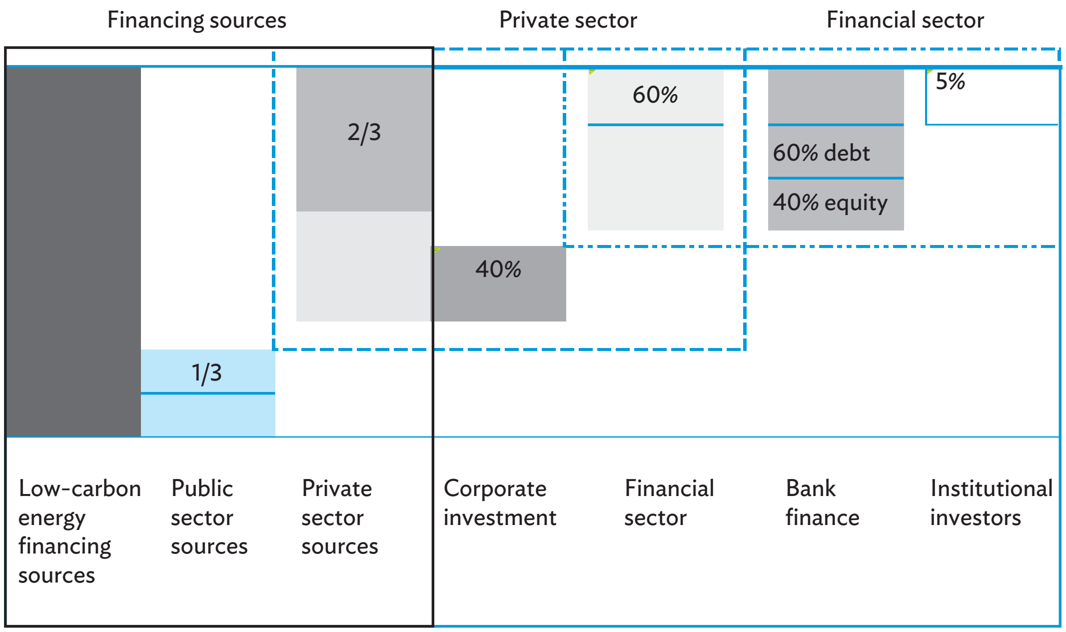
[4] ADB. 2016. *Asian Development Outlook 2016 Update: Meeting the Low-Carbon Growth Challenge*. Manila; Economic Research Institute for ASEAN and East Asia (ERIA). 2017. *Energy Outlook and Energy Saving Potential*. Jakarta.

[5] V. Anbumozhi and X. Yao. 2015. Serendipity of Low Carbon Energy System and the Scope of Regional Cooperation. In V. Anbumozhi, K. Kalirajan, F. Kimura, and X. Yao, eds. *Investing. in Low-Carbon Energy Systems*. Singapore: Springer. pp. 1-27.

There exists multiple basis for scaling up private finance in support of a low-carbon energy future. First, developed countries are yet to agree on concrete plans for reaching their obligation to deliver $100 billion per year to developing countries for fulfilling their NDCs. Second, as several of current assessments indicate, more than $100 annually is required to achieve energy transition objectives. Third, government budgets globally are now constrained by shocks brought on by the coronavirus disease (COVID-19) pandemic, with less resolve on how public funding will be enhanced to meet the climate targets. Mobilizing private capital is critical to jump-start, leverage, and guide large-scale diffusion of low-carbon energy technologies and infrastructure investments.

Most of the financing needs for upscaling to scale up low-carbon energy systems will be sourced from the private sector. In developed economies like Australia, Japan, New Zealand, and the Republic of Korea, private sector supplies roughly two-thirds of capital mobilization through debt and equity channels. Public finance from national governments, state-owned investment agencies, and national development banks provide the remainder. Figure 2 illustrates the prevailing financing landscape. Private sector financing of energy infrastructure projects in the region that is including developed economies could be broadly divided between the financial sector (60%) and corporate sources (40%).[6] Bank financing, that is inclusive of approximately 40% equity and 60% credit, accounts for roughly 95% of the financial sector contributions. These mostly consist of medium- to long-term loans for renewable energy and energy efficiency projects. Bank investments in equity markets are an alternative source of funding for energy projects. Nonbank undertaking that includes institutional investors provide the remaining 5% of the capital requirements.

Figure 2: An Illustrative Landscape of Low-Carbon Financing in Asia



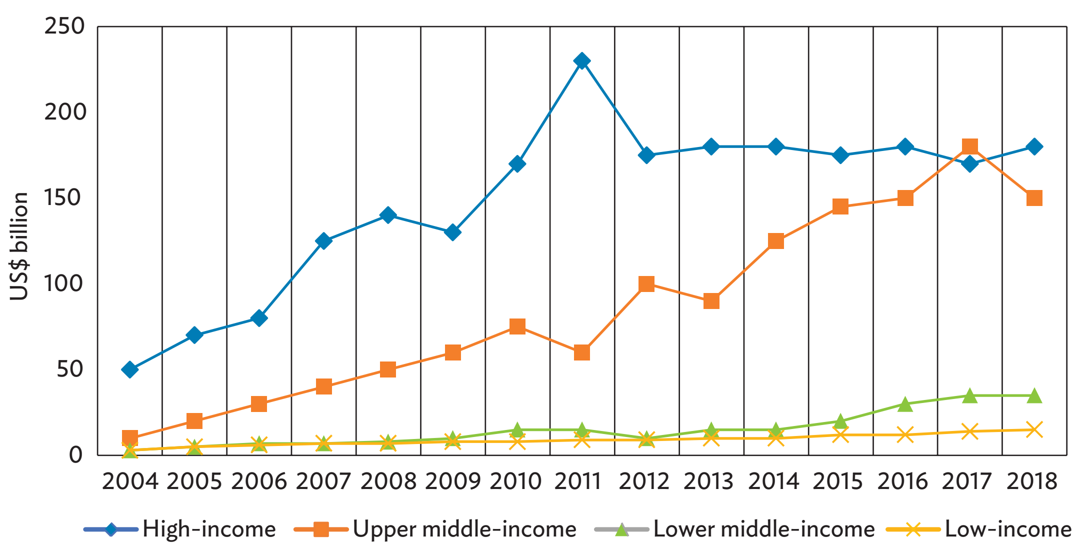
Source: V. Anbumozhi, F. Kimura, and K. Kalirajan. 2018. Unlocking the Potentials of Private Financing for Accelerated Low-Carbon Energy Transition: An overview. In V. Anbumozhi, K. Kalirajan, and F. Kimura, eds. Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital. Singapore: Springer.

6 V. Anbumozhi, F. Kimura, and K. Kalirajan. 2018. Unlocking the Potentials of Private Financing for Accelerated Low-Carbon Energy Transition: An overview. In V. Anbumozhi, K. Kalirajan, and F. Kimura, eds. *Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital*. Singapore: Springer. pp. 1–13.; UN Environment Programme (UNEP). 2014. *Inquiry into the Design of Sustainable Financial Systems: Policy Innovations for a Green Economy*. UNEP.

The magnitude of this portfolio varies across countries. Public and quasi-public financial institutions like national development banks, state-owned commercial banks, and autonomous government guarantee programs account for two-thirds of corporate financing. Energy, finance, and trade ministries are making parallel efforts to enhance the scale of private investments. This trend could further be accelerated by the governments by casting in much more funds to leverage private finance. Schmidt-Traub and Sachs (2015) reported a leveraging ratio of 1:10, which indicates that for every dollar the government put toward a particular energy investment, private companies have put $10. A country with a higher leverage ratio means lowered public financing expenditure. In general, international financial investors are playing a central role in upscaling the energy investment flows into lower- and middle-income countries of the region.[7]

Figure 3 depicts low-carbon investment flows into the region. Upper middle-income countries of ASEAN and the PRC are witnessing high private investments, followed by lower middle-income countries like India. Renewable energy investments into developing countries of Asia hit a record of $230 billion, accounting for 17% of global total, in 2018. This renewable energy and energy efficiency investment flows characterized a six-fold increase from 2005 in all the four country income groups. This is partly due to new crowd-in financing strategies initiated by several countries to implement clean energy projects as well as cross-border energy connectivity (footnote 5). In combination with appropriate energy policies and regulatory environments, public and development assistance was used to stimulate and direct private capital by demonstrating feasibility, creating markets, reducing risks, and fostering financial innovations. Anbumozhi, Wolff, and Yao (2020) mapped the channels for low-carbon investment flows and found that since 2015, intraregional investments originated from East Asia exceeded that of other industrialized countries. However, this increase in capital flows has been unevenly distributed across markets and technologies. There have been relatively limited financial flows into the establishment of small-scale distributed energy systems to improve industrial energy efficiency.[8]

Figure 3: Private Energy Investment Flows by Country Income Groups
($ billion)



Source: Bloomberg New Energy Finance Database https://energydata.info/organization/bloomberg-new-energy-finance (accessed on 25 April 2021).

[7] G. Schmidt-Traub and J. Sachs. 2015. *The Role of Public and Private Development Finance*. SDSN Issue Brief. Sustainable Development Solutions Network. Paris and New York.

[8] V. Anbumozhi, P. Wolff, and X. Yao. 2020. Policies and Financing Strategies for Low-Carbon Energy Transition: Overcoming Barriers to Private Financial Institutions. ERIA Discussion Paper 324. Jakarta: ERIA.

Channels and Approaches in Mobilizing Private Finance

Understanding Investment Channels in Financing the Low-Carbon Energy Transition

While policy makers recognize an immediate need to leverage private financing, it can be a challenge for them to have a common understanding of the full opportunities as well as perceived risks of investment to meet energy transition goals. Table 1 illustrates different categories of financing instruments, techniques, tools, and funds. This was developed by analyzing about 50 recent examples of private investments made in ASEAN and East Asian countries in renewable power.

Table 1: Category of Private Funds, Financial Instruments, and Risk Mitigants of Low-Carbon Investments

Type of Financing	Instruments of Mobilization		Funds	Risk Mitigants	Transaction Enablers
	Capital Market	Cash			
Debt	Sovereign bonds	Secured loans	Infrastructure debt funds (listed and unlisted)	Subordination	Pooling
	Project bonds	Unsecured loans	Private debt funds	Securitization	Co-investment
	Corporate bonds	Subordinated loans	Special purpose vehicle	Performance guarantees	Joint venture/ consortium
	Covered and		Bond fund	Insurance products	Co-investment
	Asset-backed security		Exchange-traded fund	Currency swap	Cooperation and collaboration
	Collateral debt obligation		Mutual fund	Seed capital	
	Structured note				
Mixed	Convertibles (equity and debt) and mezzanine financing		Mixed debt and equity fund		
Equity	Stock (share)	Unlisted share	Energy infrastructure equity fund (listed and unlisted)		
			Private equity funds		
			Venture capital funds		
			Special purpose vehicle		
			Exchange-traded fund		
			Mutual fund		

Source: Author.

The type of private financing channels that facilitate low-carbon energy transition may be broadly classified into debt and equity channels. Debt financing is often used to borrow money by energy project developers to be paid back within an agreed time frame. The most common forms of debt finance are bank loans, bonds, and mortgages. Private equity funds use either their own financial resources or credits raised from other investors to finance energy projects with the aim of first managing the assets better and later selling them for more profit. Equity finance is suitable when cash flows are still relatively unpredictable. They are often used finance large-scale energy projects. Although there are combinations of equity and debt-type financing of low-carbon energy projects, they still face a multitude of risks that increase the cost of capital. Risk mitigants are targeted financial interventions aimed at decreasing different types of uncertainties. Transaction enablers are techniques that facilitate low-carbon energy investments by reducing the costs of transaction and enabling it for specific projects. Shifts in using private capital for low-carbon energy investment very much depend on the wider adoption of risk-mitigating instruments.

Environmental, Social, and Governance Investments and Equity Markets

Capital market investors in the region are increasingly aware of the need to shift capital flows away from activities that may result in stranded assets and high-carbon lock-ins. Among the 1,500 global signatories to the Principles for Responsible Investments,[9] asset owners and investment managers in ASEAN and East Asia accounts for nearly 12%. Of the 52 partner exchanges that are signed into the Sustainable Stock Exchange initiative, 17% are from East Asia. Table 2 presents the Environmental, Social, and Governance (ESG) related assets in stock markets. Low-carbon energy assets in ASEAN and East Asia countries were estimated to be worth $44.9 billion in 2018, an average 22% increase every year since 2011.[10] Australia; Hong Kong, China; Malaysia; the Republic of Korea; and Singapore account for nearly 90% of all declared ESG asset management. While the sustainable energy market segment is growing fast, it started from a low base and still constitute of small fraction of total asset management. The reasons for this could be attributed to lack of sufficient carbon disclosure requirements and other systemic risks associated with ESG investments.[11]

The Indonesian Stock Exchange and Indonesian Biodiversity Conservation Fund have jointly launched a Socially Responsible Investment index in 2009. Based on the index criteria so far, about 25 companies have listed their stocks in Indonesia.[12] Bursa Malaysia Bhd launched the Financial Times Stock Exchange (FTSE4) in Malaysia. Since 2014, it has demonstrated a strong investment drive toward the low-carbon economy.[13] In the PRC, the Shanghai Stock Exchange launched a training program on voluntary carbon disclosure strategies for their investments in 2013.[14] While there is no single definition of low-carbon assets, in general, use of a taxonomy featuring the following eight categories could be considered as green: energy, buildings, water, waste, transport, land use, industry, and information and communication technology investments. The same taxonomy is also often referred in the stock exchanges and green bond markets of ASEAN and East Asia.

9 Principles for Responsible Investment are voluntary guidelines that offer a menu of possible actions for incorporating environmental and social protection issues into investment practices.

10 ASria. 2016. *Asia Sustainable Investment Review*. Association for Sustainable & Responsible Investment in Asia. Hong Kong, China.

11 T. Hongo and V. Anbumozhi. 2015. *Reforms for Private Finance toward Green Growth in Asia in Managing the Transition to a Low Carbon Economy*. Tokyo: Asian Development Bank Institute.; G. Ang, P. Burli, and D. Rottgers. 2017. The Empirics of Enabling Investment and Innovation in Renewable Energy. *Organization for Economic Cooperation and Development (OECD) Working Papers*. No. 123. Paris: OECD.

12 P. Wolf et al. 2016. *Financing Renewable Energy Investments in Indonesia*. Bonn: German Development Institute.

13 B. K. Sovacool. 2016. The History and Politics of Energy Transition. *WIDER Working Paper 2106/81*. Helsinki: United Nations University.

14 X. Wang, L. Barroso, and G. Elizonodo. 2014. *Promoting Renewable Energy through Auctions: The Case of China*. Live Wire 2014/14. World Bank Group.

Table 2: Environmental, Social, and Governance, and Low-Carbon Asset Management in Selected ASEAN and East Asian Stock Markets

Economy	Number of companies listed in the stock exchange	Market capitalization ($ million)	Requires ESG reporting as listing rule	Has written guidance on carbon reporting	Offers low-carbon energy investment-related training	Has sustainability related indices
Australia	2,275	1,507,050	Yes	No	Yes	No
PRC	3,500	9,299,503	No	Yes	Yes	Yes
Hong Kong, China	2,186	4,443,082	Yes	Yes	Yes	Yes
India	7,497	4,753,385	Yes	Yes	Yes	Yes
Indonesia	566	520,687	Yes	No	No	Yes
Japan	3,604	6,222,825	No	No	Yes	Yes
Korea, Republic of	2,138	1,869,629	No	No	No	Yes
Malaysia	904	4,55,773	Yes	Yes	Yes	Yes
New Zealand	176	98,685	No	Yes	No	No
Philippines	267	290,339	No	No	Yes	No
Singapore	749	1,100,000	Yes	Yes	Yes	Yes
Thailand	688	595,573	Yes	Yes	Yes	Yes
Viet Nam	728	126,502	Yes	Yes	Yes	Yes

PRC = People's Republic of China.
Source: Author based on data available at www.sssinitative.org (accessed 25 April 2021).

Status and Trends of Regional Green Bond Markets

Green bond is a financial instrument that is specifically earmarked to raise resources to finance fixed-income projects on climate change and environmental protection. The growth of the green bond markets, in terms of issuance and volume, has been rapid since 2014. In general, bond markets may be categorized as either corporate or project. The first corporate green bond in Indonesia was issued in April 2014 by PT Ciputra Residence. Bonds worth $44 million were issued for energy efficiency investments, which received a partial credit guarantee from the International Financial Corporation (IFC). Subsequently, Indonesia's Export-Import Bank issued a green bond, raising a capital of $500 million to finance renewable energy projects.[15] The first project green bond worth $ 250 million in Japan was issued in October 2014 by the Development Bank of Japan. In February 2015, India saw its first green bond issued by YES Bank in 2014.[16] The Indian corporate and project bond market expanded quickly after the Securities and Exchange Board of India issued guidelines for green bonds in January 2016. Sinajiang Gold Wind Science and Technology of the PRC issued the country's first offshore corporate green bond in August 2015, which was followed by a project-related climate bond issued by the Agriculture Bank of China. Demand for low-carbon assets is strong in East Asia when compared to ASEAN as some 94% of the $1 billion were sold to investors in

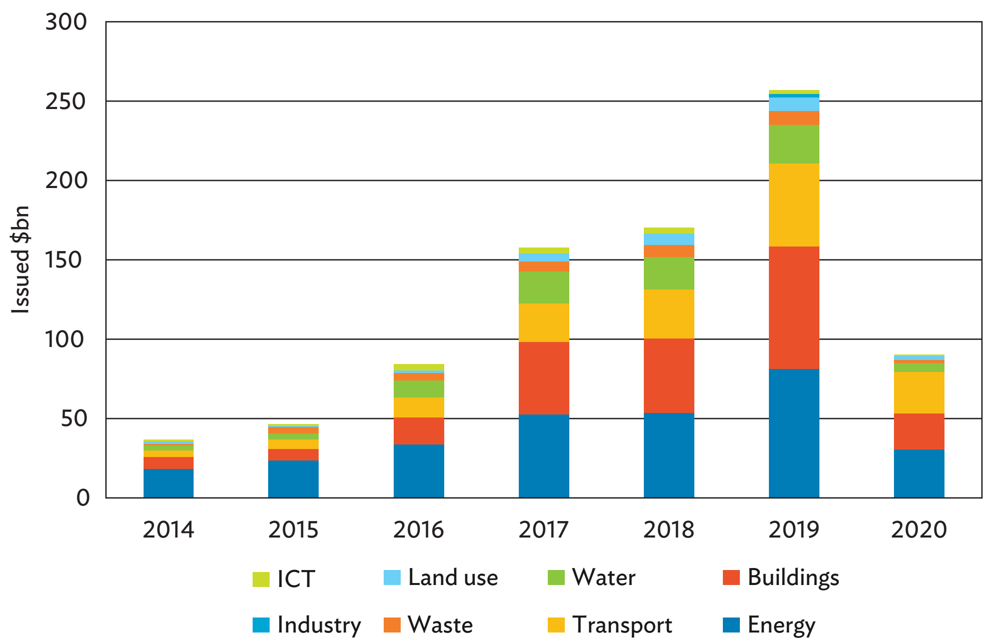
[15] C. Polycarp et al. 2013. Raising the Stakes: A survey of Public and Public–Private Fund Models and Initiatives to Mobilized Private Investment, *WRI Working Paper*. Washington: World Resources Institute. p. 40.

[16] N. Robins and R. Choudhury. 2015. *Building a Sustainable Financial Systems to Serve India's Developmental Needs. UNEP Inquiry into the Design of Sustainable Financial Systems*. Geneva and Federation of Indian Chambers of Commerce and Industry, New Delhi.

Japan, the Republic of Korea, and the PRC.[17] Nevertheless, most of these bonds were issued in stable foreign currencies. Taxonomy, regulatory, and corporate governance issues could be the reasons for relatively underdeveloped local currency green bond markets in developing countries of ASEAN.[18] Moreover, growth in project bond markets is relatively low. There also seems to be a trend of standard corporate loans being termed green or climate bonds.[19]

Figure 4 depicts growth patterns of climate bonds in ASEAN, which mirrors global trends. Volume and loan issuance in ASEAN jumped from $47 billion in 2014 to $259 billion in 2019.[20] This epitomized 3% of the global total and 12% of ASEAN and East Asia.[21] The Philippines issued the first local currency green bond from an ASEAN member country in 2016. It was a renewable energy bond partially guaranteed by ADB and certified under the geothermal criteria of climate bonds standards. By 2020, the number of issuances had risen to 32 in ASEAN.

Figure 4: Global Green and Climate Bond Market Growth
($ billion)



ICT = information and communication technology.
Source: Compiled by the author based on data available at Climate Bonds Initiative https://www.climatebonds.net/market/data/ (accessed 25 April 2021).

[17] C. Payeroles. 2020. Energy transition issues within ASEAN. *Tressor Economics*. No. 263. Paris: Ministry of Economy and Finance.
[18] I. Overland et al. 2021. *The ASEAN Climate and Energy Paradox, Energy and Climate Change*.
[19] International Capital Market Association (ICMA). 2018. *Green Bond Principles Green Bond Principles Voluntary Process Guidelines for Issuing Green Bonds*. Zurich.
[20] Climate Bond Initiative. 2020. *Green Bonds-Global State of the Market 2019*.
[21] Climate Bond Initiative. 2020b. *ASEAN Green Finance State of the Market 2019*.

While green bonds issued by government-backed financial entities in ASEAN focus more on building energy efficiency, corporate climate bonds have a diverse portfolio. To help drive down costs, reduce greenwashing, and have impact investments, the ASEAN Capital Markets Forum released a set of voluntary ASEAN green bonds guidelines in 2017. These guidelines, based on the International Green Bond Principles,[22] seek to boost the basic fundamentals of bond markets such as consistency, transparency, and uniformity of bond issuance across the region. The key elements of ASEAN standards include geographical and economic connection to the region, exclusion of fossil energy projects, and inclusion of external reviewers for the management of proceeds. Discussions are in progress to align these regional standards with that of the International Capital Market Association's global standards, as summarized in Table 3. Implementing and reinforcing similarities between the two means increased requirements for disclosure, more clarity on reporting requirements, and further flexibility for issuers on the allocation of proceeds.

While bond markets have become a catalyst for mobilizing private investments, the banking sector continues to have a catalytic role in allocating capital to low-carbon projects.

These stock and bond market dynamics and a tendency to search for a higher leverage ratio by the governments for public financing has created several misplaced assumptions (footnote 10). Public sector officials perceive they are taking high risks, although a high leverage ratio means that the private financiers have a superior influence over the project being funded. However, if the public sector capital is used for financing more specific risk-mitigating instruments, or subordinated to private capital, then the public sector capital can maintain a stronger degree of influence, while at the same time enable a higher leverage ratio. Indeed, there is trade-off between commercial objectives of maximizing profit margins and other low-carbon energy transition objectives, which are a public good in nature. Moreover, an inverse relationship often exists between the two because certain energy investment options, such as building energy efficiency business propositions, may not require significant additional risk guarantees. Indeed, the interrelationships between several financing instruments, risk mitigants, and transaction enablers as illustrated in Table 1 are complex, leaving policy makers and public financial institutions with a divided sense of the range of private financing networks available and effectiveness of policy instruments. Nevertheless, several technical, market, and regulatory barriers do prevent the harnessing of the full potential of private financing.

Table 3: Features of the International Capital Market Association Climate Bonds Standards

Issuer guidance	Specific guidance given to issuers on establishing green bond framework. Guidance establishes mandate for labeling and transparency, including public disclosure.
Reporting	Mandates annual reporting to maintain certification of bonds. Detailed guidance given for reporting updates, which include eligibility reporting, allocation reporting, and impact reporting.
Public disclosure	Requirements for pre-issuance and post-issuance certification of the bond. Both requirements must be met by the issuer to maintain certification. Encourages issuer to include a list of projects in the bond disclosure documentation.
Robust verification	An assurance framework with independent verifiers established as part of standards with consistent procedures. Approach under climate bond standards aligns with proposed approach for verification under European Union green bond standards.
Definition for use of proceeds and expenditure	Clear definition on low-carbon and climate-related attributes of eligible projects and assets to avoid confusion about ownership, indebtedness, or other related expenditures. This is in line with Green Bond Principles 2018, which includes related and supporting expenditure.

Source: International Capital Market Association, 2018.

[22] Green Bond Principles are voluntary guidelines that recommend transparency and disclosure in issuing bonds and promote professional integrity in developing markets for green or climate bonds. They provide guidance to bond issuers on the key functional components of a green bond.

Barriers to Mobilizing Private Finance

Private finance in the context of energy projects is often defined as raising capital to finance investments where the investor looks to future cash flows from the project to service their loan and provide a return. It has been challenging to move beyond incremental increases in terms of financing volume and energy sector distributions of private financing for these projects in the region. Financing low-carbon energy projects has a significant difference with conventional project investments. In the direct finance model, lenders scrutinize the entire asset portfolio to estimate cash flow to service their loans. For a low-carbon project, assets are examined and financed as stand-alone entities rather than as part of a broader corporate balance sheet. This means a low-carbon energy project must able to generate sufficient cash flow to cover all operating costs and debt services, while delivering an acceptable rate of return on the equity invested.

The questions to consider further are what types of barriers and short-term risks exist and what financial innovations are necessary to make the transition to a low-carbon economy complete by 2030. Given that innovations must mitigate undue financial risks and adhere to NDC goals, it would be necessary to map the challenges. In the first quarter of 2019, 1,800 private financial institutions including commercial banks, equity providers, and renewable energy project developers across the region were contacted to share their insights on completed and ongoing low-carbon energy investment plans (footnote 10). The types of risk they identified for mobilizing private finance could be classified into policy, institutional, and market barriers (Table 4).

Table 4: Investor Views on the Challenges of Mobilizing Private Finance

What do you perceive as barriers to receiving private finance and bank loans?
(Respondents could choose multiple answers)

Category	Obstacles	ASEAN	ASEAN+3	ASEAN+6-Mongolia and HK
Policy	Changing policies	56%	45%	50%
	Complex procedures	28%	27%	29%
Institutional	High initial investment cost	50%	45%	50%
	Longer recovery period	50%	45%	46%
	High collateral requirement	44%	45%	46%
	Insufficient credit and maturity	28%	27%	25%
	Lack of capacity to value assets	17%	14%	13%
Market	Currency risk	33%	32%	29%
	Insufficient profits	33%	32%	29%
	Unpredictable cash flows	28%	23%	25%
	Non-favorable interest rates	28%	23%	25%
	Rising interest rates	28%	23%	21%
	Technology advancement risks	22%	18%	17%
	Unstable consumer market	11%	9%	13%

ASEAN = Association of Southeast Asian Nations, HK = Hong Kong, China.
Colors are on a green–red spectrum. Green indicating more support for a response, red indicating less.
Source: Author.

Some 31% of respondents believed the Paris climate agreement is somewhat important to their investment decisions, and 55% said it is very important. More than 50% of respondents reported that high investment amounts, upfront capital, and longer recovery periods are major institutional barriers in driving their low-carbon investment decisions. Inconsistent support policies for renewable energy development and complex procedures in power purchase agreements were also highlighted as policy obstacles. Market barriers faced by commercial banks included lack of capacity to value risks in monetary terms associated with small-scale energy projects. Further, they lacked incentives given the relatively high cost of evaluating non-standardized small-scale low-carbon energy projects and relatively high credit risks.

The banking sector could provide leadership in financing the low-carbon energy projects by increasing the availability of risk-adjusted lending matched to borrower's requirements. Good lending practices, where attractive risk-return profiles, offer new opportunities for commercial banks to upscale and retroflex established credit models. In situations where low-carbon energy financing offers larger profit revenue, but are coupled with uncertainties on returns, commercial banks can jointly work with public or quasi-financial institutions using their blended finance, risk sharing, and project formulation tools.

The survey also revealed that, for many types of bank-financed activities, there is a lack of benchmarks to determine whether a bank's overall funding is in line with the NDC targets set by the governments.[23] Roadmaps that show economy-wide financing needs by country, type of bank transactions, or asset types are needed to fill the gap and allow the finance sector to benchmark their portfolios in order to enhance the banking sector's role in transitioning to a low-carbon energy future.

Green investment banks are publicly catalyzed financial institutes to attract private investment. Some countries have made progress in creating channels to boost green investment. Green Fund of Japan and Malaysia's Green Technology Financing Scheme represent innovative lending frameworks that supported low-carbon energy transition.[24] The United Kingdom (UK) Green Investment Bank was established in 2012 as a tool to expand financial markets and cost effectively meet the UK's NDC targets and change in energy mix. Australia's Clean Energy Finance Corporation was also initiated in the same year with the same purpose. The New York Green Bank in 2013 was established by the state government to attract more private investments for its low-carbon energy transition. While these various institutions each offer debt financing different in name and scope, in common they all seek to provide leverage public finance to facilitate private financial transactions that would not occur without government involvement.

However, in most of the commercial banks in developing countries of ASEAN and East Asia, the concept of low-carbon financing, other than for conventional renewable energy projects, is relatively new, and most bank officials have little experience or training in due diligence of complex low-carbon technology projects that have multiple co-benefits as well as risk. As of now, overall lending for low-carbon energy transition in most of the developing and least developed countries constitutes only a fraction of total profitable crediting and often done at a high-risk guarantee, compared to traditional energy finance programs.[25]

[23] V. Anbumozhi and X. Yao. 2015. Serendipity of Low Carbon Energy System and the Scope of Regional Cooperation. In V. Anbumozhi, K. Kalirajan, F. Kimura and X. Yao, eds. *Investing in Low-Carbon Energy Systems*. Singapore: Springer. pp. 1–27.; World Bank. 2016. *Readiness for Investment in Sustainable Energy (RISE)*. World Bank Group.

[24] K. Berensmann, F. Dafe, and N. Lindenberg. 2017. Demystifying Green Bonds. In S. Boubaker, D. Cummings and D. Nguyen, eds. *Sustainable Investing and Financial Markets*. Cheltenham: Edward Elgar.

[25] Energy Transition Commission. 2016. *Making the Mission Possible: Delivering Net Zero Economy*.

The Role of Central Banks in Upscaling Private Financing

Central banks in ASEAN and East Asia are paying attention to the issues surrounding financial sector involvement in energy transition for two main reasons. First, managing their sector contributions well will avoid their ongoing energy investments becoming stranded assets in the future. Second, they play a role in meeting national financing goals set by their governments as a commitment to the Paris Climate Agreement. In 2015, in the lead up to the Conference of the Parties (COP) 21, many central banks in the region made policy commitments related to climate change. They included statements on investment support to either increase the financing of low-carbon energy solutions or decrease the financing of industries related to fossil fuels. Meanwhile, as a follow-up initiative to the Paris Climate Agreement, the Financial Stability Board of G20 created a Task Force on Climate Related Disclosure in 2010, which has improved the central banks' interest to the potential risks associated with financing the conventional fossil energy infrastructure in the region.

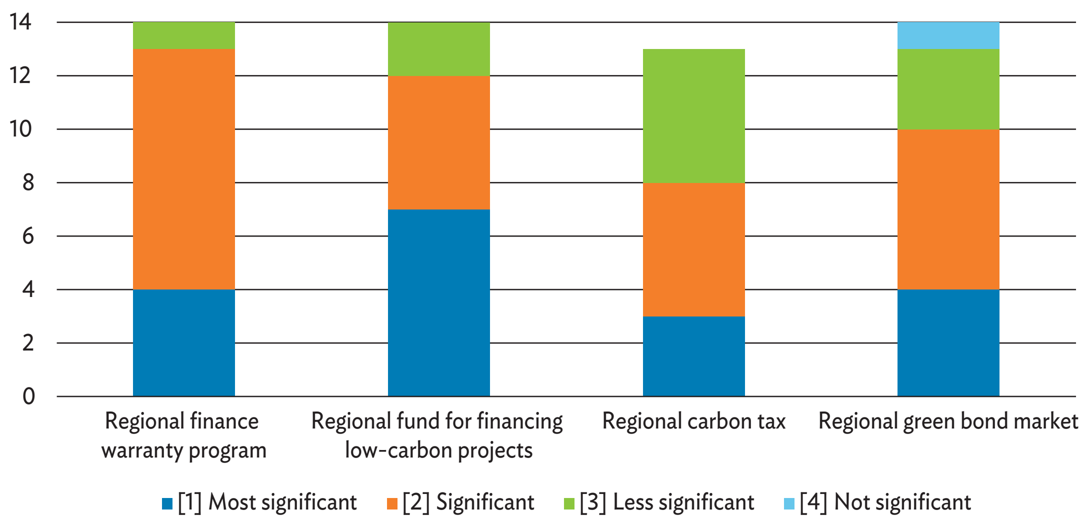
This was reflected in a survey by the South East Asian Central Banks Research and Training Centre about central banks and monetary authorities' views on policies related to low-carbon energy finance.[26] Eighteen of the center's 35 members, associate members, and observers responded to the survey in the second quarter of 2019. The results showed that climate change and low-carbon energy financing increasingly find relevance and importance to the operations of central banks. Many Southeast Asian countries are particularly impacted by climate change and are preparing to develop innovative financing solutions. Nearly 90% of the 18 surveyed central banks agreed that low-carbon finance had become a critical area of focus, particularly after the ratification of NDCs. A third of central bank governors in the region had already issued policy statements on improved framework conditions for sustainable finance solutions. Three central banks have published guidelines on lending to low-carbon energy projects. Almost all the central banks think that they would play a critical role in guiding the finance industry to develop appropriate tools and policy instruments to stimulate markets for equity investments and the issuance of green bonds.

Respondents also considered whether direct financing for low-carbon energy projects and regional cooperation could have a strong impact. Figure 5 illustrates perceptions on regional policy coordination in the real and financial sectors to promote private investments. The specific areas for regionally coordinated actions include (i) establishing a finance warranty programs, (ii) creating a regional fund for bankrolling low-carbon energy projects, (iii) formulating regional-level carbon taxes, and (iv) integrating the evolving green bond markets.[27] While regional finance warranty programs and green bond markets are preferred as most significant by majority of the respondents, several of the central banks and monetary authorities also perceive that a carbon tax and a consolidated regional fund could support the necessary change within the financial sector.

[26] A. Durrani, U. Volz, and M. Rosmin. 2020. The Role of Central Bank in Scaling Up Sustainable Finance, What Do Monetary Authorities in Asia and the Pacific Think. *ADB Institute (ADBI) Working Paper 1099*. Tokyo: ADBI.

[27] V. Anbumozhi and T. F. Rakhmah. 2018. Prospects of catalysing Regional Solutions and the Role of Low-Carbon Transition Fund. In V. Anbumozhi, K. Kalirajan and F. Kimura, eds. *Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital*. Singapore: Springer. pp. 397–421.

Figure 5: Central Banks' Confidence About Regional Cooperation and Monetary Policy Coordination to Enhance Low-Carbon Finance



Source: Compiled by the author based on data available at https://www.climatebonds.net/market/data/ (accessed 25 April 2021).

Accelerating Private Investment through Regional Cooperation and Integration

Trends of Regional Cooperation and Integration

While several countries in ASEAN and East Asia effectively promote private financial initiatives in the low-carbon energy sector, they take a more critical stance on cross-border energy infrastructure development and associated investment decisions. At the ASEAN level, domestic regulatory reforms under the framework conditions of the ASEAN Plan of Action on Energy Cooperation and the ASEAN Economic Community (AEC) are in full action, resulting in increased intra-regional investment flows in the energy sector, and in the departure from International Investment Agreement (IIA) regimes by member states. Termination of at least 19 IIAs from 2010 to 2016 became effective within AEC framework.[28] Countries particularly active in abolishing investment agreements were India with 17 and Indonesia with 11 in 2018.[29]

For mega-trade and investment treaties such as the Regional Economic Cooperation Partnership (RCEP), the Trans-Pacific Partnership, and the Transatlantic Trade and Investment Partnership, the expectations of an IIA that is inclusive of low-carbon energy transition goals remain uncertain. Nevertheless, entry conditions for financing energy projects in sectors such as coal, oil and gas, as well as renewable energy are being liberalized at faster rate. Almost all the 15 member countries of RCEP have streamlined national registration processes of cross-border energy investment, provided new incentives for renewable energy investments, and reformed policies guiding foreign direct investment.[30] Other remarkable features of ongoing regional cooperation efforts are the adoption of new guidelines on public–private partnerships and enacting

[28] ERIA. 2012. *Mid-term Review of the Implementation of AEC Blueprint*. ERIA. 2016. *The Development of Regulatory Management Systems in East Asia*.
[29] WIR. 2019. *World Investment Report*. Geneva: United Nations Commission on Trade and Investment.
[30] OECD. 2015a. *Mapping Channels to Mobilize Institutional Investment in Sustainable Energy, Green Finance and Investment*.

competition laws. This has been reflected in the increased inflow of investment in the subsectors of energy efficiency, net zero energy production, and reduction in transport energy use.[31]

Nevertheless, new regulations and restrictions are also increasing in the upstream energy sector investments, which largely reflect less cross-border ownership in energy distribution—often due to reasons of national security, safeguarding the interests of state-owned enterprises. and protecting the domestic financial industry. Between 2010 to 2016, 24 new non-tariff measures were introduced in East Asian countries alone.[32] Investment priorities in the renewable and energy efficiency sectors are also exposed to stresses pruning from international agreements to promote free trade, and the targets set for cross-border energy infrastructure connectivity under the AEC framework. Nevertheless, new guiding principles for cross-border investment were endorsed by the East Asia Summit in 2019. Driving these aspirations were the motivational efforts to strengthen coherence between national and regional commitments, and to boost consistency among energy, climate, and investments policies. They also serve as a guide for examining financing strategies to accelerate low-carbon energy transition at country levels.

Three issues are worth bearing in mind as regional policies are developed, as follows:

Determining the actions needed for low-carbon energy transition across countries and the technology cycle is a complex task. To achieve NDC targets by 2030, it will be important to deploy many types of low-carbon technologies across sectors, and coordinate investments along the entire technology cycle. In several developing ASEAN countries, no strong, progressive technology roadmap and effective supporting financial framework has been developed. Given that these countries, which constitute an integrated market, may well be the first-mover advantage in entering the market for many low-carbon energy technologies. Hence, it is necessary to think of financing downstream energy markets along with upstream investments that lie across ASEAN members.

Low-carbon energy transition is more than mere technology replacement. Financing a low-carbon energy transition is not just about financing an isolated energy infrastructure, but rather a complex socio-technological paradigm shift that includes hardware, supporting policies, enabling human resources, new regulatory frameworks, innovative institutional arrangements, and formulating coherent co-benefit investment regimes. Consequently, the challenge of privately financing the low-carbon energy transition is changing an interconnected socioeconomic technological regime.

Equitable distribution must be considered of both costs and benefits. It is vital to ensure that the benefits of public–private partnership reach developing countries and are not concentrated on a few individuals and advanced countries.

Catalyzing Regionally Coordinated Solutions to Upscale Private Financing

Components of a Regional Architecture

Private financing of low-carbon energy systems requires concurrent advancements on multiple fronts, including the advancement of several independent and interconnected technological systems, new business models, and supporting regulatory reforms that incentivize free trade and investments. Such a change is unlikely to proceed systematically without collaboration, cooperation, and coordination in a constructive way at regional level. In the survey detailed in section 4, respondents were asked to rank their preferences on a scale of one to six on possible regionally coordinated actions that would help ASEAN and East Asian

[31] OECD. 2015b. *Overcoming Barriers to International Investment in Clean Energy, Green Finance and Investment*. Paris.

[32] Z. Simon and C. Zhang. 2015. *Greening China's Financial System: Synthesis Report. Winnipeg: Institute for Sustainable Development*. Beijing: Research Centre of the State Council.

economies accelerate low-carbon investment (Table 5). The respondents ranked regionally coordinated carbon price mechanism as the best option, followed by the creation of a regional low-carbon transition fund. A financial warranty program to reduce, reassign, and re-appropriate different project financing risks was the third preferred choice. Coordinated regulations on goods and services, and a new taxonomy and guidelines for green bond markets, were ranked fifth and sixth, respectively.[33]

Table 5: Preferences for Regionally Coordinated Actions for Upscaling Investments

Regional Structures and Incentives	Rank	Average Ranking from Respondents	
Regional carbon price	1	Most significant (1)	2.68
Regional fund for investing in low-carbon energy transition projects	2	↑	2.70
Regional finance warranty program	3		3.39
Regional low-carbon guarantee fund	4		3.39
Regional regulations on goods and services	5	↓	4.05
Regional green bonds	6	Least significant (6)	4.79

Source: Compiled by the author.

Growth of Regional Carbon Markets and Potentials of Integration

Future investments in energy infrastructure should take advantage of emerging carbon markets and national emission trading schemes.[34] Several studies have also pinpointed the introduction of a carbon tax as the most effective way of generating new revenue streams to finance low-carbon energy infrastructure needs. A global carbon tax at the rate of $75 per ton of CO_2 emission by 2030 is recommended for climate stabilization.[35] This may however be a high price for developing countries. A price range of $75 to $140 for alternate low-carbon options like carbon capturing and storage as well as nuclear energy could be feasible.

Instituting a cap-and-trade system has considerable support among institutional investors who prefer internalizing externalities through market-based mechanisms.[36] Emissions trading systems (ETS) set the quantity of energy-related emissions for a fixed time period to let the carbon price by the market players. On the other hand, a carbon tax sets a price on emissions, which motivates energy efficiency investments, by allowing the actual amount of carbon reduction to change across the jurisdictions. Nevertheless, both instruments can act as a new source of revenue for refinancing low-carbon energy projects. Both place a cost on energy use, correct market failures, and mitigate private financing risks, and could work within the proposed regional low-carbon transition fund. Table 6 shows the status of carbon market evolution in selected ASEAN members.

33 V. Anbumozhi et al. 2017. Clean Energy Transition for Fuelling Economic Integration in ASEAN. In S. Bhattacharya, ed. *Routledge Hand Book of Energy in Asia*. pp. 331–347.

34 V. Anbumozhi. 2021. Challenges to Carbon Pricing in ASEAN and Potentials for Regional Cooperation, Working Paper, Korea Environmental Institute, Seoul.

35 OECD, World Bank and UN Environment. 2018. *Financing Climate Futures-Rethinking Infrastructure*. Paris: p. 117.

36 A. Y. Lo. 2016. Challenges to the development of carbon markets in China. *Climate Policy*. Vol. 16. pp. 109–124.

Table 6: Carbon Pricing and Emission Trading Systems in Selected ASEAN Members

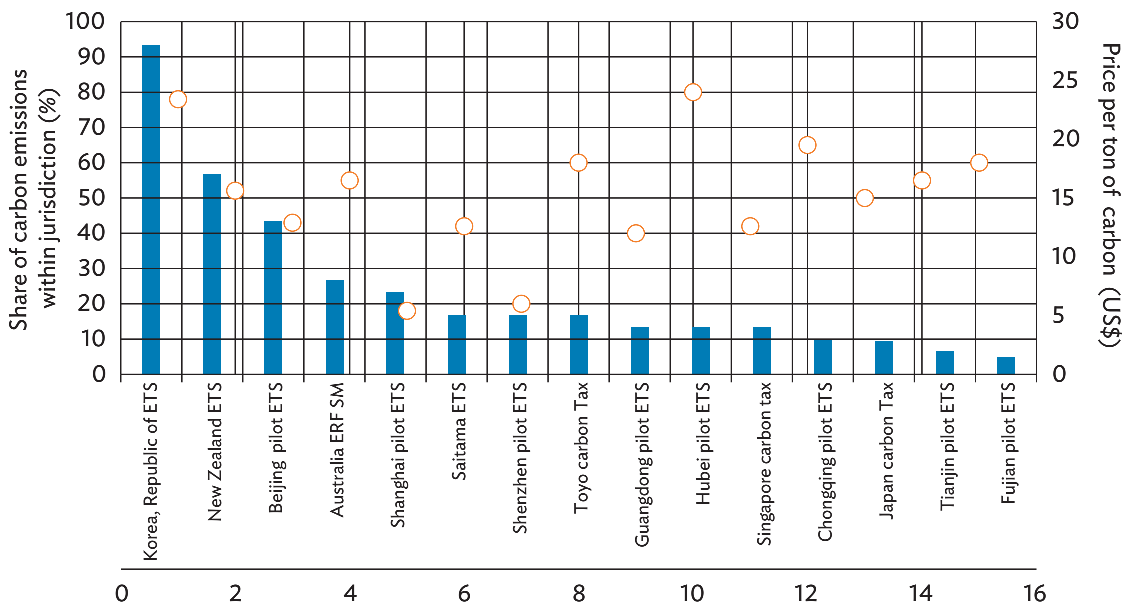
Country	Status	Development
Singapore	Under implementation	Economy-wide carbon tax was introduced on 1 January 2019. Covers 80% of country's energy-related emissions.
Indonesia	Under consideration	Presidential notification mandates the establishment of an ETS by 2024. Emission trading is the carbon pricing instrument of choice.
Malaysia	Under consideration	Both carbon tax and ETS are being considered in the country context.
Thailand	Under consideration	Voluntary ETS is in piloting stage under the new Climate Change Law.
Viet Nam	Under consideration	Power generation, steel, and waste sectors are most likely candidates for piloting approaches for ETS , which is under consideration.

ETS = emission trading systems.
Source: Author.

At present, only Singapore has a direct carbon tax, set at $3.5 per ton of CO_2 equivalent, which is paid by major industrial energy users. This could rise to $10 by 2020. Indonesia and Viet Nam are considering introducing an ETS, while Thailand is considering adopting either an ETS emission allowance or a carbon tax. Almost all of ASEAN Member States (AMS) have renewable energy project development experience with a carbon credit mechanism, either through UN-supported Clean Development Mechanisms or the Japan-initiated Joint Credit Mechanism.

Figure 6 presents the status of ETS in East Asia. While trends in Japan, the PRC, and the Republic of Korea are encouraging, faster and more ambitious carbon pricing would further drive private capital allocations. Globally, average carbon pricing remains at only $2 per ton and existing schemes cover only about 20% of total emissions. In East Asia, the price ranges from about $1 per ton in subnational ETS in Japan and the PRC to $29 per ton in the Republic of Korea.

Figure 6: Evolving Carbon Market Mechanisms in East Asia



Source: Author.

There is considerable variation in the design and sector coverage of ETS in East Asia. In the PRC, carbon markets have covered more than 1,000 energy entities from more than 20 industry sectors, with total emission trade volume reaching 200 million tons of carbon with an estimated monetary value of about $7 billion. The price ranged from $0.15 to $18.93 per ton of CO_2.[37] Japanese voluntary ETS have 389 members and achieved a reduction of 59,419 tons of carbon from 2012 to 2019, with a mean trading price of $2 per ton of CO_2.[38] The Republic of Korea's ETS is supposed to have an estimated emission cap of 538.7 million tons of CO_2, covering mostly the power and manufacturing industries.[39]

When compared to European Union (EU) ETS, the emerging carbon markets of East Asia are still in the naive stage of implementation. Within carbon markets, different efficiency pathways are being implemented, resulting in varying costs within each capacity. These fragmented carbon markets and diversified carbon pricing approach does not encourage the private sector to invest as transaction costs are higher. Creation of a regional carbon market by linking different carbon pricing approaches would establish a single carbon price and create more equitable access to investments.

An integrated carbon market would deliver several benefits. It would lower the carbon abatement cost and enlarge the scope of financing for low-carbon energy projects. and offer efficiency and effectiveness, and instill investor confidence on the market. As integrated regional carbon markets evolve, volatility of prices would decrease because supply for emissions permits would be less dependent on a single country or investor financing plans. Linked markets not only reduce transaction costs, but also reduce the potential consequent carbon leakages.[40] A regional institution could monitor low-carbon energy investments, evolving carbon markets, carbon pricing mechanisms, and their interlinkages. For instance, the EU ETS has adopted a two-level organizational structure, which includes central management and line energy ministries in the next level. It has a clearly specified division of work between the energy, economic, and climate ministries, and explicitly draws a distinction between carbon rights and obligations to investments made on energy efficiency. This way, regional cooperation is ensured to achieve higher operational efficiency and management of carbon markets.

Outside ASEAN and East Asia, increased cooperation among carbon market jurisdictions has been seen in recent years. In Europe, the Swiss ETS and EU ETS became linked in 2020, allowing covered entities in the former to use allowances from the latter for compliance, and vice versa. Following the departure from the EU, the UK is making plans to design its own ETS and then linking it to the EU ETS. Similarly, in the United States (US), a regional carbon market for the power sector is established to include New Jersey and Virginia jurisdictions under a regional GHG initiative. More sectors are also being progressively covered by a carbon price and thresholds are being lowered to regulate more companies. To achieve a net zero economy, countries like Japan, the PRC, and the Republic of Korea are increasing their use of carbon-crediting mechanisms and results-based low-carbon energy finance. With carbon border adjustments being endorsed in Europe, countries in Asia may be incentivized to proactively implement their own carbon market initiatives and integrate with Europe in later years.

37 J. Li and J. Zhang. 2018. Regional cooperation on Carbon Markets in East Asia. *Asian Development Review*. 35(2). pp. 39–52.

38 T. Arimura and T. Abe. 2020. The Impact of the Tokyo Emissions Trading Scheme on Office Buildings: What Factor Contributed to the Emission Reduction? *Environmental Economics and Policy Studies*. Vol. 118. pp. 35–44.

39 Y. Choi, Y. Liu, and H. Lee. 2017. The Economy Impacts of Korean ETS with An Emphasis on Sectoral Coverage Based on A CGE Approach. *Energy Policy*. Vol. 109. pp. 835–844.

40 K. Hamilton. 2009. Unlocking Finance for Clean Energy: The Need for Investment Grade Policy. *Energy and Environment Development Programme Paper*. No. 09/04, London: Chatham House.

Innovations in Financing Small-Scale, Low-Carbon Energy Projects

The existence of many relatively smaller-sized low-carbon energy projects is often a barrier for investors who are looking to advance large capital for meaningful impacts.[41] This is partly due to meticulousness required before investing, and the lack of meaningful impact of investing small sums has on their portfolios. Further, a lack of harmonized monitoring and verification protocols to win trust also hinders investment (footnote 14), along with unattractive financial terms.[42] Several innovative financial instruments such as dedicated funds, direct loans, and warehousing, however, are often being used as risk mitigants and investment enablers.

Such innovative instruments have effectively removed investment barriers. Malaysia's Green Technology Financing Scheme offers loan assurances to small-scale energy projects. Qualified low-carbon projects under this scheme could seek a loan from authorized private banks, and are eligible to receive a loan guarantee of about 60%.[43] On-bill finance is an innovative program implemented by Australia's Clean Energy Financing Program, where the utility company collects payment fees from the borrower and remits to the investor. It is a desirable environment for private lenders due to less default rates.[44] Property assessed clean energy (PACE) is a form of renewable energy financing by keeping property as collateral, where a debtor repays a loan through taxes attached to project asset such as buildings.[45] It simulates on-bill financing, but this program makes repayment less risky for borrowers and creates increased safekeeping for creditors.

Warehousing is another innovative tool for accumulation of loans targeted for small business that will become securitized through a collateralized debt obligation. It has been used in many forms of small-scale energy efficiency projects. For example, in the US, Connecticut Bank acts as a custodian of loans and warehouses its PACE loans, which are then sold to private investors as a portfolio.[46] By using the warehouse structure as shown in Figure 7, Connecticut Bank was able to create standards, stability, and consistency among many small projects, and then aggregate them to a scale, which would become attractive for private investors.

To mobilize private capital and recapitalize the warehousing, Connecticut Bank solicited bids from investors to purchase the property-adjusted clean energy edits. This contract marked the first commercial energy efficiency securitization for small business in the US. These kind of innovative financing programs typically require enabling regulations, that can be often complicated without full involvement of local banks.

A barrier to increased lending by local banks for these types of small-scale technology projects is unfamiliarity or being averse to unsecured lending. Local commercial banks issue credits and other equity-based loans, to expand their portfolio of activities. Low-carbon energy projects, despite creating their own income streams, are judged to have more risk contemplations. Because a local bank does not account the savings in the underwriting process, they treat loans on energy efficiency in par with other loans that have greater risks. The capacity of local banks needs to be enhanced through targeted personal training programs.

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41 V. Anbumozhi et al. 2020. Unlocking the Potential of Private Financing for Low-carbon Energy Transition: Ideas and Solutions from ASEAN Markets. *ERIA Discussion Paper* 313. Jakarta: ERIA.

42 Black and Veatec. 2020. *Electric Industry Asia 2021*.

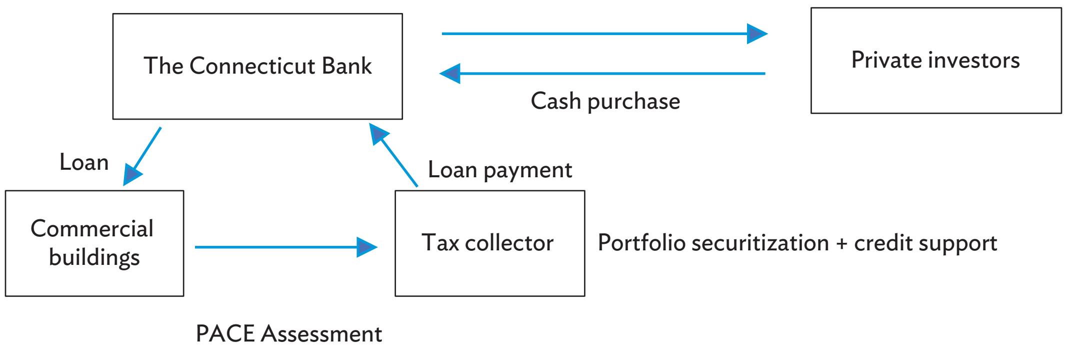
43 GTFS. 2014. Green Technology Financing Scheme. Presentation by Tan Ching Tion. UNFCCC Regional Workshop for NAMAs, 22–25 April, Vientiane.

44 State and Local Energy Efficiency Action Network. 2014. *Financing Energy Improvements on Utility Bills: Market Updates and Program Design Considerations for Policy Makers and Administrators.* DOE/EE-1100. State Local Energy Efficiency Action Network.

45 National Renewable Energy Laboratory (NREL). 2010. Property Assessed Clean Energy (PACE) Financing of Renewables and Efficiency, Fact Sheet Series on Financing Renewable Energy Projects. *NREL/BR-6A2-47097 NREL Energy Analysis*.

46 Coalition for Green Capital. 2015. *Creating State Financing Tools to Male Clean Energy Market Grow Quickly*.

Figure 7: PACE Model for Financing Small-Scale, Low-Carbon Projects



PACE = property assessed clean energy.
Source: Author.

Overcoming Financial Barriers to Demonstration and Early-Stage Low-Carbon Technologies

Low-carbon technologies have long research, development, and deployment periods. A recent analysis done for developing countries pointed out the limitation of the traditional venture capital model for funding these technologies, as they focus more on a narrow range of matured low-carbon technologies.[47] This is in part due to time constraints of venture capital investors and the relatively high risks on the returns from investments on research and development.

A strong enabling policy environment for private investment is fundamental for pulling low-carbon technology innovations, diversifying investment funds, and aligning very different stakeholders at the different stages of technology development. Governments can support to fill the financing gaps by supporting the growth of public–private technology incubator programs and accelerators, and leveraging public cash to finance risky long-term projects that have large low-carbon energy transition benefits. Governments in ASEAN and East Asia can help to form new partnerships to ensure continued investment along the innovation value chain from basic research to development and deployment of low-carbon technology and business models (footnote 7). It could be modelled after, for example, the Breakthrough Energy funding mechanism in Europe, which brings together risk-tolerant private investors, multilateral institutions, and new green financing establishments with the investment necessary to finance low-carbon technology projects.

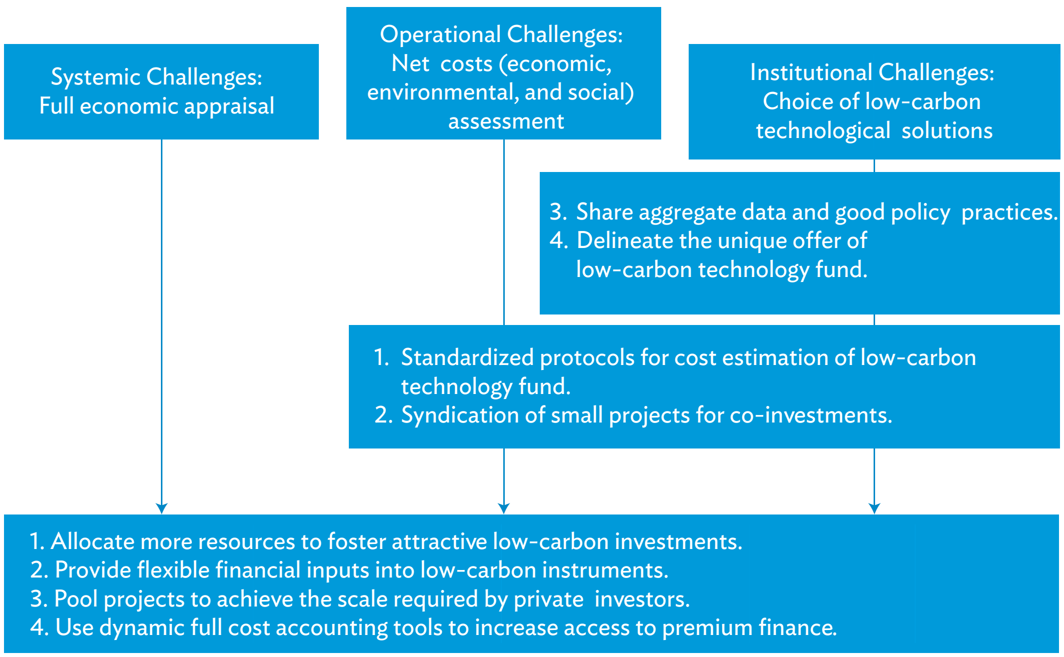
Capacity Building for Implementing Regional Solutions

Regionally coordinated initiatives such as vertically developing technologies, integrating carbon markets, establishing transition funds, and designing financial warranty programs could become risk mitigants and investment enablers. Seed funding initiatives could be provided bypass on current pervasive fuel subsidies as loans for new low-carbon project developers who can help to meet NDC targets in primary sectors. The project loans could be converted into grants when planned carbon reductions are realized. By implementing regionally coordinated actions of this nature, policy makers would improve risk-bearing capacity of private financiers.

[47] B. Gaddy, V. Sivaram, and F. O. Sullivan. 2016. *Venture Capital and Clean Tech: The Wrong Model for Clean Energy Innovation.* Cambridge, Massachusetts: MIT Energy Initiative.

Nevertheless, some framework conditions are needed for new energy project developers to deepen their capital stocks and build stronger public–private partnerships. Standardization of cost estimation, syndication of small projects, sharing best regulatory practices, and institution building could form a four-step agenda for analyzing the operational risks (Figure 8). By analyzing the systemic challenges, policy makers would be able to better understand the extent and type of low-carbon energy funding solutions and further refine governing mechanisms to continuously enhance conditions for promote private investments.

Figure 8: Change Structure for Addressing Systemic Risks in Mobilizing Private Capital



Source: Author.

A regional low-carbon transition fund that could be complemented by a best regulation program would empower subscribing countries to request an independent valuation of latent investments. A knowledge base stemming from the academic, nonprofit, and industry–community to assess current public policy programs and regulatory implications would further enable these regionally coordinated solutions.[48] Such a program should also aim to enhance the capacity of the finance industry to effectively participate in carbon market programs. This would require greater harmonization of policies and good regulatory practices to ensure the continuous flow of private investment across countries. Indonesia's risk financing of geothermal energy development is one example (Box 1).

[48] V. Anbumozhi and K. Kalirajan. 2017. Paris Agreement and Globalization of Low-Carbon Technologies: What is Next for Asia? In V. Anbumozhi and K. Kalirajan, eds. *Globalization of Low-Carbon Technologies: The Impact of Paris Agreement*. Singapore: Springer. pp. 1–17. M. Stadelmann, P. Castro, and A. Michaelowa. 2011. *Is There a Leverage Paradox in Climate Finance?*. Cambridge.

Box 1: Risk Financing of Geothermal Energy Development in Indonesia

Indonesia is a predominant player in geothermal development and use, with an estimated 29 gigawatts (GW) and an installed capacity of 1.9 GW. It strategies to develop an additional 4.6 GW to support its renewable energy target of 23% by 2030, with an investment of $35 billion. Geothermal projects are perilous investments especially at the costly and lengthy exploration stage. No bank would provide credit for this early stage. Mobilizing equity is also difficult due to an inadequacy of tariffs and power purchase agreements. A key problem for raising debt finance is that even international financial institutions are reluctant to fund upfront exploration and typically will only provide financing when half or more of the geothermal steam resource is proven. To address this challenge, the Government of Indonesia established a Geothermal Resource Risk Mitigation program as an investment enabler through which a new tariff regulation and a special power purchase agreement are established.

As a result, international financial institutions provided technical and financial support to PT Geo Dipa Energi (GDE), a private entity, to develop specific geothermal projects in Java and Sumatra. Through this facility, new loans and grants are provided by the World Bank and Asian Development Bank with the additional support of the Green Climate Fund, Clean Technology Fund, and Global Infrastructure Facility. These initial low-carbon investments worth $ 4 billion are calculated to reduce carbon emissions by more than 1 million tons per year.

Source: Compiled by the author.

Regional research institutes like the Asian Development Bank Institute (ADBI), Economic Research Institute for ASEAN and East Asia (ERIA), ASEAN Center for Energy (AEC), and South East Asian Central Banks (SEACEN) Research and Training Centre have been using the ability of individuals, international organizations, state institutions, networks, entrepreneurs sector, and society itself to catalyze regional cooperation through country-owned processes of capacity building for effective policy making. However, the determination of targets and agreement on the capacity-building outcomes is crucial for obtaining the change structure required at the regional level to ensure lasting and successful financial innovations in support of low-carbon energy transition.[49] ADB has already begun working on building capacity within the carbon markets of East Asia. ADB's involvement in catalyst financing and capacity building for the government and private sector creates a signaling effect that mobilizes more private capital toward low-carbon investments. These organizations can act as counselors using their regional view and information resources to build regional capacity and modify the private financing landscape needed for low-carbon transition.[50]

[49] V. Anbumozhi and M. Kawai. 2015. Towards a Low-carbon Asia: Challenges of Economic Development. In V. Anbumozhi, M. Kawai, and B. Lohani, eds. *Managing the Transition to a Low-carbon Economy*. Tokyo: ADBI. pp. 11–44.

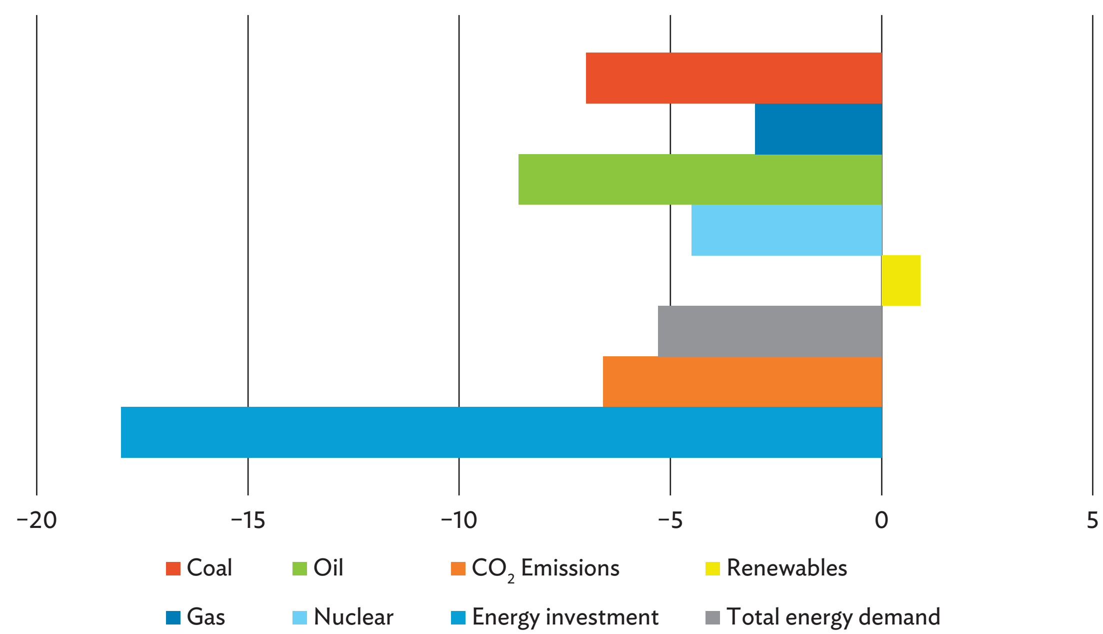
[50] L. Mo, Y. Zhai, and X. Lu. 2017. Establishing Low-carbon Technology Finance Mechanisms Asian Development Bank Experiences on Climate Technology Finance Centre. In V. Anbumozhi and K. Kalirajan, eds. *Globalization of Low-Carbon Technologies*. ERIA-Springer. pp. 537- 566.

Impact of the COVID-19 Pandemic on the Private Financing Landscape

Impacts of the Pandemic on the Energy Sector

COVID-19 has caused enormous disruption to energy investment, creating short-term uncertainties and long-term implications on the private financing landscape. The cumulative economic and financial fallout is estimated to be much worse than that of 1997 economic crisis and 2008 global financial meltdown.[51] The quarantines, industrial lockdowns, and work-from-home arrangements have changed the way energy is consumed and interrupted the supply chains of both fossil fuels and renewable energy, with corresponding lost revenues. Figure 9 shows the changes in energy demand and investments at the global level. The global energy demand has been estimated to be down by around 5%–9% since the outbreak in March 2020 until December 2020, when compared to the same period in 2019.[52] Some countries, including Malaysia and the Philippines, experienced a drop of 30%–45% in electricity demand during the first half of 2020, though this bounced back in the third quarter. The oil demand of ASEAN and East Asian countries has declined by 8% during that period, with transport and aviation fuel demand accounting for the most. While renewable energy output is steady at a global level, fossil fuel units are absorbing profitability declines (footnote 47). Although electricity demand shifted from the industrial and transport sectors to the residential sector, increased household use has been outweighed by a massive reduction in demand from commercial offices and industrial operations. Relative to 2019, energy investments contracted by 17%. The rebound of energy demand depends on the rollout of vaccines and a restart of the industry and transport sectors, and other economic activities.

Figure 9: Changes in Global Energy Demand and Investments During the COVID-19 Pandemic



CO_2 = carbon dioxide, COVID-19 = coronavirus disease.
Source: International Energy Agency, 2020.

[51] Economic Research Institute for ASEAN and East Asia (ERIA). 2020. *Policy Brief Implications of the COVID-19 Crisis for the Energy Sector and Climate Change in ASEAN*. Jakarta.

[52] ASEAN Centre for Energy (ACE). 2020. Covid-19 vs. ASEAN Energy Sector: Electricity. *Energy Insight*. No. 4/2020, Jakarta.; IEA. 2020. *World Energy Outlook*. Paris; ERIA. 2020. *Policy Brief Implications of the COVID-19 Crisis for the Energy Sector and Climate Change in ASEAN*.

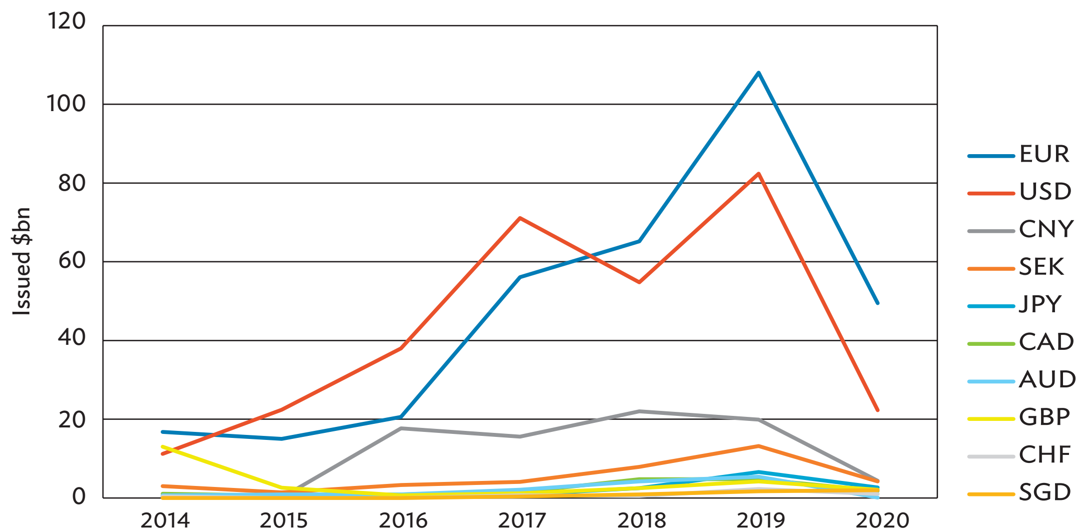
The pandemic also had an impact on energy job markets. In total, about 8.3 million jobs have been estimated to be lost due to COVID-19 outbreak in the Philippines. Indonesia's Planning and Development Agency reported its unemployment rate rose to about 10.0%, or nearly 14 million people from April–December 2020, a substantial part of them is in energy and manufacturing sector. Thailand's state planning agency has estimated that up to 2 million jobs, both direct and indirect and nearly one-third of them in the energy sector, may be lost (ERIA, 2021).[53] Significant efforts should be made for the region to generate more jobs through future low-carbon energy investments.

Private Financing and Resilience of Low-Carbon Energy Systems during the Pandemic

The pandemic has impacted the ability of equity and credit markets as well as the finance sector to finance low-carbon energy projects. Several renewable energy projects have been delayed due to disrupted supply chains, while projects requiring permits and approvals from governments have also been affected. With lockdown and social distancing measures, tender permits, approvals, and subsequent cash flows have been halted or delayed the planned financing of the projects. Further, the capacity of oil refineries has also been reduced. Since the proceeds of revenue from major oil-producing countries like Brunei Darussalam, Malaysia, and Indonesia have fallen, decreased capital spending on alternate low-carbon projects has also been observed.

There has been a reported loss of equity for many energy investments during the pandemic and investments in higher risk low-carbon energy projects have fallen substantially. The pandemic put a stress on bond markets issued in weak currencies. As illustrated by Figure 10, for the first time since 2014 bond issuance dropped drastically across all currencies. This trend may suggest the inclination for safe and sound investments during a time of marketplace uncertainties. This could be due to the origin of private capital, which is largely concentrated in the advanced economies of East Asia.

Figure 10: Changes in Global Green Bond Issuance During the Pandemic
($ billion)



Notes: EUR = euros; USD = US dollar; CNY = Chinese yuan; SEK = Swedish krona; JPY = Japanese yen; CAD = Canadian dollar; AUD = Australian dollar; GBP = British pound sterling; CHF = Swiss franc; SGD = Singapore dollar.

Source: Author based on data available at Climate Bonds Initiative. https://www.climatebonds.net/market/data/ (accessed 25 April 2020).

[53] ERIA. 2021. Webinar on *COVID-19 Pandemic and Financing the Low-Carbon Transition*. 26 February.

However, there are differences between categories of green bond issuance. In 2020, public sector issuers, such as national development banks, experienced a smaller decline compared to corporate sector issuers. Creating a stable and predictable policy environment for both local and foreign currency bond markets through institutional coordination and standard setting is critical. The growth of green bond markets in Malaysia (Box 2) offers a valuable lesson for the coordinated role of stock exchanges, private investors, and central banks.

Box 2: Growth of the Green Sukuk Bond Market in Malaysia

Malaysia has the third-largest bond market relative to gross national income in ASEAN and East Asia, and it is also a global leader in sukuk issuance. A sukuk is an interest-free bond that makes returns to investors without breaching the principles of Islamic Shariah law. The roots of Malaysia's success in growing its sukuk bond market have origins in 1990s when the country chose to develop bond markets as a tool to mobilize private capital in support of national infrastructure projects. The first sovereign five-year sukuk worth $600 million was launched in 2002. Since then, the Malaysian sukuk bond market is witnessing exponential growth with the support of the Securities Commission and the Central Bank.

In 2017, the first green sukuk in 2017 was launched by Malaysia, demonstrating the country's leadership and innovations in the global sukuk market. Green sukuk are Shariah-compliant investments in clean energy and other environmental assets as characterized by Climate Bond Standards. The Securities Commission and Central Bank of Malaysia are the two key institutions that played core roles to acquire authenticity in the advancement of sukuk markets by issuing comprehensive regulations and best-practice guidelines. The progress of the sukuk market is also supported by a wide-ranging reporting and settlement system, which has resulted in an active primary sukuk market. Further, the public pension fund also channeled a significant share of its savings into the sukuk bond markets, which in turn inspired buyer's confidence in securities and secondary markets. Sukuk issuance in 2019 reached nearly $100 billion. Considering the impact of coronavirus disease (COVID-19), the government continues to power its well-established sukuk bond market with the issuance of a $150 million 'care sukuk' to pay for economic relief packages and green recovery plan. The proceeds from the sukuk will be used to finance micro-enterprises, female entrepreneurs, support grants for research into infectious diseases, and to improve digital connectivity for rural schools.

Source: Compiled by the author.

Bond issuance during the pandemic witnessed renavigations in the second quarter of 2020. The Government of the Republic of Korea issued its first green bond for $996 million, the proceeds of which will be used to finance the mass rail transit project. The Republic of Korea's Kookmin Bank issued a COVID-19 Response Sustainability Bond for $500 million in September 2020, the first corporate initiative to refinance new and existing ESG-related projects in accordance with the bank's sustainable financing framework. In May 2020, the Government of the Hong Kong Special Administrative Region of the People's Republic of China, along with the Hong Kong Monetary Authority and Securities and Futures Commission, established the Green and Sustainable Finance Cross-Agency Steering Group, which is tasked with coordinating the supervision of climate risks to the financial sector. The Sustainable and Green Exchange was also established to serve as an information hub for low-carbon finance investments. Hong Kong, China's Mass Transit Railway issued a $1.2 billion green bond to alleviate the financial damage faced by the company due to the pandemic. The Hong Kong, China branch of the Industrial Bank also issued blue bonds of $450 million and COVID-19 resilience bonds of $0.38 billion. In Japan, the Mitsubishi UFJ Financial Group issued a 500 million-euro sustainability bond, the first corporate bond issued in Japan to be linked to COVID-19.

While many developing economies of Asia are set for an extended period of very low interest rates, there could be increased opportunities for green bond markets if downside risks are addressed, and sector imbalances corrected through improved disclosure strategies. Some public sector issued bonds may require temporary debt relief to respond to the adverse impact of pandemic on borrowings.

Unlocking Private Financing Potential Through Stimulus Packages

Whichever way the new energy investment regimes evolve in the post-pandemic era, a lot more private capital will be required to facilitate the low-carbon energy transition. On the other hand, the pandemic provides an opportunity to implement energy policy reforms that could serve as risk mitigants for private financing. Policy makers should align their crisis response to avoid lock-in on a high-carbon emissions trajectory. The relative resilience of renewable energy investments in several emerging economies of ASEAN, India, and the PRC may be attributed to support provided to state-owned enterprises and financial institutions, and to private financial institutions through recovery and stimulus packages. In response to the pandemic shock, governments have introduced fiscal stimulus packages on a massive scale, amounting to 4%–40% of gross domestic product (GDP) (Table 7). ASEAN's recovery packages as of April 2021 totaled $191.64 billion, accounting for 10.89% of GDP, while that of seven partner countries totaled $6.74 billion, accounting for 9.71% of GDP.

Table 7: Size and Content of Fiscal Response to COVID-19
($ billion)

Country	Total	Health Sector	Non-health Sector	Accelerated Spending/ Deferred Revenue	Equity Injections, Loans, Asset Purchase, or Debt Assumptions	Guarantees	Quasi-Fiscal Operations	Share of GDP (%)
ASEAN	191.64	8.36	103.10	11.56	23.71	35.23	9.39	10.89
Indonesia	41.70	5.20	23.84		2.40	10.26		13.50
Singapore	70.15	0.58	53.69		15.88			20.70
Brunei Darussalam	0.14							10.70
Malaysia	30.66	0.38	14.47	3.87		11.94		23.50
Philippines	12.36	1.29	7.18		1.46	2.41	0.02	39.20
Thailand	21.73				2.94	10.62	8.17	38.40
Cambodia	0.06	0.06						39.90
Lao PDR	0.00	0.00						15.50
Viet Nam	13.50	0.69	3.52	7.69	0.41		1.20	14.30
ASEAN partners	6,743.37	389.69	3,617.01	535.01	77.05	852.96	1,271.65	9.71
Australia	180.63	6.61	149.93		10.33	13.77		7.50
Japan	1,961.00	47.58	507.51	242.56		146.47	1,016.88	7.40
Republic of Korea	246.54	4.26	51.11	27.56		59.21	104.39	3.80
United States	2,977.00	304.00	2,145.00	18.00	56.00	454.00		11.40
PRC	1,141.84	21.83	684.83	237.63		59.41	138.13	8.30
India	190.77	4.90	41.49	9.25	6.80	116.08	12.25	23.60
New Zealand	45.60	0.51	37.13		3.93	4.02		6.00

ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Source: Author based on International Monetary Fund database https://www.imf.org/en/Topics/imf-and-covid19/Fiscal-Policies-Database-in-Response-to-COVID-19 (accessed on 1 May 2021).

The creation of special purpose vehicles for mobilizing private capital is in progress in India, Indonesia, Malaysia, the PRC, and Thailand. During the pandemic, Thailand outlined new financial mechanisms to establish the country as a manufacturing club for electric vehicles in the next 5 years. The Sustainable Energy Development Authority (SEDA) of Malaysia announced plans to build 4.3 gigawatts of solar cell module manufacturing units, making it the third-largest maker in the region. The Republic of Korea's W66 million New Deal plans to invest in low-carbon green infrastructure, including renewable energy and energy efficiency.

In order to develop more clean energy and sustainable financial products and markets, the Monetary Authority of Singapore launched the Sustainability-Linked Loan Grant Scheme, worth S$91.75 million. It defrays expenses incurred from engaging with independent advisors to validate green and sustainability-linked loans and encourages banks to develop more accessible framework conditions for green and sustainability loans. The Government of Japan launched a Y$2 trillion ($19.2 billion) innovation fund to support zero-emission projects for the next 10 years. The fund will create large-scale and low-cost hydrogen production equipment. In July 2020, the PRC's Ministry of Finance and Ministry of Ecology and Environment, along with the Shanghai City Government, launched the National Green Development Fund, which seeks to assist the low-carbon transformation of the Chinese economy and reinforce the market's role in combating pollution. In its first phase, the fund has raised CNY88 billion ($12.6 billion), which will be used to invest in green projects.

There are several strategic sectors in the developing countries of ASEAN whose transformation is central to stimulate green recovery. But the key challenge for institutional investors in many countries is a careful selection of the types of low-carbon technological and infrastructure investment that can bring both jobs and economic growth benefits. Pricing carbon and removing fossil fuels subsidies can accelerate the low-carbon transition and raise revenues for the public financing of low-carbon energy infrastructure that would have leveraging effects in attracting private capital. Nevertheless, green stimulus appeared to be most effective in countries and communities which had workforce that already possess the skills required for green jobs.[54]

Governments will need to take the following three actions as a priority. First, planned low-carbon energy infrastructure investments will need to be fast and labor-intensive in the short term, and have high multiplier co-benefits in the long run. Second, the stimulus and recovery packages will need to incorporate supporting energy, environment, and economic policies that maximize social benefits and reduce the cost of climate actions. While several stimulus packages announced by Japan, the PRC, and the Republic of Korea have spelt out strategies and financial outlays for net zero emission targets, they are not comparable to the EU's 500 billion-euro economic response to the pandemic, with 25% of the stimulus set aside for low-carbon energy investments. The European package is designed to maximize private financing potentials and the effective use of private financing channels in renewable energy, energy storage, hydrogen fuel, storage batteries, and carbon capture and storage. Third, it will be crucial to establish a regional transition fund to give guarantees for initially high-risk, low-carbon energy investments. Regionally coordinated carbon pricing and subsidy reform as well as issuance of social and green bonds will provide a source of revenue and can be part of wider fiscal reforms to instill confidence among private financiers.

Conclusion and Recommendations

Transitioning to a low-carbon economy requires massive mobilization of private capital. It is imperative for governments to have a clear view of policy instruments that may unlock the potential of private capital. Emerging regional experiences in ASEAN and East Asia suggest that private financial flows channeled through innovative private financing instruments have the capacity to support clean energy infrastructure

[54] Z. Chen et al. 2020. Green Stimulus in a Post-pandemic Recovery: the Role of Skills for a Resilient Recovery. *Environmental and Resource Economics*. Vol. 76. pp. 901–911.

projects. Surveys show that private investors and central banks are looking for ways to upscale private financing in the low-carbon economy, but barriers do exist. Four interrelated regionally coordinated actions may reduce these barriers and act as risk mitigants and investment enablers. They are: (i) the creation of a low-carbon fund, (ii) formulation of a financial warranty program, (iii) drafting of supporting regulations, and (iv) the creation of an integrated carbon market. In order to realize these actions, new carbon markets need to be created at national levels and then integrated at the regional level. This means working to develop market-oriented energy pricing policies and scaling up emission trading systems, optimizing the risk that the private sector carries and using concessional finance windows.

The COVID-19 pandemic has brought new risks and uncertainties to the trajectory of equity and bond markets. While the health crisis is provoking both demand- and supply-side shocks in the energy sector, it also offers a rare opportunity for the strategic reorientation of private investments in the low-carbon energy sector. It is critical to align the objectives of stimulus and economic recovery packages with low-carbon energy development and devise appropriate support policies.

For equity markets, one of the main challenges to accelerate investment in the low-carbon economy lies in investor perceptions and viability gaps. While low-carbon energy investments in geothermal, solar, and wind have become competitive, institutional investors may be skeptical as to whether new investments in other renewable energy sources could achieve reasonable risk-adjusted returns. Communicating long-term energy policy objectives and comparative advantages of such investments in clear statements and enhanced power purchase agreements would help to address the concerns of financiers. For listed stock markets, firm- or sector-level data availability on monetizable carbon benefits and transparency is an imperative for private financiers to make well-informed decisions. To improve data availability, public authorities and stock exchanges could design better reporting practices and develop a regional level open-source registry of low-carbon energy projects. Where possible, a regionally accepted taxonomy to define low-carbon energy projects and green bonds requires to be worked out.

The biggest impediment to further developing the green bond market is not the willingness of investors, but the availability of appropriate taxonomy and respective securities. Moreover, there are few service providers in the region who can support a bond issuer, either government-backed or corporate, on the green certification or labeling process. To help develop the market, governments should provide favorable and verifiable listing conditions and incentivize the issuance of bonds for specific low-carbon energy projects by covering some of the extra costs required for the verification process. Despite the growing popularity of climate bonds, a broader set of instruments will be required in the aftermath of the pandemic to divert capital from the refinancing of carbon-intensive fossil energy projects and business models.

Crowd funding or blended finance, with a lead role played by public capital injection, could be a suitable financing structure to improve the appeal for private financing during the pandemic recovery phase. Governments, including several local governments in ASEAN and East Asia, possess considerable know-how in this field and should now focus on promoting these solutions for energy efficiency and renewable energy investments. Broadening opportunities through stimulus packages could increase the interest of private financiers. This could be fostered by low-carbon investment knowledge platforms, currently hosted by regional knowledge institutes, documenting and sharing best practices.

Enhanced private financing of a low-carbon energy transition requires the willingness of governments to internalize the externalities of energy transition adequately. Financial assets in the real economy and conventional energy infrastructure are long-existing, and curtailing their lifetime is politically and financially challenging. Public policies are also needed to incentivize private investment in the research, development, and deployment of new technologies and innovations systems. An intense dialogue between all stakeholders, namely governments, financial market regulators, central banks, lenders, and investors, is recommended to build an effective regional cooperation framework.

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11 Role of Carbon Markets in Clean Energy Finance

Lingshui Mo and Xuedu Lu

Introduction

Carbon dioxide (CO_2) emissions from fossil fuels combustion accounts for over two-thirds of global greenhouse gas emissions.[1] Efforts to reduce carbon dioxide emissions in the energy sector is critical to combat global climate change. Putting an appropriate price on carbon emissions will effectively limit carbon emissions in the energy sector and promote clean energy investment. The carbon pricing mechanism offers a channel to direct private financial flows to clean energy due to increasing the carbon emission cost of fossil fuels. There are two main routes for the carbon pricing mechanism: carbon trading and carbon tax. Unlike carbon tax enforced by regulations, the carbon market takes the market force to incentivize entrepreneurs' and private investors' investment in clean energy.

Carbon trading involves two tradable units: emission allowances and emission savings–carbon credits. They are created in two types of carbon markets: the emissions trading scheme ([ETS], trading emission allowances) and the crediting scheme (trading carbon credits). In an ETS, emissions are capped at a predetermined level, and the market establishes an emission allowances price necessary to meet that cap. In a crediting scheme, emission reductions relative to a baseline or target are credited, which can be for specific projects, sector performance, or the result of policies. The price of carbon credits is determined by the demand and supply balance. Buyers may purchase credits either for compliance under an ETS or voluntary purposes. Through trading carbon assets (including allowances and carbon credits), the carbon market could reduce mitigation cost as it facilitates emissions reductions to take place where it is cheapest.

The carbon market is a cost-effective policy instrument to combat climate change and is also an important component of the Paris Agreement. The carbon market has been implemented at the international level and at the regional, national, and subnational levels in Asia and the Pacific. There are growing interests in carbon trading mechanism as a key option for ambitious climate action in the region.

This chapter discusses the potential of the carbon trading mechanism (called carbon market mechanism) in clean energy financing and explores ways to maximize the use of the carbon market in financing clean energy.

The chapter is structured into four main sections: the introduction session is followed by the section on the role of the carbon market in clean energy financing, the state of the carbon market in Asia and the Pacific and its impact on clean energy investment and financing, overall assessment of existing carbon markets on clean energy financing, potential carbon markets for financing clean energy. The final section discusses the ways to enhance the role of the carbon market in clean energy financing.

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[1] International Energy Agency (IEA). 2020. CO_2 Emissions from Fuel Combustion: Overview 2020.

Role of the Carbon Market in Clean Energy Financing

This section discusses the possible avenues that the carbon market could contribute to clean energy financing and investment. In general, the carbon market could influence clean energy investment and financing in three ways:

Firstly, carbon market can improve the market competitiveness of clean energy. The lack of carbon pricing is one of the barriers preventing clean energy from competing with fossil fuels. Carbon market mechanism could internalize the environment cost of fossil fuels, which increases the operational cost of fossil fuels investment and reduces its investment return rate. The carbon market, in turn, raises the competitive advantage of clean energy investment, which would promote clean energy investment and attract financing for clean energy.

Secondly, under a crediting scheme, the carbon market allows clean energy projects to earn revenues from sales of their greenhouse gas emission reductions (carbon credits). The eligibility of offset projects, trading products, e.g., spot contract, forward or future contract could affect traded volume and traded value of carbon credits, which have direct impact on clean energy financing. As such, carbon market could provide additional financing for clean energy projects. Meanwhile, additional revenue stream could also motivate clean energy investment and direct private capital into clean energy.

Thirdly, with an emission trading scheme, the allocation method of allowances, offset rules and trading policy could impact clean energy financing. Governments could collect revenues through auctioning emission allowances or require the ETS participants to make a payment to the government at a fixed price, and then distribute the revenues to clean energy projects. For example, the European Union Emissions Trading System (EU ETS) directive[2] requires the European Union (EU) Member States to use at least 50% of auctioning revenues or the equivalent in financial value for climate- and energy-related purposes. The total revenues raised from selling allowances in the EU ETS from 2012 to the end of 2017 exceeded €21 billion. In 2018, €14 billion were raised, and in 2019 over €14.6 billion. Around 80% of raised revenues in 2013–2018 were used for climate- and energy-related purposes. In particular, the EU established the NER300 program, a large-scale funding program for innovative low-carbon energy demonstration projects (including carbon capture and storage [CCS] and innovative renewable energy [RES] technologies) on a commercial scale within the EU. The NER 300 program is funded by the sale of 300 million emission allowances from the new entrants' reserve (NER) set up for the third phase of the EU ETS. In addition, offset rules of an ETS allows its ETS participants to offset their emissions through purchasing carbon credits generated by clean energy projects, which could help clean energy projects raise revenue streams from sales of carbon credit. The ETS participants may also sell their extra allowances leftover in secondary market and earn revenue.

State of Carbon Markets and Its Impact on Asia Clean Energy Financing

This section reviews current international carbon market and domestic carbon markets. It discusses those critical elements of a carbon market that could directly affect clean energy investment and financing, e.g., allocation method, offset rules, trading policies etc. This section also analyzes the factors relating to clean energy financing, including eligible emissions-reduction projects, certified emissions reductions, and carbon price, and assesses their impacts on clean energy investment and financing.

[2] European Union. 2021. https://ec.europa.eu/clima/policies/ets_en.

International Carbon Market: Clean Development Mechanism

International carbon market refers to those governed by international climate treaties and administrated by international organizations. International carbon market allows trading carbon assets across borders and could reduce the costs of global climate mitigation. Current international carbon market was established under the Kyoto Protocol.

The Kyoto Protocol defines three market mechanisms, namely, International Emission Trading (ETS), Joint implementation, and Clean Development Mechanism (CDM). CDM is an international crediting scheme that allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits. Each CER is equivalent to 1 tonne of CO_2 reduction. These CERs could be traded and used by developed countries to meet part of their emission reduction commitments from 2008 to 2020 under the Kyoto Protocol. Emission-reduction projects in developing countries could earn a revenue stream from sales of CERs. With this design, the CDM provides financing for clean energy projects and creates incentives to stimulate clean energy investment in developing countries.

Basic Prerequisite of a Project Taking Advantage of Clean Development Mechanism for Financing

CDM provides a possibility for the emission-reduction projects to earn a revenue stream. However, to earn revenue from sales of CERs, a project must register as a CDM project, and the generated emissions reduction must be certified as CERs.

A CDM project must meet two fundamental requirements:

- The project activity would result in emission reduction. The project's emissions must be below the identified baseline scenario;
- Project activity is additional by applying a tool to demonstrate the additionality, which the project activity would not have proceeded without CDM financing.

Review of the Clean Development Mechanism

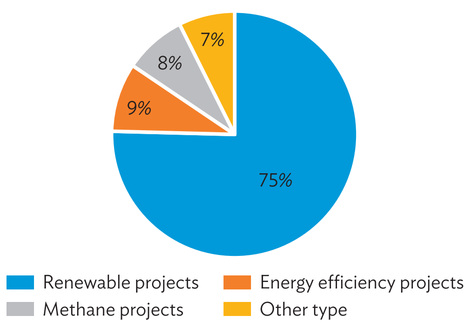
Asia Clean Energy Projects under Clean Development Mechanism

Clean energy is a key focus for Asian countries' low carbon development. From 2004 to 2019, there were 5,673 clean energy projects registered as CDM projects, taking up 84% of Asia CDM projects.[3] Renewable energy was the most popular sector among all types of CDM projects (Figure 1). The People's Republic of China (PRC) and India accounted for the lion's share of Asia's clean energy projects, with 60% and 27%, respectively (Figure 2).

The Asia clean energy projects registered under CDM rapidly increased after the Kyoto Protocol came into force in 2005 until 2012, with the most rise in 2012. But it saw a drop in 2013, and then declined year-by-year (Figure 3). This was because that the European Union (EU) ETS restricted the use of CERs from the non-least developed countries' (LDCs) projects from April 2013. Meanwhile, there were no greenhouse gas (GHG) emission reduction commitments by developed countries after 2012 as the second phase of the Kyoto Protocol failed to reenter into force. Policy changes in the use of CERs and the lack of commitments to emission reduction reduced registered CDM projects from 2013.

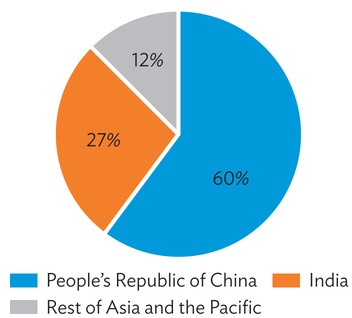
[3] United Nations Framework Convention on Climate Change (UNFCCC). 2020. Database for Project Activities and Programmes of Activities (PAs and POAs). https://cdm.unfccc.int/Statistics/Public/CDMinsights/index.html (accessed 24 August 2020).

Figure 1: Distribution of Asia Clean Development Mechanism Projects by Technology (%)



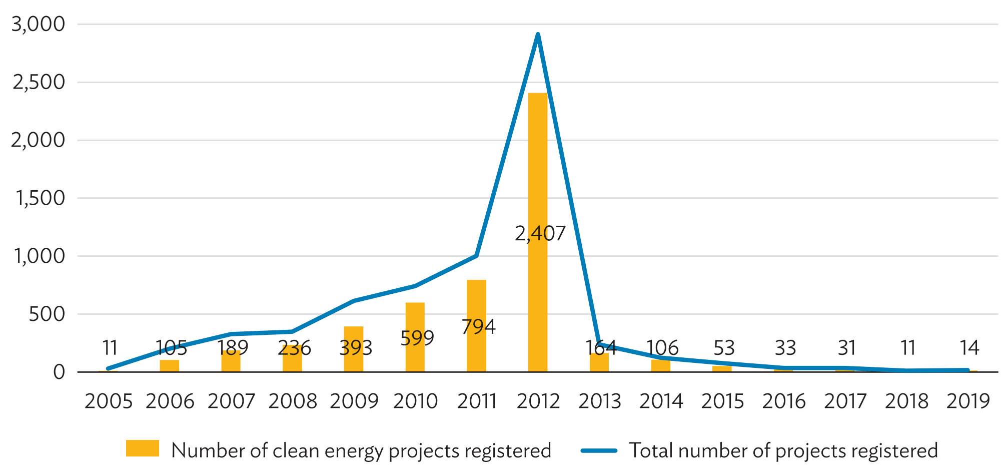
Source: United Nations Framework Convention on Climate Change.

Figure 2: Distribution of Asia Clean Energy Projects under Clean Development Mechanism by Country (%)



Source: United Nations Framework Convention on Climate Change.

Figure 3: Trend of All Projects and Clean Energy Projects Registered under Clean Development Mechanism in Asia and the Pacific



Source: Database for Project Activities and & Programmes of Activities (POA), United Nations Framework Convention on Climate Change.

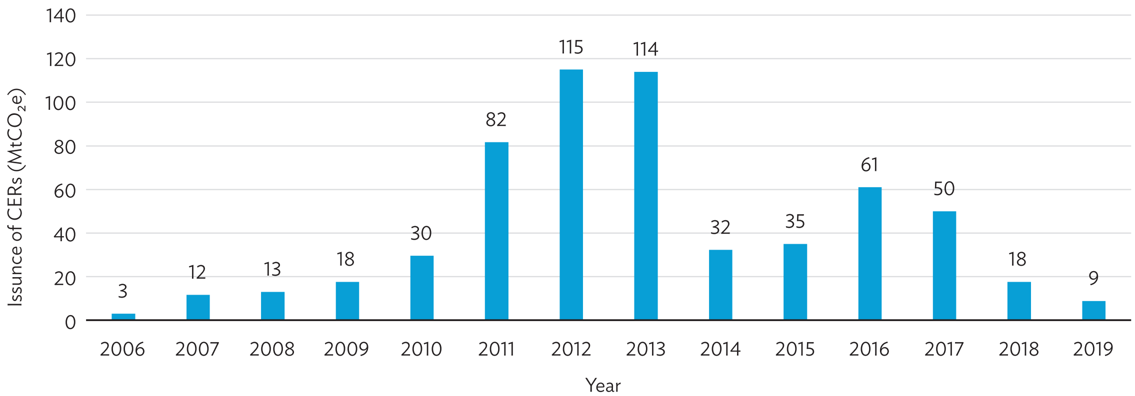
Issuance of Certified Emissions Reductions

From 2006 to 2019, cumulative issuance of CERs by Asia clean energy projects was 590 million tons of carbon dioxide equivalent ($MtCO_2e$), making up 37% of the total issued CERs in Asia & Pacific.[4] Figure 4 shows that CERs' issuance trend is consistent with that of registered clean energy projects in Asia and the Pacific, as presented in Figure 3.

The issued CERs gradually increased since 2006, peaking in 2013 and dropping in 2014. From 2014, CERs' issuance declined continuously as a result of the lack of demand for CERs due to no commitment to emission reductions and future uncertainty of CDM.

[4] Footnote 3.

Figure 4: Issuance of Certified Emissions Reductions by Asia Clean Energy Projects 2006–2019



CER = certified emissions reduction , $MtCO_2e$ = million tons of carbon dioxide equivalent.

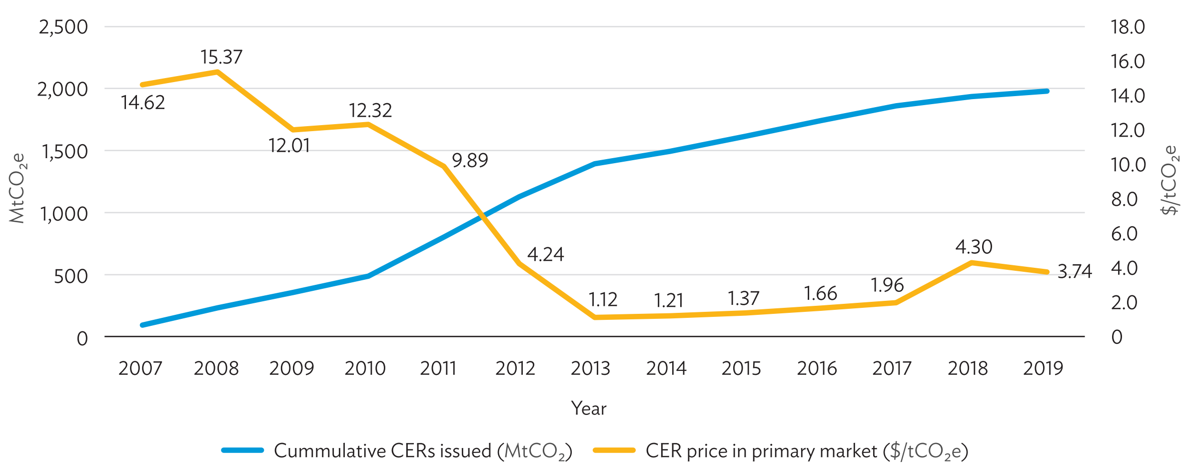
Source: United Nations Framework Convention on Climate Change.

Certified Emission Reductions' Prices

The CERs' price in the primary market (pCERs market) represents direct trading price between CDM projects' investors and/or developers and buyers that directly affects the sales' revenues of CDM projects. The pCERs is indexed to the price of CERs in the secondary market (sCERs market). The pCERs usually traded at 75%–90% of the value of sCERs, so when the latter changed, did the former.

Figure 5 indicates that the pCERs' price experienced a short period of rising between 2007 and 2008, with a drop in 2009 due to the global economic downturn. From 2009, pCERs price has fallen and collapsed to only $1.12 per tonne of carbon dioxide equivalent (tCO_2e) in 2013, then kept running low. The declining trend of CERs' price since 2009 reflects a lack of demand for CERs while increasing cumulative issued CERs in the market.

Figure 5: Historic and Average Certified Emission Reductions' Price in the Global Primary Market and Cumulative Volume



CER = certified emissions reduction, $MtCO_2e$ = million tons of carbon dioxide equivalent, tCO_2e = ton of carbon dioxide equivalent.

Note: CERs prices was calculated based on traded value in primary market according to the data from Carbon Market Monitor in Thomson Reuters Point Carbon.

Source: CERs issuance extracted from United Nations Framework Convention on Climate Change CDM Insight.

Impact on Clean Energy Investment and Financing

One of the CDM contributions is that the revenue from sales of CERs can both complement and leverage other financial resources to unlock low carbon investment in developing countries.

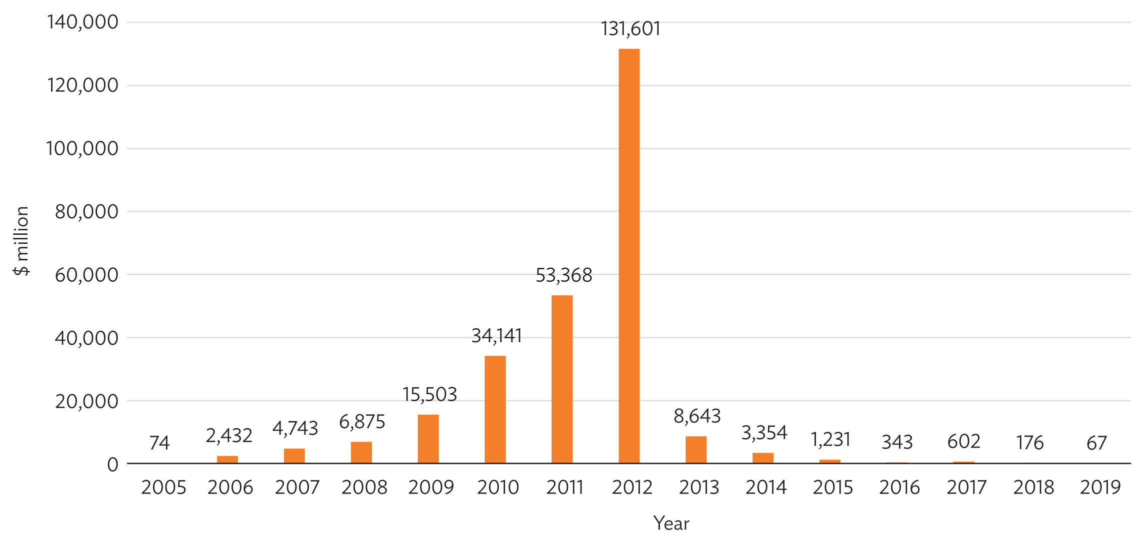
Triggering Clean Energy Investment

The revenues created by the CDM enhance the overall financial viability of clean energy projects. The CDM revenues also leverage upfront capital for underlying investments that could help overcome clean energy investment barriers. In combination with other financing instruments, CDM catalyzed large additional investment flows to clean energy.

From 2005 to 2019, CDM attracted about $263 billion of investment into clean energy projects in Asia and the Pacific developing countries, accounting for 88% of the total investment of all Asia CDM projects.[5] This investment would not have taken place without CDM.

Figure 6 exhibits that annual the Asia clean energy investment triggered by CDM rapidly went up since 2005 and peaked in 2012, but deeply fell in 2013, and then contracted every year. This movement is because clean energy projects registered under CDM were getting fewer since 2013, as indicated in Figure 3 and its analysis.

Figure 6: Total Investment in Registered Clean Energy Projects in Asia and the Pacific by Year



Source: Extracted from the database for Project Activities and Programmes of Activities (PA and POA), United Nations Framework Convention on Climate Change.

Raising Additional Revenue for Financing Clean Energy Projects

From 2007 to 2019, total revenue raised by developing countries from sales of CERs in the CDM market amounts to approximately $33 billion.[6] It is estimated about 85% of the raised revenues flowing into Asia and the Pacific,[7] benefiting some $299 billion in underlying climate-friendly investment.

[5] Author's calculations according data from database for Project Activities and Programmes of Activities (PA and POA) in United Nations Framework Convention on Climate Change (UNFCCC).

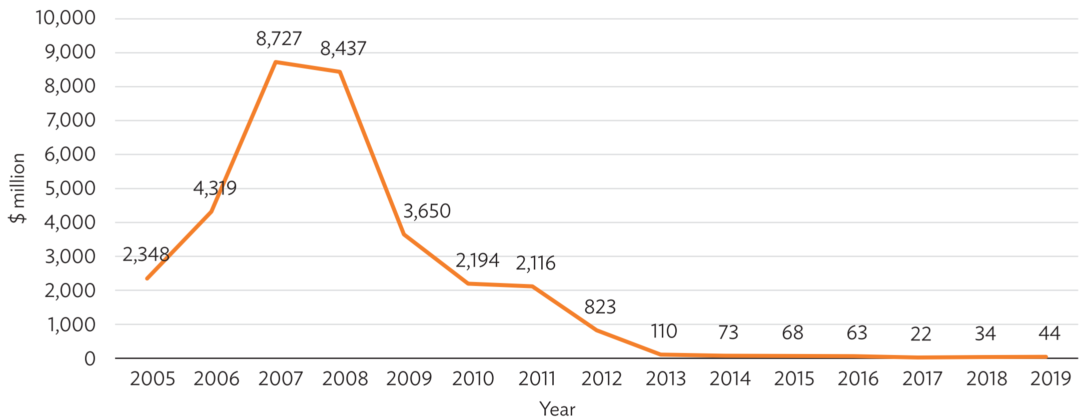
[6] Author's estimates based on traded value of pCERs.

[7] Author's estimates based on the share of issued CERs.

Weakening Impact of Clean Development Mechanism on Clean Energy Financing from 2013

The traded value of pCERs represents the revenues from sales of CERs that directly go to project sponsors or investors, which is deemed as financing for the CDM projects. The traded value of pCERs is a result of pCERs' price and traded volume of pCERs. The traded value climbed and hit to ceiling between 2007 and 2008, with a sharp drop in 2009, and then gradually contracted (Figure 7). This trend is consistent with the evolution of pCERs' price as presented in Figure 5. The traded value of pCERs has been declining, representing the drop in financing for the CDM market. The traded value of pCERs dropped to only $44 million in 2019 from peaking at $8.7 billion in 2007. Declining traded value of pCERs is as a result of falling demand for CERs and depressed prices of CERs.

Figure 7: Certified Emissions Reductions Traded Value in Global Primary Market by Year



pCERs = certified emissions reductions' price in the primary market.

Source: Carbon Market Monitor in Thomson Reuters Point Carbon.

National and Subnational Carbon Markets in Asia and the Pacific

Carbon Markets in the People's Republic of China

Pilot Emissions Trading Schemes

The PRC officially approved seven pilot emission trading schemes in Beijing, Shanghai, Tianjin, Chongqing, Shenzhen, Hubei, and Guangdong. The seven pilot ETSs cover about 1.2 billion tCO_2e of emissions.

Allocation Method

Table 1 shows that the free allocation of allowances is a main method used in seven pilots ETS. Auctioning allowances was only used for market stabilization (in the case of carbon price exceeds certain level) in four pilots ETSs (including Beijing, Shanghai, Tianjin, Hubei) and increasing market supply for entities' compliance (Shenzhen), not as allocation approach. Only a small share of allowances was auctioned in Guangdong ETS, while no auction of allowances was reported in Chongqing ETS.

Table 1: Allocation Methods and Carbon Price in Pilot Emissions Trading Systems in the People's Republic of China

Pilot ETS	The Latest Number of Covered Entity	Free Allocation	Auction and Auctioning Price	2019 Average Carbon Price in Secondary Market ($/t$CO_2$e)
Beijing	903	Mainly free allocation through grandparenting based on emissions or emissions intensity in the baseline years	Beijing sets aside up to 5% of allowances for market stability. The government would auction extra allowances if the weighted average price exceeds $21.34 for 10 consecutive days, and buy-back allowances from the market using a special funding source. To date, the trigger price for additional auctions has never been met.	11
Chongqing	195	Free allocation through grandparenting based on historic emissions	Not applicable	1
Shanghai	298	Free allocation based on sector-specific benchmarks	A small share of the annual cap would be auctioned is to provide entities with additional allowance to meet their compliance demand. Shanghai auctioned two million tonnes from the government reserve in 2019, with a floor price set at 1.2 times the weighted on-exchange allowance price from 1 August 2018 to 28 November 2019 ($6.83). A total of 73,421 allowances were sold at floor price. An auction of 2 million allowances was held in 2018. Fifteen percent of allowances were sold, at the floor price of $6.28.	6
Shenzhen	794	Free allocation based on sector-benchmarking and intensity, grandparenting	Three percent of allowances could be auctioned to increase market supply, and not as a means of allowance allocation. So far, only one auction took place (June 2014) in order to increase market supply.	2
Tianjin	113	Mainly free allocation through grandparenting based on 2009–2012 emissions or on emissions intensity	The first auction was held in 2019. 2 million tonnes were on offer with the auction clearing at CNY14.63/ton ($2.08).	2
Guangdong	279	Ninety-five percent of allowances is free allocation for power sector and 97% for remaining sectors, based on grandparenting, historical intensity, or benchmarking	Three to five percent of total allowances is allocated through auction. The available auction allowances was increased from 2 million allowances in previous years to 5 million allowances in 2019. Quarterly auctions were held until 2016, while in 2017 and 2018 auctions were ad hoc. No auction took place in 2018 or 2019. Auctions are subject to an auction floor price.	3

continued on next page

Table 1 *continued*

Pilot ETS	The Latest Number of Covered Entity	Free Allocation	Auction and Auctioning Price	2019 Average Carbon Price in Secondary Market ($/$tCO_2$e)
Hubei	338	Free allocation of 2018 were vintage allowances through benchmarks for power and cement (except the entities using outsourced clinker).	In 2019, two separate auctions of 5 million allowances were made available from the government reserve (8% of the total cap is kept as a government reserve for market stabilization), with a reserve price set at the weighted spot market price from 30 October 2017 to 30 October 2019. The first auction offered 2 million allowances, with only 1.49 million sold to compliance entities at an average price of $3.50. Remaining allowances were made available to compliance entities and other market participants. The total auction volume was 3.51 million tonnes, including 0.51 million that was left from the first auction at an average price of $3.48.	5

ETS = emissions trading scheme, tCO_2e = tons of carbon dioxide equivalent.

Sources: Beijing Development and Reform Commission (DRC), Chongqing DRC, Fujian DRC, Shanghai DRC, Shenzhen DRC, Tianjin DRC, Guangdong DRC, Hubei DRC.; International Carbon Action Partnership. 2020. Emissions Trading Worldwide: Status Report 2020. Berlin: International Carbon Action Partnership.

Offset Rules

All pilot ETSs allow their participants to use domestic credits but sets limits. The limit on using credit for compliance varies by scheme, with different requirements for project types and geographic range. The China Certified Emission Reductions (CCERs) under the People's Republic of China GHG Voluntary Emission Reduction Program (CVER) can be used by participants for compliance in seven polit ETSs. Table 2 shows the range of credits for compliance and requirements for source of credits in pilot ETSs. The CCERs sourced from clean energy projects, especial renewable energy projects were the most popular for compliance (see details in China Voluntary Emission Reduction Program).

Limits on using credits of pilot ETSs ranges from 5% to 10% of their participants' emission obligations. Based on this percentage, it is estimated that theoretical demand for domestic credits of all pilot ETSs would have been at 60 million tCO_2e–120 million tCO_2e per year.

Table 2: Requirements and Limits on the Use of Credits for Compliance in Pilot Emissions Trading Schemes in the People's Republic of China

Pilot ETS	Limit on Use of Offset Credit for Compliance	Project Type for CCERs	Geographic Range for Source of CCERs
Beijing	China Certified Emission Reduction (CCERs) units up to 5% of the annual allocation and at least 50% from local projects	Emission reduction projects except for hydro, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrous oxide (N2O), sulfur hexafluoride (SF_6)	At least 50% of CCERs from local projects
Chongqing	CCER units up to 8% of the compliance obligation	Emission reduction from energy conservation and energy efficiency, non-hydro renewable energy, carbon sequestration in forestry; as well as emission reduction from agriculture and waste disposal, etc.	No geographic restriction
Shanghai	CCER units were up to 5% of the annual allocation between 2013 and 2015. Since 2016, the use of CCER credits is limited to 1% of the annual allocation.	Emission reduction from non-hydro projects	No geographic restriction
Shenzhen	CCER units up to 10% of the annual compliance obligation	Wind and solar power, waste incineration for power generation, household biogas and biomass for power generation, clean transport, carbon sequestration in marine, mitigation projects in forestry, agriculture, etc.	1. CCERs from wind, solar, and waste incineration for power projects in defined provinces 2. CCERs from all forestry and agriculture 3. CCERs from other projects in the regions that have a memorandum of understanding with Shenzhen
Tianjin	CCER units up to 10% of the annual compliance obligation	Only CO_2 reduction projects, excluding hydro	CCERs from projects in Beijing–Tianjin–Hebei region
Guangdong	CCER units up to 10% of emissions. Pu Hui Certified Emission Reductions (PHCER) that encourages the public to reduce carbon emissions are also allowed to use for compliance during 2017 and 2018. In 2018, entities were allowed to make use of 1.5 million offsets (CCER and PHCER) toward compliance obligations. The number for 2019 has not yet been announced.	Mitigation projects except for hydro, fossil fuels for power and heating, utilization of waste energy	At least 70% of CCERs from local projects
Hubei	CCER units up to 10% of the annual initial allocation for each entity	Emission reduction from agricultural biogas and forestry projects	Only CCERs from local projects in poverty areas of the province

CO_2 = carbon dioxide, ETS = emissions trading scheme.

Source: Compiled by the authors from Beijing Development and Reform Commission (DRC), Chongqing DRC, Fujian DRC, Shanghai DRC, Shenzhen DRC, Tianjin DRC, Guangdong DRC, Hubei DRC.

Trading Policy

Pilot ETSs only allow trading spot commodity of allowances and credits. Trade derivatives are prohibited.

Impact on Clean Energy Financing

Since the first auction in Shenzhen ETS in 2014, about $117 million was collected by the local governments through auctioning allowances. Guangdong ETS contributes to $114 million, accounting for 97% of total collected revenue of pilot ETSs as Guangdong ETS takes auction as one of allocation ways. Auction is used as a means of market stabilization in other pilot ETSs and it is only triggered in the case of carbon price exceeding a certain level. Therefore, the revenue collected by other pilots ETSs is limited. The auctioning price ranged from $2.08(Tianjin ETS) to $6.83/t$CO_2$e (Shanghai ETSs). The raised revenue was used as general government budgets, not assigned for clean energy.

Table 3 : Revenue from Auction of Allowances in Pilot Emissions Trading Systems in the People's Republic of China

Pilot ETS	Total revenue collected from auction	Auctioning price ($/t$CO_2$e)
Beijing	N/A	N/A
Chongqing	N/A	N/A
Shanghai	Since the beginning of the program: CNY18.17 million ($2.58 million) was collected by 2019.	6.28–6.83
Shenzhen	Since the beginning of the program: CNY2.6 million in 2014 ($390,000)	N/A
Tianjin	Revenue collected in 2019: CNY15.7 million ($2.23 million)	2
Guangdong	Since the beginning of the program: CNY804 million ($114 million) No revenue in 2019 (no auctions took place in 2019)	1.33–8.54
Hubei	Since the beginning of the program: CNY122.74 million ($17.45 million) Collected in 2019: CNY122.74 million ($17.45 million)	3.48–3.5

CNY = yuan, ETS = emissions trading scheme, tCO_2e = tons of carbon dioxide equivalent.

Source: International Carbon Action Partnership. 2020. Emissions Trading Worldwide: Status Report 2020. Berlin: International Carbon Action Partnership.

Carbon prices in secondary market of seven pilots ETSs were lower, ranging from $1.98/t$CO_2$e (Shenzhen and Chongqing) to $11.37/t$CO_2$e (Beijing) in 2019 (Table 4).

Table 4: 2019 Average Carbon Prices in Seven Pilot Emissions Trading Systems

Pilot Emissions Trading System	Beijing	Chongqing	Shanghai	Shenzhen	Tianjin	Guangdong	Hubei
Carbon price ($/t$CO_2$e)	11.37	1.41	5.86	1.98	1.98	3.36	4.64

tCO_2e = tons of carbon dioxide equivalent.

Source: Sino-carbon. 2020. Annual Review: The total transactions increased in pilot carbon markets. 27 October.

The trading spot commodity policy limits market liquidity, plus low carbon prices, causes a low traded-volume and traded value. By 2019, accumulated traded volume was 395 million tCO_2e, with a traded value of CNY916 million in seven pilot ETSs, while traded volume and traded value were respectively $6,777 million

tCO_2e and $189,766 million in EU ETS in 2019.[8] The low traded volume and the traded value represents a weak ability in attracting capital into the carbon market.

The People's Republic of China Greenhouse Gas Voluntary Emission Reduction Program

The People's Republic of China Greenhouse Gas Voluntary Emission Reduction Program (CVER) began operation in 2014 as an offset crediting scheme. The CVER program has two objectives: one is to promote domestic GHG emission reductions and provide flexibility for pilot ETSs participants to offset their emission obligations, and another is to build experience on carbon trading for its upcoming national ETS.

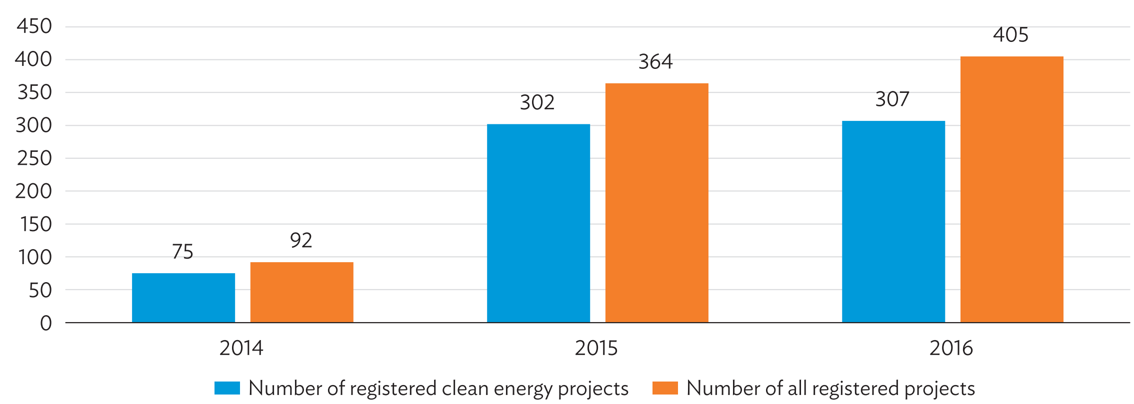
Chinese Certified Emission Reductions (CCERs) issued under CVER can be used by participants to meet emission obligations in the pilot ETSs. The CVER program covers five sectors: energy efficiency, renewable energy, fuel switch, forestry, and waste.

The registration and issuance of CCERs have been suspended since March 2017 due to the amendment of the CVER program. However, CCERs already issued can still be traded and used in pilot ETSs.

Projects under the People's Republic of China Greenhouse Gas Voluntary Emission Reduction Program and Issuance of Chinese Certified Emission Reductions

Since its operation, 861 projects were registered under CVER, with 79% of projects from clean energy[9] (Figure 8). From 2014 to 2019, around 53 million of CCERs were issued, of which 67 % were from clean energy projects.[10]

Figure 8: Registered Clean Energy Projects vs. All Registered Projects under the People's Republic of China Greenhouse Gas Voluntary Emission Reduction Program



Source: National Development and Reform Commission. 2020. China Certified Emission Reduction Exchange Info-Platform (accessed 28 July 2020).

Demand for China Certified Emission Reductions

As estimated at 5%–10% of allowances, the theoretical demand for CCERs is at a range of 60 million–120 million tCO_2e per year. However, the actual demand for CCERs was far below the estimation. Since its operation, the cumulative amount of 18 million CO_2e of CCERs were used by pilot ETSs' participants for compliance

[8] Sino-carbon. 2020. Annual Review: The total transactions increased in pilot carbon markets. 27 October.

[9] National Development and Reform Commission. 2020. Projects' information of issued projects. China Certified Emission Reduction Exchange Info-Platform.

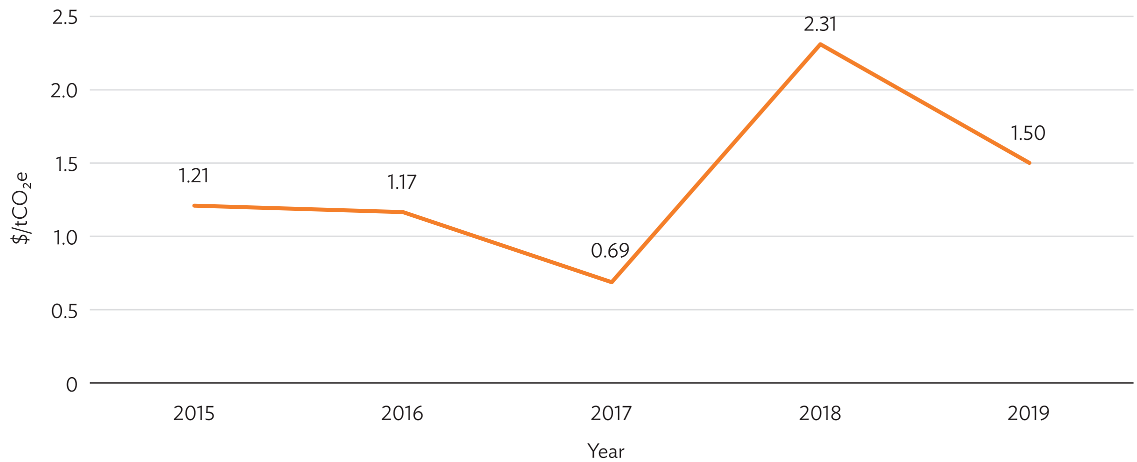
[10] Footnote 9.

by August 2019, accounting for 22% of the total amount of issued CCERs.[11] This explains an oversupply of CCERs in CVER market. Lack of demand for CCERs reflects that the participants of pilot ETSs did not face shortage of allowances to cover their emission obligations.

Price of China Certified Emissions Reductions

Given that the oversupply of CCERs, CCERs' prices has been running low (Figure 9), at a range of \$1–\$2/ tCO_2e from 2015 to 2019.

Figure 9: Average Prices of China Certified Emissions Reductions, 2015–2019



tCO_2e = tons of carbon dioxide equivalent.

Source: Carbon Market Monitor in Thomson Reuters Point Carbon and World Bank.

The CCERs' prices declined from 2015 to 2017 as cumulative amount of issued CCERs increased. The prices slightly grew between 2017 and 2019 as the stock of CCERs declined due to suspension of CCERs' issuance.

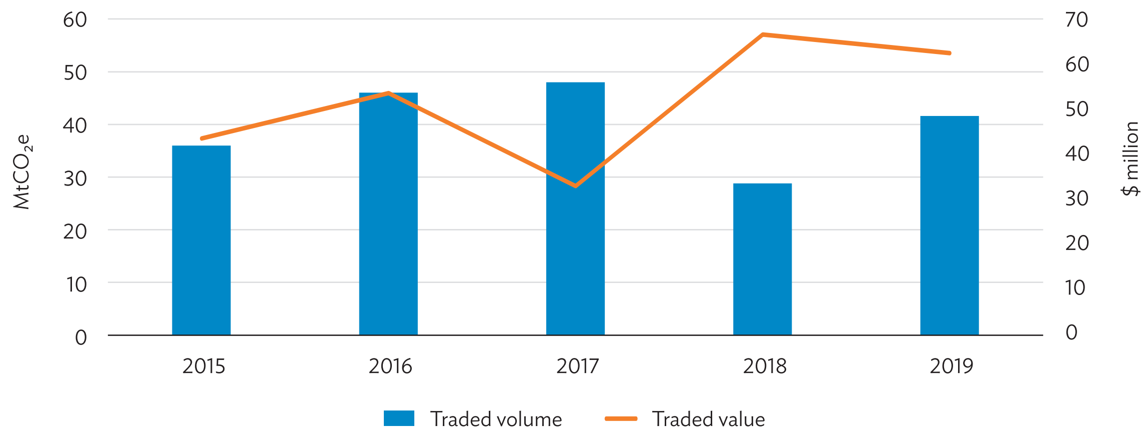
Impact of China Greenhouse Gas Voluntary Emission Reduction Program on Clean Energy Investment and Financing

The CVER sparked investment in 684 clean energy projects (only including registered clean energy project), with a total installed capacity of more than 45 gigawatt (GW).

Contribution of CVER to clean energy financing is quite limited. Lack of demand for CCERs and cheap CCER prices mean low CCER transaction. By June 2020, the cumulative traded volume of CCERs was only 193 $MtCO_2e$ (including primary and secondary market). The total traded value of CCERs was \$62 million in 2019 (Figure 10), about \$38 million or 61% of transactions attributed to CCERs from clean energy projects. The highest traded value was only \$67 million in 2018.

[11] Environmental Defense Fund and Energy Research Institute associated to NDRC. 2020. 2018–2019 Progress Report of China's Carbon Market.

Figure 10: China Certified Emissions Reductions Traded Volume and Traded Value by Year



$MtCO_2e$ = million tons of carbon dioxide equivalent.

Source: Carbon Market Monitor in Thomson Reuters Point Carbon and World Bank.

Carbon Market of the Republic of Korea

Carbon market of Republic of Korea consists of Korea emission trading scheme (KETS) and Korea offset crediting mechanism. The KETS creates demands for credits under the Korea offset crediting mechanism. Korea offset crediting mechanism provides flexibility for participants of KETS to meet their emission obligations. Korean carbon market only allows trading spot commodity of allowances and credits.

Korea Emission Trading Scheme

KETS, operated in 2015, was designed to support to meet the Republic of Korea's 2030 Nationally Determined Contributions (NDCs) target (37% below business as usual (BAU) emissions. Phase II KETS (2018–2020) covers 610 entities in six sectors: heat and power, industry, buildings, transportation, waste sector, and public.

Allocation Method and Offset Rules

Total emission allowances of phase II (2018–2020) are 1,796 $MtCO_2e$, 548 MtCO annually. KETS allocated all allowances (KAUs) to its participants for free during phase I (2015–2017). In phase II, 97% of allowances was offered for free and 3% was auctioned. Ten percent of allowances will be auctioned in phase III (2021–2025).

KETS allows its participants to use credits from Korean CDM projects (CERs) and credits from domestically certified projects under Korean Offset Credits Program (KOCs) to offset part of their emission obligations. The limit on the use of credits is 10% of KETS participants' emission obligations, with a maximum of 5% from international offsets (CERs) starting from 2018. Eligible projects included those under the CDM and the Carbon Capture and Storage (CCS) projects. CERs from registered Korean CDM projects need to be reissued and converted to KOCs. KOCs must be further converted into Korean Credit Units (KCUs) by the Korean government before it can be used to offset emission obligations.[12]

Impact on Clean Energy Financing

A major role of KETS in financing clean energy is to raise revenue from auctioning allowances. The original plan of auctioning 3% of allowances in 2018 were suspended due to strong resistance of industrial participants.

[12] Korean Research Institute on Climate Change. 2018. Introduction to Korea Emission Trading Scheme; Korean Offsetting Program.

Eight million KAUs were sold on government auction[13] at an average price of $28/t$CO_2$e in 2019.[14] About $224 million was collected through auctioning KAUs.

The Government of the Republic of Korea intended to use the revenue for supporting mitigation projects, and innovation and technology development for ETS participants. However, specific rules on the use of revenues have not yet to be decided.

Korean Offset Crediting Mechanism

Korean Offset Crediting Mechanism includes credits issued by Korean Offset Credits Program (KOCs) and the credits from Korean CDM projects issued by the CDM (CERs). The CERs of Korean CDM projects needs to be reissued as KOCs. KOC is the trading unit of the offset market.

Korean Offset Credits Program

The KOC program, established in 2015, was designed to provide offset credits to be used under KETS, covering emission reductions from six sectors: energy efficiency, renewable energy, industrial gases, manufacturing, transport, and waste.

Korean Clean Development Mechanism Projects

From 2018, the Korean offset crediting mechanism allows CERs from Korean CDM projects to be reissued as KOCs, provided that they are cancelled from the CDM. The Korean CDM projects need to register in Offset Registry System to convert CERs into KOCs. A total of 26.5 million CERs[15][16] from Korean CDM projects were cancelled from the CDM registry from 2018 to 2019 and were converted into KOCs.

Registered Projects under the Korean Offset Credits Program and Issuance

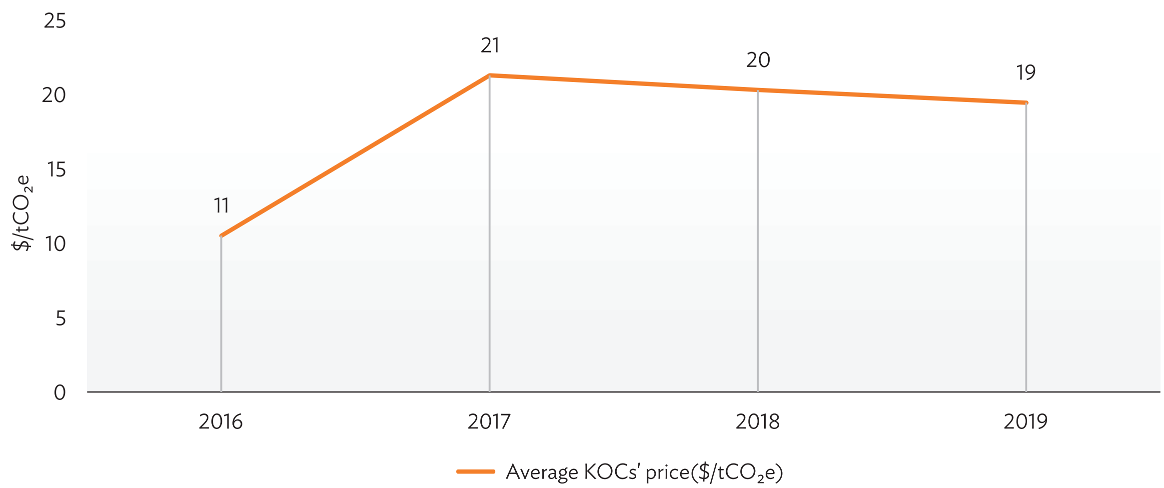
From 2015 to 2019, 461 projects registered as KOCs' projects, including new projects under KOC program and Korean CDM projects registered in Offset Registry System.[17] Sixteen MtCO_2e of KOCs were issued for 171 KOCs projects (including projects converted from CERs of Korean CDM projects), with 68% of issued KOCs from clean energy projects.

Price and Traded Value of the Korean Offset Credits Program

The 2019 KOCs' price ranged from $21 to $37 per t$CO_2$e.[18] As shown in Figure 11, the average KOCs' prices rose before 2017 and slightly declined after 2017. The changes in KOCs' prices reflect the supply of KOCs. The supply of KOCs was rather limited before 2017 due to only domestic credits being eligible for use in KETS. From 2018, international credits are eligible to be used in KETS. A large amount of CERs being converted into KOCs and influx to offset market caused KOCs' prices gradual decline.

13 Thomson Reuters Point Carbon. 2019. Carbon Market Monitor in Thomson Reuters Point Carbon. Carbon Market Reviews in Year 2019. January 2020.
14 Korea Exchange (KRX) (accessed 15 September 2020).
15 World Bank. 2019. State and Trend of Carbon Pricing 2019. Washington, DC.
16 World Bank. 2020. State and Trend of Carbon Pricing 2020. Washington, DC.
17 Government of the Republic of Korea. 2020. Offset Registry System (accessed 22 December 2020).
18 Thomson Reuters Point Carbon. 2020. Carbon Market Year in Review: Record High Value of Carbon Markets in 2019. January.

Figure 11: Average Price of the Korean Offset Credits Program in Korean Offset Market, 2016–2019



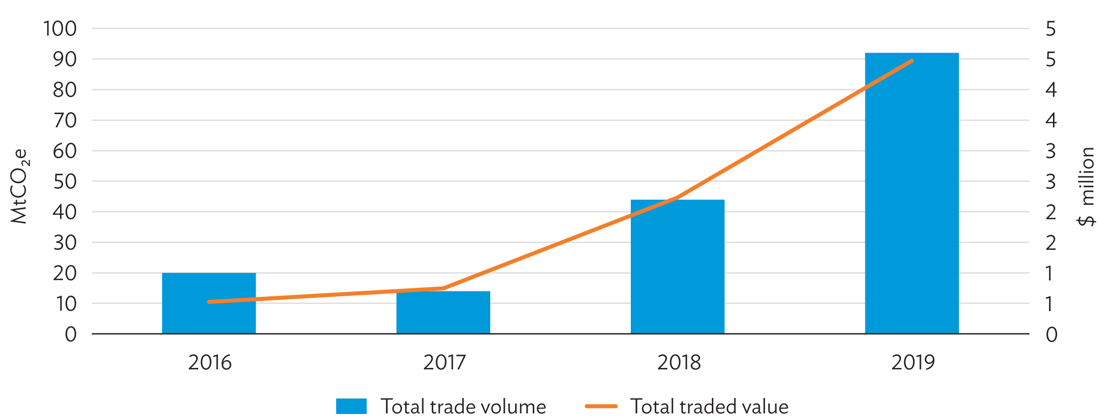
KOCs = Korean Offset Credits Program, tCO_2e = tons of carbon dioxide equivalent.

Note: Average price of the Korean Offset Credits Program is calculated using traded value divided by traded volume.

Source: Thomson Reuters Point Carbon, Carbon Market Reviews in Year 2019, 2017, 2016, and 2018 Carbon Market Wrap-up.

Figure 12 shows that the traded volume and traded value of KOCs has been steadily increasing. Traded value is a result of interaction between carbon price and traded volume. Although the traded volume slightly declined in 2017 due to the short supply of KOCs, rising price offset the impact of decreasing traded volume. This made traded value still went up in 2017. From 2018, KOC's price slightly decreased, but increasing traded volume offset the impact of declining KOC's price and hence traded value saw a rise.

Figure 12: Traded Volume and Traded Value of Korean Offset Credits Program by Year



$MtCO_2e$ = million tons of carbon dioxide equivalent.

Note: Data for 2018 was estimated based on data from Thomson Reuters.

Source: Thomson Reuters Point Carbon, Carbon Market Reviews in Year 2019, 2017, 2016, and 2018 Carbon Market Wrap-up.

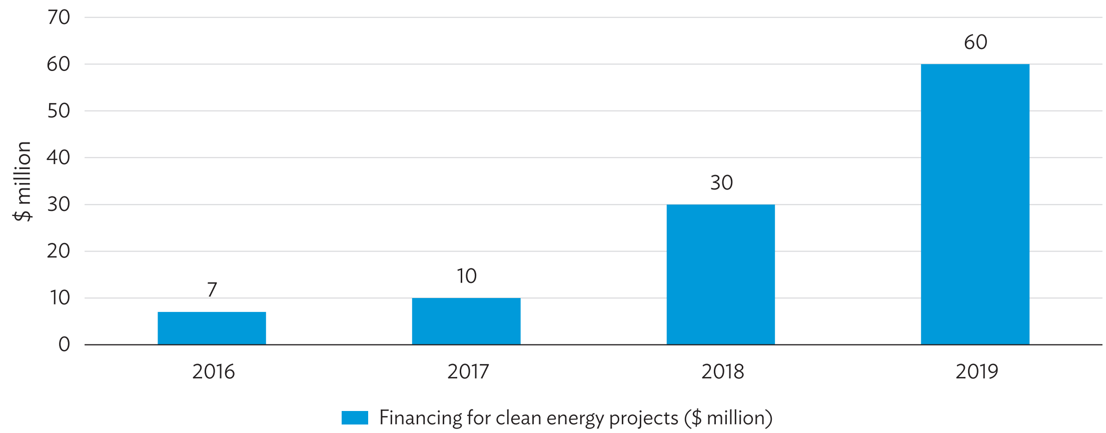
Rising demands for KOCs were due to gradually tightening of both annual cap and allowances allocated to KETS participants. Average annual caps in phase II (2018–2020) is 1.38% lower than ones in phase I (2015–2017). Meanwhile, the market reserve in phase II is 8.5% of the total allowances compared to 5.2% of the market reserve in phase I.

Impact on Clean Energy Financing

It is estimated that approximately $160 million in financing for KOCs' projects, of which, about $107 million flows into clean energy projects.[19]

Financing from credit market is determined by demands for carbon credits, that affects carbon prices and traded volume. High demand for KOCs would create more financing. Figure 13 presents that financing for clean energy projects has been rising since 2016. This trend is consistent with trading volume and traded value of KOCs over the same period, a result of increasing demand for KOCs.

Figure 13: Financing for Clean Energy Projects under the Korean Offset Credits Program Mechanism 2016–2019



Source: Author's estimation.

Kazakhstan Carbon Market

Kazakhstan established its emission trade scheme (KAZ ETS) in January 2013. Phase I operated for only 1 year in 2013 and phase II for 2 years 2014–2015, and then suspended during 2016–2017 due to the ETS amendment. It operated its third phase (2018–2020) with a cap of 485.9 $MtCO_2$ (162 $MtCO_2$ on annual average). Phase III covers 225 participating installations from 129 entities in power generation and central heating and extractive industries including oil and gas mining, metallurgy, chemical and processing industry.

Allocation Methods and Offset Rules

The total allowance of phase III is 485.9 $MtCO_2$. All allowances are allocated for free. As designed, KAZ ETS allows its participating entities to use domestic credits for compliance. However, a crediting scheme is still under development. The first exchange of allowances took place at the end of 2019 since the KAZ ETS restarted operations in 2018. The average weighted price was $1.14/$tCO_2e$.[20]

Impact of Carbon Market on Clean Energy Financing

Given that KAZ ETS adopts free allocation of allowances and the crediting scheme is not yet ready, the contribution of Kazakhstan carbon market to clean energy financing cannot be assessed so far.

[19] Author's estimates based on traded value and clean energy share of issued KOCs.
[20] International Carbon Action Partnership (ICAP). 2020. Emissions Trading Worldwide: Status Report 2020. Berlin: ICAP.

New Zealand Carbon Market

New Zealand ETS (NZ ETS), established in 2008, as one of the climate policies to meet its long-term commitments to cut its emissions by 5% below 1990 GHG emission level by 2020 under Kyoto Protocol and by 30% below 2005 levels by 2030 under the Paris Agreement. The latest Climate Change Response (Zero-Carbon) Amendment Act 2019 sets a new target to achieve net-zero emissions of all GHGs by 2050.

NZ ETS covers activities in forestry, liquid fossil fuels, stationary energy, industrial processes, synthetic GHGs, agriculture and waste, with 2,409 participants. The NZ ETS was originally designed to operate without a specific domestic cap as this accommodated carbon sequestration from forestry activities and a full link to the international Kyoto Protocol.

Allocation Method and Offset Rules

Most of New Zealand Allowances (NZUs) is allocated for free charge. The government intends to introduce auctioning mechanism to begin in late 2020.

The NZ ETS allowed to use international credits from Kyoto Protocol flexible mechanisms in the system with no restrictions until May 2015. As of 1 June 2015, international credits were not eligible for surrender in the NZ ETS as New Zealand did not sign the second phase of the Kyoto Protocol.

A fixed price option was introduced to the NZ ETS in 2009. The participants could opt to pay a fixed price to the government for covering their emission obligations in NZ ETS, instead of surrendering emission units (e.g., NZUs) or credits. The fixed price varied overtime. The fixed price was NZ\$25/tCO_2e (\$18/tCO_2e) from 2010 to 2019. It increased to NZ\$35/tCO_2e (\$23/tCO_2e) in 2020. The fixed price option acts as the ceiling price of New Zealand carbon market. The participants would pay a fixed price to cover their emission obligations if the carbon price was higher than the fixed price.

The fixed price option will be replaced with a cost containment reserve (CCR) incorporated into the auctioning mechanism. Allowances from the CCR will be auctioned if a predetermined trigger price (currently proposed at NZ\$50 (\$32.94) for 2020–2025 is reached.

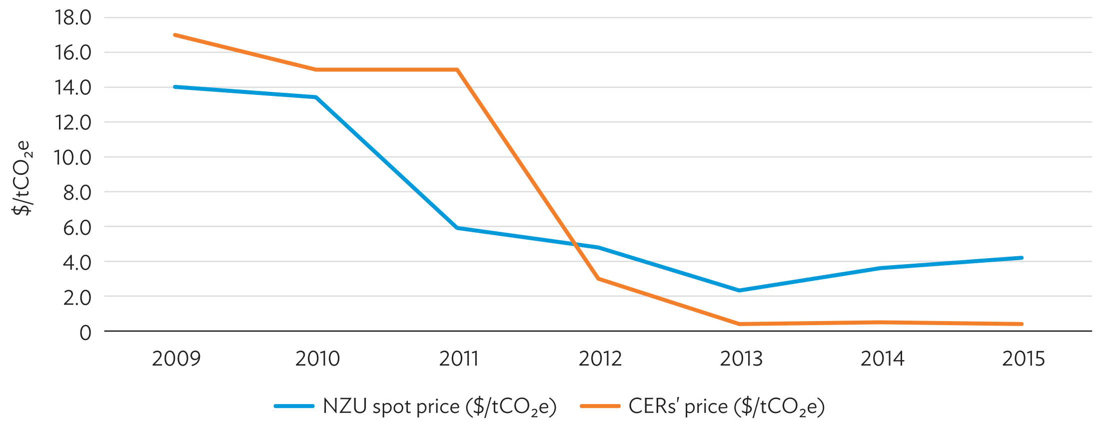
Carbon Prices, Surrendered Emission Units, and Certified Emission Reductions for Compliance

NZ ETS fully linked to the international carbon market under the Kyoto Protocol before May 2015. The NZUs' price was indexed to the international carbon market. Figure 14 presents how the NZUs' price fluctuated as CERs' price. The movement of NZUs' price was consistent with the trend of CERs' price. When CERs' price was lower, the NZ ETS participants unlimitedly purchased CERs from the international carbon market and surrendered them for compliance while banked allowances to sell at a higher price. An influx of large amounts of CERs into the NZ ETS market led to a surplus of NZUs and declining NZUs' price. NZUs' prices fell from above \$14/NZU in 2009 to an average price of \$2.3/NZU in 2013, contracting by 83%.

Figure 15 shows that CERs surrendered for compliance of emission obligations climbed over the period of 2010 to 2014 and peaked in 2014 before the deadline of restriction on use of international credit in NZ ETS. A total of 16 million CERs were used for compliance between 2010 and 2014, taking up 21% of total surrendered units.[21] Meanwhile, units surrendered for compliance with obligations through payment to the government at a fixed price were almost zero during this period. But it rapidly soared after restriction on the use of international credits on 1 June 2015.

[21] New Zealand Environmental Protection Authority. 2019. NZ ETS facts and figures 2018, 2018-ETS-Facts-and-Figures.pdf(Review)-Adobe Document Cloud.

Figure 14: New Zealand Allowances Price vs. the Price of Certified Emissions Reductions in the Secondary Market between 2009 and 2015[a]

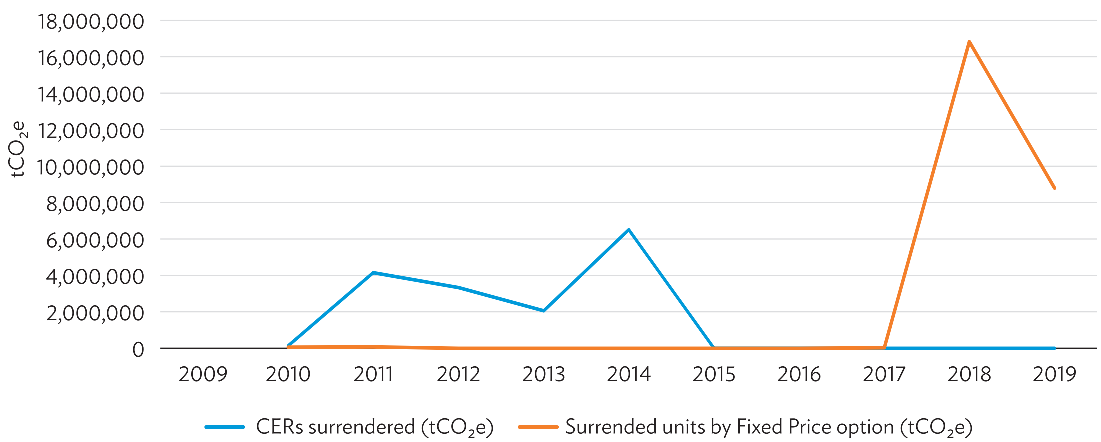


CER = certified emission reduction, NZU = New Zealand Allowances, tCO_2e = tons of carbon dioxide equivalent.

[a] CERs price is the average price in secondary market.

Source: Thomson Reuters Point Carbon.

Figure 15: 2010–2019 Certified Emissions Reductions Surrendered vs. Units Surrendered by Paying a Fixed Price to Government



CER = certified emissions reductions, tCO_2e = tons of carbon dioxide equivalent.

Source: New Zealand Environmental Protection Authority.

Impact on Clean Energy Financing

According to CERs used in NZ ETS and prices of pCERs, it was estimated that the market value of CERs used in NZ ETS was about $58 million.[22] This amount is deemed as the financing to mitigate activities in developing countries. Given the lack of information on specific sellers and projects' types, the NZ ETS's contribution to Asia clean energy financing cannot be assessed.

[22] This was calculated using average CERs' price at primary market.

The Government of New Zealand raised the revenue from ETS through a fixed payment estimated at $464 million from 2010 to 2019.[23] The revenues from the fixed payment by ETS entities to the government were assigned to the general budget and was not earmarked for clean energy.

Japanese Carbon Market

The Japanese carbon market involves two city-based emission trading schemes along with their offset mechanisms, and a bilateral Joint Crediting Mechanism (JCM).

Joint Crediting Mechanism

The JCM, established in 2012, is a bilateral crediting mechanism between Japan and partner countries who entered into the bilateral agreement with the Government of Japan to implement the emission reduction projects. The Government of Japan provides advanced low carbon technology and technical support and purchases the JCM projects' credits in host countries to meet its emission reduction obligations.

The Government of Japan has now entered into bilateral agreements with 11 Asia and Pacific developing countries, including Bangladesh, Cambodia, Indonesia, the Lao People's Democratic Republic, Maldives, Mongolia, Myanmar, Palau, the Philippines, Thailand, and Viet Nam. The government expected the JCM programs to result in accumulated emission reductions and removals of about 50 million–100 million tons of carbon dioxide equivalent (tCO_2e) by 2030.[24]

Clean Energy Projects under the Joint Crediting Mechanism and Credits Issued

The Government of Japan committed a budget of $84.1 million for JCM model projects. A total of 156 JCM model projects, which are purely from clean energy, were selected worldwide, with 140 model projects from the Asia and Pacific countries.[25] By July 2020, 53 projects were registered under JCM, with 51 projects coming from clean energy.[26] So far, only 0.03 million credits were issued, of which, renewable energy and energy efficiency take up 75% of total credits issued.[27] There is no detailed information on total financing transferred to clean energy projects in host countries. The JCM demonstrates a different approach in each partner country to accommodate a partner country's circumstance and their needs. Such an approach inevitably brought about a lengthy project cycle and increasingly complex implementation. This is reflected in a low volume of credits issued and credits retired so far.

Joint Crediting Mechanism Fund

The Government of Japan contributed $71.1 million to the JCM Fund established in 2014 and managed by ADB. The fund aims to provide financial incentives for adopting advanced low carbon technologies in ADB-financed and administered sovereign and nonsovereign projects of eligible ADB developing member countries (DMCs), which have signed a bilateral agreement with the Government of Japan for the development of the JCM projects at the time of financing. As of 2019, the JCM Fund provided $31.6 million to five projects to adopt advanced low-carbon technologies, with three clean energy projects out of the five.[28]

The JCM demonstrates the cooperative approach of using internationally transferred mitigation outcomes to achieve a national mitigation target, which is deemed an experiment of transferred mitigation outcomes between parties, one route of carbon market mechanisms under the Article 6 of the Paris Agreement.

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23 New Zealand Environmental Protection Authority. 2020. Emission Units Movement.
24 ADB. 2019. *Article 6 of Paris Agreement: Drawing Lessons from the Joint Crediting Mechanism*. November.
25 Global Environment Centre Foundation. 2020. *The Joint Crediting Mechanism*.
26 Footnote 25.
27 World Bank. 2020. State and Trend of Carbon Pricing 2020. Washington, DC. May.
28 ADB. 2020. *ADB Annual Report 2019*. Manila.

Tokyo Cap and Trade Program

The Tokyo Cap and Trade Program (Tokyo CaT) was formally put into place in April 2010, the first mandatory ETS in Japan and linked to the Saitama ETS. It covers about 1,200 facilities in office/commercial buildings and industry that consume energy above 1,500 kiloliter (kL) (crude oil equivalent) a year.

Allocation of Allowances

Allowances are allocated to the participating facilities for free. Allowances are determined based on baselines for facilities as set according to the following formula: base-year emissions x (1 - compliance factor) x compliance period (5 years). Compliance factor is set for the different compliance period. Base-emission is the average emissions of three consecutive fiscal years selected by facilities between fiscal year (FY) 2002–2007. Credits are only issued to facilities whose emissions fall below the baseline.

Offset Rules

Tokyo CaT allows its participating facilities to use domestic credits to offset their emission reduction obligations. Domestic credits must be sourced from four types of credits:

- **Small and Midsize Facility Credits.** Emission reductions achieved through energy efficiency measures by small and midsize facilities within the Tokyo area;
- **Renewable Energy Credits.** Credits from solar (heat, electricity), wind, geothermal, or hydro (under 1,000 kW) electricity production are converted to 1.5 times the value of standard credits until the end of the second compliance period (FY2015–FY2019) and will be converted on a one-on-one basis from 2020 onward;
- **Outside Tokyo Credits.** Emission reductions achieved through energy efficiency measures by large facilities outside the Tokyo area. Large facilities are those with an energy consumption equivalent to at least 1,500 kL of crude oil in a base year and with base-year emissions of 150,000 tonnes or less. A limit on the use of this type of credits is up to one-third of facilities' reduction obligations;
- **Saitama Credits.** including extra emission reductions from the participants in Saitama ETS, and small and midsize facility credits issued by Saitama Prefecture.

To issue offset credits (excluding Saitama Credits), facilities must file an application for certification of the reduction amount and an application for credit issuance to Tokyo Metropolitan Government.

Impact on Clean Energy Investment and Financing

Tokyo CaT's offset mechanism mobilized investment for 1,481 clean energy projects by the end of 2019. About 500,000 $MtCO_2e$ credits were issued.

Tokyo CaT only allows its participating facilities to sell emission allowances that are leftover once a facility's annual emissions are accounted for. This policy reduces transactions of allowances and credits. Meanwhile, many facilities tend to meet their obligations through their own reduction measures.[29] The emission trading policy and its practice explain that trading activities incurred only for meeting emission reduction obligations under Tokyo CaT, not for financial gains. For this reason, Tokyo CaT serves as a market for emission reductions, not as a financial market. These may be the reasons for the low transactions in Tokyo CaT.

For these reasons, the demand for offset credits has been quite low. The carbon financing to clean energy projects was limited. From 2010 to 2019, only 150,000 tCO_2e credits were used,[30] of which 29,300 tCO_2e of credits were used by 123 participating facilities to meet their emission reduction obligations in the first

[29] Tokyo Metropolitan Government. 2020. Results of Tokyo Cap-and-Trade Program in the 9th Fiscal Year—Covered Facilities Continue Reducing Emissions in Second Compliance Period. 26 March. 9thYearResult.pdf (tokyo.lg.jp).

[30] World Bank. 2020. *State and Trend of Carbon Pricing 2020*. Washington, DC. May 2020.

compliance period.[31] It should be noted that the carbon price for renewable energy offset credits was quite high, ranging from $46 to $59 in 2019.[32]

Before the Tokyo 2020 Olympics was postponed, the government planned to offset emissions through the "Towards Zero Carbon" initiative, including the use of credits from the Tokyo and Saitama mechanisms.

Saitama's Emissions Trading Scheme

Saitama's ETS was established in April 2011 as part of the Saitama Prefecture Global Warming Strategy Promotion Ordinance. Saitama's ETS is quite like Tokyo CaT. It covers facilities with fuel consumption, heat, and electricity of at least 1,500 kL of crude oil per year in commercial and industrial buildings. It involves about 580 facilities in the office/commercial buildings and factories. Saitama's ETS requires its participating facilities to reduce emissions below base-year emissions. Saitama's ETS is linked to Tokyo CaT. The Saitama-wide cap is aggregated based on emissions baselines set at the facility level.

Allocation Method

Emission allowances are offered for free, based on the baselines for facilities as set according to the formula: Base-year emissions x (1 - compliance factor) x compliance period (5 years). Based on the average emissions of 3 consecutive years between FY2002 and 2007, base-year emissions are based on the average emissions as chosen by each entity. Credits are issued to facilities whose emissions fall below the baseline.

Offset Rules

The Saitama ETS allows its covered facilities to use the credits from five types of projects:

- **Small and midsize facility credits.** Emissions reductions from non-covered small and medium-sized facilities in Saitama;
- **Outside of the Saitama Credits.** Emission reductions achieved from large facilities outside of the Saitama Prefecture. Large facilities are those with energy consumption of 1,500 kL of crude oil equivalent or more in a base year, and with base-year emissions of 150,000 t or less. This type of credits can be used for compliance up to one-third of offices' reduction obligations. Factories can use up to 50%;
- **Renewable energy credits.** The credits from solar power (heat), wind, geothermal, and hydropower were awarded previously at 1.5 times the amount of credits, but decrease to 1 from 2020 onward.
- **Tokyo credits** (VIA Linking)
  - Extra credits: including emissions reductions from facilities with base-year emissions of 150,000 tonnes or less, with the issuance of credits from FY2015;
  - small and mid-size facility credits issued by Tokyo government, with the issuance of credits from FY2012.
- **Forest absorption credits.** Credits from forests inside the Saitama Prefecture are counted at 1.5 times the value of regular credits. Others are converted with factor 1.

Impact on Clean Energy Finance

The trading policy of Saitama ETS is similar to Tokyo CaT. Credits would be traded when only there was a need for meeting emission reduction obligations, so the transaction of offset credits was quite low. Offset mechanism in Saitama ETS incentivizes clean energy projects especially renewable energy projects within and outside Saitama prefecture. As for 2019, 680 clean energy projects registered and 6.2 $MtCO_2e$ of credits

[31] Tokyo Metropolitan Government (TMG). 2016. Tokyo Cap-and-Trade Program: All Covered Facilities Achieve Their CO_2 Emission Reductions For The First Compliance Period.

[32] Mizuho Information & Research Institute. 2019. Tokyo Emission Trading Seminar: Obligation to Reduce Total Emissions and Emissions Trading System.

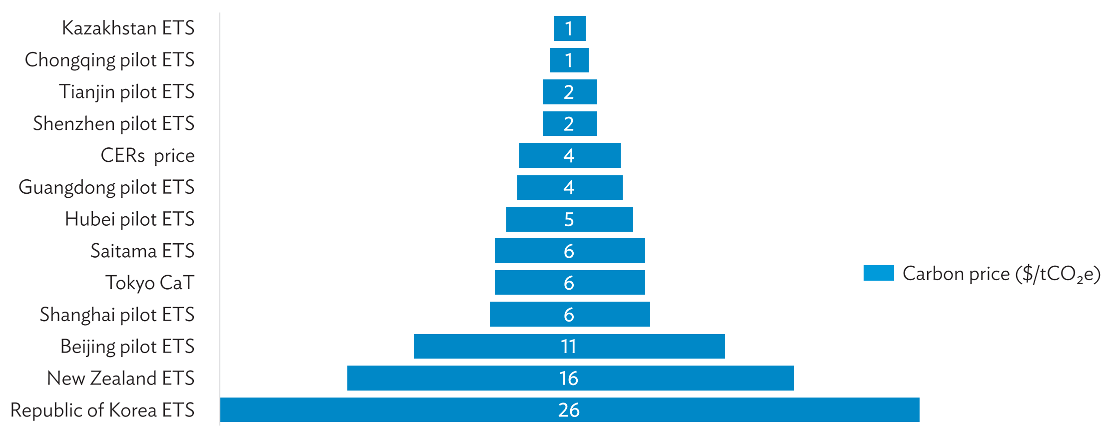
were issued, purely from renewable energy projects. However, only 0.17 $MtCO_2e$ of credits were used by covered facilities offsetting their emissions,[33] which illustrates that real carbon financing to clean energy projects is very limited.

Overall Assessment of Existing Carbon Markets on Clean Energy Financing

Low Carbon Price

Carbon prices in Asia and the Pacific vary widely from $1/$tCO_2e$ to $26/$tCO_2e$, with most of the carbon price less than $10/$tCO_2e$ (Figure 16). Such a low carbon price could not generate adequate carbon revenue to incentivize clean energy investment.

Figure 16: 2019 Carbon Prices in Related Markets



CaT = Tokyo Cap and Trade Program, CER = certified emissions reduction, ETS = emissions trading scheme, tCO_2e = ton of carbon dioxide equivalent.

Note: The prices presented are the carbon prices in secondary market. CERs' price was average price by using traded value divided by traded volume.

Sources: International Carbon Action Partnership (ICAP). 2020. *Emissions Trading Worldwide: Status Report 2020*. Berlin: ICAP; Thomson Reuters Point Carbon, Carbon Market Reviews in Year 2019.

The failure to implement the second commitment period of the Kyoto Protocol led to the lack of demand for CERs, which is the major cause of the low price of carbon. While the low carbon prices in national or subnational ETSs may mainly come from the concern on the impact of carbon prices on industries. The countries or jurisdictions with ETS preferred a low price, which rise over time that could reduce the impact of carbon price on industries. For this reason, the countries or jurisdictions tended not to tighten the supply of allowances. Free allocation, a modest cap, and trading spot commodity are the strategies used in existing ETSs to avoid a high carbon price.

The level of carbon price largely decides the role of the carbon market for achieving mitigation goals and carbon financing mobilization. According to the report of the High-Level Commission on Carbon Pricing and Competitiveness, achieving emission reduction goals under Paris Agreements requires carbon prices at

[33] World Bank. 2020. *State and Trend of Carbon Pricing 2020*. Washington, DC. May.

the level of at least \$40–\$80/tCO_2 by 2020 and \$50–\$100/tCO_2 by 2030.[34] The International Energy Agency (IEA) also predicted that a carbon price needs to reach at a range of \$75/tCO_2 to \$100/tCO_2 to stay on track with the Paris Agreement pathway.[35] Nevertheless, existing carbon prices are far below the estimated carbon prices needed for driving a low carbon transformation toward the Paris Agreement's goals.

Dominant Role of the International Carbon Market

The international carbon market can pull demand and supply at scale, as demonstrated by CDM. The CDM incentive attracted a large amount of private capital into clean energy in developing countries during the first commitment period of the Kyoto Protocol. CDM demonstrated that it could leverage other resources to unlock low carbon investment by overcoming barriers to clean energy investment and creating a revenue stream that sustains projects over time.

The investment scale and number of clean energy projects spiked by the CDM are far more than those national and subnational carbon markets in Asia and the Pacific. The international carbon market can create more demands for mitigation activities than national and subnational carbon markets. In the PRC, the CDM incentivized 3,215 clean energy projects with installed capacity of 156 GW from 2006 to 2012,[36] totaling an investment of \$186 billion.[37] These CDM projects were expected to bring at least \$11.3 billion additional carbon revenue.[38] This is equal to an annual increase of 459 clean energy projects, with an addition of installed capacity of more than 22 GW per year, compared to 228 clean energy projects per year and annual addition of 15 GW of clean energy facilitated by CVER in the PRC between 2014 and 2016.[39] In the case of the Republic of Korea, between 2006 and 2012, the CDM brought about 69 clean energy projects with investment of \$1.9 billion, additional carbon revenue of \$92 million, and increase of 728 MW in clean energy capacity in total.[40]

The CERs' revenue proves to be a decisive factor to bring a CDM project forward. From 2006 to July 2020, among 3,490 registered clean energy CDM projects in Asia and the Pacific, project IRR with CERs' revenue could increase by 3.53% on average.[41] This suggests the CDM helps facilitate and mobilize the private sector's investment into clean energy projects.

The operation modality of the international carbon market under the Paris Agreement is under negotiation. Given the significant role of CDM in stimulating clean energy and sustainable development, it is imperative to draw the experience and lessons from CDM and speed up the development of the international carbon market under the Paris Agreement, enabling it to promote low carbon investment.

Limited Role of the Domestic Carbon Market

The role of national and subnational ETS in Asia and the Pacific in clean energy financing is quite limited.

As analyzed above, almost all national and subnational ETSs in Asia and the Pacific allocated allowances for free. Auction of allowances are only adopted as a means of market stability. The government may auction the reserved allowances if the carbon price exceeds a predetermined level, so as to keep carbon price stable. For this reason, the revenue from the auction of allowances is limited, as seen in the PRC pilot ETSs.

34 World Bank Group. 2019. *Report of the High- Level Commission on Carbon Pricing and Competitiveness*. Washington, DC: World Bank Group.
35 International Energy Agency (IEA). 2019. *World Energy Outlook 2019*. Paris: IEA.
36 Only count the projects between 2006 and 2012 due to the restriction on the CDM eligibility of the PRC's projects after 2013.
37 UNFCCC. 2020. Database for PAs and POAs (accessed on 24 August 2020).
38 Author's estimates according to UNFCCC *Database for PA and POA*.
39 National Development and Reform Commission. *China Certified Emission Reduction Exchange Info-Platform* (accessed 28 July 2020).
40 Footnote 38.
41 Footnote 38.

The existing national and subnational ETSs have less demand for domestic carbon credits as seen in the ETSs of Japan and the PRC, which explains why the participants of the ETSs do not face a shortage of allowances for compliance with their obligations. This also mirrors a relaxed ETS cap. The consequence of an unambitious ETS cap is the weak carbon price and low levels of domestic abatement.

Less Encouragement of Private Sector Engagement in Domestic Carbon Market

The carbon market is seen as a commodity market. Tradable units (allowances and credits) are usually traded in the commodity exchange. Existing national and subnational carbon markets mainly help participants to meet mitigation obligations under ETSs. The carbon assets are traded mainly for compliance. The participants would purchase allowances or credits in commodity market when they are short of allowances to satisfy their obligations in ETSs at the end of the compliance period.

Some carbon markets place some restriction on the source of credits, and the time and form of trading. For example, pilot ETSs from the PRC, Tokyo CaT, and Saitama ETS set restrictions on the use of credits from outside jurisdictions. Tokyo CaT and Saitama ETS allow trading of credits only if the participants fail to comply with their obligations at the end of the compliance period. These policies made very low transactions in most of existing carbon markets.

Meanwhile, to avoid overspeculation, most carbon markets including those in Japan, the PRC, and the Republic of Korea only allow trading allowances and/or credits in the form of spot commodity, rather than the trade of commodity derivatives (e.g., commodity future, forward, and option). Such regulation curbed the involved participants of the ETSs to take advantage of commodity derivatives to hedge price risks and make financial gains in carbon markets, and also limited the participation of more investors into the carbon market.

By contrast, CERs were traded in the form of both spot commodity and commodity derivatives. This enabled the CDM market to attract numerous banks and investment funds to create or acquire carbon trading operations. They invested in CER assets in the form of derivatives such as forwarding contract, option contract, or future contract. The secondary market represented 74% of the transaction volume of CERs and 76% of CERs' traded value. The CER price in the secondary market was usually about 15% higher than one in the primary market. Trade of commodity derivatives made CDM attract many private investors into the CDM market, mobilizing huge financing for clean energy.

In conclusion, encouraging more investors' participation including private sector participation and introducing commodity derivatives into the carbon market is necessary for existing carbon markets and new carbon markets to create a large capital pool for clean energy.

Impact of Uncertainty of Policies on the Carbon Market

The carbon market is a policy regulated market whose demand is largely dependent on the certainty of policies and political will on taking mitigation commitments.

Following the financial crisis in 2008, the carbon prices have run at a low level. Among many other factors, the most important factor is policy changes for the use of CERs in EU ETS. Closely related to the EU ETS policy change is that the second phase of the Kyoto Protocol has not been in effect in a timely manner, then there is no commitment to emission reduction in the second phase of the Kyoto Protocol, the major factor contributing to low demand for CERs. Whether these CDM credits could be valid under the Paris Agreement remains uncertain. These factors lead to a low demand for CERs and depressed CERs prices, which weakens the role of the CDM to mobilize clean energy investment and financing.

A similar case to the CDM market occurred in the PRC carbon market. Uncertainty on how pilot ETSs transition to a national ETS hindered the market players' participation.

Potential Carbon Markets for Financing Clean Energy

International Carbon Market Under the Paris Agreement

Existing Nationally Determined Contributions (NDCs) pledge under the Paris Agreement is far from sufficient to reach the goal of holding global temperature rise to below 2°C while pursuing an aspiration of 1.5°C. Implementing current NDC pledges would lead to global temperatures to rise by 3.2°C.[42] International carbon market will be critical to implementing NDCs and further raise national climate ambitions over time. It harnesses cost–saving mitigation options and creates financial incentives for GHG emission reductions.

The Paris Agreement encourages the parties to use a market-based mechanism to their commitments defined in NDCs to enhance higher climate ambitions. Article 6 of the Paris Agreement, a framework of international carbon market, provides two kinds of international carbon market: a cooperative approach to use internationally transferred mitigation outcomes (ITMOs); and a mechanism for countries to contribute to GHG emissions mitigation. ITMOs serve as a basis for building an international carbon market by linking carbon pricing initiatives across countries. The mechanism to incentivize GHG emission mitigation and sustainable development envisions an international credit-based carbon market, similar to CDM.

The international carbon market's scale and reach under the Paris Agreement will be enormous compared to the Kyoto Protocol. Participating countries in the Paris Agreement and the countries to adopt carbon market mechanism are more than those in the Kyoto Protocol. As of 1 April 2020, 195 parties have signed the Paris Agreement, and 189 have deposited their ratification instruments. Among 195 parties, 97 parties representing 58% of global GHG emissions indicated to use market-based mechanism in their submitted NDCs, either the use of international carbon markets and/or domestic carbon pricing to meet their NDC commitments

Under the Paris Agreement, the potential of the international carbon market to reduce the cost of achieving the NDC commitments and incentivize additional mitigation ambitions will be significant. According to a study by the International Emissions Trading Association (IETA), the international carbon market would result in a cost–saving of $250 billion per year in implementation of NDCs by 2030. The cost–saving may incentivize the countries to invest in additional mitigation activities to reduce additional GHG emissions by 50% compared to the scenario without an international carbon market. This equals to an additional abatement of 5 gigatonnes of carbon dioxide equivalent per year ($GtCO_2e$) in 2030.[43]

Carbon Market Associated with International Aviation

Aviation sector shares about 2% of global CO_2 emission and has a growing trend.[44] To facilitate emission reductions in the international aviation sector, the International Civil Aviation Organization (ICAO) will implement a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), to keep international aviation's emissions at a 2019–2020 baseline level from 2020 onward. The scheme requires the airlines to purchase credits offsetting their emissions over the baseline level. Offsetting CO_2 emissions will be achieved by acquiring and canceling emission units from global carbon markets by airplane operators.

The states' participation is voluntary during the pilot phase (2021–2023) and the first (2024–2026) phase. The second phase (2027–2035) will cover all states. Least developed countries, small island developing states, and landlocked developing countries are exempt unless they volunteer to participate.

42 UNEP. 2019. *Emissions Gap Report*.
43 IETA. 2019. *The Economic Potential of Article 6 of the Paris Agreement and Implementation Challenges*.
44 The International Council on Clean Transportation. 2019. *CO_2 Emissions From Commercial Aviation, 2018 (theicct.org)*, 19 September.

As of July 2020, 88 countries pledged to volunteer to participate in the pilot phase from 1 January 2021, including 15 states from Asia and the Pacific, representing more than 77% of international aviation activities. Airlines worldwide have started to monitor and report emissions from their international routes to establish their baselines. The participating states' airlines will be required to purchase credits to cover their 2021–2023 emissions over the baseline (2019–2020 emissions level).

The implementation of CORSIA will expand the coverage and scale of international carbon market outside the Paris Agreement, and create huge potential demand for international mitigation outcomes from clean energy. The potential demand for credits is predicted at about 104 million tons per year,[45] and 3 billion credits would be needed for the period between 2020 and 2035.[46] The COVID-19 outbreak might increase the demand for credits in the pilot phase to 158 million credit units due to lower the CORSIA baseline emissions, which are set at the average of 2019–2020 emissions.[47]

The Aviation Carbon Exchange was launched for participating airlines to purchase eligible credit units for CORSIA, expecting a full operation by 2020. The credits from six schemes including American Carbon Registry (ACR), the CVER, the CDM, the Climate Action Reserve, the Gold Standard and Verified Carbon Standard (VCS) were approved for use to comply with offsetting requirements in the first phase of CORSIA. India Perform, Achieve, and Trade Scheme and Joint Crediting Mechanism between Japan and Mongolia applied for approval to be used by CORSIA.[48]

CORSIA will create a robust market demand for credits and boost the current carbon prices. It will provide an additional channel to realize the value of mitigation outcomes of clean energy and to incentivize clean energy investment and financing. More Asian developing countries would benefit from their crediting scheme to offset emissions by participating airlines of CORSIA.

Emerging Carbon Market Initiatives in Asia

About half of ADB's DMCs expressed their willingness to use a market-based mechanism to implement their NDCs. Among them, a few countries are testing or developing their domestic carbon market schemes.

The People's Republic of China National Emission Trading Scheme

The national ETS is a key policy tool among climate policy package to support the PRC's NDC commitments. The PRC launched a national ETS in 2017. The first compliance period starts in 2021. Currently, national ETS covers 2,225 participants in power sectors with carbon emissions of 3.5 billion tonnes of CO_2e, representing more than 30% of the country's emissions.[49] It will then gradually roll out to other industrial sectors, including petrochemical, chemical, building materials, steel, nonferrous metals, paper, and domestic aviation. These sectors represent about 52% of total energy consumption in the PRC, with about 4.8 billion tonnes of CO_2e emissions in 2017. Undoubtedly, the PRC national ETS is the largest carbon market in the world.

According to the latest announced implementing plan for allocation of allowances, the allowances will be allocated free of charge. It adopts a benchmark method to calculate the allowances for power generation units owned by the ETS participants. The national ETS does not set a ETS cap. Total allowances is the sum of allowances allocated to individual participants.

The offset rules have not been determined. However, if the national ETS adopts offset mechanism, with an estimate of offsetting percentage at 5%–10% of the emission cap, it would potentially bring about

45 International Civil Aviation Organization (ICAO). 2020. *Committee on Aviation Environmental Protection.*
46 GIZ. 2018. *Crediting Forest-Related Mitigation under International Carbon Market Mechanisms*. Accessed 7 September.
47 Environmental Defense Fund (EDF). 2020. *Coronavirus and CORSIA*.
48 ICAO. 2020. *Technical Assessment Body (TAB), 2020 Programme Applications*.
49 EDF and Energy Research Institute Associated to NDRC. 2020. *2018–2019 Progress Report of China's Carbon Market*.

the annual demand for 175 million to 350 million CO_2e of carbon credits in the first phase. This demand is equivalent to 29%–50% of the total issued CERs by clean energy projects in Asia and the Pacific.[50]

Other Carbon Market Initiatives

Other countries, including Indonesia, Thailand, and Viet Nam, have opted to develop domestic voluntary crediting schemes or voluntary ETS as a first step to accumulate experience. Then they may consider piloting ETSs in certain sectors or national or subregions beyond 2020.

Indonesia ETS

The Government of Indonesia considered developing a domestic ETS covering the power and industrial sectors to support its NDC implementation. The Indonesia ETS will be piloted in the power sector voluntarily and then will shift to a mandatory domestic ETS.

Indonesia is building market readiness and strengthening its carbon market infrastructure, particularly technical readiness around the MRV framework. The government released the MRV guidelines for the power sector in mid-2018. An online GHG reporting platform for electricity generators and a pilot MRV program for electricity generators in the Java–Madura–Bali grid (covering ~70% of Indonesia's electricity demand) were launched in late 2018. An online GHG emissions reporting system for industries was also developed. The government is piloting MRV programs in the cement and fertilizer sectors. The regulatory, technical, and operational frameworks are also under development.

Although Indonesia carbon market's scale cannot be predicted now, Indonesia's domestic ETS will provide potential demand for carbon credits, which incentivizes clean energy projects in Indonesia.

Pakistan

Pakistan considered market-based instruments to leverage low carbon investment. Pakistan's government launched the National Committee on Establishment of Carbon Markets in 2019 to assess the carbon market's role and scope in delivering Pakistan's NDC, and identifying opportunities and challenges to improving emissions data. The Committee was also required to review existing carbon market designs, consult with national stakeholders, draft reports, share information, and carry out capacity-building activities.

Thailand

The carbon market was advocated as a potential mechanism to reduce Thailand's GHG emissions included in its National Reform Plan (2018). It is expected to be outlined in the Climate Change Act for consideration in 2021.

Thailand has been building readiness to establish a domestic carbon market with a focus of technical readiness. Thailand has implemented Thailand Voluntary Emissions Trading Scheme (T-VER) for carbon intensity industrial sectors to reduce their GHG emissions.

T-VER consists of two pilot phases. The pilot phase I (2015–2017) focused on testing an MRV system in four carbon-intensive industrial sectors, including cement, pulp and paper, iron and steel, and petrochemical. In the pilot phase II (2018–2020), the MRV system test was expanded to five additional industrial sectors, including petroleum refinery, glass, plastic, food and feed, and ceramics. The registry and trading platform were also piloted. Result of piloting T-VER will build a basis of the domestic ETS. Meanwhile, the GHG reporting regulation is being drafted, and policy recommendations for establishing domestic ETS is under development.

[50] Author's estimates based on UNFCCC *Database for PA and POA*.

Viet Nam

The carbon market is one of market-based instruments to implement Viet Nam's NDC under the Paris Agreement.

Viet Nam is exploring an appropriate market-based instrument to reduce its GHG emissions. As part of Partnerships for Market Readiness sponsored by the World Bank, it developed a road map of carbon market development. At the first step, it piloted a crediting National Appropriate Mitigation Actions (NAMAs) in the waste; industry (steel, cement, chemical); and power sectors. The second step is crediting NAMAs in iron and steel, waste sectors, and developing an MRV system. Based on the experience on the crediting NAMAs and the MRV capacity, it may shift to a cap-and-trade system in the iron and steel sector as the next step.[51]

Enhancing the Role of the Carbon Market in Clean Energy Financing

Long-Term Climate Ambitions and a Compatible Emissions Trading Scheme Cap

As analyzed in section 3, the existing carbon market reveals that a lack of credible commitments to mitigation undermined the carbon market's role in incentivizing mitigation activities.

A long-term and credible commitment to reducing GHG emissions is essential for generating consistent demand in the carbon market and delivering credible signal for a carbon price, which is the basis for the carbon market to generate reliable carbon revenue. As well known, the commitments under current NDCs to 2030 are not sufficient to reflect the needs for climate change mitigation. The nations need to raise climate ambitions over time and to set a clear mitigation goal toward 2050. Specifically, a mitigation pathway against holding global temperature rise below 2°C, and pursuing the aspiration of 1.5°C is a foundation of enhancing the carbon market's role in incentivizing clean energy investment.

A long-term ETS cap should be set to compatible with the long-term climate goal. The assets of investment activities either mitigation (e.g., wind and solar power plants) or high emissions (e.g., coal-fired power plants) activities can run more than 20 years. Setting a long-term ETS cap can provide a clear requirement for emissions trajectory, enabling greater confidence for investors in demand for abatement and carbon price.

Meanwhile, it is necessary to plan and implement phased caps of an ETS based on the long-term ETS cap to ensure the ETS progress to support the long-term climate goal. The risk of unforeseen events may weaken the efficacy of the carbon market when an ETS cap set over longer time frames. Fast progress in clean energy technologies, over-performance of other mitigation policies (e.g., renewable energy policy and energy efficiency policy) may contribute to more abatement than expected. Moreover, unseen events such as financial crisis and weather conditions may also result in emissions lower than estimated emissions. These factors lead to the emissions trajectory that deviate from what is expected, which is a basis of setting the ETS cap, and the consequence is an oversupply of allowance and low carbon prices. A long-term ETS cap alone cannot address the unexpected changes in the short-term period. The phased ETS caps aligned with a long-term ETS cap, with a flexible remedy mechanism (e.g., reserve allowances within a phased ETS cap) is the way to respond to unexpected changes in a short-term time frame. The setting a long-term ETS cap with support of phased caps ensure the functioning of an ETS market.

[51] Government of Viet Nam. 2014. *Market Readiness Proposal (MRP) under Partnerships for Market Readiness Program*. October. 20141013_MRP Vietnam_FINAL.pdf (thepmr.org).

The carbon market can help achieve long-term climate goals at a lower cost, while a long-term ambitious climate commitments generate carbon market demand. So, a clear long-term climate mitigation commitment and well-functioning carbon market complement each other. A long-term cap equipped with phased caps and a flexible remedy measure ensures an ETS market's functioning.

Predictable Policies on the Carbon Market

As a climate policy-induced market, the carbon market is susceptible to political commitments and policy shocks. The CDM market and pilot ETSs in the PRC prove that significant policy changes affected credits' demand and carbon price, bringing about unreliable revenue stream, and undermined market players' confidence and trust on the carbon market.

The carbon market policies should be consistent. The guidelines regarding cap arrangement, allocation of allowances, requirements for offset, trading policy should be consistent between compliance periods. Or at least, a clear road map on the progressive movement of the carbon market's policies can be disclosed at the start. If these policies need to be improved or revised, enough time for adjustment and transition should be given. The impact of changes in these policies, if inevitable, should be assessed, and the comprehensive consultations should be held to minimize its negative consequence.

A valid period of credits is another fundamental vital factor to affect the proper operation of the carbon market. Existing carbon markets do not specify the valid period of eligible carbon credits for use. Eligibility of carbon credits was changed or not explicitly stated between different compliance periods, as seen in ETSs of the EU, New Zealand, the PRC, the Republic of Korea, etc., which impacted the demands for credits and carbon prices. In addition, lack of clearly defined valid period of carbon credits impedes emitters to take early mitigation actions. Meanwhile, the absence of a long valid period for the use of carbon credits may bring on temporary mismatches between demand and supply of allowances and credits, which causes volatility of carbon prices, and reduces market players' participation. Consequently, the carbon market would not be able to fully perform its function.

Defining a longer time frame valid period for the use of carbon credits means that the carbon credits will be used to offset emissions at any time during a long-term commitment period. In theory, if carbon credits are deemed as carbon assets under an ETS, it should have endowed with value in the long-term and should be worth in investment. A long-term valid period for the use of carbon credits should be defined in the law. A law-based carbon market policy can build investors' trust on carbon market and encourage abatement activities.

Linking Carbon Markets in Asia and the Pacific

The CDM demonstrated the international carbon market's ability in mobilizing carbon financing for clean energy investment.

Compared to a country's carbon market, linking different carbon markets among countries could expand coverage of carbon markets, increase market size, and improve market liquidity due to more market players involved and more transaction activities. This would bring more investment opportunities for market players and benefits investors, enabling carbon market to mobilize clean energy investment and carbon financing.

Another important benefit of linking different carbon markets is to lower the aggregate costs of global climate mitigations by reducing GHG emission in the place with the least cost. The full linkage of carbon markets among all countries under the Paris Agreement could reduce global costs of implementing NDCs by a third in 2030 and by half in 2050. From this point of view, trading carbon assets across borders can enable countries to raise their climate ambitions without increasing mitigation cost and promote achieving a global objective of limiting global warming to well below 2°C and pursuing efforts to limit the temperature increase 1.5°C above preindustrial levels.

Article 6 of the Paris Agreement underlines two routes to establish the international carbon market: linking ETSs among countries (emissions trading across countries) and linking crediting-based carbon market (trading carbon credits between countries). Article 6 serves as a solid political basis of linking carbon markets.

Many countries in Asia and the Pacific expressed their intention to use market-based mechanisms to implement their NDCs while a few countries are operating or planning to develop their carbon markets through either emissions trading scheme or crediting scheme. If these carbon markets in Asia and the Pacific were linked together to form a regional carbon market, it would much lower the costs of achieving NDC commitments of all participating countries and incentivize the countries to raise their climate ambitions.

The carbon markets in place or planned are taking diverse forms. Simultaneously, their development levels and maturity are quite different. The routes to linking carbon market need to accommodate diverse forms and different development stages of the carbon markets. Linking a crediting scheme in one country with an ETS in another country could be the first step toward a full carbon market linkage. This means the buyers in one country with an ETS could purchase carbon credits from sellers in other countries with crediting scheme. For example, the PRC's national ETS could be linked with crediting schemes in Indonesia, Thailand, and Viet Nam, thereby allowing participants in the PRC ETS to offset their emissions by purchasing carbon credits from these countries by taking advanced mitigation actions. It could also be applied to two countries where both have an ETS in place. For example, since the amended K-ETS of the Republic of Korea allows ETS participants to use international credits to offset their emissions from 2018 onward, K-ETS participants could use CCERs under the Chinese Voluntary Emission Reduction Program to offset their emissions. A full linkage of K-ETS with the PRC ETS could be developed in due course when political will, policy, technical standard, and capacity are getting ready.

To link carbon markets across countries, several key issues need to be addressed.

(i) Political will is the key to the linkage of the carbon market.
(ii) Policy, methodology, procedure, and other practical guidelines on the carbon market, including certified emission reduction, must be harmonized to avoid double counting of GHG emission reductions and undermine environmental integrity, and to ensure the operation and functioning of all linked markets.
(iii) Operational framework and infrastructure for carbon market linkage should be built as early as possible, including a legal framework to establish domestic markets and international linkage, and a functioning system of carbon-market operation (including, for example, robust MRV mechanisms and oversight of trading).

Enhancing the Role of the Carbon Market in Pooling Capital

As assessed in subsection 4.3 and 4.4, existing carbon markets in Asia and the Pacific are mainly served for compliance with mitigation obligations. The carbon market's ability in mobilizing financing is limited. For the carbon market to play a full role in mobilizing financing, several key policies should be introduced.

First, use auction in allocation of allowance, instead of free allocation. Auctioning allowances not only impose a cost on carbon emission but also collect revenue for further carbon mitigation actions. Governments may use revenues from allowance auctioning to support clean energy projects or set aside allowances to be sold for funding clean energy projects.

Second, carbon assets, either allowances or carbon credits, should be allowed to trade in the form of derivatives. The carbon market creates carbon assets (either allowances or carbon credits) for participants to comply with their obligations, then such assets should be considered as financial assets class for investing. As such, the carbon market could attract the financial sector and other investors in particular private investors to invest in carbon assets, which could pool a large amount of capital for clean energy.

Finally, lift the geographic restriction on the source of carbon credits and time for use. This enables ETSs' participants to buy carbon credits offsetting their emissions at the lowest cost and in early stage. Also, market participants could hedge risk through buying carbon assets at a low price and could sell them at a higher price for capital gain.

Using Carbon Finance for Further Mitigation Actions by Governments

The carbon trading offers a possible mechanism for raising additional carbon revenue for governments to supplement existing public climate finance. Governments may levy tax on carbon transactions or carbon revenues for supporting clean energy development. For example, the PRC established a CDM fund through levying a tax on revenue from sales of CERs by the PRC CDM project's participants. The CDM fund is earmarked into financing climate-friendly projects.

One way is to use public climate fund to pre-purchase carbon credits from clean energy projects. Usually, the private sector favors those projects with higher IRR and lower risks, shorter time for recovering the capital cost. Some clean energy projects are high technology risks and have low IRR and require a longer period to recover investment cost but have higher sustainable development benefits. The private sector may be reluctant to invest in those clean energy projects with high technology risk and low investment return. Governments may step in by using public climate finance to buy the carbon credits from these clean energy projects at a reasonable price through advance payment, which will also ensure the clean energy project success by providing direct financing, reducing financing cost, and lowering investment risks. For example, the ADB Future Carbon Fund (FCF) has funding commitments of $115 million from the governments of Belgium (Flemish region), Finland, the Republic of Korea, and Sweden, as well as from two private companies, namely POSCO (Republic of Korea) and Eneco Energy Trade (Netherlands). The FCF is administrated by ADB and provides upfront payment for credits generated by mitigation projects in ADB DMCs beyond 2012 and up to the end of 2020. To date, the FCF contracted 33 projects to procure 8.67 million CERs. Of which 8.09 million CERs was delivered.

Auctioning allowance in an emission-trading scheme that could provide a new revenue stream to fill the climate finance gap for clean energy as suggested in subsection 5.4. Such an approach is used in many emission trading schemes such as EU ETS, Regional Greenhouse Gas Initiatives, Quebec ETS, and California ETS.

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Financing Clean Energy in Developing Asia

This book is the first of two volumes that review various approaches and instruments that have been tried, tested, and utilized to scale up clean energy development in Asia and the Pacific. This volume examines clean energy investment needs and financing gaps in the region and reviews existing financing options and approaches, including examples of how these have been applied. Innovative solutions for mobilizing private finance and managing risks associated with clean energy investments are also discussed.

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