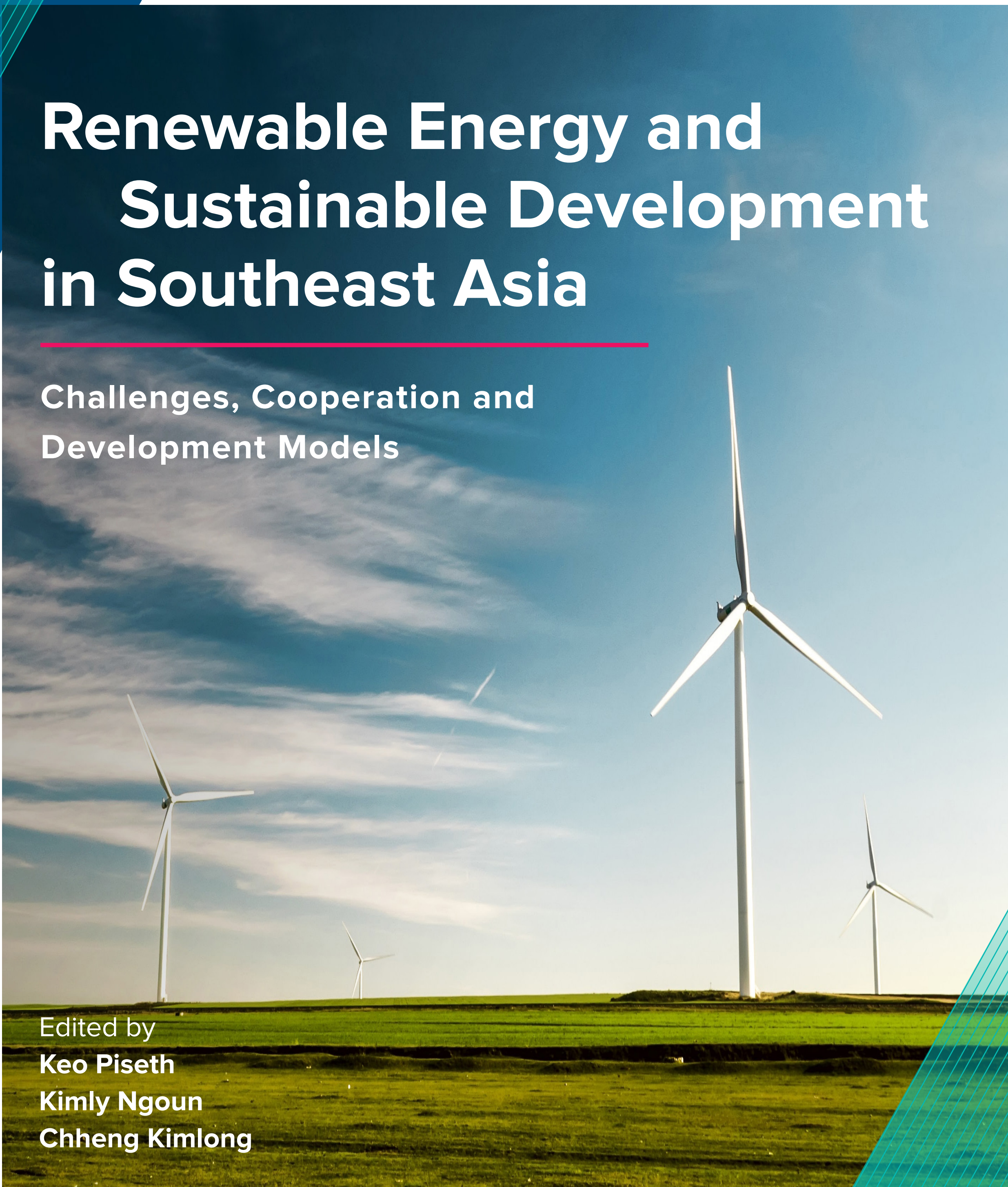
Renewable Energy and Sustainable Development in Southeast Asia

Challenges, Cooperation and Development Models



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KONRAD ADENAUER STIFTUNG

Published by the Asian Vision Institute and Konrad-Adenauer-Stiftung
Phnom Penh, Cambodia

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Acknowledgements

This edited book project was conceived in April 2020 and the whole book manuscript was ready and submitted for publication in January 2021. The entire process for the book coincided with COVID-19 which caused so much damage, disruption, stress and anxiety to the world population. The editorial team, authors, and everyone who was involved with this book project were also affected by the pandemic. Without their strong commitments, support and cooperation, the book would not be published in a timely manner. Therefore, we would like to express our heartfelt thanks and appreciation to all of them.

Our first and foremost appreciation goes to Konrad-Adenauer-Stiftung (KAS) for close collaboration and financial support for the publication of this book volume. KAS team namely Dr Daniel Schmücking, Mr. Saroeun Mom, Mr. Fayard Jean-Marie, Ms. Touch Likhedy, Dr Christian Hübner, and Mr. Eric Lee have been supportive and helpful throughout the whole process. We are also grateful to KAS for taking charge of typesetting, designing and preparing this book for publication and printing.

We indeed owe our heartfelt thanks to all the authors of chapters in the book. Without them taking additional workloads with a kind understanding of the tight deadlines of submission and return of the revised versions of their chapters and their prompt responses, the publication of this book would not proceed in a timely manner.

Last but not least, our gratitude goes to the Asian Vision Institute (AVI) team. AVI President, Dr Chheang Vannarith, and all the Directors of AVI Centres have also provided encouragement and support for this book project. A number of individuals at AVI also deserves our great appreciation, particularly Ms. Pheap Chakriya, Mr. Fai Mesa, and Ms. Lim Maneth. Ms. Pheap Chakriya has provided excellent coordination and communication with the reviewers, editors, authors and KAS team to ensure things proceeded as planned. Mr. Fai Mesa and Ms. Lim Maneth have been very helpful and provided excellent support for administrative arrangements.

Content

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Introduction

Keo Piseth and Kimly Ngoun

Introduction

The global efforts to increase the uptake of renewable energy including hydro, solar, wind, and geothermal in global energy mix have dominated international agenda in recent decades. In 2015, at the United Nations Sustainable Development Summit, global leaders adopted "Affordable and Clean Energy" as one of the key Sustainable Development Goals (SDGs) to be achieved by 2030. This paradigm shift towards the inclusion of clean energy in the SDGs resulted mainly from the severity of climate change and air pollution.

Industrial development, while bringing about great progress and globalisation to the human race, has aggravated climate change because it relies heavily on fuel-based energy, which emits a large volume of greenhouse gas, particularly carbon dioxide (CO2), into the atmosphere. A high level of concentration of greenhouse gas has resulted in increased global temperature causing changes in rainfall patterns, extreme weather events (frequent storms, heavy floods, drought, heatwave), sea level rise, water scarcity, human health, reduced agriculture productivity, biodiversity loss, and ecosystem degradation.

A study in 2011 indicates that carbon dioxide concentration has increased around 40%, compared to the pre-industrial time in 1750, predominantly as a result of burning fossil fuels, deforestation, and changes in land use (Pachauri and Meyer 2015). The Earth has warmed by 0.7°C since 1900. Over the past 30 years, global temperature has risen rapidly at around 0.2°C per decade, bringing the global mean temperature to what is probably at or near the warmest level reached in the current interglacial period, which began around 12,000 years ago. Climate models project that the world is moving towards a further warming of 0.5°C–1°C for several more decades due to past emissions. If annual emissions continue at today's level, greenhouse gas level would be close to double the pre-industrial levels by the middle of the century. If this concentration sustains, global temperatures are projected to eventually increase between 2–5°C or even higher. If greenhouse gas levels are to reach 1,000 part per million, more than triple the pre-industrial levels, the Earth would see around a 3–5°C of warming or more, which would cause pervasive and irreversible impact on human and ecosystem.

Besides the severe impact of climate change, air pollution caused by fossil fuels energy-based industrial production activities and transportations has compelled national leaders to consider pursuing more sustainable development models based on renewable energy. Air pollution ranks second for the cause of deaths from non-communicable diseases (NCDs) after tobacco smoking (World Health Organisation 2020). In 2016, household and ambient air pollution caused approximately 7 million premature deaths (World Health Organisation 2018). The main diseases associated with the pollution include heart disease, lung cancer, stroke, and chronic obstructive pulmonary disease (World Health Organisation 2020). Besides the adverse impact on human health, air pollutants including black carbon and small particles have destructive effects on biodiversity, ecosystem, water sources, food sources, as well as cultural and historical monuments (UNECE 2020).

Against the backdrop of the urgent needs at the national, regional and global levels for sustainable development based on clean and renewable sources of energy, the Asian Vision Institute (AVI) and Konrad-Adenaur-Stiftung (KAS) have collaborated to publish this book volume focusing on renewable energy in Southeast Asia, a timely and relevant topic for the region. The authors are policy advisers, researchers, analysts and practitioners in the energy sector. The book aims to present (i) recent development and challenges in the energy sector in Southeast Asia, (ii) bilateral and multilateral cooperation frameworks on renewable energy in the region, and (iii) private investment in renewable energy. This book, a collection of policy-oriented research papers, is expected to raise public awareness and stimulate policy interests in renewable energy and approaches to sustainable development. Its empirical data and findings may better inform renewable energy policy dialogues and policymaking as well as improve understanding among key stakeholders including government institutions, private investors, non-government organisations, and research institutions.

Renewable Energy in Southeast Asia

To address the above concerns about climate change and air pollution, efforts are being made to reduce carbon emissions while increasing the share of renewable energy in global energy mix as well as expanding the deployment of energy efficiency. Renewable energy contributed to almost 11% of total energy consumption in 2018 (International Energy Agency 2020). This represents approximately 56% of the increased share of renewable-based energy, which has been mostly driven by hydro, wind, and solar photovoltaic since 2000 (International Energy Agency 2020). It is projected that the share of renewable energy in total primary energy supply will rise from 14% to 63% between 2015 and 2050 while the share of fossil fuels will drop from 86% to 37% (Gielena et al. 2019).

The progress being made owes to the commitment of large energy producers, including China, the European Union, the United States of America, India, and Russia. As the largest energy producer and consumer, China commits to reducing its carbon emissions per unit of gross domestic products by 60–65% and the share of non-fossil fuel of 20% by 2030, while the European Union aims to achieve 32% of renewable energy in the energy mix in the same year (Gielena et al. 2019; NDRC, n.d.). In the United States of America, 17% of electricity generation come from renewable resources (U.S. Energy Information Administration 2020). In a similar vein, Russia, owning one of largest stocks of fossil fuel resources, and India, one of the largest consumers and producers, both have set high targets and deployed technologies for electricity generation from solar, wind and renewable sources (IRENA 2017; Ministry of New and Renewable Energy, n.d.).

An increased deployment of renewable energy is of significant contribution towards the achievement of the Sustainable Development Goals. It has contributed to improved electricity access, which is crucial for increased productivity, poverty alleviation, improved living standard, affordable and clean energy, increased income, and economic growth. In 2019, the number of the global population without access to electricity dropped to a record low at 770 million compared to 1.5 billion in 1990 (International Energy Agency 2020). In the same period, over 30%, approximately 2.6 billion, of the global population did not have access to clean sources of energy. They depended on such polluted sources as solid biomass, kerosene or coal, which are the causes of indoor air pollution killing millions of people every year (International Energy Agency 2020). Therefore, there is a need for more intervention and investment in research, development, and deployment of renewable energy and energy efficiency technologies. Lower cost of energy produced by renewable sources and improved efficiency than the conventional coal plants and other fossil-based energy production is key for enhancing progress and achieving greater sustainability.

Without exception, countries in Southeast Asia, a region home to approximately 622 million inhabitants (World Population Review 2020), are endeavouring to provide sustainable, reliable, and affordable electricity to their population, 130 million of whom do not have access to electricity. Plan of Action for Energy Cooperation (APAEC) 2016–2025 outlines strategies and programmes of actions to realise energy security, accessibility, affordability and sustainability for ASEAN population through energy connectivity and market integration (Zamora 2015). The plan sets higher targets to improve energy efficiency and increase the uptake of renewable energy by reducing the energy intensity by 20% in 2020 compared to 2005 while increasing the share of renewable energy to 23% by 2025 in the energy mix. The targets will lower the costs of energy supply, improve air quality, and create a robust energy system.

Despite the progress being made, the plan for increased deployment of renewable energy is obstructed by numerous challenges, including financial, technological, regulatory, institutional, geographical, and human resource aspects. These challenges, however, can be addressed through broadening and deepening regional partnerships and collaboration among ASEAN member countries with dialogue partners, International Organisations (IOs), research institutions, and involvement of the private sector in the forms of financial investment and technology transfer.

All countries in Southeast Asia as a whole need to work together more seamlessly to promote research, development and deployment of renewable energy in all spectrums of the economy, society, businesses and governance. In addition, innovative approaches to sustainable development need to be continuously explored, tested and implemented in order to achieve greater progress and more inclusive development in the region.

Book Outline

This book has three parts with a total of 11 chapters. Following this Introduction, Part I, which has 4 chapters, offers a broad overview of the energy sector in Southeast Asia and the Mekong region. It illustrates the challenges and opportunities in implementing and increasing the use of renewable energy in the region. Those challenges include financial, technical, institutional, regulatory, geographical, infrastructural and human resources dimensions. The chapters in Part I also offer useful policy recommendations for enhancing the integration of clean energy and renewable energy to achieve national and regional renewable energy targets.

Part II, which has 3 chapters, examines cooperation in the energy sector at both bilateral and regional levels within Southeast Asia and the Greater Mekong Subregion. It also presents various cooperation frameworks that the Mekong region has with external powers. Mekong countries can draw benefits from such cooperation frameworks in terms of financial assistance, technology and knowledge transfer, as well as human resource development in order to enhance the development and deployment of clean energy technologies and renewable energy in the Mekong region. However, countries in the region should also be cautious about the geopolitical dimensions of those cooperation initiatives with external powers. They need to work together to ensure that those cooperation frameworks are platforms serving the interests of the region, not dividing it.

Part III has two chapters, and it explores investment and business models in renewable energy in the Mekong region. One chapter offers a proposal for renewable energy cooperation and investment in the Greater Mekong Subregion. Another chapter reviews various studies related to investment and business models in renewable energy in Cambodia. Clean energy technologies, renewable energy and innovations in the energy sector can unlock the potential for economic growth as well as improve efficiency and productivity in various sectors in Cambodia.

The concluding chapter presents a synthesis and summary of the book as a whole. It highlights how the empirical data and findings in this edited book volume are significant to knowledge and policy about the energy sector in Southeast Asia and the Mekong region. It makes specific recommendations to all relevant stakeholders to work together to overcome the challenges and expand opportunities for collaborations, partnerships and investment in renewable energy to transform Southeast Asia into a clean, green and sustainable region.

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Energy Demand and Supply and Potential Distributed Energy System in Southeast Asia

Han Phoumin

Introduction

The Association of Southeast Asian Nations (ASEAN) is linked by common energy challenges, namely maintaining economic growth and gaining energy security while at the same time curbing climate change and reducing air pollution. At the intersection of these challenges is the corresponding need to rapidly develop and deploy energy efficiency and saving, low-emissions coal technology, nuclear safety, and doubling the share of renewables to energy mix policy which is inclusive and sustainable development. The ASEAN's energy demand is expected to increase triple from 2013–2040, and thus it has brought along many opportunities and challenges including climate change as a result of rising energy consumption from fossil fuel. Despite significant progress made in the last decades in terms of energy poverty alleviation, some countries in ASEAN are still struggling to provide energy access to their rural population.

At the regional level, the idea of inclusive energy will be largely linked to the Cebu Declaration with regard to providing energy access to all, applying energy efficiency and saving, and having the best energy mix for energy security. However, some of them are beyond a country level and thus cooperation for regional inclusiveness of energy is indispensable. Most countries in ASEAN are largely dependent on imports of fossil fuels from the Middle East. The growing dependency on fossil fuel imports also puts the region into a vulnerable situation in case of an oil supply disruption that may arrive by any chances from the political instability in the Middle East. Likewise, the continued use of fossil fuels has a substantial impact on the increase in CO_2 emissions.

This study on energy inclusiveness of ASEAN explored the best energy mix and also focused on energy access, affordability, and the minimising of energy security risk through reducing the dependence on fuel imports as well as improving fuel use efficiency and conservation measures. Sustainable and clean energy system of ASEAN will need to consider increasing the share of the renewable energy into the total share of the energy consumption and the cleaner use of fossil fuel

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through clean coal technologies and the deployment of caborn capture, utilisation and storage (CCUS).

Therefore, the ASEAN Summit's leadership needs to address the common energy challenges faced by the region and turn those challenges into opportunities for investment to improve energy efficiency and saving. Tapping on renewable sources will surely contribute to the regional economy, security and sustainable growth. A study by the Economic Research Institute for ASEAN and East Asia (ERIA) on the economic impacts of investments on energy efficiency technologies and saving suggested that investing in these energy low carbon-emitting technologies and saving would increase GDP in ASEAN and East Asia countries by 4 per cent by impacting all structural changes from the Business as Usual (BAU). Furthermore, the ERIA's study on "Energy Saving Potentials" also shows that "Alternative Policy Scenario" through the energy efficiency and savings could abate the carbon emitting by 1,842 Mt-C in 2035 compared to a BAU scenario.

The role of energy will remain critical as the backbone of economic growth. ASEAN and East Asia will need to look into its potential domestic resources and assess its reliable supply in the region. It is also noted that the power generation in ASEAN and East Asia will keep growing on average at 3.7 per cent per year from 2010 (7740 TWh) to 2035 (18,999 TWh) (ERIA 2013), and the share of coal–fired generation will continue to be the largest (above 55 per cent) of the total share until 2035. Thus, coal supply in the region will play a critical role as electricity will be the major energy sector for decades to come. The supply of coal is more reliable and stable as Indonesia and Australia have proved to have plenty of reserves to supply to ASEAN and East Asia. In this regard, the strategic usage of coal in ASEAN and East Asia will need to look at appropriate technology to use coal efficiently as part of energy security as well as contributing to green ASEAN. The choices of coal-fired generating technology will have significant implications for investments, efficiency, fuel inputs and costs, and for reducing carbon emission. Thus, to diversify the

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energy sources, ASEAN's and East Asia's future energy growths will need to come from the ASEAN and East Asia potential resources such as effective usage of coal, natural gas, renewable energy (wind, solar and advanced biomass) and bio-fuels.

In promoting the GREEN ASEAN, green technology and low carbon-emitting technology needs to stay at the heart of ASEAN. However, there are barriers in accessing those technologies because the upfront cost of investment is high compared with cheaper and dirtier technologies that emit high carbon emissions. Therefore, ASEAN may also need to voice common concerns to the international arena to ensure that such a kind of clean technologies could be deployed and made affordable to ASEAN countries.

This chapter focuses on the energy outlook for ASEAN to pursue energy resilience and green development by looking into its resource potentials and the strategic uses of those resources toward energy security, thus providing ASEAN and East Asia with a long term perspective of green development and sustainable as well as equitable growth.

Energy Access

The ASEAN region has had a spectacular growth over the past 2 decades, and this growth has lifted hundreds of millions of people out of poverty. Energy demand has grown 2.5 times since 1990 and is expected to triple by 2035. Yet about 130 million people in ASEAN countries still lack access to electricity and therefore have yet to enjoy the health, social, and economic benefits brought by electricty and clean cooking fuel such as Liquerfied Natural Gas (ACE 2013). As the ASEAN Community declared at the end of 2015, the lack of power and energy access could threaten the region's economic growth and economic transition. Energy is largely linked with economic opportunities. The expansion of energy infrastructure projects is slow and affects the potential of industrial development and growth. In ASEAN countries, small and very small power producers (SPPs and VSPPs) are playing a significant role in the electricity supply gap and in meeting growing electricity demand. However, economic zones are also increasing to promote economic growth in ASEAN Member States. As often, the electricity supply in the economic zones is in the form of Distributed Energy System (DES) as auto-electricity producers. In some cases, the auto-producers also supply surplus electricity to the grid or nearby areas. In rural areas of developing countries, schools and clinics operate with zero or little power. Therefore, DES has been recognised as a decentralised electricity system to meet end-user demand more effectively and to serve areas where grid expansion is not economically viable. This situation is observed in Cambodia, the Lao PDR, Myanmar, and some remote islands of Indonesia.

Table 1 shows electricity access in the ASEAN region. It also shows the progress of electricity access in urban and rural areas from 1990 to 2012, and only aggregates at a national level in 2016. While a tremendous 100% increase of energy access has been observed in Malaysia, Singapore, Thailand and Vietnam, some countries in Southeast Asia have struggled to improve energy access of their population.

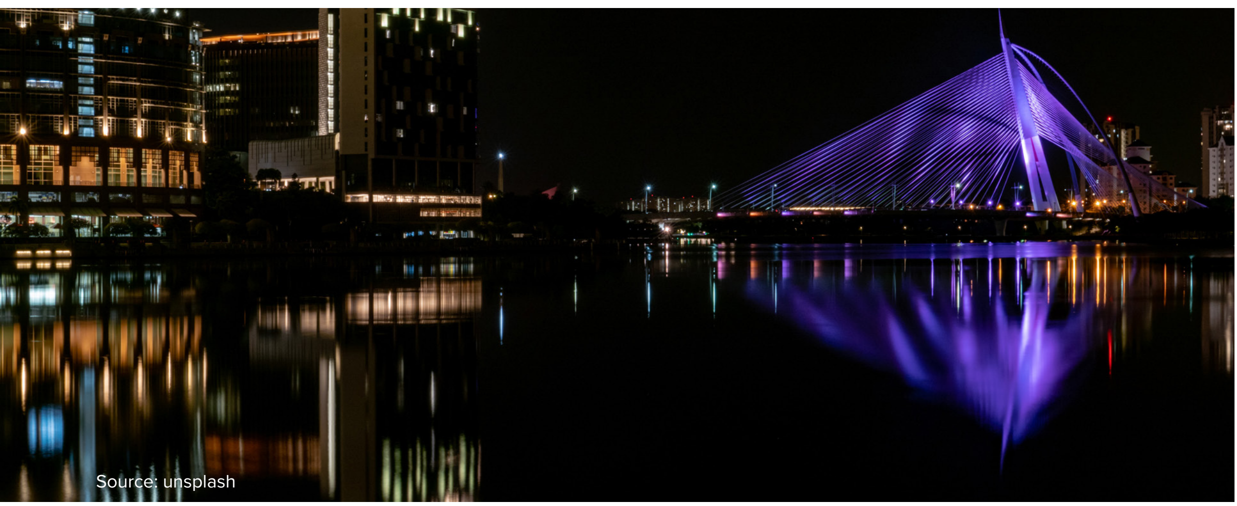

Source: unsplash

Table 1. Access to electricity, 1990–2016

	1990			2000			2012			2016
	Rural	Urban	National	Rural	Urban	National	Rural	Urban	National	National
Cambodia	5.0	36.6	19.2	9.0	49.9	16.6	18.8	91.3	31.1	49.8
Myanmar	-	-	-	-	-	-	-	-	32*	57
Lao PDR	39.7	100.0	51.5	40.0	68.7	46.3	54.8	97.9	70	87.1
Brunei	56.4	70.5	65.7	61.2	72.7	69.4	67.1	79.0	76.2	100
Indonesia	-	-	66.9	-	-	-	-	-	74**	97.6
Vietnam	84.5	100	87.9	86.6	96.9	89.1	97.7	100.0	99	100
Philip-pines	46.4	85.5	65.4	51.9	92.3	71.3	81.5	93.7	87.5	91
Malaysia	89.2	97.3	93.2	93.0	98.5	96.4	100	100	100	100
Singapore	99	100	100	99	100	100	99	100	100	100
Thailand	82	75.2	80	87.0	72.6	82.5	99.8	100	100	100

* The number was taken from the presentation of Khin Seint Wint (2014) on Renewable Energy Association of Myanmar.

** The number was taken from ASEAN Guideline on Off-Grid Rural Electrification Approaches (ACE 2013).

Source: World Development Indicator 2018.

Promoting energy access requires investing in infrastructure of grid expansion and off-grid electricity systems. Regardless of the on-grid or off-grid systems, DES can be well used depending on the context and the development of the energy market in that particular country and region.

Energy Demand and Supply

The energy demand and supply outlook of ASEAN used country data, assumptions, and energy policies as well as targets set by respective governments to analyse the potential impacts of energy-saving and greenhouse gas emissions. The study also provides a platform for energy collaboration and capacity building within Southeast Asia nations. The rising energy demand is driven by a variety of socio-economic factors including growing population, sustained economic growth, increasing vehicle ownership and easier access to electricity.

The energy models of ASEAN countries were developed using the Long-range Energy Alternative Planning System (LEAP) software, an accounting system used to develop projections of energy balance tables based on final energy consumption and energy input/output in the transformation sector.

Final energy consumption is forecast using energy demand equations by energy and sector as well as future macroeconomic assumptions. The macro-economic module also projects prices for natural gas and coal-based on exogenously specified oil price assumptions. Demand equations are econometrically calculated in another module using the historical data, and future parameters are projected using the explanatory variables from the macro-economic module. An econometric approach means that future demand and supply will be heavily influenced by historical trends. However, the supply of energy and new technologies is treated exogenously. For electricity generation, specified assumptions were provided by respective ASEAN Member States, as it is used to determine the future electricity generation mix.

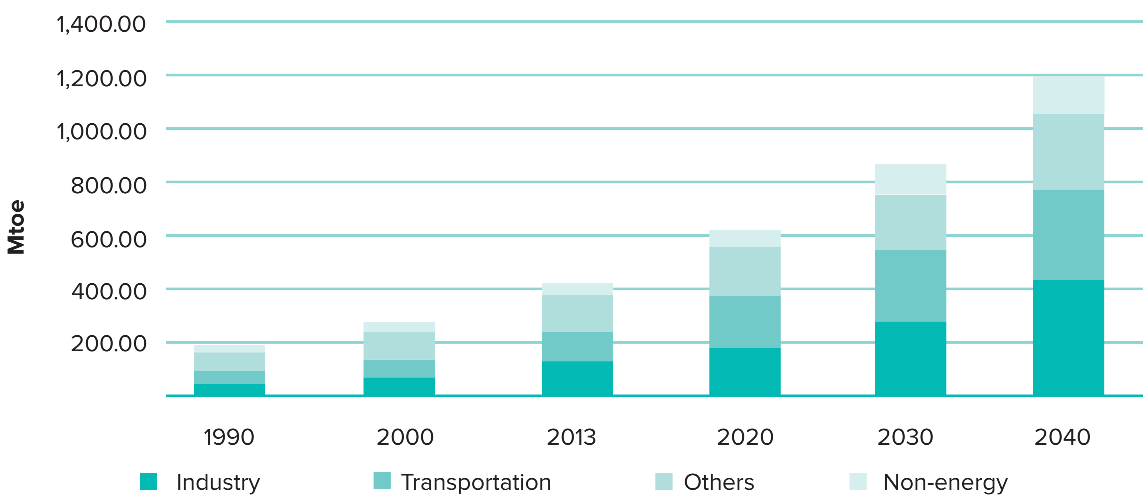
The total energy saving potentials could be realised by implementing energy policies and targets through the improvement in both the transformation sector, particularly the power generation as well as in the final energy consumption sector where efficiencies of household appliances and more efficient building designs are expected in ASEAN.

Final Energy Consumption

The final energy consumption is projected to increase from 431 Mtoe in 2013 to 1,191 Mtoe in 2040 (see Figure 3). The final energy consumption grows about 2.8 times from 2013–2040, and its average growth rate is projected at 3.8 per cent for the 2013–2040 time period. By sector, industry and transport energy demand are projected to grow most rapidly, increasing by 4.9 per cent and 4.1 per cent per year respectively, as a result of industrial expansion and motorisation driven by increasing disposable income in ASEAN Member States. The commercial and residential ('Others') sectors' demand will grow 2.5 per cent per year.

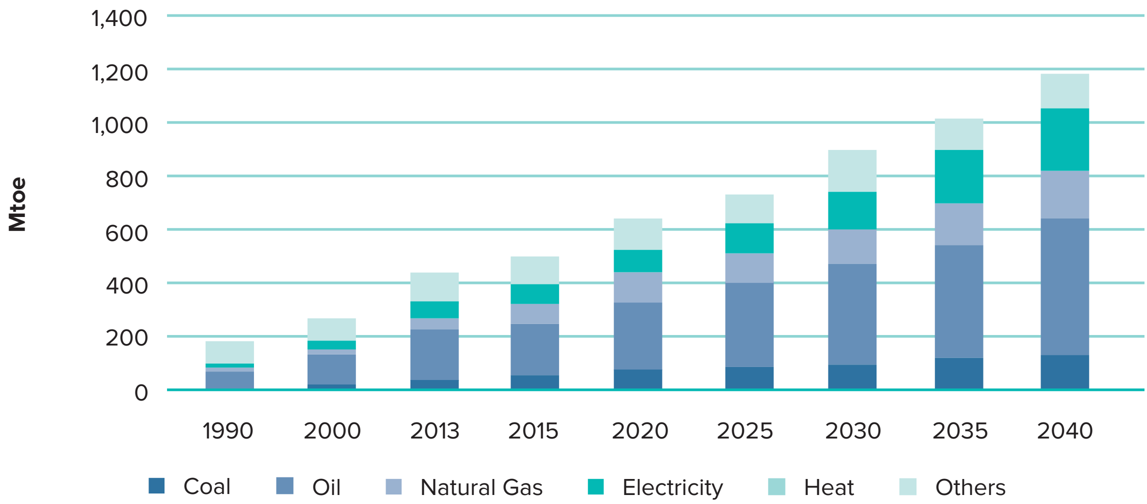
Oil demand will grow more than double from 188 Mtoe in 2013 to 520 Mtoe in 2040 (see Figure 4), representing an average growth rate of 3.8% per year. Oil remains the highest share with 44 per cent of TFEC by 2040 (see Figure 5). Natural gas will grow almost fourfold from 49 Mtoe in 2013 to 185 Mtoe in 2040, representing an average growth rate of 5.1 per cent per year. By 2040 the share of gas will be at 15.5 per cent of TFEC. Natural gas is the 2nd largest share of 37 per cent (after coal of 42 per cent) for power generation (see Figure 6).

Figure 1. ASEAN's final energy demand by sector, BAU



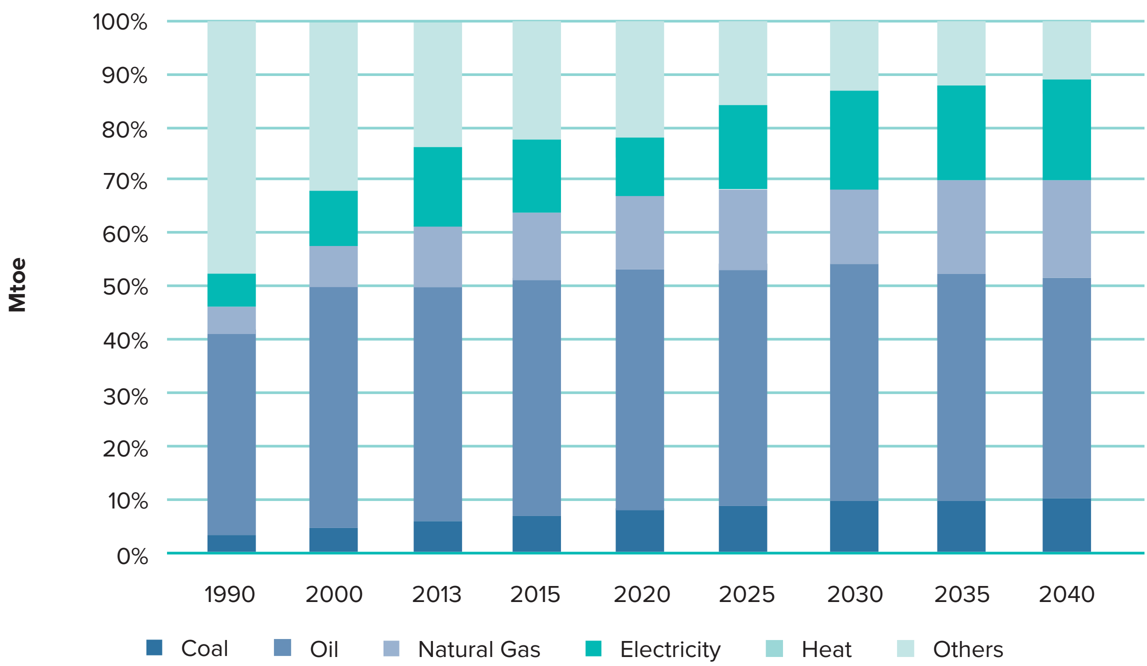
Source: Author's calculation.

Figure 2. ASEAN's final energy demand by fuel, BAU



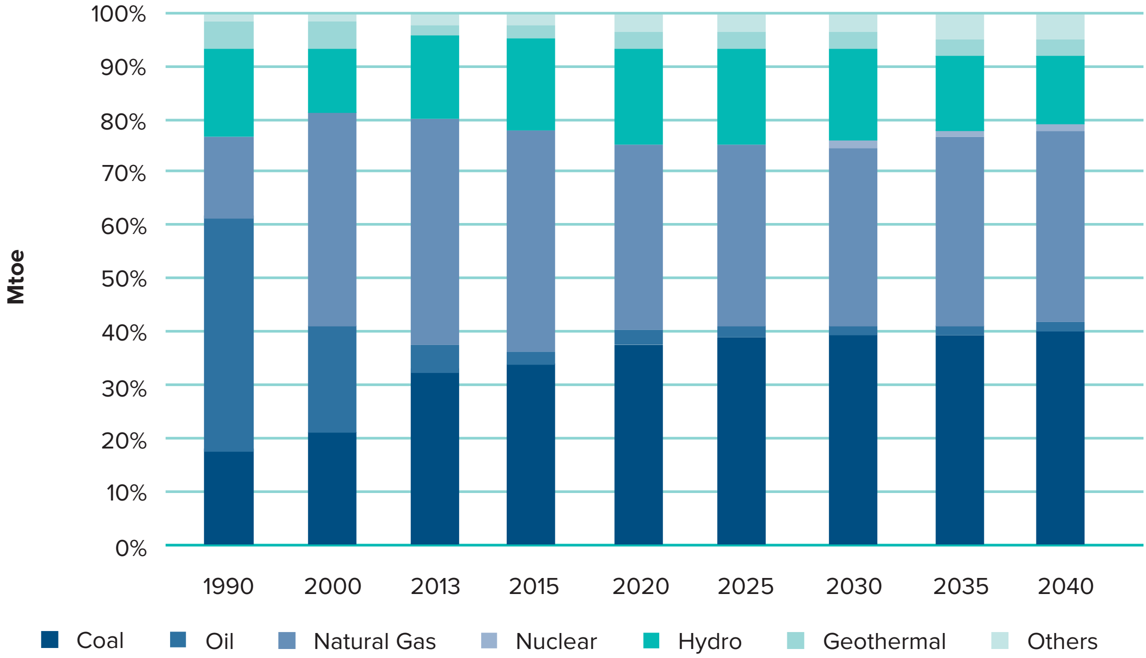
Source: Author's calculation.

Figure 3. ASEAN's final energy consumption share by fuel, BAU



Source: Author's calculation.

Figure 4. ASEAN's power generation share by fuel, BAU



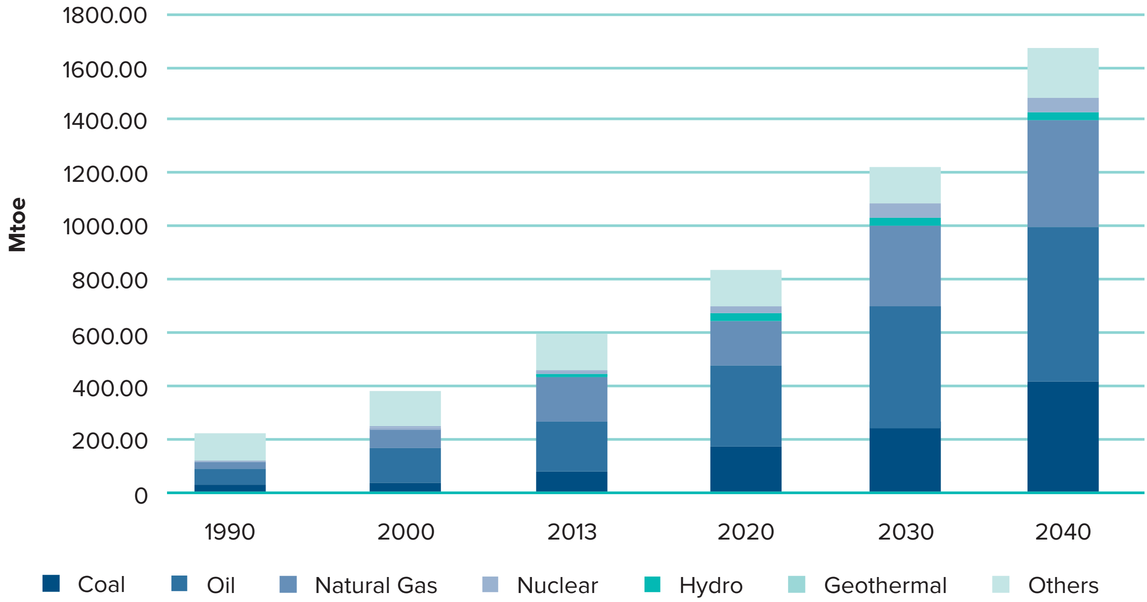
Source: Author's calculation.

Primary Energy Supply

The ASEAN primary energy supply is projected to increase from 592 Mtoe in 2013 to 1,697 Mtoe in 2040 (see Figure 7). The increase of TPES is almost threefold in the 2013–2040 period, and it reflects an annual average growth rate of 4.0 per cent during the same period.

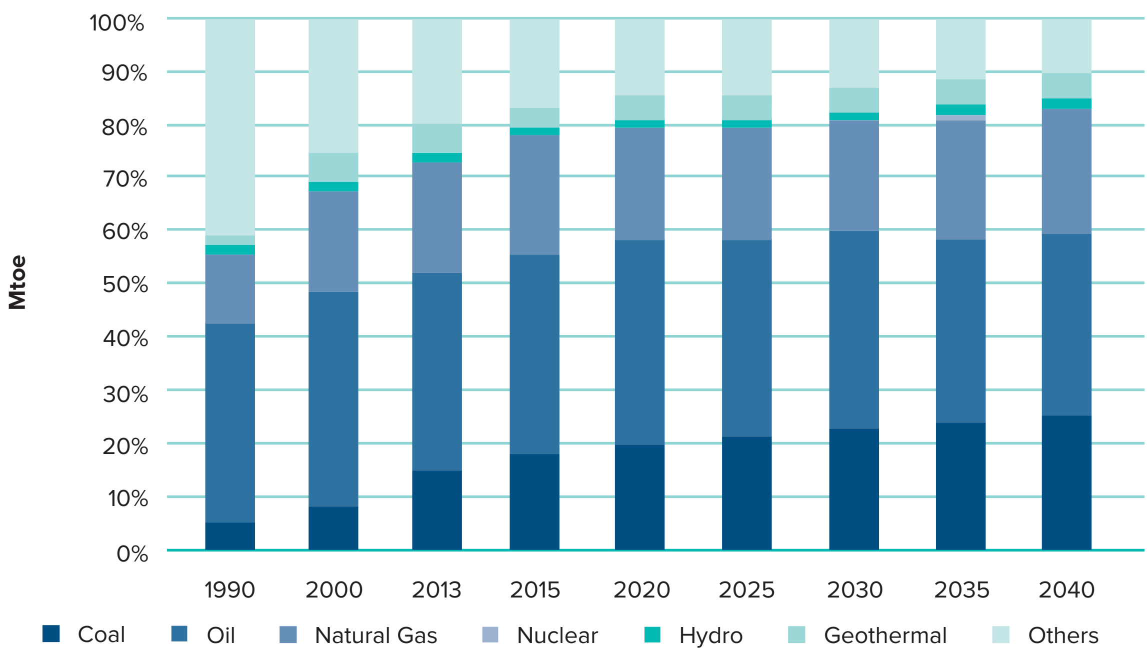
Oil will remain the largest share of primary energy supply, but its share is dropped to 34.5 per cent in 2040 from 36.6 per cent in 2013 (see Figure 8). Coal is predicted to have the fastest growth rate at 5.7 per cent per year during the 2013–2040 period, and its share will increase from 16 per cent to 25 per cent during the same period. Coal will be the second-largest share after oil. Natural gas is predicted to grow at 4.4 per cent per year during the 2013–2040 period. Its share will increase from 21.5 to 23.8 per cent during the 2013–2040 period. Although small, hydropower, geothermal, wind, and solar will see some increase in their shares as well.

Figure 5. ASEAN's primary energy supply, BAU



Source: Author's calculation.

Figure 6. ASEAN's share of primary energy supply by fuel, BAU

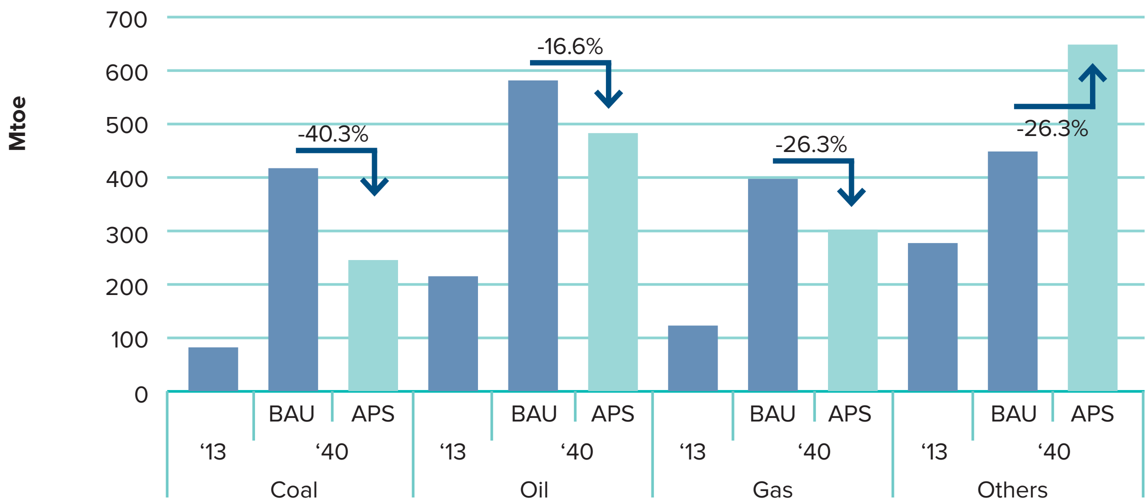


Source: Author's calculation.

Energy Saving Potential

ASEAN's primary energy supply by fuel sources in the Alternative Policy Scenario (APS) is lower than the BAU case. The growth rate of primary energy supply of APS is projected to be at 3.2 per cent per year on average during the 2013–2040 period. This rate is lower than the BAU case, in which the growth rate is projected to be 4.0 per cent. In absolute amounts, the largest reduction will be in coal demand, a 169 Mtoe or 40.3 percent reduction from the BAU's 420.7 Mtoe (see Figure 9 & 10). The saving potentials for other fuels are projected to be 97 Mtoe for oil (equivalent to a 16.5 per cent reduction from BAU) and 106 Mtoe for gas (equivalent to a 26.3 per cent reduction from the BAU scenario).

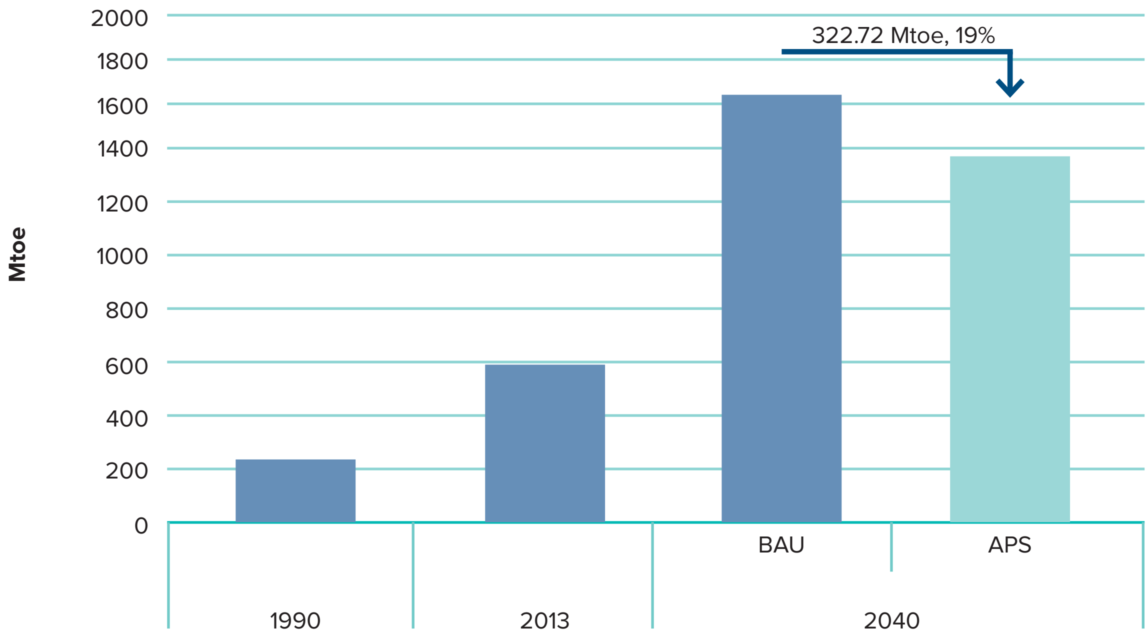
Figure 7. ASEAN's primary energy supply by sources, BAU and APS



Source: Author's calculation.

The ASEAN's total saving potentials in the aggregate primary energy supply is expected to be 322.72 Mtoe, a consumption reduction from 1,697.82 Mtoe in BAU to 1,375.10 Mtoe in APS. This saving potential represents a 19 per cent reduction. The energy-saving potentials is brought about by improvement in both the transformation sector, particularly the power generation and the final energy consumption sectors where efficiencies of household appliances and more efficient building designs are expected. For the "others" sector, there is an expected increase of renewable energy in the energy supply which is projected to be a 42.3 per cent increase from the BAU to APS.

Figure 8. ASEAN's total primary energy supply, BAU and APS



Source: Author's calculation.

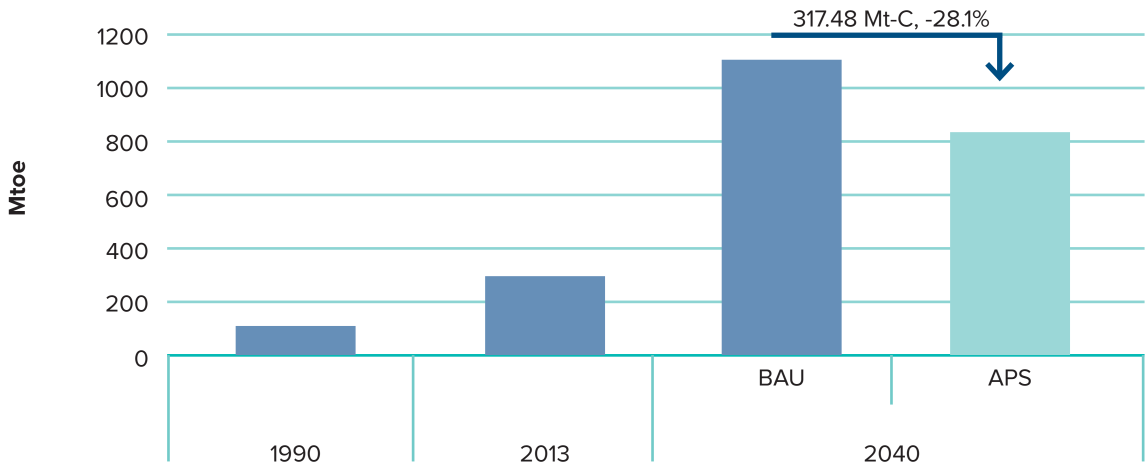
Carbon Dioxide (CO2) Emission

ASEAN's Carbon Dioxide (CO2) emissions from energy consumption in the BAU case are projected to increase from 326 million tonnes of Carbon (Mt–C) in 2013 to 1,128 Mt–C in 2040, implying an average annual growth rate of 4.7 per cent. In the APS case, CO2 emissions are projected to be 811 Mt–C in 2040, 28.1 per cent lower than the BAU scenario (see Figure 11).

Although the reductions of emissions under the APS are significant, CO2 emissions from energy demand in the APS case will in 2040 still be above 2013 levels and, regarding ASEAN countries, be more than 6.7 times higher than 1990 levels. Scientific evidence suggests that these reductions will not be adequate to prevent severe climate change impacts. Analysis by the Intergovernmental Panel on Climate Change (IPCC) suggests that in order to keep the increase in global mean temperature to not much more than 2 degree Celsius compared with pre-industrial levels, global CO2 emissions would need to peak between 2000 and 2015.

In the adopted version of the Paris Agreement, the parties will also "pursue efforts to" limit the temperature increase to 1.5 °C. According to the scientists, this will require zero emissions sometime between 2030 and 2050. However, this study shows that even in the APS scenario, the combined emissions of ASEAN, China and India will be about 4,324 Mt-C in 2030 eventhough it is supposed to be zero emission in order to limit the temperature increase to 1.5 Degree Celsius.

Figure 9. ASEAN's total CO2 emission reduction, BAU and APS



Source: Author's calculation.

Potential Development of Distributed Energy System in ASEAN

The distributed energy systems make use of renewable energy sources such as biomass, wind power, small hydro, solar power, biogas and geothermal power, and other thermal plants with small capacity. DES systems play an important role in the electric power distribution system. The shift in preferences towards green energy is one of the major factors that are encouraging the demand for DES systems across the globe. Moreover, the opportunity in developing nations and the development of eco-friendly DES systems are the key opportunities for the growth of the market.

The global DES systems market is categorized into off-grid and on-grid segments. It is estimated that the DES market will increase owing to the adoption of financial incentive schemes worldwide for the promotion of clean energy as emphasized in COP21 and INDC commitment. The ASEAN region is also predicted to have a significant rise of DES to meet energy demand (see Table 3). All countries in the East Asia Summit (EAS) region are expected to have increased the share of solar and wind in the power mix. However, hydropower and geothermal are also expected to increase their output in countries with resource potentials.

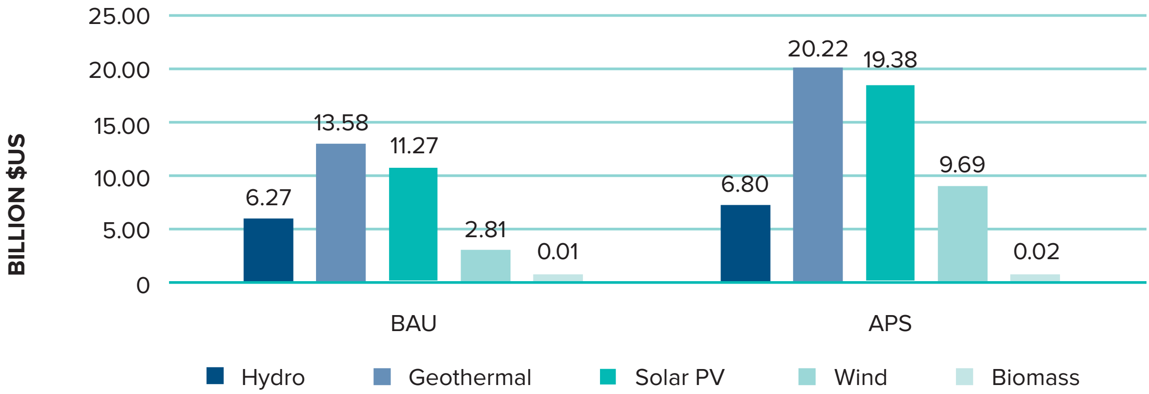
Table 2. Estimates off-grid DES generation output (MWh) in ASEAN (solar, wind, biomass, hydro and geothermal)

EAS Region	BAU vs APS	Generation output (GWh) 2013			Generation output (GWh) 2040		
		Solar, wind, biomass	Hydro-power	Geo-thermal	Solar, wind, biomass	Hydro-power	Geo-thermal
Cambodia	BAU	1.4	50	0	11.6	1,650	0
	APS				25.6	1,197	0
Myanmar	BAU	0	443	0	918	2,137	350
	APS				2,363	1,497	350
Lao PDR	BAU	0	775	0	0	2,528	0
	APS				0	2,397	0
Brunei	BAU	0.34	0	0	9	0	0
	APS				175	1.45	0
Indonesia	BAU	54	846	1,882	12,890	4,380	15,295
	APS				13,905	5,475	18,921
Vietnam	BAU	26.4	2,847	0	160.8	6,231	0
	APS				12,353	6,550	0
Philippines	BAU	59.8	500	1921	1033	738	3,028
	APS				1952	1,575	6,668
Malaysia	BAU	150	529	0	839	1,600	0
	APS				2,967	1,695	0
Singapore	BAU	274	0	0	1,292	0	0
	APS				1,710	0	0
Thailand	BAU	1,671	287	0	9,773	740	0
	APS				9,277	792	0
TOTAL	**BAU**	**2,240**	**6,281**	**3,804**	**26,927**	**20,008**	**18,673**
	APS				**44,731**	**21,182**	**25,941**

* The number was taken from the presentation of Khin Seint Wint (2014) on Renewable Energy Association of Myanmar.
** The number was taken from ASEAN Guideline on Off-Grid Rural Electrification Approaches (ACE 2013).
Source: World Development Indicator 2018.

The increase DES energy supply in the ASEAN region also implied the investment opportunity for DES-related renewable investment (see, Figure 12). The figure shows that investment opportunity by 2040 in BAU for combined solar, wind, biomass, hydropower and geothermal, are about US$34 billion, and in the APS is about US$56 billion. Amongst the DES-related renewable investment, solar and geothermal power are expected to increase the investment double from BAU to APS. Wind energy will increase more than threefold in terms of investments required to meet the expected generation output by 2040.

Figure 10. Estimates of off-grid DES-related renewable investment opportunity by year 2040



Source: Author's calculation.
Note: Various assumptions were made to calculate the estimated DES-related renewable investment opportunity.

Conclusion and Policy Implications

The energy demand and supply situation tells something about how ASEAN can move forward for resilient and green ASEAN which will need to ensure the balance of economic growth with ecological and environmental sustainability. Thus, the energy mix will be of strategic importance for this region. Leaders in ASEAN countries are fully aware of their countries' profound dependency on imports of fossil fuel from the Middle East to fuel its economy and thus it puts the region in a vulnerable spot in case a supply disruption of oil and gas that may occur from the political instability in the Middle East. The energy security in the region will need to be less dependent on the global political landscape in major oil-exporting Middle East countries which could send the shock through crude oil prices fluctuation. Thus, Green ASEAN's growth will not only focus on less dependent on fuel imports but its fuel use efficiency and the diversification of fuel sources, especially the increasing share of renewable energy into the total share of the energy consumption will make the ASEAN region more resilient to external shock and at the same time help abate carbon emissions into the environment.

The ASEAN primary energy supply is projected to increase from 592 Mtoe in 2013 to 1,697 Mtoe in 2040, representing an increase of more than threefold in the 2013-20140 period. This increase in energy demand will put pressure on energy security, an overwhelming issue of energy access as well as affordable energy prices. Thus, the study of the distributed energy system (DES) is explored as part of the energy system that could promote energy access at less cost and efficiently. The study found that DES is in its kind a modern small power generation capable to provide electricity to end-users more effectively due to its advantage of less investment costs and easy to handle as opposed to the large national power plants and national grids.

At the ASEAN level, the idea of transboundary grids is being promoted in the ASEAN Power Grid (APG). The APG is expected to contribute significantly to maximize the ASEAN's benefit from avoiding the cost of power generation; however, they are expensive and it may take years to realize the connectivity. In opposite, the DES has the ability to overcome cost constraints that typically inhibit the development of large capital projects as well as transmission and distribution (T&D) lines. Thus, the prospect of DES will widely be used. It is also expected that the modern grid system could handle the DES's integration into the grid system. DES could be a stand-alone power generation or to be connected to the power grid. So its use is also very suitable for rural areas, mountains, and islands.

The study also estimated the DES-related renewable capacity and needed investment at the ASEAN level. The estimated power generation from combined renewable energy such as wind, solar PV, geothermal, hydropower and biomass in ASEAN will increase significantly from BAU to APS, and it also implies investment opportunity in this sector. It is estimated that investment opportunities by 2040 in BAU for combined solar, wind, biomass, hydropower and geothermal, are about US$34 billion, and in the APS they amount for US$56 billion. Amongst the DES-related renewable investments, solar and geothermal power generation investment is predicted to grow double in the APS scenario compared with UAU scenario. Wind will increase more than threefold in terms of investment required to meet the expected generation output by 2040.

The introduction of DES's application also implies a reduction of CO2 emission. The study estimates that about 46.1 to 64.6 million metric tons of CO2 emission reduction could be realised by switching from BAU to APS.

The study offers the following policy implications:

- Sustainable, reliable and affordable energy are key for the ASEAN region to pursue green growth. ASEAN's green growth-based future will need to come from renewable energy as countries in ASEAN are endowed by resource potentials such as wind, solar, hydropower, biofuels and other renewable energy. Although leaders have committed to implementing the Cebu Declaration and UN Conference on Environment and Development (UNCED), the ASEAN and East Asia will need to foster renewable aspirations and deployment targets. ASEAN members could also develop RE deployment goals for each country within a target period that reflects the reality in each member's economy. In this regard, energy policies such as Feed-in-Tariff (FIT), Renewable Portfolio Standard (RPS) and incentives on technology development shall be formulated to promote NRE.

- ASEAN's leadership to implement Energy Efficiency and Conservation (EE&C) will bring large energy saving potentials and surely contribute to the regional security. ERIA's study on the economic impacts of investments on energy efficiencient technologies and saving suggested that investing in these energy low carbon-emitting technologies and saving will increase GDP in ASEAN and EAS countries by 4 percent by impacting all structural changes from the Business as Usual. Furthermore, it could abate the carbon emitting by 1,842 Mt-C in 2035 compared to a Business as Usual (BAU) scenario. Thus, ASEAN needs to find a framework to support the deployment of efficient and low carbon technologies.

- Technological development and financing mechanisms in RE are key to reducing the lead time for RE deployment. Recognizing each ASEAN


Source: flickr

country's level of development, ASEAN countries will need to have access to financial support in order to acquire technology development for the NRE. Thus, it is necessary that financial cooperation and technology development incentives amongst ASEAN & East Asia countries shall be policy priorities and the world will need to support developing member countries to embark on RE development.

■ DES, as a stand-alone generator or combined with the grid system, offers ASEAN countries one of the best options in responding to increasing energy demand. It also provides energy access for remote areas, mountainous and island regions, and economic zones. The promotion of DES is crucial, but DES will need policy support depending on the level of maturity of technologies and its up-front investement cost such as solar PV, wind, geothermal, biomass and other clean and renewable technologies. Basically, the policies should focus on the reduction of upfront investment costs of DES-related renewable generation. Those friendly policies are the required top-down renewable energy targets, for instance, Renewable Portfolio Standard (RPS) and other policies such as fiscal incentives, exemptions of VAT, fuel tax, Income tax, import and export, local taxes, as well as accelerated depreciation through premium tariff rate and as fit-in-tariff. The introduction of a carbon tax could be considered in the future. It is also important to note that banking institutions will need to enlarge their role and policy to finance DES-related renewable energy and find a mechanism to dispel risk and increase the profitability aspects of DES-related renewable investment.

■ DES has been widely applied in Thailand through the application of Small Power Producers (SPPs) and Very Small Power Producers (VSPPs). The current share of DES in Thailand is about 17.4% in the power generation mix, and its share and capacity will increase significantly in the future. This experience in Thailand could provide a good example for other ASEAN countries to use DES to respond to increasing energy demand and one of the modern options of a decentralised energy system.

■ The DES-related investment opportunity is large, and it will provide jobs and many business opportunities to the community. DES is one of the modern generation systems and its deployment will also help to address national energy security.

■ A comprehensive DES study will need to be followed up with a questionnaire to capture the real situation of DES in some ASEAN countries. Thus, this type of study will be further examined at a later time by using a questionnaire mapping out the current capacity of DES, its prospects and applications in the future.

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3

Challenges and Opportunities for Regional Energy Supply in the Mekong

Venkatachalam Anbumozhi

Introduction

The Mekong region, where Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand and Vietnam are located along with the Yunnan Province of China, has great potential for energy cooperation and offers the opportunity to attain energy security, resilience and low-carbon growth.

In recent years, these countries have achieved remarkable progress in economic development. Together with rapid industrial growth and the implementation of rural electrification, electricity demand has increased rapidly. There is often a two-way relationship between the provision of renewable energy services and poverty in the Mekong. In many aspects, this relationship is a vicious cycle in which low-income economies which lack access to energy are often trapped in a reinforcing cycle of economic deprivation and the need to improve their living conditions while using significant amounts of their very limited income on expensive imported energy choices. The link between energy and poverty is also demonstrated by the fact that poor households in rural areas constitute the bulk of an estimated 3 million–5 million people relying on traditional biomass for cooking, most of whom do not have access to grid electricity – particularly in Cambodia, the Lao PDR and Myanmar.

On the other hand, access to modern forms of renewable energy is essential to achieve high levels of human development, generate employment opportunities and support inclusive growth (Martchamadol and Kumar 2013). In the next decade, electricity demand in the Mekong region is expected to continue increasing at a high rate due to economic growth. The use of renewable energy is not only associated with environmental and health impacts, but petroleum consumption and import dependence also greatly impact national budgets, trade balances and household incomes. The exploitation of renewable energy sources and cross-border clean energy trade are cost-effective options to meet the expected increase in electricity demand, achieve energy security, reduce carbon emissions and contribute to economic competitiveness.

The outlook and opportunities for the energy system in the Mekong region will depend on how leaders shape energy policy now to create a better and cleaner energy system. Thus, managing and investing in the energy transition will be key to shifting away from fossil fuel dependence towards more renewables, energy efficiency, a smart grid with the internet of things (IoT) and promising hydrogen fuels.

Availability and Use of Energy Resources in the Mekong Region

The Mekong region has a vast variety of energy resources, including oil, natural gas, coal and other renewables – mostly hydropower. Table 1 below illustrates the distribution of such resources across the five countries. Thailand, Myanmar and Vietnam have extensive gas resources. The Lao PDR and Myanmar also have large hydropower potential. The Mekong River basin has a total catchment area of 795,000 square kilometres (km2) and an estimated potential of 285 terawatt-hours, with exploitable capacity mostly in the Lao PDR and Myanmar. The total exploitable hydropower potential is estimated at about 248,000 megawatts (MW). Less than 25% of the remaining potential is shared among the other three countries. The total installed capacity of hydropower generation in the five Mekong countries is estimated at about 21,035 MW, representing only 8% of the exploitable potential resources (Yu 2003). Thailand has exploited almost all its hydropower resources.

Table 1. Technical potential of renewable energy

	Type of Energy Resources Available		
Country	**Fossil fuel**	**Renewable – Hydropower (MW)**	
		Potential	**Installed**
Cambodia	Oil and gas	15,000	13
Lao PDR	Coal	18,000	663
Yunnan, China	Coal	90,000	11,980
Myanmar	Coal (230 thousand), crude oil (2.7 billion oil barrels), gas (450–560 bcm)	100,000	802
Thailand	Coal, gas	10,000	3,422
Vietnam	Coal (33,000 t), oil, natural gas	15,000	4,155
Sub-region	**Total**	**158,000**	**9,055**
	Total: **Coal (81,421 Mtoe)** **Lignite (11,475 Mtoe)** **Crude oil (1,200 Mtoe)** **Natural gas (1,645 bcm)**	**248,000**	**21,035**

Note: bcm = billion cubic metres, Lao PDR = Lao People's Democratic Republic, Mtoe = million tons of oil equivalent, t = ton.
Source: Compiled by the author from various sources.

The population, installed capacity, energy consumption and carbon emissions of the Mekong countries varies widely, as shown in Table 2. Thailand is the key energy market in the region, with high installed capacity, per capita energy use and carbon dioxide (CO_2) emissions. It accounted for more than 50% of the total regional energy consumption in 2015. Vietnam accounts for 27% of total energy demand. The remainder was consumed by Cambodia, the Lao PDR and Myanmar.

Table 2: Current status of energy use in the Mekong sub-region

Country	Area (1,000 km2)	Population (million)	GDP ($ billion)	Installed electricity capacity (GW)	Energy use (TWh)	Carbon dioxide emissions (1,000 t CO2)
Cambodia	181.04	15.64	36.82	0.26	0.98	4,180
Lao PDR	236.80	6.78	13.75	0.67	2.28	1,874
Yunnan, China	394.1	44.2	51.7	13.5	52.0	-
Myanmar	676.58	53.86	91.13	1.56	6.01	8,995
Thailand	513.12	66.30	596.50	24.76	144.08	295,282
Vietnam	331.69	94.67	262.80	11.65	60.62	150,230

Note: CO_2 = carbon dioxide, GDP = gross domestic product, GW = gigawatt, km2 = square kilometre, Lao PDR = Lao People's Democratic Republic, t = ton, TWh = Terawatt-hour.
Source: Compiled by the author from various sources.

When combined, the Mekong region has insufficient indigenous fossil fuel resources to meet growing demand, and the share of imported fossil fuel is expected to increase, which has important energy security implications. From 1990 to 2015, electricity production in the Mekong region increased at an average annual rate of 8.2%. During this period, growth was fastest in Vietnam, followed by Cambodia and the Lao PDR. This is around twice the growth rate of the 10 ASEAN Member States (AMS) and three times the world growth rate. The region will see 4% annual growth in energy demand until

2040, amounting to a rise of 50% over 2015 levels. Electricity demand will also double from 2010 to 2040 (Yoshikawa and Anbumozhi 2019).

Energy demand and electricity production will rise at the fastest pace in 2035. According to business-as-usual scenarios based on current policies and expected market developments, most demand will be met by fossil fuels such as coal (IEA 2017). Rising fossil fuel demand from the Mekong region will also result in increased carbon emissions and local air pollution. Energy-related carbon emissions will increase by 61%, reaching 2.2 Gigatons. External costs related to air pollution from the combustion of fossil fuels will increase by 35% from US$167 billion in 2014 to US$225 billion in 2019 (ACE 2017). This would equal around 5% of the region's gross domestic product (GDP) in 2040 (IEA 2020). These energy security and environmental challenges could be addressed by promoting cross-border energy trade, wherein surplus energy from one country is shared with other countries in the Mekong region.

Opportunities for Clean Energy Mix and Regional Grid Connectivity

A country develops energy infrastructure and decides on its energy mix based on the premise of energy security. However, when demand growth outstrips the capacity to supply the necessary domestic resources or when economically efficient power station development is difficult due to constraints such as high fuel transportation costs and power loss during transmission, importing electricity from neighbouring countries is considered. In light of the above, it may be possible to optimise or improve the efficiency of energy infrastructure investments in terms of supply stability, economic efficiency and carbon emissions reduction if we consider ways to develop the cross-border infrastructure of power stations and grids on a subregional basis.

The region has several frameworks on grid connectivity. The Greater Mekong Subregion (GMS) Strategic Framework, signed in 1992, was the first effort by the five-member countries plus China to formulate and adopt a development planning agreement which defined the vision, goals and strategic thrust for cross-border infrastructure connectivity. This was complemented by the ASEAN Plan of Action for Energy Cooperation, 1999–2004, which focused on activities such as engaging cross-country energy dialogue, promoting energy security, and creating responsive policies to progressively enhance market reforms. The ASEAN Plan of Action for Energy Cooperation, 2016–2025 outlined the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline as two of seven key cross-border cooperation programs. While these programs lay the foundation for greater regional energy cooperation to investigate cross-border energy supply options to realise larger energy markets and economies of scale, it remains unclear whether their implementation can help the GMS to achieve the objectives of energy

Source: unsplash

Source: Mekong River Commission

security, affordability and sustainability.
Defining and integrating the imperatives of energy security, affordability and sustainability within the context of cross-border infrastructure connectivity, subregional cooperation often remains dynamic and contextual, with increasing scope. Depending on the issue to be addressed, as few as three (APERC 2007) to as many as 372 indicators (Sovacool 2009) may be examined. In the broader sense, energy security refers to the availability and accessibility of all types of energy resources – both fossil and renewable – within national boundaries that have the potential to replace imported energy (Martchamadol and Kumar 2013). Therefore, the estimation of current and future available renewable energy resources, in conjunction with fossil fuels, is necessary to assess the need for cross-border energy connectivity investment in a low-carbon manner. The readiness of interconnected grids to integrate energy procured from renewable sources is an important characteristic that will improve the sustainability of cross-border energy projects. Affordability refers to the economic dimension regarding the price of the energy, which depends on the cost and quality of the interconnected infrastructure. Sustainability is the ability of cross-border infrastructure to efficiently enhance the effective utilisation of low-carbon energy sources such as hydropower. This can also serve as an indicator for technological innovations at the grid level to support renewable energy and policy innovations such as carbon pricing to promote the increased absorption of non-fossil energy resources. From the perspective of energy sector resilience and quality infrastructure, recognising the limited global reserve of fossil fuel energy and unstable global fuel prices and meeting the Paris Climate Agreement targets, it is essential for the Mekong region to accelerate cross-border connectivity and to promote open trade, facilitation and cooperation in the energy sector and related industries in the requisite infrastructure.

Current Status of Cross-Border Trade in Renewable Energy

The Mekong region is a net importer of energy. In 2018, nearly 25% of the region's total primary energy consumption was imported. Thailand remains the largest importer of energy in the region, having to buy nearly 60% of its energy needs. Vietnam and the Lao PDR import 100% of their transport fuels, such as gasoline (Yoshikawa and Anbumozhi 2019). Myanmar is the only country in the region to remain a net exporter of energy.

Energy trade within the region started in 1971 when the Lao PDR and Thailand signed a power purchase agreement for importing electricity to the northeastern region of Thailand from Nam Ngum Hydropower Plant in the Lao PDR. Bilateral electricity trade progressively intensified as memoranda of understanding were signed between various governments, including Vietnam. The existing energy trade flows in the Mekong sub-region are presented in Table 3. The trade is mainly from the Lao PDR to Thailand and Vietnam, with a relatively smaller amount happening between the Lao PDR and Cambodia.

Table 3: Status of cross-border energy trade, 2016 (GWh)

Mekong country	Imports	Exports	Total trade	Net imports
Cambodia	1,546	-	1,546	1,546
Lao PDR	1,265	6,944	8,210	−5,679
Myanmar	-	1,720	1,720	−1,720
Thailand	6,938	1,427	8,366	5,511
Vietnam	5,599	1,318	6,917	4,281
Total	**15,348**	**9,861**	**26,759**	**-**

Note: GWh = gigawatt-hour, Lao PDR = Lao People's Democratic Republic.
Source: Yoshikawa and Anbumozhi 2019.

Infrastructure connectivity is key for power trade. Cross-border power connections in the Mekong region are mainly via transmission lines of 110 kilovolts (kV) and 230 kV capacity, such as those between Nam Ngum and Xeset hydropower plants in the Lao PDR and Thailand. The first 500 kV cross-border transmission line within the GMS was constructed to connect Nam Theun 2 Hydropower Plant in the Lao PDR and Thailand.

In the Mekong sub-region, major load centres are concentrated in capital cities, except in Vietnam where Ho Chi Minh City accounted for 40% of energy consumption in 2018 (World Bank 2019). Amongst the Mekong countries, Vientiane is the capital with the highest ratio of energy consumption at 75%, followed by Phnom Penh at 56%, Bangkok at 30% and Hanoi at 19%. The design and implementation of several 500 kV transmission lines between Cambodia, Myanmar, the Lao PDR, Thailand, and Viet Nam – connecting major cities – are ongoing (see Table 4). China's Yunnan Province is also connected to the Lao PDR, Myanmar, and Thailand by 115 kV lines (Kuttani 2014).

Table 4: Ongoing cross-border transmission lines in the Mekong sub-region

No.	Location	Interconnection points	Voltage (kV)	Capacity (MW)	Length (km)
1	Myanmar–China (Yunnan)	Shweli 1 HPP–Dehong	220	600	120
2		Dapein 1 HPP–Dehong	500	240	120
3	Lao PDR–Thailand	Nam Theun 2 HPP–Roi Et 2	500	950	304
4		Houay Ho HPP–Ubon 2	230	126	230
5		Theun Hinboun HPP–Thakhek (Lao PDR)–Nakhon 2 (Thailand)	230	434	176
6		Nam Ngum 2–Na Bong (Lao PDR)–Udon 3	230	600	187
7		Hongsa TPP–Nah (Thailand)–Mae Moh 3	500	1,878	325
8		Xayaburi HPP–Thali Kon Kaen 4	500	1,220	390
9		Pakse–Ubon 3	500	400	90
10		Takhek–Nakhon Phanom	115	160	61
11		Nam Leuk HPP–Pakxan–Bueng Kan	115	80	11
12		Phontong–Nong Khai 1	115	160	51
13		Pakbo–Savannakhet–Mukdahan 2	115	80	5
14		Xeset HPP–Sirindhorn HPP–Ubon 1	115	80	61
15	Viet Nam–Cambodia	Chau Doc–Phnom Penh	220	200	111
16	Lao PDR–Viet Nam	Xekaman 3 HPP–Thanh My	220	250	115
17		Xekaman 1 HPP (Hatxan)–Pleiku	220	300	120
18		Xekaman 4 HPP–Ban Soc–Pleiku	500	80	120
19		Nam Mo HPP–Ban Ve	220	120	200
20	Thailand–Cambodia	Aranyaprathet–Banteay Manchey	115	80	40

No.	Location	Interconnection points	Voltage (kV)	Capacity (MW)	Length (km)
21	China (Yunnan)–Viet Nam	Xinqiao–Lao Cai	220	300	56
22		Maguan–Ha Giang	220	200	51
23		Maomatiao–Ha Giang	110	115	n/a
24		Hekou–Lao Cai	110	91	20
25	China (Yunnan)–Lao PDR	Mengla–Na Mo	115	35	60
26	China (Guangxi)–Viet Nam	Fangcheng–Mong Cai	110	25	60

Note: HPP = hydropower plant, km = kilometre, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, MW = megawatt, TPP = thermal power plant.
Source: World Bank 2019.

The main catalyst for the cross-border projects is the Electric Power Forum, established in 1995. This intergovernmental institution adopted a two-pronged approach of establishing (i) physical infrastructure, such as transmission lines, to facilitate power dispatch across borders; and (ii) institutional and policy frameworks that augment cross-border power trade. To advance the power trade, an international agreement on power trade was signed and a committee for regional power trade coordination was established. The committee meets annually to set the rules governing trade and establishing new infrastructure. The Vientiane Plan of Action is another agreement, which listed about 73 activities that focus on institutional and financial capacity building for enhanced power trade across the Mekong sub-region.

The benefits from cross-border integration of the energy sector across the GMS are calculated to total US$200 billion or 17% savings from total energy costs over the 20-year period from 2010 to 2030 (ADB 2008). A 6% reduction in import dependence was also anticipated. In light of the above, it may be possible to optimise or improve the efficiency of energy infrastructure investments in terms of supply stability, economic efficiency and a reduction in emissions and pollution, if we consider ways of developing cross-border infrastructure of power stations and grids on a subregional basis.

However, numerous barriers confront cross-border energy infrastructure development. These have been classified as regulatory, technical, political and environmental, which need to be systematically evaluated to assess the full benefits of future cross-border projects. Regulatory barriers include distorted energy prices, including the existence of pervasive subsidies, which have negative consequences on cross-border energy infrastructure investments. Technical barriers include grid codes, capacity, and engineering characteristics of transmission lines. Unequal starting points in power purchase agreements hinder the development of cross-border projects. While integrating renewable energy into existing grids brings carbon benefits, large-scale construction of hydropower is found to have a negative impact on the living environment. Therefore, a more structured methodology is needed to estimate the net costs and optimise the full benefits of cross-border connectivity in the Mekong sub-region.

Priorities in Cross-Border Grid Connectivity and Regional Energy Supply in the Mekong Sub-region

As indicated above, two initiatives are underway for developing power connectivity in the Mekong region. The Asian Development Bank (ADB) initiated the GMS Program in 1992, in which multisectoral partnership was developed in the sub-region, including China (Yunnan Province and Guangxi Zhuang Autonomous Region). The program envisions a stepwise process to integrate the current and planned interconnections listed in Table 4. The four steps for integrated cross-border connectivity are as the following:

Step 1: Formulate a power purchase agreement for one-way power sales under which an independent power producer in one GMS country sells power to a utility in a second country, using dedicated transmission lines established.

Step 2: Institute power trade between two GMS countries, initially using spare capacity in dedicated stage 1 transmission linesMyanmar and eventually using other third-country transmission facilities.
Step 3: Interconnect all GMS countries with 200–300 kV lines, after introducing centralised operations, with a regional system operator that will facilitate third-party participation in energy trading.
Step 4: Make all the GMS countries accept the legal and regulatory challenges to enable a free and competitive electricity market with independent third-party participation.


Source: Mekong River Commission

Another initiative on cross-border interconnection is the APG, which covers five countries in the lower Mekong River basin. The plan for the APG is to make power grid interconnections on bilateral terms, which then gradually expand to a subregional basis, leading to an integrated APG system. As one of the physical energy infrastructure projects in the Master Plan on ASEAN Connectivity, the APG is designed to enhance electricity trade across borders – aiming to meet rising electricity demand and improving access to energy services in the region. As of 2015, six bilateral interconnections had been put in operation, linking Singapore and Peninsular Malaysia; Thailand and Peninsular Malaysia; and connecting Myanmar to Cambodia, the Lao PDR and Vietnam via Thailand. Following 2015, a new initiative was announced by four AMS – the Lao PDR, Thailand, Malaysia, and Singapore – to undertake a detailed project to explore multilateral cross-border power trade from the Lao PDR to Singapore, which could serve as a pathfinder to enhance multilateral electricity trading.

The progress of the APG projects in the Mekong region is presented in Table 5, including seven hydropower projects with 4,152 kilometres (km) of transmission lines, integrating the existing connections and four new projects having a combined transmission length of 2,469 km.

Table 5: Cross-border energy transmission connectivity under APG programme

Cross-border connectivity	Existing	Ongoing	Future	Total
Thailand–Lao PDR	3,584	2,469	1,865	7,328
Lao PDR–Vietnam	248	1,879	NA	538
Thailand–Myanmar	-	290	11,709–14,859	11,709–14,859
Vietnam–Cambodia	200	-	-	200
Lao PDR–Cambodia	NA	-	-	300
Thailand–Cambodia	120	300	2,200	2,320
Total	**4,152**	**2,469**	**15,774–18,924**	**22,395–25,545**

Note: APG = ASEAN Power Grid, Lao PDR = Lao People's Democratic Republic, NA = not applicable.
Sources: ADB 2014; Kutani and Li 2015.

Evaluation studies by ERIA reflect multiple economic benefits of cross-border interconnectivity. In the case of Lao PDR–Thailand connectivity, the benefits are more evident in the Lao PDR. Exports of electricity as a percentage of GDP increased five times from 1.63% in 1994 to 34.2% in 2010 (ADB 2013). The hydropower plants built to export electricity to Thailand have benefited rural communities in the Lao PDR with electrification. In 1995, only 45% of households nationwide had access to electricity, but this increased to 75% of households in 2005 (ADB 2008).

Policy Challenges and Opportunities for Low-Carbon Energy Development in the Mekong Region

Compared with other countries in the Mekong region, Thailand has made impressive progress with low-carbon energy development. Alternative energy sources (solar, wind, biofuel, biogas, and mini-hydropower) account for 12% of Thailand's overall energy use, and the government is targeting an increase to 25% by 2021 (Anbumozhi and Tuan 2015). The main policy and regulatory framework for reaching this target is the Alternative Energy Development Plan, announced in 2012. The projected quadrupling of installed alternative energy capacity over the period from 2000 to 2021 is expected to derive from dramatic advances in solar and wind power, a doubling of biomass energy and a multiple increases in mini-hydropower. The main support for renewable energies in Thailand is the feed-in tariff premium, differentiated according to technology, capacity and location. Other mechanisms in support of investment in renewable energy in Thailand are financial incentives in the form of grants and low-interest loans, fiscal incentives in the form of exemption from import duties and personal income tax and corporate income tax provisions.

Vietnam has renewable energy resources such as hydropower, biomass, wind energy, geothermal energy and solar energy. So far, these clean energy sources have not been widely used due to a lack of policy initiatives and the absence of a supportive institutional framework. However, Vietnam has ambitious targets for the development of renewable energy technologies, described in the National Master Plan for Power Development, 2011–2020 with Outlook to 2030 or the Power Development Plan VII. The share of renewable energy in electricity generation is expected to grow from 3.5% in 2010 to 6.5% in 2020, and from 6.9% in 2025 to 10.7% in 2030. Targets are set for four renewable energy sources: wind, solar, biomass, and small hydropower. Originally, a feed-in tariff for wind power was approved by the Prime Minister's Decision No. 37/2011/QD-TTG in 2011. A fixed price of US$0.078 per kilowatt-hour (kWh) is offered for a grid-connected onshore wind project. However, compared with other countries in the region and the world, the support price of wind power in Vietnam is too low and is not attractive to national and international investors (Anbumozhi and Tuan 2015). In 2018, the prime minister amended the Prime Minister's Decision No. 39/2018/QD-TTg (Decision 39), stating that the wind feed-in tariff (excluding value-added tax) would be D1,928 per kWh (equivalent to US$0.085 per kWh) for onshore wind power projects and D2,223 per kWh (equivalent to US$0.098 per kWh) for offshore wind power projects (Linh et al 2016).

Source: flickr

Other supporting mechanisms for grid-connected biomass co-generation and solid waste power projects were also approved by 2014, which regulated a fixed price of US$0.058/kWh for biomass co-generation, US$0.1005/kWh for incineration technology, and US$0.0728/kWh for the burial of solid waste (Anbumozhi and Tuan 2015). The Vietnamese government has provided many additional incentives to encourage investment in renewable energy, including import duty exemptions, an incentive rate for corporate income, and the exemption or reduction of land use fees/rental.

The Lao PDR's low-carbon energy development strategy, approved in 2011, defined the capacity required to achieve a 30% share of renewable energy in the total energy use in 2025. This is the most ambitious target in the Mekong region. However, large hydropower is not included as part of this target – only installed capacity and generation for small hydropower are specified. In 2011, the total installed and operational capacity of the Lao PDR was 2,566 MW for both domestic consumption and export, of which 1,987 MW was used for the export market in Thailand and Vietnam (ADB 2013). The installed capacity of renewable energy sources was around 28 MW in 2015. In 2016, the Lao PDR added 599 MW of installed hydropower capacity, bringing its total installed capacity to 4,168 MW (International Hydropower Association 2016).

Myanmar has significant renewable energy potential, but little of the country's solar, wind, and biomass energy potential had been exploited by 2015. The focus had been on hydropower investments. The total installed renewable capacity is about 150 MW in 2015. The Ministry of Energy is targeting an additional 600 MW of renewable energy, which represents 17% of the current installed capacity in 2017. At present, there are no specific renewable energy incentives. However, the government in 2017 announced a new foreign investment law which offers general foreign investment incentives, including, for example, tax exemptions, income tax relief, and targeted customs duties for the importation of machinery and equipment, which could be applied to renewable energy promotion (US Commercial Service 2019).

Compared with other countries, the development of renewable energy in Cambodia in 2015 was still limited to a demonstration project. Financial incentives for renewable energy are not yet in place. Some investment incentives under the 1994 Investment Law are available, such as tax exemptions and import duty exemptions. Cambodia does not have a renewable energy development target, but this is linked to the electrification program to achieve full electrification of villages by 2020 and 70% household electrification by 2030. Some of the main components of this program are solar, wind, mini and micro-hydro, biogas, biomass, and financial resources for the development of renewable energy are mainly from foreign countries. These are in the form of donations or grants. Access to finance is considered one of the main barriers to the implementation of low-carbon energy development in Cambodia (ACE 2017).

In summary, Thailand has achieved early success in low-carbon energy system development, mainly by relying on important support measures that include subsidies and feed-in tariffs. However, this measure of success is based on renewable energy capacity expansion and does not necessarily capture other indicators including energy security, innovation, job creation, and environmental impact mitigation. Moreover, an integrated strategy that sets clean energy targets, priorities for renewable energy


Source: unsplash

technologies and skills development is still lacking. In the case of Thailand, these additional considerations could be used as lessons learned to be shared and to help advance the development and use of low-carbon energy development throughout the region.

Factors Constraining Full Integration of Renewables in Cross-Border Grid Connectivity

Achieving energy security and affordability as well as meeting intended nationally determined contribution targets remain the objective of future energy development in Mekong countries. More investment in cross-border interconnectivity means reducing emissions from the energy sector and addressing growing concerns in the heterogeneity of global commitments. However, there are several barriers to the operationalisation of this connectivity. The operation of interconnecting transmission lines may be roughly divided into passive and active operations. In passive operations, interconnecting transmission lines are used only for when an excess or shortage in the power supply ability emerges for some reasons on the premise that each country maintains the supply and demand balance based on the concept of

Source: unsplash

energy security. In active operations, interconnecting transmission lines are used for maximising the economic benefits of facility operations by balancing the power supply capacity of each country and the demand in the sub-region. The active operation may be what the GMS is aiming for, as demand for power is increasing rapidly in every country and an integrated energy market is thus desired.

As cross-border transmission progresses and the use of interconnections expands, the benefits for the entire system in the region will increase (ADB and ADBI 2012). Therefore, it is necessary to carry out structural formulation and system design for the management and operation of interconnections while Mekong countries are still making considerations and deliberations. Additionally, to accelerate the interconnection projects in progress in the GMS and materialise the benefits of electric power interchange, some conditions need to be satisfied. In this regard, the following region-wide actions are required: (i) overall optimisation and adjustment of power infrastructure development plans that fully integrate renewables, (ii) the harmonisation of technical standards and energy pricing mechanisms, and (iii) the establishment and authorisation of regulatory and consultative bodies to support Mekong-wide energy market integration.

The Mekong region has abundant potentials for renewable energy development, and these potentials once harnessed could be integrated into grid networks. However, cooperation and harmonisation are still very limited. There is room to increase cooperation and harmonisation for individual countries and the region as a whole. The expansion of renewables such as wind, solar, biomass, and geothermal would increase diversity, assuming that they do not completely displace fossil fuel sources. However, an increased share of renewable energy in power generation at the country level may have alternative impacts. For example, it could result in a higher cost of electricity or fewer jobs. The impacts of expanded renewable energy uptake in place of coal are not very clear from a net cost-benefit perspective.

There are few initiatives on regional cooperation, apart from joint studies on the renewable energy support mechanism for bankable projects, off-grid rural electrification approaches, and renewable energy technical standards. To help shape influential renewable energy policies and increase the deployment of cross-border transmission lines, several feasibility studies have been undertaken by international organisations, on topics such as (i) CO_2 reduction – a greater role for renewable energy in the ASEAN power generation sector; and (ii) the impacts of renewable energy integration through a grid connection. Since countries in the region are at different levels of development, interregional cooperation on regulatory standards, and exchange of information as well as lessons learned on pilot and demonstration projects, best practices, and benchmarking would facilitate rapid progress. Cambodia, the Lao PDR, and Myanmar have the opportunity to benefit from other experiences such as those of Thailand, Malaysia, and Vietnam in implementing successful policy reforms through interregional cooperation. Energy policy and planning in the region have been developed individually, as countries are at different stages of development. That said, the governments require capacity building to define the necessary policies and redefine the planning process under the agreed framework of the ASEAN Plan of Action for Energy Cooperation, 2016–2025.

Conclusion

The benefits of cooperation amongst Mekong countries on regional energy supply, energy security, affordability, and sustainability are high. However, countries will need to address many of the technical and regulatory barriers to achieve the multiple benefits of interconnections. What will determine the realisation of future renewable energy supply across the borders are not only technical limitations but also political and regulator limitations.

Mekong countries are developing their national power development plans, low-carbon implementation frameworks, and priority actions for the Sustainable Development Goals. However, these plans lack a regional focus and new opportunities with cross-border energy infrastructure development. Therefore, while countries develop their own energy strategies, they should work together to formulate regional targets within their own energy and power development strategies for operationalising cross-border connectivity. This would allow for enhancing energy security and reduced emissions, as determined by several existing studies. The social benefits of such an approach are clear in terms of employment and local development. Nevertheless, the following key policy options are recommended to realise the planned cross-border interconnections.

- Conduct an overall assessment, optimisation, and adjustment of planned cross-border power connectivity plans to provide detailed information for public and private decision makers about the quantity, quality, and location of APG and GMS master plan projects, technical standards, and institutional capacities.

- Develop a comprehensive renewable energy investment roadmap as a strategy to show bold leadership in removing the barriers to integration and to make new investments more cost-effective at the grid level through regulations, incentives, and capacity building for taking credit risks.

- Earmark financial resources for power market integration by expanding the ASEAN Infrastructure Fund to drive private investments with clear policy signals.

The emerging digital and industry 4.0 revolution is also set to transform energy demand and supply in the Mekong sub-region. The adoption of smart transport, housing, and manufacturing on a large scale will have a profound impact on both energy demand and the optimisation of energy supply at the national level. Therefore, a sound policy and market design will be critical in steering a digitally enhanced energy system along more efficient, secure, and stable grid connectivity across the borders.

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4

Current Prospects of Regional Energy Consumption and Production in the Mekong Region

Alfred Christopher Gurning

Introduction

The Mekong River begins in the Tibetan plateau and passes through six countries, namely China, Myanmar, Thailand, Lao PDR, Cambodia, and Vietnam. The countries where the river runs through are those in the Greater Mekong Subregion (GMS). They are blessed with biodiversity and a high potential for renewable energy.

Globally, several imperatives are driving the development of renewable energy. First and foremost, it is the global need to reduce greenhouse gas emissions. Second, it is the need for developing countries to reduce their vulnerability arising from heavy reliance on imported energy. Third, it is the need for inclusive growth. Therefore, GMS countries need to embrace their potential renewable energy sources.

In the current era of the energy transition, where many countries are aiming to decarbonise their electrical grid, renewable energy plays a crucial role. Renewable energy generates power that produces no greenhouse gas emissions. Moreover, renewable energy offers an opportunity for economic growth and innovation while increasing clean, safe, and more affordable energy use. Meanwhile, pursuing renewable energy development will also diversify the sources of energy supply and reduce dependence on imported fuels. The Mekong region has the potential to pursue different types of renewable energy.

Renewable energy comes from natural sources or processes that are constantly replenished, such as a flowing river, sunlight, or wind. The natural sources are harnessed by using several technologies such as hydropower dam, solar panel, and wind turbine, so people can produce energy for daily use. Moreover, the energy produced from agricultural activities is also considered renewable, which is called bioenergy. Plants and other bioproducts from agricultural activities are harnessed by producing bioenergy through biomass or biofuel. The GMS countries are blessed because they have a high potential for all


Source: rawpixel

types of renewable energy.

This chapter aims to offer an overview of the current prospects of renewable energy consumption and production in five Mekong countries. It also highlights the potentials for renewable energy in each country.

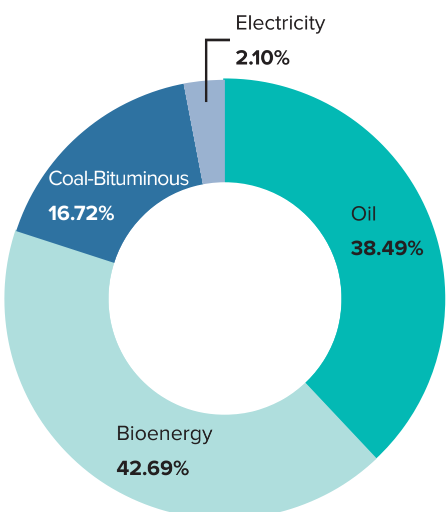
Current Energy Situation

Cambodia

There is not yet any specific target for renewable energy development in Cambodia. The private sector and educational institutions are driving the country's development towards higher renewable energy implementation with several successful initiatives. Pilot projects, innovation hubs, and system pilot development are being deployed by various stakeholders to accelerate renewable energy development in Cambodia and to encourage participation from more stakeholders, making renewable energy important for the country's energy outlook.

Cambodia has 77% of the population living in rural areas. Its total primary energy supply (TPES) of 6,036 Ktoe consists of electricity (2%), coal (17%), oil (38.5%), and bioenergy (43%) as shown in Figure 1. However, Cambodia currently has a low installed capacity for renewable energy. In 2017, the total installed power capacity was 1,889 MW, of which 52% came from large-scale hydro, 4% from solar and biomass, 29% from coal, and the rest from oil (ACE 2019, 22). Also, Cambodia's power generation in 2017 depended mainly on coal (3,569 GWh, 5%), large- scale hydropower (2,711 GWh, 40%), oil (391 GWh, 6%), and solar and biomass (56.5 GWh,1 %) (Ibid). The Cambodia Renewable Energy Report (2016) shows that a diverse mix of renewable sources could meet nearly all of Cambodia's electricity demand by 2050. According to the 5th ASEAN Energy Outlook , Cambodia's renewable energy target is based solely on increasing its hydroelectricity capacity to 2,241 MW by 2018.

Figure 1. Cambodia's total primary energy supply



Source: ACE 2019.

Cambodia is considered to have high solar energy potential, estimated to be at least 8,074 MW. The country has average direct normal irradiation (DNI) levels above 5 kWh per square meter per day due to the 6-9 hours of sunshine. Despite these favourable conditions for solar energy development, the installed capacity in Cambodia for solar photovoltaics remains at around 10 MW.


Source: unsplash

Cambodia has average wind speed of 5 metres per second. Some projects have been piloted in the Northeastern and Southwestern provinces. A wind turbine has been installed at Sihanoukville Autonomous Port. This pilot project aims to demonstrate that wind power could be an effective energy source in Cambodia as well as in the region.

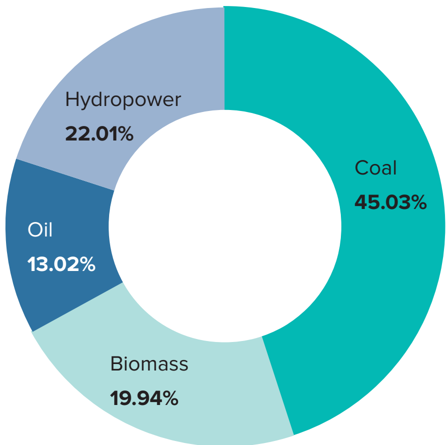
Significant biomass energy resources from a variety of agricultural residues such as rice husk, acacia, cassava, and coconut have been identified in Cambodia. Rice husks from about 22% of the total rice milled in the country are available for power generation and can fulfil more than 30% of the country's electricity needs (ACE 2019, 26). Several small-scale biogas projects have been deployed in Cambodia though they are still in the pilot and demonstration stages. A joint development programme between Cambodia and The Netherlands, called the National Biodigester Programme (NBP), was developed to establish a market-oriented biogas sector in Cambodia. The implementation of the NBP began with the construction of the first digester in 2006. The programme focuses on system deployment piloting and capacity-building, in the form of on-the-job-training which is provided to local staff to have knowledge, strengthen their capabilities, and ultimately embrace the adoption of technologies.

Lao PDR

Lao People's Democratic Republic (Lao PDR) is currently relying on hydroelectricity to meet most of the country's energy demands. A target of 30% of renewable energy in total energy consumption has been set for 2025. The government is implementing renewable energy policies development and implementation alongside several other national initiatives to reduce fossil fuel consumption and increase renewable energy utilisation. Meanwhile, several institutions such as the Institute of Renewable Energy Promotion (IREP), along with the Renewable Energy, New Material Institute (REMI), and the National University of Laos (NUOL) are actively pursuing further renewable energy development.

A strong economic growth in the Lao PDR over the last six years has of course been accompanied by an increase in energy consumption by different sectors. Hence, the Lao PDR has started to establish energy policies to promote energy efficiency, renewable energy, and an optimum energy mix to maintain energy security. The TPES in Lao PDR in 2017 is shown in Figure 2. Currently, the primary energy source is coal (45%), followed by hydropower (22%), biomass (20%), and oil (13%). As for the power sector that year, 73 %of the total installed capacity was large-scale hydro, followed by coal 26.5%, and renewables (solar and biomass) 1% (ACE 2019, 36).

Figure 2. Lao PDR's total primary energy supply



Source: ACE 2019.

As hydropower generates most of the electricity in the Lao PDR, NUOL is known for its research and development in hydroelectricity technologies. The university's latest notable pieces of research are "Pico Vs Micro Hydro-Based Optimised Sizing of a Centralised AC Coupled Hybrid Source For Lao PDR's Villages" and the "Design and Optimisation of Z-Converters for Micro-hydro Power Systems". Another notable product from the university is a model to implement hydropower in the mountainous regions of the country.

Lao PDR has an average of 200–300 sunlight days per year, which means the potential capacity of solar energy in the country per day is estimated at around 4.5–5.0 kilowatt-hours (kWh) per square meter. The Lao PDR government has constructed a renewable energy roadmap specifically for solar PV. On the private sector side, Sunlabob, a 100% Lao PDR-owned company is engaged in training and demonstration of solar PV. The company has also provided its expertise in rural electrification to governments, multilateral development agencies, multinational companies, NGOs and private individuals throughout Southeast Asia, India, Africa and the Pacific. Furthermore, the company has also actively engaged the general public to raise awareness about energy efficiency issues and apply energy efficiency standards in the Lao PDR. Meanwhile, Japan has also funded projects aiming to demonstrate and research the performance of a small-scale pumping system using photovoltaic technology in the Nga district and a hybrid small-scale power generation in Phongsaly province of the Lao PDR. However, so far only limited progress has been made in the grid-connected solar sector, with only one existing rooftop solar PV system (of 236 kW capacity) installed at Wattay Airport. The country does not have any manufacturing facility to produce renewable energy technology equipment/applications.

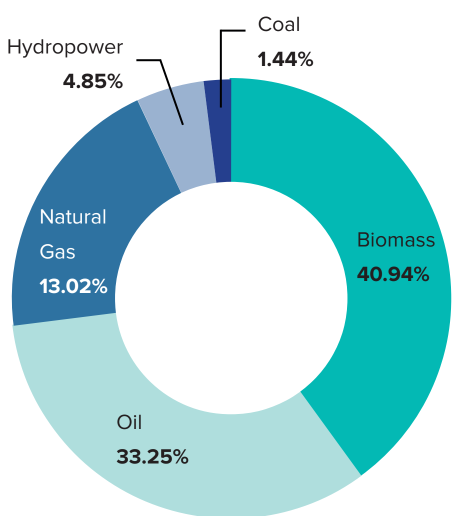
The Lao Government has signed an MOU with Impact Energy Asia Limited for conducting wind resource assessment in the Lao PDR. It has carried out feasibility studies at two sites at Nong and Xonbuly districts of Savannakhet province. The roadmap for 2025 has taken up the following tasks for the development of wind energy: 1) identification of sites for demonstration; 2) preparation of pre-feasibility studies for demonstration; 3) development of wind IPPs; and 4) Target development of 50 MW by 2025. Biomass energy in Lao PDR is used mainly for cooking as well as for small-scale rural industrial production (e.g. alcohol production and tobacco processing). The estimated potential from biogas and solid waste resources is around 313 MW and 216 MW respectively. The Lao PDR is developing a national programme on biomass development for 2025.

Myanmar

Renewable energy research and development in Myanmar has not been developed yet. Different stakeholders must connect to a better guide of renewable energy development to achieve the country's energy targets. Myanmar can learn lessons and increase the role of renewable energy stakeholders by building collaborations with established renewable energy institutions, either regional or international ones.

Myanmar has one of the lowest electrification rates in Asia, at about 38.0% in 2016–2017. As a result, it has developed a National Electrification Plan (NEP) which aims to provide universal electricity access by 2030. Myanmar's TPES consists mostly of biomass (41%) and oil and gas products (53%), as shown in Figure 3. The rest is hydropower (5%) and coal (1.44%). The total installed power capacity as of mid-2017 was 4,928 MW, with 2,841 MW (57.6%) from hydropower, 1,967 MW (40.0%) from gas and 120 MW (2.4%) from coal (ACE 2019, 56). The Myanmar Energy Master Plan Draft envisions a 15% to 20% share of renewable energy in the total installed capacity by 2020. Myanmar has at least 4,000 MW of wind and several thousands of megawatts of solar PV potential. Feasibility studies have already been conducted for the construction of wind-powered electricity generating plants at 30 sites in the East and West of the country. However, renewable energy

Figure 3. Myanmar's total primary energy supply



Source: ACE 2019.

technologies, other than hydroelectricity projects, have not been adopted in a significant way in the country.

Myanmar has on average solar radiation levels reaching 5kWh/ m2 per day. The development of solar energy is still at the beginning stages, conducted by national and international institutions. The government is conducting a preliminary investigation to construct solar power plants, with foreign direct investment projects in Minbu, Magway region, Wundwin and Nabuaing, as well as in Mandalay. Japan and Yangon Technological University have collaborated on a project to supply villages with solar power. Besides, Japan and the Myanmar's government have a solar energy research demonstration project. Meanwhile, the Myanmar's government in coordination with the Mandalay Technological University has successfully tested 3 kW solar PV installations at six sites, but there has been no large-scale deployment of solar PV in the country. Moreover, there is one hybrid project characterising a solar-diesel-battery hybrid system for off-grid rural electrification by Mandalay Technological University. It evaluated the usefulness of such a technology for Myanmar, and the long-term plan includes 50MW of solar to be developed.

The country's potential annual yield of wood fuel is 19.12 million cubic tonnes, and 18.56 million acres of land could generate residues, by-products, or direct feedstock for biomass energy (ACE 2019, 59). Five biofuel plants have been constructed by various agencies between 2003 and 2010, with a total annual production of 19.5 million gallons. An enabling framework needs to be put in place for financing, implementation, and maintenance of the projects.

Throughout the country, there is a total of 93 potential locations for commercial geothermal-generated electricity. Around 43 of these sites are being assessed and tested. Geothermal energy has been noted in the draft National Energy Plan as an option. Although the feasibility of generating electric power using geothermal resources has not been fully explored, it is currently under investigation and 200 MW of geothermal power has been included in the power development plan. Meanwhile, the first tidal power plant (3 kW) was installed in 2007 in Kanbalar village, providing electricity to about 220 households. On the other hand, there is potential to develop waste-to-energy projects, together amounting to at least 20 MW of waste-to-energy installed capacity in urban areas.

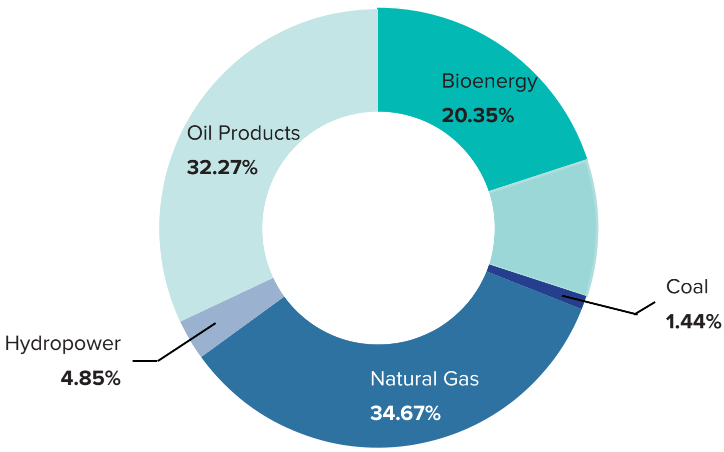
Source: rawpixel

Thailand

Thailand is a country rich in renewable energy sources, namely biomass, biogas, solar electric, solar thermal and wind energy. Thailand's government has a strong set of bodies with different ministries and departments working together towards achieving the 30% renewable energy share in the total energy consumption by 2030. Bioenergy is more focused, and many technologies are being developed by the government and private sector. Solar is also doing well and has a maximum number of patents in this field. Universities in the country are actively participating in increasing renewable energy deployment.

Thailand has potentials in fossil fuel and renewable energy resources. However, more than half of its energy supply relies on imported energy, a proportion that is likely to increase further when its proven reserves of fossil fuels are depleted. The primary energy supply in 2017 included coal, oil, and natural gas collectively at 78% while the remaining 22% was solar, wind, and bioenergy, as shown in Figure 4. Thailand's installed power capacity was natural gas (23.7 GW, 55%), coal (7.3 GW, 17%), large-scale hydropower (3.1 GW, 7.2%), biomass (2.8 GW,6.7%), solar (1.4 GW, 3.3%), wind (0.3 GW, 0.6%), and others (4.4 GW) (ACE 2019, 82). The country has pledged to increase the share of renewables in its energy mix. This would also fulfil the goals of decarbonisation and make the country self-sufficient. According to the 5th ASEAN Energy Outlook, Thailand is striving towards 30% renewable energy in its total energy consumption by 2036. The Ministry of Energy has developed the Thailand Integrated Energy Blueprint (TIEB), with a focus on energy security, increasing energy supply, diversifying energy sources, and increasing domestic renewable energy production. The Ministry of Energy has also developed the Alternative Energy Development Plan (AEDP) 2015, with a focus on promoting energy production

Figure 4. Thailand's total primary energy supply



Source: ACE 2019.

using the full potential of domestic renewable energy resources and developing appropriate renewable production for the benefit of the social and environmental dimensions of the community. The AEDP aims to have a 30% share of renewables compared to 12% in 2014.

Biomass and biogas sources in Thailand are abundant. Wood, agricultural residues and waste are used for cooking and heating in rural areas. Animal waste is used to produce biogas. In Thailand, the biomass being brought for heating and electricity generation can be divided into three groups, namely agricultural waste and agro-industries, residues from processed wood industries and furniture, and biomass from fast-growing crops. Regarding biogas, the current use of biogas technologies at the industrial level in Thailand involves both imported technologies from other countries (with systems designed by foreign experts) and technologies that are developed and improved domestically (construction and installation overseen by local entrepreneurs). Three main institutions are involved in biogas research, namely Chiang Mai University (as there is a dedicated agency for biogas research within the institution), Kasetsart University, and King Mongkut's University of Technology Thonburi. There are a few private sector players that are also involved in setting up biomass technologies, namely Nortis and Gussing Clean Energy (GCE). GCE has been developing biomass technologies and even set up a demonstration plant in Thailand in 2017.

Because of its geographical location and landscape, Thailand has a high potential for solar energy use in terms of concentration and amount of utilisation areas. Approximately 50% of Thailand's terrain is exposed to concentrated sunlight all year round. In 2017, Thailand achieved a significant milestone of 3GW of solar installations which account for 50% of the 2036 target under the current 20-year roadmap. The government has a keen interest in developing solar technology. A rapid expansion of solar technology has been brought about by a government project to provide electricity with Solar Home Systems (SHS) to households in remote areas not yet connected to an electricity grid. Of all the solar cell technologies, crystalline silicon solar cell technology is still the most efficient when compared to thin-film technology. There have been efforts in researching and developing solar water heating technologies. It requires the development of two parts: solar collectors and hot water tanks. The Ministry of Energy launched a project in 2008 to develop this technology. In the private sector, the most active sponsor in renewable energy was Gunkul Engineering of Thailand, with 60 MW in pipelines, and 20 MW, or USD55 million in financed projects. There is a solar project which is a collaboration between Solarite GMBH and Thai Solar Energy Ltd, in which they are developing and using the Parabolic trough technology in the Huai Kachao region to generate 8000MW/hr. A joint venture called Natural Energy Development Company, a USD250 million project which was a joint venture between CLP Thailand Renewables, Diamond Generating Asia, and the Electricity Generating Public Company, built the 55-megawatt photovoltaic solar plant in 2012.

The Eastern and Western coasts of Southern Thailand have a high potential for wind energy use. There are several agencies in Thailand, such as the Electricity Generating Authority of Thailand (EGAT), the Department of Alternative Energy Development and Efficiency (DEDE), and other agencies that have researched the use of wind turbines to generate electricity. Most of the projects involve using secondary data to calculate and evaluate projects using statistical methodologies. As there is a rapid growth in the use of wind turbines, there has been a large quantity of technical research on composite materials and the future of this technology, especially relating to the design of large wind turbines with power production capacity at the MW level. Thailand's first wind farm, built by Fellow Engineering Co., Ltd. is planning to construct a 360 MW wind farm operating at a 90% load factor. It is proposed to be located along the coastline from Pak Phanang in Nakhon Si

Source: rawpixel

Thammarat to Singhanakhon in Songkhla.

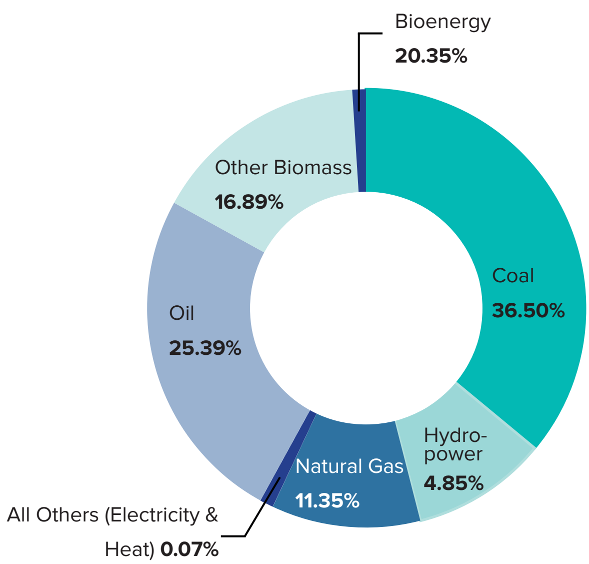
In Hydropower, there are several stakeholders for developing hydropower projects. EGAT, the Provincial Electricity Authority (PEA), and DEDE have developed 75 hydropower projects in villages, with a combined capacity of 2,500 kWe. The majority of the equipment, such as runners, power generators, and electromechanical equipment are developed domestically by research teams and the Department of Naval Dockyards.

Vietnam

Vietnam has a good potential to develop renewable energy with the availability of potential resources and the interest of investment from international firms. If Vietnam can develop a framework which can lead the efforts to focus on renewable energy technologies and the applications needed to advance them, as well as dedicate funding into that area, it can hasten the development of the national renewable energy infrastructure and output. Moreover, research and development should be a focus for Vietnam to increase renewable energy deployment.

The energy economy of Vietnam has changed rapidly in the past few decades, with its transformation from an agricultural economy based on traditional biomass fuels to a modern mixed economy. This has led to an increase in energy demand, averaging 4.1% annual growth from the 2006 to 2015 period. In the total primary energy supply, coal accounts for 36.55% of TPES, followed by oil at 25.3%, biomass at 17%, and natural gas at 11.3%, as shown in Figure 5. Therefore, except for hydropower, the market for renewable forms of energy such as wind and solar power still in the early stages of development. Although Vietnam has significant renewable energy potentials, the current development and regulative processes of renewable energy in the country are still limited compared to the actual potential. The installed power capacity in 2017 was dominated by hydropower (42.4%) and coal (36.5%), followed by natural gas (16.7%) and oil (2.8%), with the rest in biomass and

Figure 5. Vietnam's total primary energy supply



Source: ACE 2019.

others. According to the 5th ASEAN Energy Outlook, Vietnam is aiming for a 21% renewable energy share (60 GW) installed capacity in 2020, 13% renewable energy share (or 96 GW) in 2025, and 21% renewable energy share (130 GW) in 2030.
The renewable energy development in Vietnam is facing several challenges such as a lack of project development capacity, the need for relatively large initial investments, and difficulties in accessing loans. Vietnam is targeting a renewable energy utilisation rate of approximately 7% by 2020 and around 10% by 2030. The share of hydropower in total electricity production in 2020 will account for 96 TWh, followed by 2.5 TWh of wind, and 1.4 TWh of solar power.

The Vietnamese government is encouraging business opportunities and collaborations between Vietnam and other countries like the Netherlands in bioenergy development. The Netherlands conducted an assessment study which revealed that the collaborations are fulfilling knowledge transfer and capacity-building. The study also reviewed the eight major feedstocks which can be used in bioenergy production, namely bamboo, cassava, coffee, coconut, sugarcane, rice, and wood residues. A wide range of conversion technologies is used for bioenergy production in the country. However, most are still in a start-up phase and involve pilot-scale projects at varying levels of commercialisation and deployment. There is a general need for knowledge transfer and capacity-building in all the bioenergy-related technologies. Densification (pelleting, briquetting) technologies, as well as combustion and (co-)generation technologies, are not widely available, but the country is trying to develop and bring in those technologies. Many plants, including Phu Tho Bio-Energy Co., Dai Tan Ethanols, Orient Bio-Fuels Co., Ethanol Daklak JSC, and Dai Viet Co., have been set up to produce ethanol.

The potential for concentrated solar energy in Vietnam is between 60 and 100 GWh per year while PV systems have around 0.8 to 1.2 GWh per year. With around 1,600 to 2,700 hours of sunlight per year and an average direct normal irradiance (DNI) of 4-5 kWh/m2, the country has huge potentials for solar power. The first feed-in-tariff (FIT) scheme for solar PV was announced by the government in April 2017, and nearly half a year later the Ministry of Industry and Trade (MOIT) issued guidelines on developing grid-connected solar power projects which came into effect in October 2017. It has been encouraging the citizens to produce solar power at home to meet their domestic electricity demand and to contribute to the national power grid. As the solar energy sector has witnessed an improvement, the list of renewable energy projects registered by both overseas and domestic financiers in Vietnam has been growing. Ninh Thuan province in South-Central Vietnam has the highest potential for solar power generation. The region has already attracted over 140 projects. Other potential areas include Binh Thuan, Daklak, and Khanh Hoa, which have respectively attracted 100, 13, and 12 projects. In the private sector, Conergy began the development of a 204 MW solar plant in April 2018 in Ninh Thuan province. The power plant, the nation's largest solar power plant to date, will have over 705,000 solar panels, and once operational (slated for June 2019) will produce a maximum output of approximately 450 million kWh each year. On the other hand, Da Nang Energy Conservation and Technology Consultant Centre (DECC), under the city's Department of Science and Technology, will design and install solar energy systems at Da Nang General Hospital, the Oncology Hospital, two schools and six households on a pilot basis, and it will build a database of solar power capacity in the city as well as a policy framework for clean energy development.

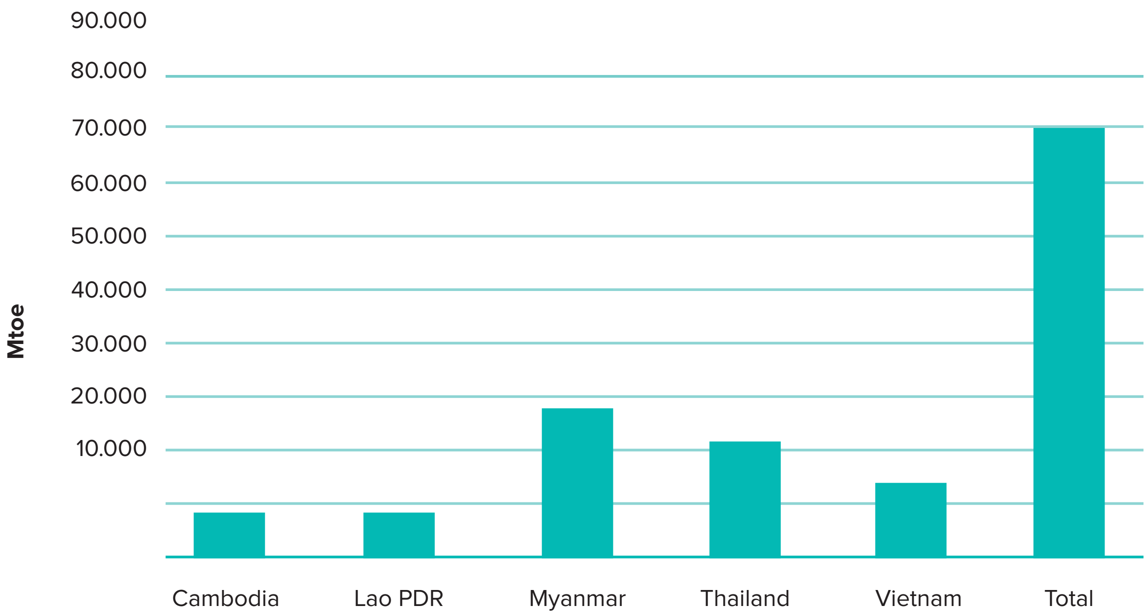
Wind technology development is a promising industry in Vietnam. One of the most recent wind development projects is the 340 MW wind farm in Bac Lieu. In the project of Bac Lieu, there are several sub-projects, namely the 40 MW wind farm facility in Ca Mau completed in the second quarter of 2020, followed by the 30 MW wind farm in Soc Trang Phase 1 completed in mid-2020 and the 142 MW wind farm in Bac Lieu by the end of 2020. Furthermore, General Electric (GE), Mainstream Renewable Power, and the

Phu Cuong Group are working together on an 800-MW wind farm in Soc Trang province.

Renewable Energy Potential

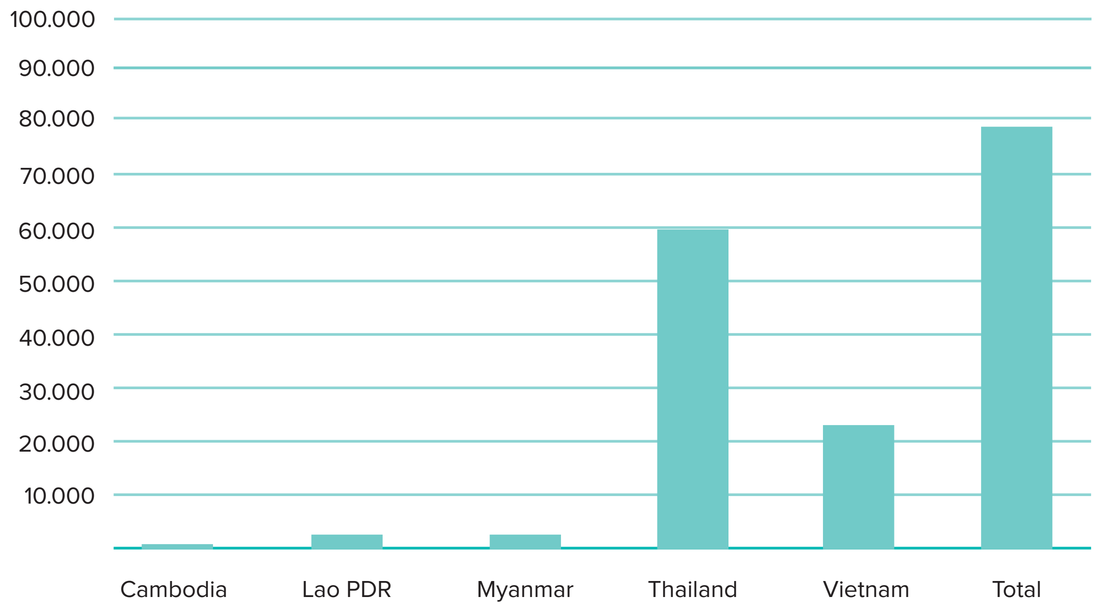
A study by ADB (2015), "Renewable Energy Developments and Potential In The Greater Mekong Subregion", has analysed renewable energy potentials in the GMS. The study shows that the sub-region is blessed with many renewable energy potentials. The technical potential of solar energy is based largely on the degree and intensity of solar irradiation, the estimated land area suitable for photovoltaic (PV) installations, and the efficiency of the solar systems. Meanwhile, to analyse the wind power potential, areas with at least 6 meters per second of wind speed are considered. On the other hand, the potential of biomass energy depends on the amount of agricultural land that can be devoted to suitable feedstocks. The summary of the study can be seen in the figures below.

Figure 6. GMS theoretical solar potential (MWp)



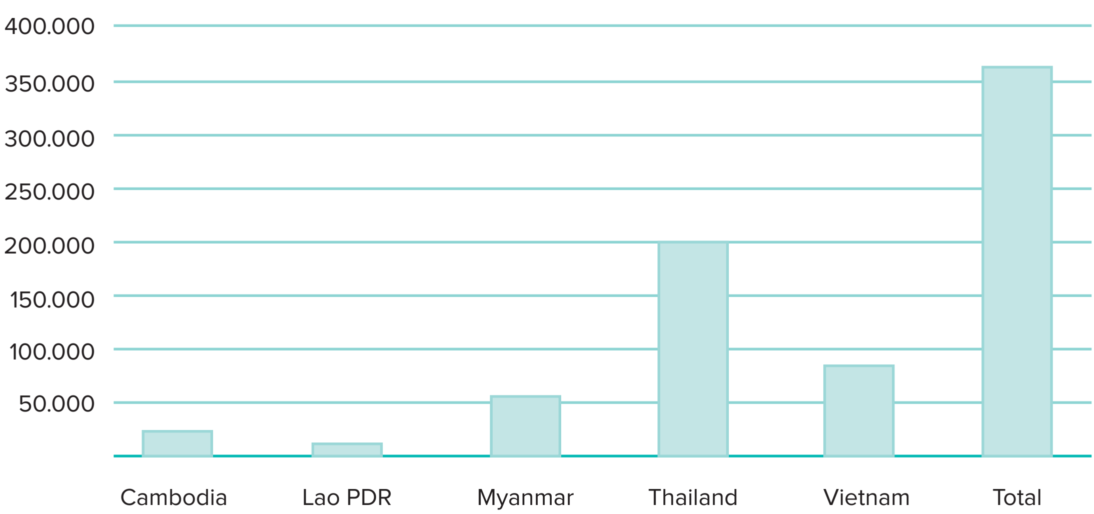
Source: ADB 2015.

Figure 7. GMS theoretical average wind potential (MW)



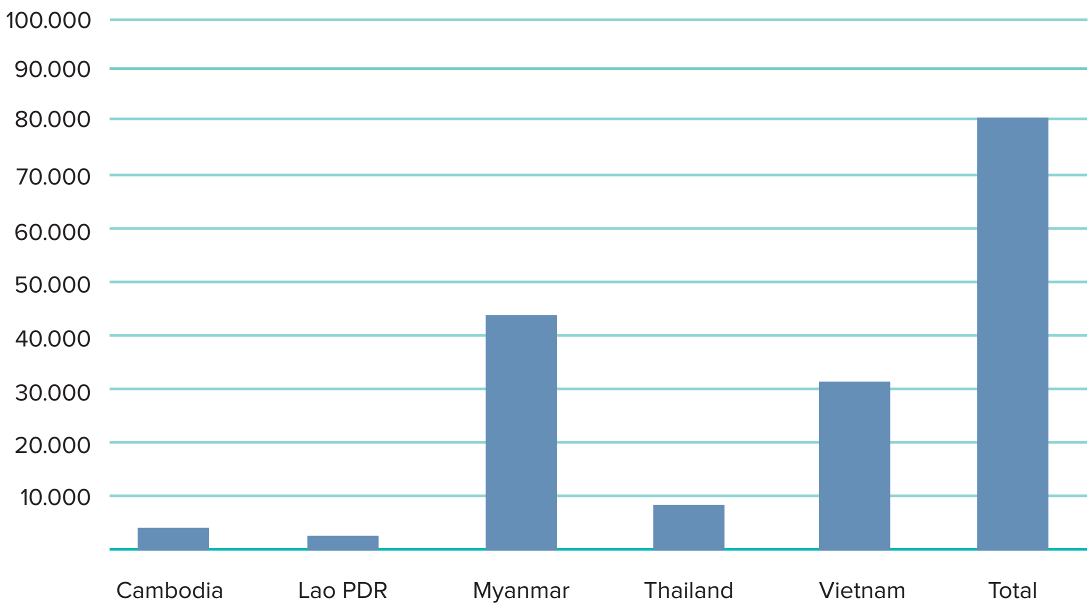
Source: ADB 2015.

Figure 8. GMS theoretical biomass potential (GWh)



Source: ADB 2015.

Figure 9. GMS theoretical biogas potential (GJ/m3/day)



Source: ADB 2015.

Highlights of the renewable energy potentials for each country in the GMS are as the following.

- Cambodia has a good solar resource potential but has a relatively low wind resource potential. It has substantial solar energy potential that could be harnessed on a competitive basis, especially since so much of the country is without a grid system. Meanwhile, wind energy is limited by inadequate wind speeds and the weakness of the grid and load system. Nonetheless, there are areas where wind energy can be commercially viable, as illustrated by a pilot wind turbine project in Sihanoukville. Cambodia's biomass energy potential is diverse, with large concentrations of agricultural residues in the lowland corridor, extensive tracts of land suitable for growing feedstocks for biodiesel and ethanol production, and many farms with sufficient livestocks and collectable manure for the operation of biodigesters.

- In Lao PDR, mini hydropower projects will be the main contributor while solar, wind, biomass, and biogas sources will also have a major role. It has a strong technical wind resource potential, but it is limited in practice due to the lack of a national grid system. Large-scale solar and wind systems are limited by gaps in the Lao grid network and a lack of connectivity for most of the rural population. The Lao PDR has a significant biofuel potential, and the government has created a positive regulatory and support framework for biofuel production. Biogas could be an important energy source for farm-households, with most of them having enough supply of manure for biodigesters, even if the mostly free-range livestock farming complicates collection.

- Myanmar is focusing on hydropower investment. While large areas of the country have high solar irradiation levels, the largely mountainous terrain and protected areas and the limited grid system weaken the energy potential from this source. Average wind speeds in most of Myanmar are too low for modern wind turbines. The country's biofuel potential is high, a reflection of the importance of the country's agriculture sector and its large landmass.

- Thailand has an excellent solar power potential, and solar power is being supported by a well-structured institutional framework and financial and fiscal incentives. Thailand's wind resources, on the other hand, are relatively modest although there has been significant development of wind power projects. The government is strongly encouraging for an increase in the production and use of biofuels while it is also strengthening and promoting biogas energy.

- Vietnam has suitable wind speeds in the Southern coastal areas and offshore, an extensive grid system, and a strong load capacity enabling more grid-connected wind power. Vietnam has relatively high solar irradiation levels in the Southern half of the country, where more than 60% of the country's solar potential is located.

Conclusion

In summary, the GMS countries are at an early stage in developing their renewable energy resources. Solar energy is being extensively promoted in the region. While the cost of solar power is still high compared to conventional sources, further development will offer the economy of scale and the use of newer, lower-cost technologies. This is also the case for wind power, which will benefit from the extension of the transmission grids and feed-in adder or bonus systems. Biomass energy is generally small-scale, and its expansion critically depends on the availability of agricultural land. Biogas from animal manure is also small-scale and a suitable energy source for off-grid farm communities.

Increasing renewable energy deployment is both a challenge and opportunity. The opportunity includes the creation of new industries and employment opportunities, new ways of reducing dependency on fuel imports and of providing electricity to poor remote areas, the reduction of air pollution, and achieving a healthier environment. Therefore, the GMS countries need to step up the development and be committed to helping to mobilise the necessary expertise and financial resources. Moving forward, the regional economic cooperation is needed regarding energy supply, management, and use. The promotion and identification of the most cost-efficient and effective way of meeting energy security in an environmentally-friendly manner is also crucial. Furthermore, the experience and lessons learned in each country should be shared to help advance the development and use of green energy throughout the region. Through the development of renewable energy, the GMS can be a model of what can be done in response to the threat of climate change and to the call for a sustainable and inclusive growth.

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Source: unsplash

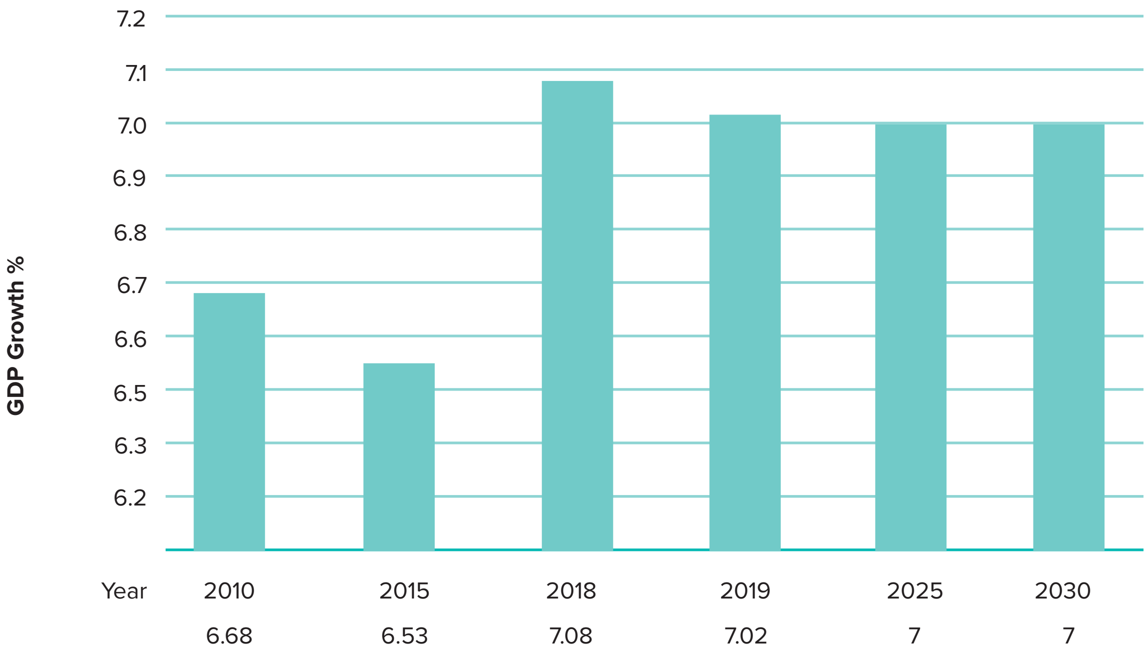
5

Renewable Energy Production in Vietnam and its Implication for the Region

Tran Thanh Lien

Introduction: Vietnam Country Profile

Vietnam has adopted strategies for sustainable economic development and low carbon emissions since the beginning of this decade. The country's GDP growth as shown in the period 2010–2019 varied from 6.53% to 7.08%, particularly high in the last two years. It is expected to continue increasing by 7% in the period 2020–2030.



Source: Author's compilation from MOIT 2016, chapter 2; GSO 2018, session 3.

Total primary energy supply (TPES) increased from 52,490 KTOE in 2010 to 92,329 TOE in 2019 with a growth rate of 6.48% during this period, of which the growth rate of commercial renewable energy was 9.3% with its share accounting for nearly 14 per cent in 2019 (MOIT IE 2020a). In contrast, non-commercial energy that largely uses biomass for cooking significantly decreased by 21% in the past ten years in terms of growth rate. This reflects the effect of increasing rural electrification in Vietnam.

As for greenhouse gas emissions, the total GHG emission was 283.7 million tons CO2e in 2014. Of this figure, the share of GHG emission in the energy field was the highest accounting for 60.5% of the total, with an emission increasing from 134.8 million tons (MT) CO2e in 2010 to 171.6 MT in 2014. Among them, the rate was about 33.4% coming from power generation (MONRE 2019).

According to the "Resolution No. 55-NQ/TW dated 11/02/2020 on the National Energy Development Strategic Orientation to 2030 with a Vision to 2045" (NQ/TW 2020), the Government of Vietnam projected the country's total electricity demand of 550–600 TWh or 125–130 GW in 2030. At the same time, the Ministry of Industry and Trade (MOIT) is formulating the "National Power Development Plan for the Period of 2020–2025 with Outlook to 2045" (MOIT IE 2020b), in which the draft projected capacity is 268.1 GW or 960 TWh (including electricity import) for the base scenario in 2045.

Potential Sources of Energy Production in Vietnam

Vietnam has a large reserve of primary energy resources, such as coal, and a substantial reserve for oil and natural gas. It also has a high potential for renewable energy such as hydro, solar, wind, and biomass. Since 2015, Vietnam has shifted from a net exporter of energy to a net energy import country, with the rate in TPES increasing from 6% in 2015 to 36.3% in 2019 due to increased energy demand (MOIT IE 2020a).

Non-renewable energy potentials

Coal

Coal reserve of Vietnam was assessed at about 2.598 billion tons (MOIT IE 2020a). The domestic production of coal in 2019 reached about 47.3 MT/year (Vietnam News 2020). Its exploitation is expected at about 50–55 MT/year from 2030 to 2035 (QD-TTg 2016). Due to the rapid increase in domestic energy demand, Vietnam has had to import coal for power generation and industrial production with the volume increasing sharply from 3.2 MT in 2016 to 43 MT in 2019 (Vietnam News 2020). Its coal import is also expected to increase from 2020 onwards.

Oil and gas

Oil and gas reserves updated as of 31 December 2014 were at 711 million m3 for recoverable oil reserves and 725 billion m3 for recoverable associated gas. The main feedstock for future refineries will be imported with an amount of 28.8 and 38.8 MT of crude oil in 2030 and 2035 respectively (VPI 2016). Proven natural gas reserves in the country are assessed at 464.24 billion m3, the accumulative production amount during the period 2016–2035 is 295 billion m3. LNG import could be needed at about 8–15 billion m3/year for Vietnam to offset the gas shortage of consumers between 2030 and 2045 (NQ/TW 2020).

Renewable energy potential

Hydro energy

Hydropower technical potential is estimated at 123 billion kWh, equivalent to an installed capacity of about 25,000–30,000 MW. For small hydropower, the Ministry of Industry and Trade has specified that a small hydropower plant (SHP) has a capacity not exceeding 30MW. With that, the technical potential of capacity has been recently reassessed at 7000 MW.

Wind energy

In 2010, the World Bank supported MOIT to update the wind energy map for Vietnam. According to the World Bank's assessment (WB 2010), the technical potential is at 26,763 MW, with the wind speed from 6m/s at the height of 80m. Vietnam is also the country with the best wind energy potential among Mekong countries. A study (GIZ 2017) performed GIS analysis, based on wind map data combined with transport infrastructure maps and transmission grids, and assessed the technical potential for wind power in Vietnam at 27,000 MW of capacity for onshore wind (if calculated at the available transport infrastructure and neighbouring transmission networks of about 10 km) and at 162,200 MW for offshore wind, concentrating mostly along the coastline of Central Vietnam (MOIT IE 2020).

Solar energy

Solar energy potential is distributed widely and unevenly by different topographical and climatic characteristics. The Central and Southern regions have very good potential for solar power development, with the number of sunshine hours reaching over 2,000 hours per year and the radiation intensity ranging from 4.3 to 5.7 kWh/m2/day, while the Northern region has a lower sunshine hour numbering at between 1,600 and 1,800 hours/year with a radiation intensity varying from 3.3 to 4.9 kWh/m2/day. The technical potential is assessed at 339,628 MWp and 434,000MWp, including rooftop and water face solar potentials (MOIT IE 2020a).

Biomass energy

As an agriculture-based country, Vietnam has a huge potential for biomass energy. The main types of biomass are wood and agricultural residues such as rice husks, rice straw, sugar cane trash, and cassava stalks. Generally, in considering the current area and development plans for crops and domestic waste generation in the future, the technical potential of energy recovered from all types of biomass nationwide is estimated at 7,184 MW or 46,696 GWh, of which the potential for power and cogeneration from rice husks and sugarcane trash is the largest.

Biogas energy

Biogas is exploited mainly from two main sources of animal manure and crop residuals. The technical potential of biogas is low at about 2 GW (MOIT IE 2020a).

Solid waste energy

Solid waste potential used for power generation mainly includes solid waste in the industrial and residential sectors. The Institute of Energy estimated the technical potential to exceed 1,700 MW, of which only a negligible capacity is being exploited (IE 2017).

Geothermal energy

According to RE potentials addressed in (MOIT IE 2020b), the geothermal technical potential for power generation concentrated in the Central region is at 680 MW.

Wave energy

The wave technical potential investigated for power generation in Vietnam is low at about more than 940 MW of capacity.


Source: unsplash

Table 1. Technical potential of renewable energy

Type	Capacity (MW)	Energy production (GWh)	Remark
Hydro	30,000	123,000	(including SHP)
Onshore Wind	26,763	58,600	
Offshore Wind	162,200	426,000	
Solar	434,000	356,000	
Biomass	7,184	46,696	
Biogas	9	10	
Solid waste	1,700	12,000	
Geothermal	680	3,400	
Wave	940	13,740	
Total	**670,476**	**1,059,446**	

Source: Author's compilation of data from WB 2010 and 2018; MOIT IE 2020a, 2020b; MOIT 2016.

Renewable Energy Production in Vietnam

Renewable energy policy and targets

Vietnam's renewable energy policy and targets have been addressed and updated in three recent policy documents below.

- Resolution No. 55-NQ/TW dated 11/02/2020 on the National Energy Development Strategic Orientation to 2030 with a Vision to 2045;
- Prime Minister's Decision No. 2068/QD-TTg dated 25 November 2015, approving the Development Strategy of Renewable Energy of Vietnam by 2030 with a Vision to 2050; and
- Revised Power Development Plan for the Period of 2015–2020 with Outlook to 2030. Ministry of Industry and Trade (MOIT), 2016.

Targets are important indications of Vietnam's willingness and determination to tap its maximum achievable potential over a certain period. They show best policy practices for a specific technology and how to overcome all barriers with effective policies in place. The policy targets an increase in the share of renewable energy in the total primary energy supply (TPES) from 14% in 2019 to 20% by 2030, and possibly to 25–30% by 2045. In terms of power generation, the targets on the share will increase from 30% in 2019 to 32% by 2030, and to 40–43% by 2045 and 2050.

Table 2. Renewable energy targets in Vietnam

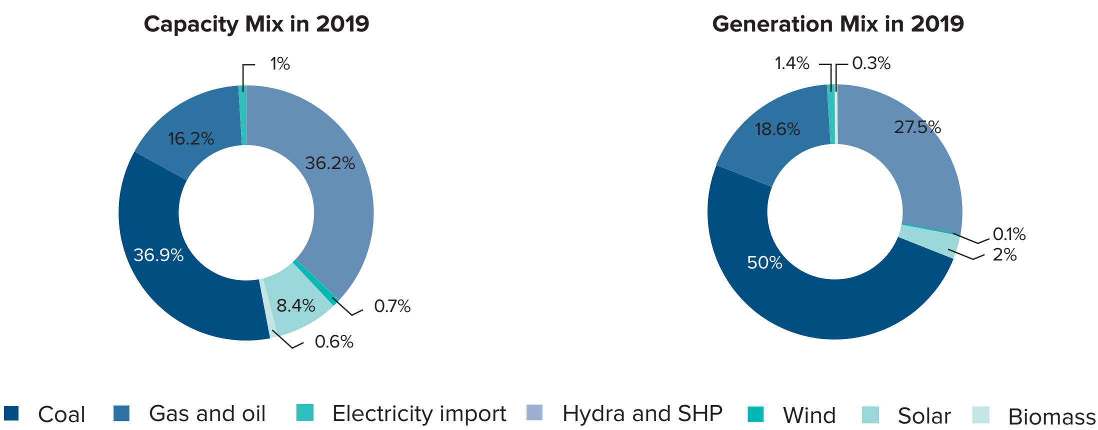
RE Policy	Item/year	2019	2030	2045/2050	Remark
Resolution No.55-NQ/TW, 2020	**Energy Strategic Orientation**				
	Share of RE in TPES	13.9%	15-20%	25-30% (2045)	
	Power capacity (GW)	56	125-130		
	Generation (TWh)	240	550-600		
Decision No. 2068/ QD-TTg, 2015	**RE Strategy**				
	Total RE share in elec. Gen.	30% (2019)	32%	43% (2050)	
	Hydro	27.5% (2019)			Including SHP
	Wind	0.30% (2019)	2.7%	5.0% (2050)	
	Solar	2.01% (2019)	6%	20% (2050)	
	Biomass	0.15% (2019)	6.3%	8.1% (2050)	

Source: Author's compilation of data from EVN 2019; MOIT IE 2020a, 2020b; NQ / TW 2020; QD-TTg 2015.

Electricity production from renewable energy

The total installed capacity of the Vietnam power system was at 55,939 MW, generating energy at about 240,100 GWh till December 2019, with RE taking up 46.5 per cent and 30 per cent respectively of the share as shown in Figure 1 below.

Figure 1: Power mix in 2019



Hydropower

In 2019, hydropower including small hydropower (SHP) capacity and electricity generation was at 20,632 MW and 66,117 GWh, representing 36.9% and 27.5% respectively. According to the revised power development plan (PDP7-revised), hydropower capacity will increase to 25,000–25,500 MW in 2030. This value will reach the maximum realisable energy potential identified for hydro at about 25,000 –26,000 MW of capacity in respect of 85–87 billion kWh/year. As a result, this energy potential will reach its peak by 2030. Its capacity will keep constant from 2030 onwards, and the share of energy production from hydropower in the total electricity system will decreased from 2020 onwards as well.

Wind power

The first operational wind power plant with a capacity of 30 MW began in 2012. After that, there was not any wind project developed before 2015 due to various barriers. One main reason was that electricity tariff incentives for wind power were still not attractive enough. Since 2015, however, the wind power development increased significantly from 90 MW of capacity to 377 MW in 2019, equivalent to electricity production of about 121 GWh and 722 GWh respectively when the Vietnamese government promoted more electricity tariff incentives for RE. The progress also looks very promising in the future, with the maximum achievable potential being exploited at 18,000–20,000 MW in 2030 and 55,000–60,000 MW in 2045. Based on the data on wind speed collected from 90 current wind gauges and investment projects, the calculation shows that the capacity factor is in the range of 23–26% for onshore wind. At the same time, the capacity factor for offshore wind is estimated at about 25–30%. Thus, the total electricity production from wind power will increase to about 45–46 billion kWh in 2030 (8–9% share), and up to 155,000–160,000 billion kWh in 2045 (16–17% share).

Solar power

As mentioned above, Vietnam's technical potential for solar projects is reportedly very attractive as it benefits from high natural solar energy intensity. However, the growth only began when Decree No.11/2017/QD-TTg on mechanisms for encouraging the development of solar power in Vietnam was released. Electricity production from solar power (only for solar farms) increased from zero in 2015 to 722 million kWh in 2019 (2% share), corresponding to 4696 MW of capacity with a much higher share (8.4%). Similarly, the capacity of rooftop solar power jumped from zero in 2015 to 765 MWp (approximately 57GWh) by 30 June 2020 (VEMP 2020). According to the policy documents as presented above and considering the feasibility of land use and electricity production cost of solar power in the future, the achievable capacity potential of solar power is expected at about 18–20 GW in 2030 and 50–55 GW in 2045. Considering the natural conditions and a number of operating solar power plants, the capacity factor of solar power plants built in Vietnam is calculated in the range of 15–20%. Thus, the total electricity production from solar power including water surface and rooftop solar power is suggested at 30–35 billion kWh in 2030, representing 6–7% share, and about 85–95 billion kWh in 2045 (9–12% share).

Biomass and biogas power

Currently, there are about 325–378 MW from biomass energy of sugar mills selling to the grid at 350 GWh in 2019. Other forms of biomass for electricity generation such as wood processing residuals and rice husks are negligible or still at the investment registration stage. A World Bank's study assumed if the farmers' willingness to sell their biomass residues is taken into consideration, the technical potential of crop harvesting residues decreases to about 7.95 MT/ year, with an energy potential of 28,075 GWh/year (WB 2018, 8).

MOIT, IE 2020b) expects that the total maximum generation capacity from biomass energy including wood, rice husks, and bagasse could reach 3,000–5,000 MW from 2030 onwards or 19.5 TWh and 32.5 TWh respectively. For biogas power, most projects are at a livestock farm-scale to meet their power needs with a small capacity and high investment. Therefore, it is difficult to develop it at a large scale in the future.

Solid waste

Municipal Solid Waste (MSW) can be used in large-scale grid-connected power plants in Vietnam. Presently, there are five MSW projects in the basic design stage with a total power capacity of 150 MW approved by local authorities. The achievable potential is expected to be at more than 1,500 MW or 10.5 TWh from 2030 onwards (IE 2017).

Geothermal energy

Currently, geothermal energy has not been exploited for power generation although the technical potential was investigated and estimated in the last few decades. During 2012–2013, ORMAT Company in coordination with EVN undertook a pre-feasibility study on a number of geothermal power plants in central Vietnam (Quang Binh, Quang Ngai, and Khanh Hoa provinces) with a total installed capacity at 113 MW. The revised PDP7 also put 200 MW in the plan up to 2030; however, so far there has not been any further progress. It is suggested that the maximum achievable capacity will be at 200–400 MW from 2030 onwards.

Renewable heat production

Renewable heat can be produced from biomass and solar thermal heat in Vietnam. Because of climatic and geographical conditions, there is no demand for space heating in the South and very little demand in the North. Renewable heat production is mostly used for agriculture (drying food), domestic/hotel hot water and heat for cooking, and some industrial processes. Generally, no existing renewable heat supply data are available for the whole Vietnam; it is only reported on a case-by-case basis of each individual project. Approximately 80.75 MT of biomass (theoretical potential) is produced yearly from crop residues such as rice residues (42.9 MT), maize trash and maize husk (17.6 MT), and sugar residues (7.3 MT) (WB 2018). These biomass sources can be also used for producing electricity as well as heat. As for solar heat production, the use for domestic/hotel hot water and drying food is concentrated in the South. Reportedly, around 950,000 solar hot water systems have been installed in households and hotels in the South, while 650,000 and 200,000 systems in the North and in the Central respectively. These systems are provided by a number of domestic companies such as Polarsun, Megasun, and Son Ha. The technical potential for RE heat production is estimated by sectors as shown in the table below.

Table 3. Technical potential for RE heat production (Unit: TOE)

Form of renewable energy	Technical potentials	
	Residential	Industry, agriculture and services
Solar thermal hot water	505,000	6,060,000
Biomass heat	17,700	7,550
Total	**522,700**	**6,067,550**

Source: MOIT IE 2020a.

Biofuel production

Vietnam has great potential for biofuel production. In the past (2010–2015), the production of sugarcane was at 15–17 MT, cassava at 10 MT, and corn at 8-9 MT. The potential for biodiesel production includes mainly feedstocks from jatropha oil, coconut, and catfish waste from fish farming and fish processing which are estimated at about 120 MT/year (DT Hieu 2015). Up to now, Vietnam has eight ethanol factories with a large capacity (of more than 100 million litres/year for each factory) and four smaller ethanol factories with a total design capacity of up to 680 million litres/year. Although Vietnam's ethanol factories have good advantages, the difficulties facing the ethanol production are preventing ethanol factories from operating in full capacity, even having to stop production in the long term because of the high price of raw materials like cassava and very limited domestic market of ethanol for medical and chemical uses. To solve the difficulties of ethanol output, the government may need to provide stronger support to the consumption of biofuel by adding environment protection fee and import tax for ethanol.

Challenges for renewable energy production and development

Below are some highlights of the RE transition in Vietnam.

- Installed capacity and generation output of wind and solar power reached a record in 2019 with 377 MW of wind power and 4,969 MW of solar power or 722 GWh and 4,818 GWh respectively of power generation. Total RE capacity including hydropower and biomass is up to 26,030 MW in 2019 compared to 20,170 MW in 2010. The most prominent feature of electricity production from solar and wind is that their share in the whole system accounted for zero in 2015 for solar and in 2010 for wind and increased to 2% and 0.3% respectively in 2019. The proportion of capacity mix was even much higher (8.9% and 0.7% respectively). As shown in Table 2, the rate of electricity generated from solar and wind power will rise to 25% in the total generation by 2050.

- The market for rooftop and water-face solar power is rapidly developing in Vietnam since the specific FIT-In tariff has been released by the government, and technical assistance to customers has been provided by power utilities. As of July 2020, there were 37,300 rooftop solar PV systems installed, with a total capacity of about 782 MWp compared to 19 MWp in 2018.

- Investment costs for solar and wind power are decreasing rapidly in Vietnam. Record on investment cost of projects in the South Central and Central Highlands provinces shows that for some onshore wind power projects, the unit investment cost was reduced from about 2,100–2,300 USD/KW in 2012 to 1,400–1,500 USD/KW in 2019. For solar power projects, it decreased from 2,000 USD/KW in 2015 to 700–800 USD/kW in 2019. Therefore, the investment cost for some renewable energy technologies in Vietnam is sharply decreasing in line with the world trend as a result of innovations in solar cell production and installation and the improvement in the design and materials of wind turbines as well as energy storage systems.

However, the "rapid" RE development process in the short and medium terms is also posing new challenges in the comprehensive development of the grid system, land use, electricity price mechanism, and human and financial resources.

- Increasing power system reserve because the capacity factors of electricity from renewable sources (solar and wind) are generally only about 15–25%, significantly lower than thermal and hydropower capacity factors (70–80%) and (40–50%) respectively.

- The phenomenon of voltage above the specified threshold will increase, especially in areas where many RE sources are concentrated and far away from the load centres. At the same time, the imbalance process in the power system tends to occur faster and more strongly.

- The transmission capacity is limited when the transmission lines have not been developed synchronously with the development of RE sources, creating pressure to release power capacity for RE projects.

All of the above-mentioned challenges really happened in central Vietnam where most solar and wind farms are located.

Policy Implications for the Region

The effects of renewable energy supply for the region remain necessary in RE deployment to reduce dependence on fossil fuel production, import and export. Further, as RE technologies are increasingly becoming cheaper even in the medium and long term, they will help address the Mekong region's low-carbon energy transition by deploying more available RE technical potential. In order to increase the share of RE in the energy mix supply, innovation and the reduction of RE technology costs (solar cell, materials of wind turbines, and energy storage systems) are essential. At the same time, from the experience of developing RE in recent years in Vietnam, it proposes that appropriate financial incentives are the driving force for RE transition in the short and medium terms.

Appropriate financial mechanisms

To reduce project marketing risk, the existing traditional PPA mechanism for RE may no longer be useful in the future. A specifically appropriate arrangement to facilitate the access and sale of the power supplied by RE producers to the targeted market may need to be considered and improved, especially for decentralised RE power sources such as roof-top PV systems. At the same time, in order to reduce the government budget for the existing Feed-in Tariff, which is used in many developing countries, a mechanism for Renewable Energy Auctions should be prepared and applied to strongly promote the transition to renewable energy sources and technologies in the ASEAN/Mekong region in the near future.

Source: flickr

Policy coordination

To tackle difficulties in the development of RE in a sustainable and effective way, policy coordination in promoting RE potential among countries in the Mekong region is fundamental, specifically for hydropower project development. Harmonisation must be considered not only on the framework of regional energy security and development but also on food-water source security of the whole region. Consequently, information exchange such as a closer consultation process with more bilateral or multilateral information exchange through the official focal point of each country in the region is necessary for speeding and improving progress in developing RE projects, especially for projects at a regional scale.

Technology transfer

It is evident that technical support is a key factor in setting up and maintaining high technology and know–how of RE projects and the power system, including power interconnection. The transfer of best practices, technology and know-how will facilitate each country and promote renewable energy in the region.

Develop more power infrastructure including power interconnection

Besides the government's supportive policies, the power utilities including the private sector need to invest more in power infrastructure (even at 500 KV level) to enhance capability of power transmission and absorb entire electricity from RE projects.

Conclusion

It is clear that appropriate financial incentive mechanisms for RE such as the improvement of Feed-in Tariff and development of technology innovation have facilitated and rapidly increased RE in Vietnam in recent years.

To attain Vietnam's renewables goals by 2045/2050, renewable energy potential and growth is expected to continue accelerating due to the increase in local technical capabilities and expertise on renewable energy technologies. The improvement of the economic diamensions of RE technologies, including energy policies and schemes to increase the cost competitiveness of renewable technologies, will also boost renewables in the country.

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Source: unsplash

6

Bilateral and Regional Cooperation on Renewable Energy Development

Rizky Aditya Putra

Introduction

The Mekong region, which includes Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam is one of the fastest-growing regions with an annual economic growth of more than 5%. Rapid economic growth has meant a rise in the demand for energy, especially for industry and transportation, which will also increase the need for secure, accessible, affordable, and sustainable energy.

The region has rich, largely untapped renewable energy resources. It has some of the best hydropower potentials in the world and also a huge potential for solar and wind energy. Realising the potential of renewable energy, Mekong countries have set the targets to increase the share of renewable energy in their energy mix shifting to low-carbon technologies that bring benefits of greater access and maintain energy security towards a sustainable energy utilisation.

Cambodia is targeting to install 2,241 MW of large hydro by 2020 while Lao PDR, whose almost 100% of electricity is generated from large hydropower, has determined its renewable energy target by excluding that particular electricity source to achieve 30% renewable energy share in total final energy consumption by 2025. Myanmar, as the country with a huge potential for hydropower, is targeting 38% of hydropower and 9% of other renewable energy resources in the energy mix by 2030. Meanwhile, Thailand is aiming to achieve 30% renewable energy in its total final energy consumption by 2036. Lastly, Vietnam is targeting 21% renewable energy of 130 GW in 2030 consisting of 2.1% wind, 15.5% hydro, 2.1% biomass, and 3.3% solar (ASEAN Centre for Energy 2017a).

Except for Thailand which has an advanced renewable energy programme, the other countries are mainly at an early stage in developing their renewable energy resources (Asian Development Bank 2009). Each country faces different challenges in the development of renewable energy, such as technical, financial, policy, and infrastructure readiness. The economical perspective of the renewable energy technologies is also one of the barriers.

Source: Mekong River Commission

Countries with very similar or complementary characteristics could work together to find solutions to their common challenges, such as energy security. Increasing regional cooperation in the energy sector and the adoption of resource-centred strategies for the management of related natural resources can enhance energy security for the whole region, resulting in a win-win situation. For example, countries can benefit from natural endowments through the development of greener cross-border energy projects, which can provide efficient and secure supplies of electricity, coal, gas, oil, and alternative energies (Asian Development Bank 2009).

Regional cooperation for renewable energy can be understood as the purposeful collaboration on issues related to the deployment of renewable energy, which encompasses both the cooperation between two or more countries. If countries within a region jointly utilise their renewable energy potential by allocating support according to resource availability in a wider geographical region, support cost, capital expenditure, and fuel imports into that region may be lowered.

Several renewable energy cooperation mechanisms are existing globally, such as joint development programme, energy trade, as well as capacity building and information sharing. These mechanisms could further support to accelerate the deployment of renewable energy, not only at the national level but also at the regional level.

Joint development usually focuses on joint research, development, and demonstration projects, which could further support the advancement of technology as well as cost reduction (Xingang 2011). In the European Union, the joint project mechanism under the Renewable Energy Directives allows the member countries to jointly finance renewable energy projects and share the cost and benefits of the project. This kind of mechanism could further enhance the capacity of countries to meet emerging challenges, including accessing policy best practices, enhancing skills and capacity, and the application and transferring of technologies between countries.

Energy trade between nations should be more beneficial than self-sufficient supply within each country, as this kind of mechanism could reduce costs in operation, plant investment and generating capacity (Yu 2003). The cooperation in energy trade can be enhanced through the removal of barriers to trade, both tariffs and non-tariffs, such as streamlining process and permits, standard harmonisation, subsidies, and other incentives, which could further reduce the developer's capital expenditure and substantially lower the support costs and consumer electricity prices (ASEAN Centre for Energy 2018).

To facilitate the effective development and implementation of policy frameworks for the deployment of renewables, knowledge and experience sharing between countries in the region is essential. Through this mechanism, all aspects of renewable energy policies implementation, ranging from design to implementation, and best practices can be drawn to develop a more effective and stable frameworks for renewable energy investments. Exchanges may encapsulate regulatory, policy, legal, technical or financial aspects of renewable energy support and deployment as well as the monitoring of renewable energy projects and targets (ASEAN Centre for Energy 2018).

Source: rawpixel

Most of the renewable energy cooperation in the Mekong region, especially in electricity trading, still heavily relies on bilateral cooperation. At the regional level, the cooperation mainly focuses on the capacity building or information sharing between the member countries, while at the same time aiming towards the establishment of multilateral electricity trading.

Bilateral Cooperation

The growth in renewable energy generation across the Mekong region has mainly been driven by the capacity deployment of hydro-based power generation, which has increased substantially from 6 GW to 26 GW over the past decade (International Renewable Energy Agency 2018).

The renewable energy cooperation among Mekong countries is mainly focusing on electricity trading, where Lao PDR plays a significant role as a net exporter of electricity, primarily from its large hydro resources which only one-fifth of its generation capacity is used for domestic purposes (International Energy Agency 2019a). The remaining capacity is exported to neighbouring countries, especially with Thailand and Vietnam as its major electricity markets.

Lao PDR, through its power utilities Electricite du Laos (EDL), first signed an MoU in 1993 for exporting 3,000 MW electricity to Thailand. The Theun-Hinboun Hydropower Plant, which is operated by a joint venture between a Thai company and EDL, began supplying electricity to Thailand through EGAT's acquisition for the first time in 1998 (Kaewkhunok 2018). Since then, Thailand has expanded its investments and imports from Lao PDR in a variety of projects, such as the Houay Ho Hydropower Project in 1999, the NamTheun 2 Hydropower Project in 2010, the Nam Ngum 2 Hydropower Project in 2012, Theun-Hinboun extension in 2012, and Hongsa Project in 2015.

Both countries have expanded their cooperation by signing another MoU in 2016 to export up to 9,000 MW by 2030. As of 2019, Lao PDR exported around 3,584 MW of electricity to Thailand over 17 interconnectors (International Energy Agency 2019a). There are also a number of projects under construction and Power Purchase Agreement (PPA) negotiations with the total expected capacity of 2,843 MW, such as Xayabouly, Xepian-Xenamnoy, and Nam Ngiep, which are expected to deliver electricity in 2020 (Ministry of Energy and Mines 2019).

For the electricity trading with Vietnam, Lao PDR is currently exporting around 572 MW (Ministry of Energy and Mines 2019) and is expected to supply more electricity as the two countries have signed an MoU for the joint development of hydropower plant projects in Lao PDR to export up to 5,000 MW by 2030.

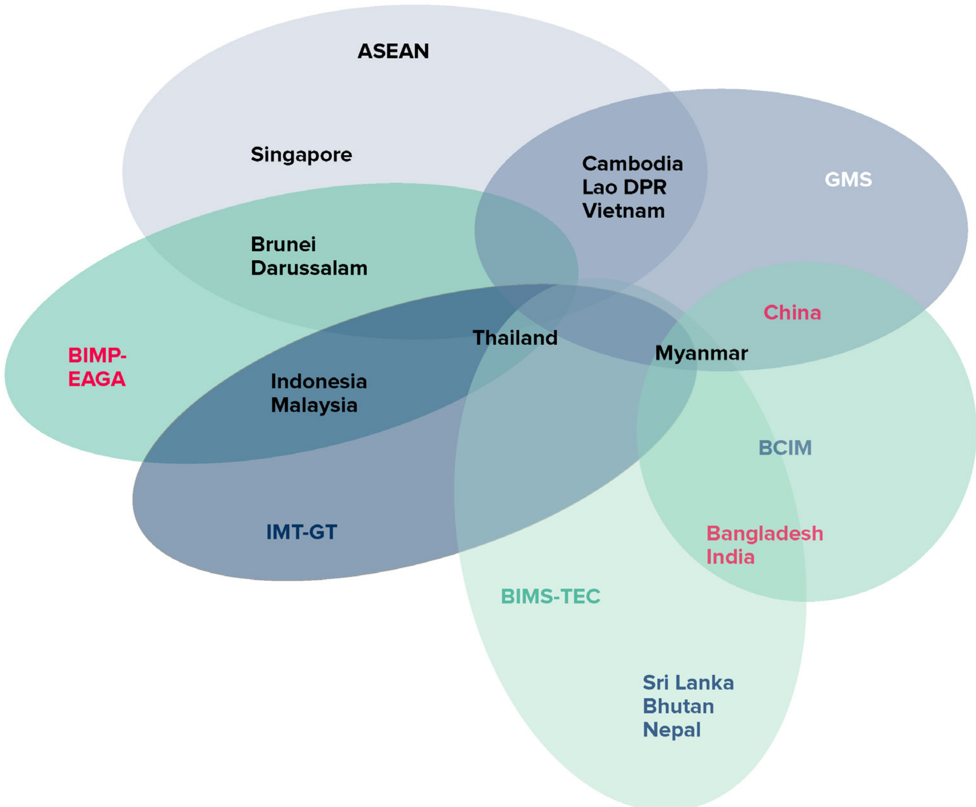
The first multilateral power trade was successfully initiated under the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), where Lao PDR has successfully exported electricity to Malaysia by utilising the transmission line of Thailand. Following the signing of the energy purchase and wheeling agreement (EPWA) by Lao PDR, Thailand, and Malaysia in 2017, the three countries are committed to increasing the maximum capacity trading up to 300 MW (ASEAN 2019).

Lao PDR is also exporting electricity from its hydropower to Cambodia. The power sector cooperation between the two countries started with the signing of an agreement in 1999. In 2019, both countries agreed to trade electricity up to 200 MW until 2021 (Ministry of Energy and Mines 2019).

Regional Cooperation

Numerous regional cooperation platforms have been established, including Mekong countries, such as the Association of Southeast Asia Nations (ASEAN), Grater Mekong Sub-region (GMS), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), and Bangladesh-China-India-Myanmar (BCIM). Most of the regional cooperation platforms was established as the framework for economic integration, with energy as one of the key priorities.

Figure 1. Regional cooperation initiatives involving Mekong countries



Source: Adapted from (UN-ESCAP 2017).

Greater Mekong Subregion (GMS) Programme

The Greater Mekong Subregion (GMS) was established in 1992, which comprises the countries along the Mekong River, including Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam. With assistance from the Asian Development Bank (ADB), these six countries entered into a programme of subregional cooperation, designed to enhance economic relations.

GMS Economic Cooperation Programme supports the implementation of high-priority subregional projects in agriculture, energy, environment, health and human resource development, information and communication technology, tourism, transport and trade facilitation, and urban development.

For the cooperation in energy sector, which is guided by the Road Map for Expanded Energy Cooperation in the GMS, the region is working towards a competitive and integrated regional market that will sustainably develop the rich energy resources of the GMS as well as achieve the subregion's energy security, accessibility, and affordability. The strategies include building national and regional institutional capacity; cost-sharing across borders;

governance and regulations; enhancing access to modern energy; developing low-carbon and renewable domestic resources; improving regional energy cooperation and energy supply security; and promoting private sector participation, especially the small and medium-sized enterprises in subregional energy development (UN-ESCAP 2017).

As one of the key priorities under the GMS Economic Cooperation Program Strategic Framework 2012–2022, power market integration adopts a "building block approach" to develop the essential grid interconnection infrastructure to physically facilitate the cross-border dispatch of power (Asian Development Bank 2018).

The development of regional power trade will be pursued through the following activities: (i) harmonisation of GMS regional technical performance standards and the development of grid codes, (ii) creation of a favourable regulatory environment to support higher RPT, (iii) in-depth studies of potential cross-border interconnections, (iv) private sector participation in cross-border RPT projects, and (v) targeting a higher share of renewable energy in planning for regional power systems.

In 2003, the GMS Member Countries signed an MoU for the establishment of the Regional Power Trade Coordination Committee (RPTCC). The committee is responsible for managing regional power trade in the Greater Mekong Subregion and providing recommendations on an overall policy in this area. It also facilitates the exchange of information on energy sector plans and projects. RPTCC comprises officials from the energy departments and ministries of the six countries in the subregion.

Although the main focus of the energy cooperation of the GMS is the regional power trade, the GMS countries are also aiming at expanding the cooperation in renewable energy promotion by incorporating the environmental element in the power projects, such as mainstream environmental considerations in the design of power expansion plans, strategic environmental assessment in power sector planning and hydropower development, as well as capacity development for promoting effective environmental management in power projects.

Association of Southeast Asian Nations (ASEAN)

ASEAN is a regional intergovernmental organisation which comprises ten Southeast Asian countries and was established on 8 August 1967 by the 1967 ASEAN Declaration (ASEAN 1967). It aims to promote multilateral cooperation for accelerating economic growth, social progress, and cultural development as well as regional peace and stability.

To facilitate regional economic integration, the ASEAN Member Countries decided to establish an ASEAN Free Trade Area (AFTA) in 1992, with the objective to increase the ASEAN region's competitive advantage as a production base geared for the world market. A vital step in this direction is the liberalisation of trade through the elimination of tariff and non-tariff barriers among ASEAN members. Furthermore, ASEAN Economic Community was formed in 2015, marking the formal establishment of an integrated economic region. Under the ASEAN Economic Community Blueprint 2025, ASEAN commits to actively supporting the promotion of a sustainable growth agenda that enables the use of clean energy, including renewable energy.

In realising the ASEAN Economic Community goals, the ASEAN energy cooperation framework has already been set up through the ASEAN Plan of Action for Energy Cooperation (APAEC). APAEC is a series of guiding policy documents to support the implementation of multilateral energy cooperation to advance regional integration and connectivity goals in ASEAN. It serves as a blueprint for better cooperation towards enhancing energy security, accessibility, affordability and sustainability under the framework of the AEC for the designated period

(ASEAN Centre for Energy 2015).

Unlike the previous three cycles of APAEC, the APAEC 2016–2025 is extended longer than a period of 10 years to focus on the short- to medium-term strategies and is divided into two phases namely Phase I (2016–2020) and Phase II (2021–2025). In November 2020, the 38th ASEAN Ministers on Energy Meeting (AMEM) has endorsed the APAEC Phase II, which maintains the theme of "Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All", while adding a new sub-theme focusing on "Accelerating Energy Transition and Strengthening Energy Resilience through Greater Innovation and Cooperation".

The APAEC is translated into seven programme areas, namely (i) ASEAN Power Grid, (ii) Trans-ASEAN Gas Pipeline, (iii) Coal and Clean Coal Technology, (iv) Energy Efficiency and Conservation, (v) Renewable Energy, (vi) Regional Energy Policy and Planning, and (vii) Civilian Nuclear Energy. Each of the programme areas has key strategies to support themes of APAEC. Furthermore, specific aspirational targets for energy intensity reduction as well as increasing renewable energy are established.

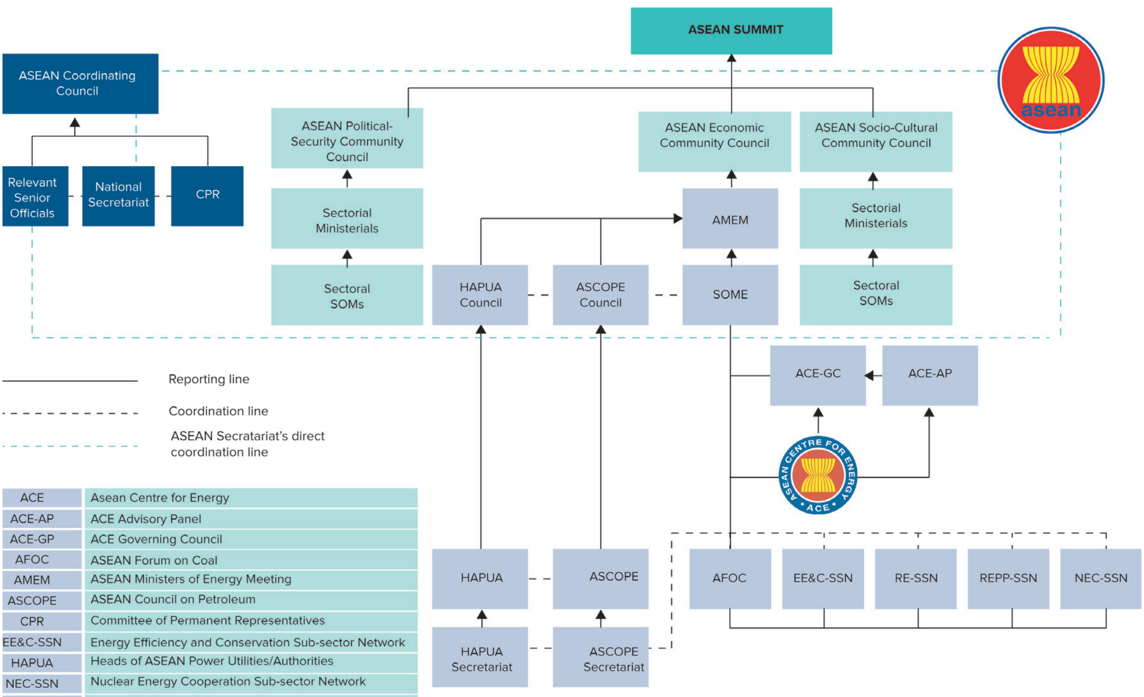
Table 1. APAEC Phase II: 2021–2025 key strategies

Programme Areas	Key Strategies
ASEAN Power Grid	To expand regional multilateral electricity trading, strengthen grid resilience and modernisation, and promote clean and renewable energy integration.
Trans-ASEAN Gas Pipeline	To pursue the development of a common gas market for ASEAN by enhancing gas and LNG connectivity and accessibility.
Coal and Clean Coal Technology	To optimise the role of clean coal technology in facilitating the transition towards sustainable and lower emission development.
Energy Efficiency and Conservation	To reduce energy intensity by 32% in 2025 based on 2005 levels and encourage further energy efficiency and conservation efforts, especially in transport and industry sectors.
Renewable Energy	To achieve aspirational target for increasing the component of renewable energy to 23% by 2025 in the ASEAN energy mix, including through increasing the share of RE in installed power capacity to 35% by 2025.
Regional Energy Policy and Planning	To advance energy policy and planning to accelerate the region's energy transition and resilience.
Civilian Nuclear Energy	To build human resource capabilities on nuclear science and technology for power generation.

Source: ASEAN Centre for Energy 2020.

The APAEC is implemented in a hierarchical arrangement (ASEAN Centre for Energy 2018). The ASEAN Ministers on Energy Meeting (AMEM) provides overall guidance and advice on the implementation of the APAEC. The Senior Officials Meeting on Energy (SOME) determines the implementation priorities and provides directions and advice on the APAEC to ensure coordination and integration of APAEC strategies and actions. The Specialised Energy Bodies and Sub-Sector Network work closely with the ASEAN Centre for Energy (ACE) as the implementing arm of the APAEC by convening the respective annual meetings, identifying the priorities and implementation arrangement, as well as developing work programme and engaging with the dialogue partners and international organisations (ASEAN Centre for Energy 2015).

Figure 2. ASEAN energy cooperation implementation and coordination structure



ACE	Asean Centre for Energy
ACE-AP	ACE Advisory Panel
ACE-GP	ACE Governing Council
AFOC	ASEAN Forum on Coal
AMEM	ASEAN Ministers of Energy Meeting
ASCOPE	ASEAN Council on Petroleum
CPR	Committee of Permanent Representatives
EE&C-SSN	Energy Efficiency and Conservation Sub-sector Network
HAPUA	Heads of ASEAN Power Utilities/Authorities
NEC-SSN	Nuclear Energy Cooperation Sub-sector Network
RE-SSN	Rnewable Energy Sub-sector Network
REPP-SSN	Regional Energy Policy and Planning Sub-sector Network
SOME	Senior Officials Meeting on Energy

Source: ASEAN Centre for Energy Website.

In January 1999, ACE was established as an intergovernmental organisation within the ASEAN structure that represents the interests of the 10 ASEAN Member States (AMS) in the energy sector (ACE 2016). ACE has a mandate to serve the AMS through its three critical roles, namely as a catalyst to strengthen and unify ASEAN Energy Cooperation and Integration, as a Think Tank to provide an innovative solution for ASEAN energy issues, and as a knowledge hub in providing knowledge depository for AMS.

Renewable energy programme

In APAEC, ASEAN has set up the aspirational target of renewable energy share of 23% in Total Primary Energy Supply (TPES) by 2025. Under the renewable energy programme, ASEAN is actively promoting the deployment of renewable energy as the solution for accelerating the energy transition, enhancing energy security, and bringing energy access towards a sustainable energy future.

The regional renewable energy capacity deployment is tracked annually to monitor the progress of the target. Regional cooperation efforts in renewable energy, led by the Renewable Energy Sub-Sector Network (RE-SSN), have focused on capacity building, knowledge and information exchange, and policy research among AMS. Under the APAEC Phase I: 2016–2020, a series of capacity building and knowledge exchange programme on policy, technical, and financial aspects of renewable energy projects has been implemented. Another example of these efforts is the ASEAN Renewable Energy Awards under the ASEAN Energy Awards. Introduced in 2001, this initiative seeks to promote and disseminate best practices in renewable energy projects in AMS and encourage all sector participation in developing innovative renewable energy projects to enhance business growth. Moreover, a demonstration project on Renewable Energy Fuelled Pico Grid Village was launched in 2018 in Cambodia.

Despite the various efforts made within the region, the progress of renewable energy deployment in the region is relatively steady. The renewable energy share in the ASEAN energy mix reached 13,9% in 2018 (ASEAN 2019), which showed a 9% gap behind the target for the next five years. Therefore, the region should deepen its efforts in addressing the gap and challenges in accelerating the deployment of renewable energy projects.

As indicated in the APAEC Phase II: 2021–2025, ASEAN will increase its efforts in the deployment of renewable energy through various initiatives, such as the development of long-term ASEAN Renewable Energy Roadmap, which will chart out the pathways for the region to achieve its renewable energy targets of 23% share in TPES as well as the 35% share in installed power capacity. Moreover, ASEAN will also further focus its strategies on enhancing research and development (RD&D) networks for renewable energy technologies, promoting innovation in financing mechanisms and schemes, and supporting the development of biofuel and bioenergy.

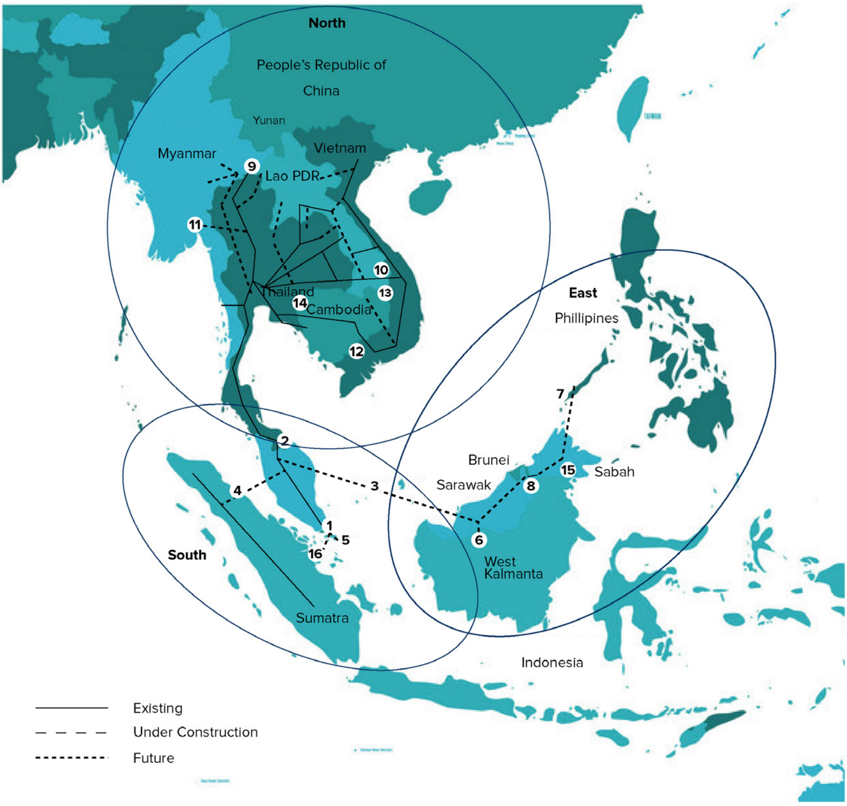
ASEAN power grid

The ASEAN Power Grid (APG) is a major energy infrastructure project mandated in 1997 under the ASEAN Vision 2020, along with the Trans-ASEAN Gas Pipeline. It aims to interconnect the electricity grids of all the 10 AMS, initially through cross-border bilateral connectivity and followed by sub-regional before gradually expanding to multilateral schemes leading to an integrated APG system. It is seen as key to meeting the rising demand in the region, transferring power from surplus to deficit regions and improving access to energy as well as the competitiveness of the region (ASEAN 2015).

The Heads of ASEAN Power Utilities and Authorities (HAPUA), as a Specialised Energy Body (SEB), is responsible for driving the APG to ensure regional energy security. It works in collaboration with ASEAN energy bodies, including the ASEAN Power Grid Consultative Committee (APGCC) and the ASEAN Energy Regulators Network (AERN), which consists of energy regulators from AMS.

The ASEAN Power Grid consists of 16 bilateral interconnection projects, which is divided into three sub-regions, namely North, South, and East. The APG Northern Sub-Region, consists mainly of the lower Mekong countries, including Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. The South region includes Singapore, Peninsula Malaysia, and Sumatra of Indonesia, while the Eastern portion of the APG consists of Kalimantan (Indonesia, Malaysia, and Brunei Darussalam) and the Philippines.

Figure 3. ASEAN power grid map



	Earliest COD
1. P. Malaysia - Singapore (New)	post 2020
2. Thailand - P. Malaysia	
• Sadao - Bukit Keteri	Existing
• Khlong Ngao - Gurun	Existing
• Su Ngai Kolok - Rantau Panjang	TBC
• Khlong Ngae - Gurun (2nd Phase, 300MW)	TBC
3. Sarawak - P. Malaysia	2025
4. P. Malaysia - Sumatra	2020
5. Batam - Singapore	2020
6. Sarawak - West Kalimantan	2015
7. Philippines - Sabah	2020
8. Sarawak - Sabah - Brunei	
• Sarawak - Sabah	2020
• Sabah - Brunei	Not Selected
● • Sarawak - Brunei	2018
9) Thailand - Lao PDR	
• Roi Et 2 - Nam Theun 2	Existing
• Sakon Nakhon 2 - Thakhek - Then Hinboun (Exp.)	Existing
• Mae Moh 3 - Nan - Hong Sa	2015
• Udon Thani 3 - Nabong (converted to 500KV)	2019
• Ubon Ratchathani 3 - Pakse - Xe Pian Xe Namnoy	2019
• Khon Kaen 4 - Loei 2 - Xayaburi	2019
• Nakhon Phanom - Thakhek	2015
• Thailand - Lao PDR (New)	2019-2023
10) Lao PDR - Vietnam	2016-TBC
11) Thailand - Myanmar	2018-2026
12) Vietnam - Cambodia (New)	TBC
● 13) Lao PDR - Cambodia	2017
14) Thailand - Cambodia (New)	post 2020
15) East Sabah - East Kalimantan	post 2020
16) Singapore - Sumatra	post 2020

● Priority Projects

Source: ASEAN Center for Energy 2015.

ASEAN has completed the physical interconnections of eight out of the sixteen planned APG projects with a total capacity of 5,212 MW (ASEAN Centre for Energy 2017b). A major initiative of the ASEAN Power Grid was the operationalisation of the first multilateral power trade pilot project, namely the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP). Initiated in 2014, the LTMS-PIP was a pathfinder for cross-border power trade of up to 100 MW of hydroelectricity from Lao PDR to Singapore using existing interconnections. In 2019, the Lao PDR, Thailand, and Malaysia signed a Supplementary Agreement to the Energy Purchase and Wheeling Agreement (EPWA) for increasing the maximum committed capacity for electricity trading from 100 MW to 300 MW (ASEAN 2019).

The expansion of multilateral electricity trading in the region could be seen not only as a tool for stimulating regional economic growth and allowing the countries to meet their energy demand but also as a potential for facilitating the integration of a higher share of renewable energy (International Energy Agency 2019b). Under the APAEC Phase II, ASEAN will further explore the potential for the integration of renewable energy as well as digital development in the ASEAN Power Grid.

Conclusion

Renewable energy is fundamental for accelerating energy transition as well as ensuring energy security and access. The deployment of the renewable energy could further diversify energy supply, which subsequently could reduce energy imports and minimising the environmental impacts of energy use. Endowed with huge potentials of renewable energy, ranging from hydropower to solar and wind energy, countries in the region have not tapped those resources to the fullest extent.

Although renewable energy development in the region is still at a nascent stage, there are existing cooperation platforms and mechanisms in place at both bilateral and regional levels, which could be a foundation for accelerating renewable energy deployment. For bilateral cooperation, electricity trading and joint development projects have led to a substantial growth of hydropower in the region. Meanwhile, at the regional level such as GMS and ASEAN, the regional electricity trading is playing an important role in stimulating the greater deployment of renewable energy. Those regional cooperation platforms are also promoting renewable energy initiatives through knowledge exchange, capacity building, joint studies, and project implementation. Building on the existing frameworks, a stronger and more comprehensive cooperation at the bilateral and regional levels is crucial for maximising the realisation of renewable energy potentials in the region.

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Source: unsplash

7

Sustainable Energy Cooperation Initiatives in the Mekong Region

Chheang Vannarith and Leng Thearith

Introduction

Energy policies and their implementation are the complex power interplay among different stakeholders including state and non-state actors. The key challenge is how these actors and stakeholders work together to realise their energy needs and more importantly to achieve sustainable energy goals. In the Mekong region, energy demand is on the rise due to urbanisation and industrialisation, and the concerns over carbon emissions are high on the development agenda of the regional countries and their development partners. Various initiatives and programmes have been developed to support this dynamic region in sustainable development including the development of clean and renewable energy.

This chapter discusses the roles of regional institutions and mechanisms in promoting regional cooperation on clean and renewable energy in the Mekong region, focusing on six subregional mechanisms namely the Mekong River Commission (MRC), the Greater Mekong Subregion (GMS), Mekong-Japan Cooperation (MJC), Mekong-Lancang Cooperation (MLC), Mekong-Korea Cooperation (MKC), and Mekong-US Partnership (MUP). The chapter argues that regional institutions and mechanisms play their parts in promoting green and renewable energy.

Overview of Energy Problems in the Mekong Region

In 2015, the total energy installed in the lower Mekong region stood at 87 GW, making up 42% of the total energy within the ASEAN region, of which 63.44% (55.2 GW) were thermal power plants based on fossil fuels. Within the same year, the non-fossil power led by hydro stood at 26.9 GW or 31% of the total power in the region, while other clean energy resources such as solar and wind were in the early stages of development (Shi, Yao and Jiang 2019, 446). It is predicted that the annual energy demand will be at 4% until 2020. Energy demand and electricity production will significantly increase in 2035. Environmental impacts are getting more severe driven by the increased use of fossil fuels

Source: unsplash

and petroleum to meet the energy need. To resolve this problem, investment in clean and renewable energy sources and the promotion of cross-border energy trade are critical to meet energy demand, achieve energy security, reduce environmental pollutions, and enhance economic competitiveness (Anbumozhi, Han, et al. 2020, 139-140).

The development of renewable energy sources in the Mekong region has been hampered by the lack of technical knowledge and funds. Concretely, the limited technical and financial resources of the public and private sectors in the lower Mekong countries are major impediments to the development and use of renewable and clean power. While renewable energy development is encouraged by these governments, appropriate policies and financial support are at the evolving stage. The lack of access to finance has posed a significant hindrance to the construction of the cross-border transmission interconnections. Since the scale of investment is huge, bankers often perceive regional power connectivity projects as having higher risks than they actually do. Bankers are usually frustrated by the complexity and are unwilling to accept completion risk when a new power grid project is to be developed (Shi, Yao and Jiang 2019, 452). Compared with other countries in the region, Thailand and Vietnam have made remarkable progress in low-carbon energy development. In the case of Thailand, alternative energy sources (solar, wind, biofuel, biogas, and mini hydropower) account for 12 per cent of the total energy use, and the government is targeting to increase to 25 per cent by 2021. For Vietnam, the share of renewable energy is expected to reach 6.5 per cent in 2020, 6.9 per cent in 2025, and 10.7 per cent in 2030 (Anbumozhi and Nguyen 2015).

Cambodia's energy consumption will double by 2040, compared with the baseline in 2015. The total final energy consumption (TFEC) grew at 7.2 per cent per annum from 2010 to 2018. Biomass accounted for 25.5 per cent of the TFEC in 2018. The annual growth rate of commercial energy, especially oil and electricity, were at 8.1 per cent and 18.3 per cent, which is significantly higher than that of the TFEC. Therefore, it is predicted that commercial energy (oil and electricity) will replace the TFEC. Hence, it is compelling to promote energy efficiency and renewable energy in Cambodia (Kimura, Han and Leong 2020).

Moreover, sustainable energy needs a sound regional power connectivity. A good regional power grid development helps promote cross-border energy trade, which in turn can promote sustainable energy development. The regional mechanisms and initiatives have been created to address technical and regulatory barriers in cross-border power trade and promote low-carbon implementation. Bilateral cooperation has been underway to facilitate cross-border energy trade. For instance, Cambodia has imported electricity from Lao PDR, Thailand and Vietnam to meet the Kingdom's domestic demand. In 2019, Cambodia and Lao PDR signed an energy cooperation agreement of 6,000 MW by 2030 (the electricity generated from the Don Sahong Dam) (Asia News Network 2020).

The key barriers to regional power trade promotion include a high degree of national market monopolisation, the lack of cross-border transmission lines and domestic grids, conflicting standards and protocols of electricity transmission and distribution. Frequencies, voltages, information technology systems, and even consumer protection policies are likely to be different within the regional countries. Harmonisation of technical standards and regulations, such as grid codes and consumer protection policies should be in place. Some countries even lack connected national power grids (Shi, Yao and Jiang 2019, 452). For example, Cambodia does not have a pan-nation interconnected power grid.

Mekong countries have developed their energy policies and power development plans, including the promotion of clean and renewable energy with the commitment to low-carbon implementation. The build-up of both fossil and non-fossil powers is still at the early stage of development, facing

Source: Mekong River Commission for Sustainable Development

significant challenges that can only be tackled using international cooperation mechanisms. This is the reason why Mekong countries have established or backed the establishment of regional institutions or mechanisms that shore up the development of clean and renewable energy.

Greater Mekong Subregion

The Greater Mekong Subregion (GMS) cooperation was founded in 1992 with the participation of six countries—Cambodia, China (Yunnan and Guangxi Provinces), Lao PDR, Myanmar, Thailand, and Vietnam. The Asian Development Bank (ADB) has served as the programme's Secretariat since the establishment. The main aims of the GMS are to promote trade and investment as well as the economic growth of the regional countries through the development of their infrastructure. The GMS programme has identified and carried out priority programmes and projects in diverse sectors, including human resource development and environmental management. In 2002, with the support of the ADB, an agreement on Regional Power Trade was signed (Zhai 2010). The GMS countries then rolled out the GMS Strategic Framework (2002–2012), a comprehensive strategic framework that embraced various sectoral programmes and projects together for sub-regional development. The GMS strategic framework covers five pillars: enhancing infrastructure linkages, in which energy interconnection sits; facilitating trans-border trade, investment, and tourism; protecting the environment; upskilling human resources; promoting the sustainable use of shared natural resources; as well as strengthening private sector participation and competitiveness.

The framework of the five pillars is under implementation up until 2022 under the Greater Mekong Subregion Economic Cooperation Program: Strategic Framework 2012–2022 (GMS SF-II). Power connectivity within the GMS countries has laid down the foundation of power market integration to be rolled out in four stages. Stage 1 is bilateral cross-border linkages. In stage 2, grid-to-grid energy trading between two of the GMS countries will be carried out. The third country's transmission facilities will be utilised for this type of trading. Stage 3 involves transmission connections for trans-national trading. At stage 4, a fully integrated GMS regional competitive energy market will be founded. Currently, the GMS countries are at stage 1, where bilateral trade is ongoing. They are moving towards stage 2 with limited progress. The Mid-Term Review of the Strategic Framework 2012–2022 (GMS SF-II) suggests that the progress in building an integrated regional grid and creating a regional power market is still limited by technical, regulatory and institutional challenges (Weatherby and Eyler 2017).

Mekong River Commission

The Mekong River Commission (MRC), formed in 1995, is one of the most important inter-governmental organisations in the Mekong region with a mission to promote and coordinate policies pertaining to sustainable management and development of water-related resources for the countries' mutual benefits and the peoples' well-being. The MRC member states are composed of Cambodia, the Lao PDR, Thailand, and Vietnam, while China and Myanmar are dialogue partners. This inter-governmental body plays a role as a regional knowledge hub on water resources management. Hydropower development is regarded as one of key cooperation areas. The MRC has issued several policy guidelines for Initiatives on Sustainable Hydropower projects (ISH), focusing on the overall effectiveness of infrastructure projects from a basin-wide perspective and assisting the member countries in their basin management and planning.

The MRC's ISH01 is aimed at identifying ecologically sensitive sub-basin for sustainable development of hydropower on the tributaries, while the ISH02 focuses on the multi-purpose evaluation of hydropower projects. The ISH0306 concentrates on hydropower environmental impact mitigation and risk management in the Lower Mekong mainstream and tributaries, while the ISH11 oversees the improved environment and socio-economic baseline information for hydropower planning. The ISH13 focuses on national-to-local benefits sharing options for hydropower on the Mekong tributaries. In September 2020, the MRC issued a comprehensive guideline on hydropower mitigation with the objective to test selected mitigation options for effectiveness and sustainability while, at the same time, maximising the operational flexibility (Mekong River Commission 2020). The above guidelines are based on a thorough detailed analysis of a range of mitigation options and scenarios using rigorous modelling.

These guidelines, despite carrying no binding obligations, are instrumental in promoting the sustainable development of hydropower energy. However, failure to implement the guidelines and other procedures of notification and prior consultation can result in conflicts and tension. For instance, the construction of the Xayaburi Dam without proper consultation has caused tension between the Lao PDR and other downstream countries. The downstream countries were compelled to redesign the institutional arrangements and stakeholder consultations by mobilising their bargaining power and involving more stakeholders in the decision-making process (Grunwald, Wang and Feng 2020).

Mekong-Japan Cooperation

The "Japan-Mekong Region Partnership Program" was announced during the 3rd Japan-Cambodia-Laos-Vietnam (CLV) Foreign Ministers' Meeting held in January 2007 in Cebu, the Philippines (Ministry of Foreign Affairs and International Cooperation of Cambodia 2020). The first Mekong-Japan Foreign Ministers' Meeting took place in January 2008, and the first Mekong-Japan Summit Meeting was held in November 2009. The first Green Mekong Forum was organised in June 2011. In 2020, the Green Mekong Forum was upgraded to the Mekong-Japan SDGs Forum (track 1.5 mechanism to seek synergy of public-private dialogue and partnership).

At the 11th Mekong-Japan Summit, the leaders reaffirmed the importance of the realisation of a Green Mekong, which is an essential factor in realising Sustainable Development Goals (SDGs) in the Mekong region. They also adopted the "Mekong-Japan Initiative for Sustainable Development Goals towards 2030" with a view to achieving the SDGs in the Mekong region. The Mekong-Japan Initiative for SDGs toward 2030 encompasses the realisation of the "affordable and clean energy" under Goal 7 of the SDGs.

Specifically, three areas of cooperation have been prioritised under the Mekong-Japan Cooperation framework, including (i) environmental and urban issues including waste management, marine plastic litter/water and river pollution, disaster risk reduction and disaster management, and reduction of greenhouse gas emissions and building of climate resilience; (ii) sustainable natural resource management and utilisation comprising agricultural productivity, water resources management, and sustainable forest management; and (iii) inclusive growth including education and human capital investment, health and social welfare, gender equality and empowerment of women, legal and judicial cooperation, promotion on inclusive and sustainable industrialisation, and tourism cooperation (Ministry of Foreign Affairs and International Cooperation of Cambodia 2020).

Mekong-ROK Cooperation

Mekong-Republic of Korea Cooperation mechanism was first established in 2011 with the aims to promote connectivity, sustainable development, and people-oriented development. Under the MKC framework, the Mekong-Korea Plan of Action (2014–2017) was formulated and stressed six areas of cooperation namely infrastructure, information technology, green growth, water resource development, agriculture and rural development, and human resource development.

In 2018, both sides agreed to elevate their cooperation to a new height with an emphasis on three pillars (people, prosperity and peace) and four connectivity areas (transportation, energy, water resources, as well as information and communication technologies). In 2019, the first Mekong-Korea Summit was held in Busan. The Joint Statement of the Summit introduced seven new cooperation areas, namely (i) culture and tourism, (ii) human resource development, (iii) agriculture and rural development, (iv) infrastructure, (v) Information and Communication Technology (ICT), (vi) environment, (vii) non-traditional security challenges (Ministry of Foreign Affairs and International Cooperation of Cambodia 2020). Under the Peace for Sustainable Development section, the statement particularly stresses the cooperation in the management of water resources, biodiversity, forest and environmental infrastructure, as well as working towards economic cooperation for green growth and sustainable development.

The ROK has extensive experiences in green growth, which can be shared with Mekong countries. It was among the first countries which have adopted the "green growth" strategy. The political leadership plays a key role in putting green growth as a national development priority while the multi-stakeholder partnership building across sectors is the driving force. The green growth is mainly driven by green energy technologies, green energy markets, and green energy choice. In 2009, the ROK announced plans to invest US$85 billion in clean energy technologies and to implement its green growth plan. It aims to develop the world's first nationwide "smart grid" system by 2030 and increase the country's renewable energy to 11 per cent of energy supplies by 2030. Therefore, the country may be able to assist Mekong countries in building a smart grid system.

Mekong-Lancang Cooperation

The Mekong-Lancang Cooperation (MLC) was launched in 2015 with a focus on three cooperation pillars, namely politico-security issues, economic affairs and sustainable development, as well as social affairs and people-to-people ties. The first MLC Summit was held in 2016. The summit has since been organised bi-annually. The Vientiane Declaration of the 3rd MLC Summit in 2020 puts "sustainable energy generation and utilisation" under the pillar on "Enhancing Partnership on Economic and Sustainable Development Cooperation" (Huaxia 2020).

Power connectivity is one of the priority areas of the MLC regional cooperation framework, and power infrastructure has been developing rapidly in the region in recent years. The Mekong-Lancang region, according to the deputy chief economist of China Southern Power Grid, is rich in clean energy sources, and power grid connectivity in the region will help promote the effective use of clean energy in the Mekong region (Huaxia 2019).

The MLC has a strong potential to provide Mekong countries with tangible benefits, especially the green energy transfer, for its main donor, China, has significantly encouraged its industries to embrace environmental-friendly technologies in their production as well as in the energy sector. The 11th Five-Year Plan (2006–2010) was, for example, aimed at boosting the consumption of renewable energy sources. Total investment in tackling environmental pollution went up 15% annually, and environmental investment had reached 1.33% of China's GDP by

2009 (OECD n.d.). Additionally, China has reformed environmental management bodies by allowing the public to have access to the environmental information, creating the National Leadership Committee on Climate Change, Energy Saving and Pollution Reduction, enforcing regulations on energy efficiency and pollution reduction targets, encouraging local governments to pursue environmental excellence, and embracing market mechanisms for pollution reduction.

According to its 12th Five-Year Plan (2011–2015), China was, by 2015, aimed at decreasing pollutant emissions, improving drinking water sources and quality, controlling pollution triggered by hazardous chemicals and dangerous wastes, improving urban environmental infrastructure operations, mitigating ecological deterioration, enhancing nuclear safety, and improving environmental regulatory mechanisms (CBI Voice of Business 2011). Environmental goals encompass decreasing carbon emissions per unit of GDP by 17% and energy consumption per unit of GDP by 16% and enhancing forest coverage to 21.66%.
Under the MLC framework, SFIEC (Shenzhen Foundation for International Exchange and Cooperation) collaborated with Myanmar Duchinj Foundation to launch the first stage of the "Sun Village along Mekong River" project in Magwe province in Myanmar. This project raised 300 sets of miniature solar power generation equipment (systems) and 1,700 solar table lamps to be donated to families, temples and schools of Ashay Thiri and Ywar Thit counties in the province (Zhuoyan 2020).

In Cambodia, a Chinese developer called QILU (Cambodia) in collaboration with a local environmental-friendly industrial firm known as EPIAC has planned to invest approximately US$1 billion in building an environmentally friendly special economic zone in Svay Rieng province. This economic zone will house several industries, including garment and textiles, machinery, construction materials, chemicals and other heavy industries. Most notably, this developer pledged to strongly embrace green technologies for the aforementioned industries (Property 2020).

Source: Mekong River Commission for Sustainable Development

Mekong-US Partnership

The Lower Mekong Initiative (LMI) was founded in 2009, focusing on agriculture and food security, connectivity, education, energy security, water security, environmental issues, and public health. In 2020, the LMI was upgraded to Mekong-US Partnership (MUP). On 11th September 2020, the first Mekong-US Partnership Ministerial Meeting stressed the importance of strengthening transparency and good governance, enhancing connectivity, economic integration, inclusive and sustainable development, and narrowing the development gap in the region (US Department of State 2020).

Four key cooperation areas falling under the purview of the Mekong-US Partnership are (i) economic connectivity; (ii) sustainable water, natural resources management, and environmental conservation and protection; (iii) non-traditional security, including collaboration on emerging threats in health security, pandemic response, countering transnational crime, cybersecurity, and countering illicit trafficking in persons, in drugs, and in restricted and endangered wildlife species, and timber; and (iv) human resource development, including education and women's empowerment.

As seen, although the MUP has the potential to

Source: Mekong River Commission for Sustainable Development

provide Mekong countries with the benefits of green technologies, it remains unclear as to whether its main pioneer, the US, has a real commitment to assisting the regional countries with environmental-friendly technologies. The current American president Donald J. Trump has appeared to pay less attention to green energy, as he withdrew from the Paris Agreement on Climate Change in 2017 (White House 2017). It is also unclear if he is serious about the energy cooperation in the ASEAN region, as well as in the Mekong, for he has personally skipped the regional summits three times in a row (Channel News Asia 2020). As of the time of this writing, President-elect Joe Biden is likely to concentrate on green energy cooperation, for he has advocated for the American reengagement with the Paris Accord on Climate Change. Moreover, Biden pledged to invest US$1.7 trillion to encourage American industries to opt for green energy instead of fossil fuels during his presidential election campaign (Mullaney 2020).

Japan-US Mekong Power Partnership

Japan-US Mekong Power Partnership (JUMPP) was founded in 2020 with the view to maintain and promote a more sustainable energy sector and quality energy infrastructure development that meets the needs of people in the Mekong region, in accordance with the "G20 Principles for Quality Infrastructure Investment" (Mekong US Partnership 2019). The Partnership will help Mekong countries meet their demand for secure, affordable, and reliable electricity and enhance regional power trade and integration.

The United States announced its intention to provide an initial US$29.5 million under the Asia Enhancing Development and Growth to support Mekong countries' pursuit of energy security and their citizens' reliable access to electricity through free, open, stable, and rules-based regional electricity markets (Mekong US Partnership 2019). The United States and Japan affirm the importance of helping Mekong countries secure their energy supplies and their shared commitment to providing technical assistance, capacity building, and other types of cooperation for a free and energy-secure Mekong region.

In spite of the above US's commitment, it is uncertain whether the current US Administration is much interested in pushing the JUMPP further, as President Trump is not much enthusiastic about adopting green technology. Nevertheless, it is believed that the next American President Joe Biden will place his strong emphasis on green energy.

Strength and Weakness of Existing Energy Cooperation Initiatives

The multiplicity of multiple energy cooperation frameworks offers a good opportunity for Mekong countries to develop their power potentials, especially green energy. Technical and financial assistance can be expected from the above initiatives. The GMS, for example, has considerably boosted the regional power grids and energy trading, thanks to its clear strategic frameworks and the ADB's continuous assistance. The MRC, in addition, has provided significant policy guidelines for the lower Mekong countries in constructing green energy facilities, particularly the hydropower projects. The other frameworks such as the MJC, MKC, MLC, MUP and JUMPP have provided extra layers of assistance to Mekong countries in multifaceted realms, ultimately contributing to the realisation of the development of green power in the Mekong region.

Despite the strength and opportunities, the above initiatives have certain drawbacks. Several initiatives such as MKC, MLC and JUMPP are still at the early stage of implementation; therefore, they may not be able to solely focus on energy cooperation. In other words, they have to simultaneously prioritise other areas of cooperation such as infrastructure development, healthcare, industrial capacity and disaster management. Other initiatives such as LMI or MUP have mainly concentrated on providing policy inputs rather than the actual provision of capital or energy infrastructure, making the riparian states unable to fast track their green energy goals.

Some initiatives have been created by competing donors, which are more interested in maximising their influence than in serving the interests of Mekong countries. Some donors have exerted their pressure on the regional countries if they deem their competitors have an edge over them. For example, the MUP and JUMPP led by Washington were created to mainly reduce Chinese influence in the region, for the US has at times pressurised Mekong countries, especially Cambodia, to be less receptive to Chinese initiatives including the MLC. Such pressure has been manifested in the US's continuous accusations of Cambodia's hosting of Chinese naval bases, despite the lack of credible evidence and Cambodia's mammoth efforts to clear the doubt.

Conclusion

Building a green energy community has been one of the key priorities the lower Mekong countries have pursued thus far. To achieve this goal, the regional countries have cooperated with several external partners including the US, China, Japan, and South Korea through various Mekong cooperation frameworks such as GMS, MRC, MJC, MKC, MLC, MUP and JUMPP. The regional mechanisms play an important role in providing policy guidelines, promoting dialogues, building energy grids, boosting power trading, building capacity, and mobilising resources to realise regional cooperation on the energy sector. Particularly, clean and renewable energy has gained traction in the regional cooperation framework in recent years, as the donors have expressed their commitments to realising the goal through their respective initiatives as mentioned above. Nevertheless, those cooperation frameworks still face certain constraints, including the actual shortage of funding for the development of infrastructure, the sparse priorities of those frameworks and the hidden agenda of the donors.

In order to overcome these shortcomings, Mekong countries and their donors should mobilise significant resources, particularly funding to encourage the use of clean and renewable energy. Moreover, they should come up with concrete strategic frameworks [as is the case of the GMS] in implementing the green energy goals. Last but not least, to further encourage renewable energy development, the regional countries should provide subsidies to public and private sectors, which are in transition and have planned to adopt renewable and clean energy sources. This once again requires significant investments from the Mekong governments and their external partners via the aforementioned initiatives.

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Source: unsplash

8

Geopolitics of Energy Cooperation between the Mekong Region and External Powers

Lim Menghour and Cheunboran Chanborey

Introduction

The Mekong region has attracted much attention from major powers due to its rapid economic growth, enhanced regional integration and connectivity within the subregion, as well as its strategic geopolitical location between the two Asian giants, China and India. More importantly, the region has been known for having a large number of cooperation frameworks with external powers, relatively more than any other subregions in the world. Those frameworks include the Mekong-Ganga Cooperation (2000), the Mekong-Japan Cooperation (2008), the Lower Mekong Initiative (2009) recently elevated to the Mekong-US Partnership (2020), the Mekong-ROK Cooperation (2010), and the Lancang-Mekong Cooperation (2016).

The Mekong cooperation with external partners focuses on broad areas of cooperation, from connectivity, sustainable development, and climate change to energy cooperation. Indeed, the region boasts great economic potentials due to its water and energy resources. However, the downside is that water management and energy development have been steadily politicised and securitised, inducing a heated competition among great powers, resulting in the twists and turns of the subregional cooperation.

External Powers' Engagement in the Mekong Region

The engagement of external powers in the Mekong region comes in different shapes and forms, reflecting their interest in the region. Two cooperation mechanisms with China and Japan are relatively comprehensive, covering both soft and hard infrastructure, while the US's engagement in the region is more policy-oriented, and the engagements of the ROK and India are sectoral in nature (Cheunboran 2020).

Mekong-Lancang Cooperation

The Mekong/Lancang River is the most important cross-border river in Asia, flowing through six

Source: unsplash

countries including China, Laos, Myanmar, Thailand, Cambodia and Vietnam. The part of the river located in China is known as the Lancang River while the rest is known as the Mekong. Over 60 million people depend on the river and its tributaries for food, water, agriculture, transportation and other aspects for daily needs. Since the ancient time, the Mekong River has been an important link between China and the countries downstream. Indeed, it is in China's strategic backyard and its traditional sphere of influence. Henceforth, China has generally taken an active part in multilateral cooperation frameworks in the Mekong region and has continued to provide assistance for sustainable development.

As early as 1992, China joined the Greater Mekong Subregion Economic Cooperation (GMS) and became a dialogue partner of the Mekong River Commission (MRC) in 1996. In the same year, China also joined the ASEAN-Mekong Basin Development Cooperation (AMBDC). At the 17th China-ASEAN Summit in 2014, Premier Li Keqiang proposed establishing the Mekong-Lancang Cooperation (MLC) mechanism between six countries in the Mekong region in order to bring new impetus for sustainable development of the region amid the ever-changing regional and global challenges. As a result, MLC was officially declared in November 2015 by the six member states, and the first MLC Leader's Meeting was held in South China's Hainan province in March 2016. The mechanism identified three pillars of cooperation: political and security issues; economic and sustainable development; and social, cultural and people-to-people exchanges. The six priority areas under MLC include interconnectivity, industrial capacity, cross-border economy, water resources, agriculture and poverty reduction.

Among the six priority areas, water resource management is the most important. Transboundary rivers have traditionally been complex and are sensitive areas, with some even witnessing wars and conflicts around the management of water resources if the demands and interests of states upstream and downstream are not well handled. Historically, as China and the Lower Mekong countries strengthened their efforts to develop the waterway, in particular dam construction, the parties also went through dealing with trust crisis due to a lack of negotiations or an effective water management mechanism. Therefore, the LMC has supported the establishment of a water-resource research centre to coordinate among member countries on river flow data sharing and the distribution of water resources.

Water resource management of the Mekong River is a source of differences and conflict of interests. China has constructed 11 giant dams in the mountainous regions of the Upper Mekong to meet its increasing energy needs. The management of water flows has long been a concern for many living along the river. The situation is particularly exacerbated by the fact that there are no water treaties or legally binding agreements that require the parties to share the data. In this connection, China, at the third MLC Leaders' Meeting in August 2020, pledged to share more hydrological data. Three mechanisms dealing with water resource management under the MLC are Water Resources Cooperation Centre, Environmental Cooperation Centre, and the Global Centre for Mekong River Studies. This is a positive development in promoting mutual understanding and cooperation between China and the lower Mekong countries on transboundary water resource management.

Apart from water resource management, for over the past 20 years, China has maintained close communication with downstream countries in hydropower development, flood forecasting and hydrological information sharing. China has held 23 consecutive cooperation dialogues with the MRC and has provided hydrological data during flood seasons for 17 consecutive years since 2003 (Zhai and Deng 2020). In recent years, China, as an upstream country, has responded positively to the interests and concerns of downstream countries when seasonal droughts and floods seriously threatened the realisation of the Sustainable Development Goals (SDGs) of the river basin. China is currently planning to further strengthen water resource cooperation with Mekong countries, such as sharing the whole year's hydrological information of the upper reaches of the Mekong river with downstream countries. The other five Mekong countries have all made positive comments and welcomed China's long-standing sharing of hydrological information and emergency replenishment to the lower Mekong (Ibid).

China's importing of hydropower from Southeast Asia is part of a push to reduce its carbon footprint by investing in renewable energy. Countries in the Mekong region are looking to deepen cooperation in improving power connectivity to boost common development. It should be noted that power connectivity is one of the priority areas of MLC, and power infrastructure has been developing rapidly in the region in recent years. Although the Mekong region is rich in clean energy resources, about 30 million people in the region still lack access to electricity due to the underdeveloped infrastructure (Xinhua 2019). Thus, China is willing to cooperate with countries in the region to promote the development of the power industry and power grid connectivity which will help promote the effective and efficient use of energy in the region. Improving power connectivity in the Mekong region will help ensure energy security, and countries in the region should further promote energy cooperation in the future.
The MLC provides 'voice opportunities' for lower Mekong countries to challenge or shape the behaviour of China. The consensus-based decision making allows the MLC members to propose or object to an agenda based on their interest calculation. China's agreement to the inclusion of the controversial transboundary water management issues in the MLC demonstrates that China is willing to cooperate and resolve the differences. This can be regarded as a concession made by China.

Mekong-Japan Cooperation

Japan's long-standing engagement in the Mekong region has significantly contributed to the transformation of a once war-torn region into one of the world's fastest-growing economies. In 2007, Japan reached out to Mekong countries through the Japan-Mekong Regional Partnership Program. The cooperation between Japan and Mekong countries has been intensified since 2008 when the first Foreign Ministers' Meeting between Japan and Mekong countries took place in Tokyo, with three main objectives: (i) narrowing the development gap among ASEAN member countries and promoting ASEAN integration; (ii) achieving sustainable economic growth with environmental considerations and health; and (3) ensuring lasting peace and stability in the region. In 2009, the Japan-Mekong Exchange Year was celebrated, and the first Japan-Mekong Submit kicked off.

Throughout the years, Japan has supported Mekong countries in terms of hard infrastructure development, logistics and transport, institutional building, human resources development, and regional community building. So far, Japan's development projects, including projects on infrastructure development, have gained positive feedbacks from local people in the region due to their high-quality standards together with good governance and transparency. At the 10th Mekong-Japan Summit in Tokyo in 2018, the leaders of Mekong countries including Cambodia, Lao PDR, Myanmar, Thailand and Vietnam agreed to elevate their cooperation with Japan to a "Strategic Partnership" and adopted the Tokyo Strategy 2018 with a focus on three pillars, namely vibrant and effective connectivity, people-centred society, and a Green Mekong.

In the Green Mekong pillar, there are four priority cooperation areas, including water resource management, disaster risk reduction and climate change, circular economy (reduce, reuse and recycle), as well as conservation and sustainable use of quantic fishery resources.

Japan and Mekong countries have been working closely with the aims of (i) enhancing hard, soft and industry connectivity; (ii) realising smart cities as guided by the framework of ASEAN Smart Cities Network; and (iii) promoting trade and investment relations. The countries in the Mekong have welcomed the steady progress in implementing key infrastructure projects to boost connectivity as well as encourage power trade and integration in the subregion. As far as energy cooperation is concerned, Japan has been implementing several initiatives in the subregion, including a project in Thailand to facilitate cross-border electricity flow and power exchange; a project in Myanmar to increase energy transmission capacity and improve system reliability; a project in the Cambodian capital city of Phnom Penh to expand transmission lines and build substations; and a project in the Lao PDR to assist a sustainable development of the power sector through a series of technical cooperation (GMS 2020).

From Lower Mekong Initiative to Mekong-US Partnership

The Mekong region is strategically important to the United States. The region is one of the most important theatres of the US's Indo-Pacific Strategy and an integral part of its engagement policy with ASEAN. As such, the US has increasingly promoted its presence and support for regional development and connectivity. In 2009, the United States proposed the establishment of a multinational partnership of the Lower Mekong Initiative (LMI) with an aim to engage with the regional countries such as Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. Principally, LMI was initiated to bring about equitable, sustainable, and inclusive growth to this region. The initiative has brought all member states to deal with their development challenges by implementing capacity building projects, involving in various development programs, establishing close cooperation with the Lower Mekong countries' governments, and sharing responsibilities for the most pressing cross-border challenges. The US has been working closely with the Lower Mekong countries and international donors to identify solutions for the critical challenges, such as water security, and


Source: unsplash

to support the political and economic integration of Mekong countries.
Economic growth in the region is driving the need for dramatic increases in energy production in the Lower Mekong region, most of which is based on conventional energy sources: coal, natural gas, fuels and large-scale hydropower. Their negative impacts are far-reaching, both for global greenhouse gas emissions as well as for regional eco-systems, human health, fisheries and livelihoods in the Mekong basin. While the Lower Mekong countries expect to triple their renewable energy capacity in solar, wind and biomass in the next 10 years, they are starting from a low baseline of only 3,500 megawatts. Therefore, an increased capacity would still only account for a small percentage (less than 10%) of installed capacity (USAID 2015).

Energy security, energy access and energy supply and demand have been the most critical energy issues facing the Mekong region. Experts have identified the potential for regional integration, availability of renewable energy technologies, and availability of financial mechanisms as some of the greatest opportunities for the region. Conversely, experts considered fragmented policy, coordination across ministries, lack of an independent regulatory body and the lack of integrated and transparent planning to be the most significant barriers (Ibid).


Source: unsplash

Building on the success of the Lower Mekong Initiative, Mekong countries and the United States launched the Mekong-US Partnership to expand the scope of cooperation, deepen the strategic engagement and promote synergy with other regional and subregional initiatives. The Mekong-US Partnership was officially launched on September 11th, 2020 at the very first virtual Ministerial Meeting under the Co-Chairmanship of Vietnam and the US. The Partnership will continue the existing work and expand the areas of cooperation, including economic connectivity, energy security, human capital development, transboundary water and natural resources management, and non-traditional security. In fact, the Mekong-US Partnership will continue to strengthen water security by pledging US$55 million in planned new investments to help the Mekong partners.

It will also increase support for energy security and electricity sector development through Asia EDGE (Enhancing Development and Growth through Energy). Along with the Japan-US-Mekong Power Partnership (JUMPP) and the Japan-US Strategic Energy Partnership (JUSEP), the Mekong-US Partnership provides technical and advisory support to strengthen national and regional power market development and to respond to the development priorities of the Mekong governments. The US's involvement is expected to promote high-quality and transparent power sector investment and capacity building to expand regional electricity trade, which will align with ACMECS and ASEAN Power Grid Initiatives.

Mekong-ROK Cooperation

South Korea started engaging in the Mekong region in 2011. The Foreign Ministers from South Korea and Mekong countries adopted the Mekong-Korea Comprehensive Partnership for Mutual Prosperity with an emphasis on connectivity, sustainable development, and people-oriented development.

Engaging the Mekong region constitutes a part of ROK's regional diplomacy. ROK and other actors such as the US have long recognised the Mekong subregion as being strategically significant. Efforts have already been underway to achieve that end since President Moon took office, with the holding of an inaugural Mekong-Korea Summit in late November 2019. During his visit to Vientiane in 2019, President Moon expressed that he hoped ROK would prosper together with countries along the Mekong Delta and that he wished to see a "Miracle on the Mekong River" to happen in a similar way to the "Miracle on the Han River" in South Korea.

The Moon Administration recognised that the Mekong remains an important region to engage as part of ROK's wider approach to Southeast Asia. South

Korean officials also understand that the operating environment has also become more contested over the past few years due to a confluence of developments, including China's rising influence and governance challenges in some mainland Southeast Asian countries.

In this connection, South Korea has developed its own initiatives to support Mekong countries to enhance their socio-economy, narrow the regional development gap and deepen their regional integration and connectivity. The initiative of the Mekong-ROK Cooperation was proposed by the Republic of Korea at the ASEAN-ROK Summit held in Hanoi in October 2010. Following this, the Mekong-ROK Foreign Ministers' Meeting was established. The objectives of the initiatives were to strengthen the political and economic relations between the members, deepen the ASEAN and ROK Strategic Partnership, promote sustainable development of the Mekong region, narrow the development gap within ASEAN, and accelerate ASEAN integration and Community building by 2025. People, prosperity and peace have been the three key pillars under this cooperation (Chheang 2019).

ROK-Mekong areas of cooperation include culture and tourism, human resource development, agriculture and rural development, infrastructure, information and communication technology (ICT), as well as environment and non-traditional security challenges. Two key concepts "co-prosperity" and "sustainable prosperity" are emphasised. These reflect the commitment by ROK to promoting a fair, inclusive, sustainable and people-centred regional community building.

In the era of digitalisation and digital connectivity, ROK and Mekong countries are compelled to double their efforts in preparing their human capital and developing their critical infrastructure to reap the benefits from the Fourth Industrial Revolution. The South Korea-Mekong Water Resources Research Centre will be created under Seoul's state-run K-water to promote safe and efficient use of the rich resources of the mighty Mekong River, which is facing mounting ecological stress, mainly because of climate change and hydropower dams. The water in the Mekong River has fallen to a critical low level and the livelihoods of the local people are seriously affected. In this case, knowledge and technology transfer, especially the experiences from managing the Han River from South Korea, are valuable for Mekong countries to manage the Mekong river in a more transparent, sustainable and inclusive manner.

To promote energy cooperation and other areas of development cooperation, ROK initiated the ASEAN-ROK Cooperation Fund in 1990. The Fund has been operated with an annual budget of USD7 million and reached USD103 million as of December 2018 (Ministry of Foreign Affairs of the ROK 2020). The ASEAN-ROK cooperation Fund has been recognised to have substantially bolstered cooperation ties between Mekong countries and the ROK as well as to have narrowed the development divide among and within ASEAN member countries, thereby helping accelerate the integration of ASEAN and forge an ASEAN Community.

Mekong-Ganga Cooperation

The Mekong-Ganga Cooperation (MGC), launched in Vientiane on 28th July 2000, is one of the multidimensional cooperation platforms in the Mekong region. It aims to foster relations between India and Mekong countries, except China, in the fields of culture, tourism, education, transport and communications. India's intention to establish the MGC was primarily to support its Look East Policy (LEP), rolled out in 1991, in expanding relations with Southeast Asian countries. Due to the lack of efficacy of its LEP, in 2014 India replaced the LEP with the so-called Act East Policy in order to better engage with Southeast Asia, and the MGC is policy framework to specifically engage with the Mekong region.

The MGC was first introduced in 2000 at the


Source: Mekong River Commission

Cambodia-India-Lao-Myanmar-Thailand Foreign Ministers' Meeting with a vision of developing closer relations and better mutual understanding among member countries in line with India's Look East Connectivity. In fact, India has traditionally considered South Asia as its utmost strategic and economic sphere of influence and Southeast Asia as its buffer zone with China. Therefore, New Delhi has made significant efforts to gain its foothold in Southeast Asia in a bid to at least to contain the spread of the Chinese influence into South Asia. By promoting some economic links with Southeast Asia, especially the Mekong, India expects to achieve its goal of containing China's economic influence. While China mainly focuses on investing in building hard infrastructure facilities such as hydropower dams and logistics, India plays a role in promoting other key areas of socio-economic development, which include cultures, tourism and education sectors.

From 2007 to 2011, India's internal socio-economic strife and the dispute with its neighbour, Pakistan, brought the MGC to a halt for almost five years. In 2012, the return of the MGC came with a new working mechanism called India-CLMV Quick Impact Projects (QIP). QIP mainly prioritises small-and-medium grassroots development projects in Mekong countries. However, the actual implementation funds only came 2 years later. QIP can be classified as the most successful implementing mechanism in the MGC. Even though the amount of the contributing fund (which is around US$1 million) is not quite significant for the five Mekong countries, the project implementation is quite acceptable and responsive to the needs of the population at the grassroots level.

Additionally, at the 7th MGC Ministerial Meeting in Vientiane on 24 July 2016, new areas of cooperation were added to the Work Programme such as SMEs, Rice Germplasm, health and pandemics, Nalanda University Archival Resource Centre and Quick Impact Projects. India's MGC is expected to serve as a complementary tool to other regional initiatives. At the 9th MGC Ministerial Meeting on 2nd August 2018, India expressed its strong commitment and willingness to establishing Digital Villages in Mekong countries, which is part of India's efforts in promoting digital connectivity. India is one of the world's leading digital communities, putting this country's position on par with China, Japan and the US in the Mekong region.

With an aim of supporting the implementation of the Master Plan on the ASEAN Connectivity 2025, India is also working towards the conclusion of the Agreements on Maritime Transport between ASEAN and India, and the Regional Air Services Arrangements. The new MGC Plan of Action 2019–2022 works to advocate the advancement of ASEAN-India Strategic Partnership in the Indo-Pacific in the areas of maritime cooperation, connectivity and sustainable development. At the 10th MGC Ministerial Meeting in 2019, India announced a new Line of Credit (LOC) of US$1 billion to promote projects that support physical and digital connectivity between India and ASEAN to and set up a centre for software development and training (CESDT) in Mekong countries.

Mekong-Japan-US Power Partnership: A New Momentum for Energy Cooperation

Apparently, external powers have paid increasing attention to energy security in the Mekong region. At the sideline of the ASEAN Ministerial Meeting in Bangkok in August 2019, the US and Japan initiated the Japan-US-Mekong Power Partnership (JUMPP) with the objectives of improving economic growth, enhancing institutional and regulatory frameworks, strengthening energy sector governance, and helping unlock private investment in the power sector in the Mekong region.

The United States and Japan have declared their intention to expand capacity building for countries in the Mekong region to strengthen energy sector governance, help unlock private investment in Mekong power sectors, and grow cross-border energy trade. The Department of State's Power Sector Program has provided over 1,000 hours of training to countries in the Mekong region. Their assistance has helped Mekong countries increase their use of renewable energy, promote cross-border electricity trade, improve tariff methodologies, and consider energy efficiency as norms and standards. This assistance has also helped Vietnam establish competitive power markets and improve system operation. It also advised Thailand's electric utility on establishing an energy trading company and on preparing for third-party access to transmission.

In the eyes of Japanese strategists, the Mekong region is a key geostrategic contesting ground that Japan must deeply and comprehensively engage with. Therefore, Japan will continue to work on its competitive advantages and strength, which include technological know-how and people-to-people ties. Moreover, the United States and Japan affirm the importance of helping Mekong countries secure their energy supplies and their shared commitment to providing technical assistance, capacity building, and other types of cooperation for a free and energy secure Mekong region.

The United States and Japan value transparency, free and fair competition, and the unfettered flow of energy supplies in the Indo-Pacific region which is vital to the stability and development of the region. Henceforth, the United States and Japan have pledged to partner with Mekong countries to maintain and promote a more sustainable energy sector and quality energy infrastructure development that meets the needs of the people of the Mekong, in accordance with the "G20 Principles for Quality Infrastructure Investment." Energy demand in the Mekong countries is projected to increase by 6 to 7 per cent per year. The Partnership will help Mekong countries meet their demand for secure, affordable, and reliable electricity while enhancing regional power trade and integration (US Department of State 2020).

The United States announced its intention to provide an initial US$29.5 million under the Asia Enhancing Development and Growth through Energy Initiative (Asia EDGE) to support Mekong countries' pursuit of energy security and their citizens' reliable access to electricity. The US needs Japan to push forwards this initiative for the obvious reason that the latter's economic and political presence in the region is prevailing. Japan's commitment to the development of the Mekong is generally driven by its economic motives and geopolitical agenda by introducing bold and proactive steps through bilateral channels and the Mekong-Japan Cooperation. The leaders of Mekong countries welcomed these initiatives and believed that they would strongly contribute to advancing connectivity and sustainable development in the Mekong region and beyond.

As for the JUMPP, Japan has expressed its intention to work in a complementary manner. Through this partnership, the US and Japan will work with ASEAN, the ADB, the World Bank, UNESCAP, UNDP and other partners to support Mekong energy security, regional integration, while promoting the newly endorsed "G20 Principles for Quality Infrastructure Investment". The Partnership supports the goals of the Japan-US Strategic Energy Partnership (JUSEP), Asia EDGE, and the "Tokyo Strategy 2018". The Partnership also contributes to the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS), particularly the ACMECS Master Plan (2019–2023) Energy Infrastructure and Connectivity's goals. It also supports the Master Plan on ASEAN Connectivity 2025 goal of prioritising energy infrastructure and ASEAN electricity market integration and governance to solidify the foundation for continued economic growth in the region. Additionally, the partnership supports the ASEAN Power Grid initiative and its associated implementing parties, including the Heads of ASEAN Power Utilities/Authorities (HAPUA), to strengthen regional energy security through interconnection development and market integration.

Conclusion

As a new growth centre, the Mekong region has attracted much attention from many regional and global powers. The countries in the region welcome the enhanced engagements with the external partners which have hugely contributed to the promotion of regional integration and connectivity. China, Japan, the US, the ROK and India are key actors who have respectively initiated cooperation frameworks with Mekong countries to address the common challenges and to further foster connectivity and sustainable development.

Energy cooperation, which is vital to the stability and development of the Mekong region, has become one of the main themes in regional cooperation. Countries such as the US and Japan have worked actively to ensure a free and energy secure Mekong region by maintaining and promoting a more sustainable energy sector and quality energy infrastructure development to meet the needs of the people of the region. Other countries including China, the ROK and India have also initiated their own frameworks to support Mekong countries' pursuit for energy security and their citizens' needs for a reliable access to electricity.

While the diverse engagements with the external powers are generally welcomed by the riparian countries, it should be noted that they would also lead to increasing competition between major powers. The Mekong region would become a geopolitical battleground in which subregional cooperation would be securitised and politicised for geopolitical reasons. These could jeopardise peace, stability and sustainable development of the Mekong region.

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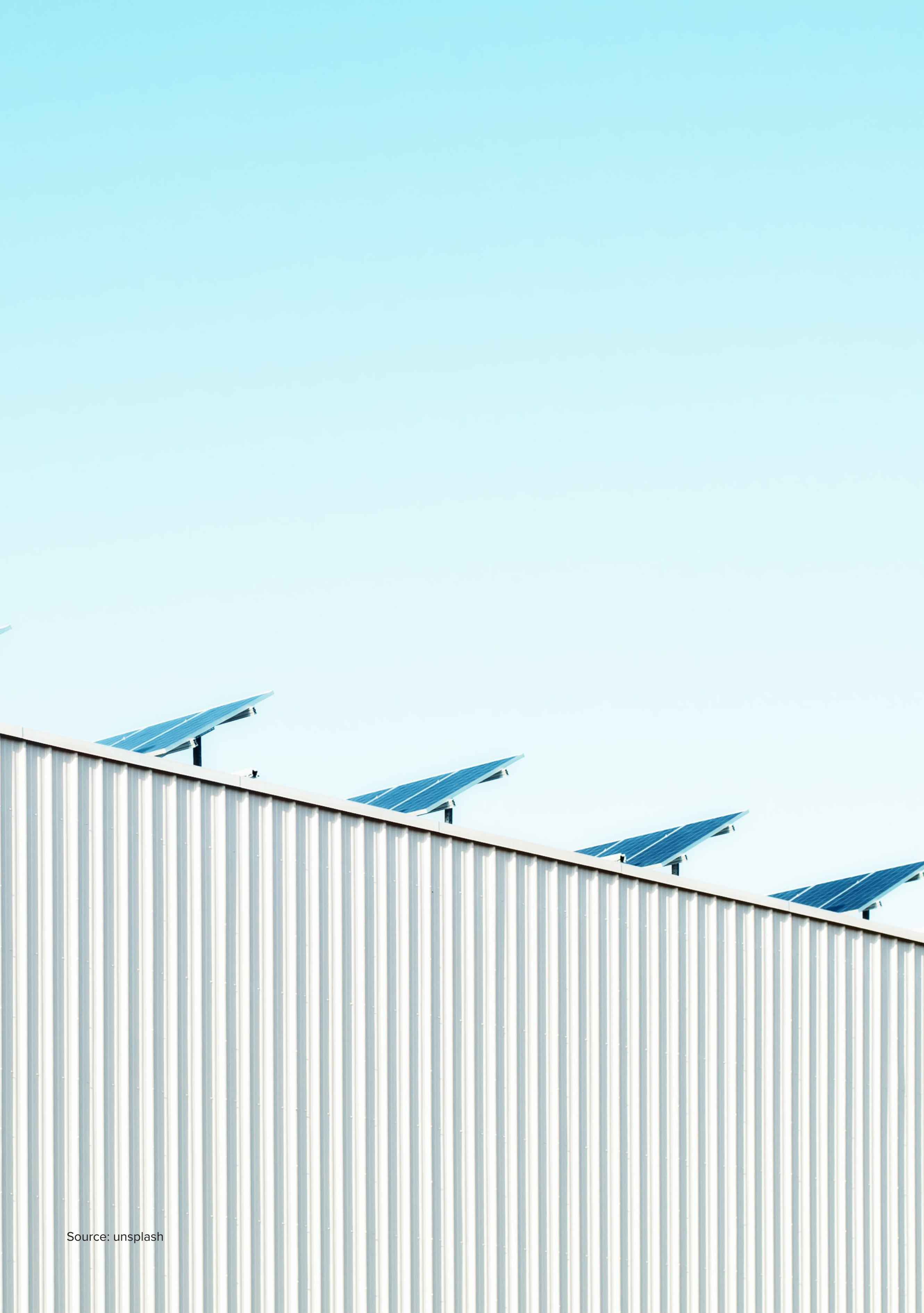

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9

Proposal for Renewable Energy Cooperation and Investment in Greater Mekong Subregion

Dynta Trishana Munardy

Introduction

All efforts to enhance the development and deployment of renewable energy should start by asking the pertinent question: Why should we consider and start a transition to this low-carbon energy source? This fundamental question might expose many imperatives that every individual should be acquainted with in order to gauge the urgency level of transitioning to renewable and low-carbon energy system. Everyone should realise that a consistent increase in the global population and the gradual progress of the industrial revolution have been impacting the world's market and economic growth. Prior to the COVID-19 pandemic, the energy demand was on a rising trend as a result of the growing global economy, which led to the concern of energy resource depletion and energy insecurity, considering the wide use of fossil fuel as the main source of energy.

Despite the drastic drop in the global energy demand in early 2020 resulted from the lockdown and travel restriction measures due to the COVID-19 pandemic, the global economy is expected to return at a swift pace. According to IEA's world energy outlook, with a scenario in which the detailed measures are applied to bring the pandemic under control, the global economy can rebound to pre-pandemic level as early as 2021 (IEA 2020). Moreover, the pandemic has exposed the vulnerability of current carbon-intensive conventional energy systems. The energy demand has plummeted to the levels which have not seen in around 70 years, which brought the fossil fuel-generated energy to breaking point, where the crude oil price has been recorded to reach its lowest point and global oil and coal demand has been expected to drop by 9% and 8% respectively in 2020.

Besides, the world is facing dire environmental and social challenges resulted from the loss of biodiversity, an increase in a number of diseases and human exposure to toxic substances. Conventional energy resources are shrinking while global greenhouse gas emissions are rising, negatively affecting climate change. According to the Intergovernmental Panel on Climate Change (IPCC), global carbon emissions from fossil fuels have significantly increased since

Source: Mekong River Commission for Sustainable Development

1900 and CO2 emissions have gradually increased by about 90% since 1970, with approximately 78% of the total greenhouse gas emissions coming from fossil fuel combustion and industrial activities (IPCC 2014).

Therefore, considering those imperatives, the establishment of cleaner, more sustainable and resilient energy system should be considered an urgent need and should be accelerated amidst the current dynamic changes. When people start to realise, witness or even experience the devastating impacts of fossil fuels and inefficient use of energy, they will also begin to think about their contributions to the energy transition and to create a more resilient energy system based on their individual capacity and circumstances. Here is the point where an effective and ideal multi-stakeholder collaboration can be established among policymakers or public institutions, the private sector, investors, non-government and research institutions. The next step is to think about how to increase the development and deployment of renewable energy. To do that, it is important to initially identify the potential resources and opportunities and to analyse the challenges of renewable energy that might hinder its application. Since the imperative of growing energy demand is to support economic growth, it is crucial to ensure that renewable energy application will not hurt the economy. Thus, a comprehensive assessment of its economic viability is essential.

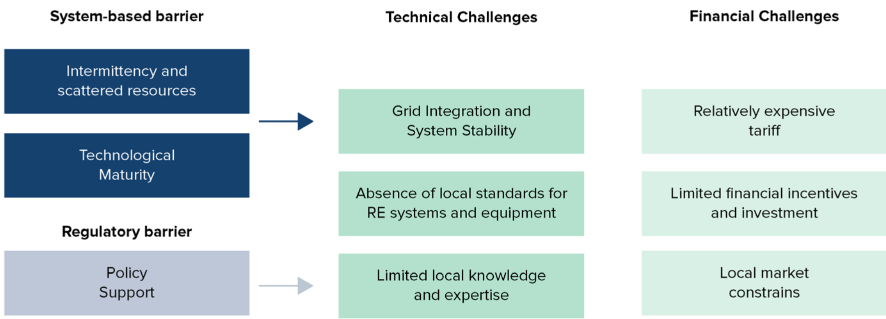
This chapter proposes some recommendations to strengthen the renewable energy initiatives specific to the Greater Mekong Subregion (GMS). The technical and financial challenges of renewable energy development both at the national and regional level are identified and used as the basis for the proposed measures and recommendations.

Identifying Challenges of Renewable Energy Development in GMS

Despite their different levels and stages of economic development, Cambodia, Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Vietnam are sharing common goals which are to increase the electrification rate and to ensure the countries' energy security and sustainability. The Greater Mekong Subregion has remarkable renewable energy potential ranges, including hydro, solar, wind, biogas, and biofuel. However, the renewable energy potentials have not yet been explored effectively, as the region is still highly dependent on large hydropower and fossil fuels. Most of GMS countries' power is being generated from gas and coal power plants. The relatively low utilisation of a renewable energy system is resulted from various technical and financial challenges faced by the GMS countries. These challenges have also been faced by multiple stakeholders, not only the government or public sector but also by the private sector.

In general, several country-specific barriers often hindering the deployment of renewable energy can be broadly classified as regulatory and policy framework, institutional, market, financial, and infrastructure, including limited knowledge and expertise on renewable energy technologies and their management, public acceptance and environmental issues (Müller, Brown and Ölz 2011). As shown in Figure 1, some of the notable technical and financial challenges in the development of renewable energy in the GMS are predominantly derived from the limitation of its system and inadequate regulatory framework. Most common system-based barriers are related to the distinctive characteristics of renewable energy sources which highly depend on the geographical location of a certain country and the maturity of its technology. Considering the relatively high dependency on fossil fuels and conventional energy systems and the uncertainty in the policy framework, the readiness of some renewable energy technologies in GMS countries are still considered lagging. Thus, the maturity of renewable energy technologies should be enhanced to make it more commercially competitive. Those challenges are interconnected and systematic, so structured measures are necessary to guarantee progressive results in tapping the opportunities of renewable energy development.

Figure 1. Notable technical and financial challenges of RE development in GMS



One of the distinctive characteristics of renewable energy sources is the fluctuation in their energy supply, particularly for variable renewable energy (VRE) such as solar and wind systems. Consequently, it creates difficulties in terms of grid integration and requires an advanced system improvement to the conventional grid system to balance the power supply and demand.

Although all the five countries of GMS have a relatively sufficient amount of solar irradiation with the cumulative potential solar energy estimated at around 80,000-megawatt peak (MWp), the electrical grid in most GMS countries is not extensive, which has caused hesitancy in the utilisation of the large-scale solar system. Therefore, the solar PV system in GMS countries is more feasible for off-grid or local applications. However, the economic viability of the off-grid system is distinctly unique compared to the grid system, which can vary not only between countries but also within smaller areas such as local villages. Meanwhile, the energy storage technology to back up the power supply from VRE electricity generation is still considered expensive and requires high capital investment.

Other notable challenges are related to the inadequate policy framework to support the deployment of renewable energy. Renewable energy technologies are relatively new to the market in GMS countries. This results in an absence of local standards for renewable energy equipment and systems which eventually lead to the local market constraints and higher tariff, and it is also aggravated by the lack of local technical knowledge and expertise. In order to create a more enabling environment for renewable energy investment, the fundamental policy framework is necessary to be in place. In regard to tapping more foreign investment, some good progress have been made. GMS countries have been starting to transform their markets to be more open and diversified, which include the renewable energy target in each country's national energy and power development plan as shown in Table 1 below.

Table 1. RE target and supporting policy in GMS countries

Country	Renewable Energy Target and Supporting Policy
Cambodia	Full electrification of villages by 2020, and 70% household electrification by 2030.
Lao PDR	30% of RE share in total energy consumptions by 2025: • 20% renewable electricity share (exclude large hydro) • 10% biofuel share (blending ratio 5-10%)
Myanmar	12% of RE share in national energy mix (generation) by 2030 (exclude large hydro)
Thailand	30% of RE shares in national energy consumption by 2037: • Renewable electricity share: 15-20% in TFEC by 2036 • Renewable heat share: 30-35% in TFEC by 2036 • Biofuel share: 20-25% in TFEC by 2036
Vietnam	• 32.3% of RE share in TPES by 2030 and 44% by 2050 • 32% of RE share in power generation by 2030 and 43% by 2050

Source: ASEAN Energy Database

Regional energy collaboration within GMS countries has been initiated to fill the gap in the national renewable energy development. For instance, through the GMS programme of the Asian Development Bank (ADB), a project was initiated aiming to assist the GMS countries in preparing the multi-sector regional investment framework and associated programmes in order to attract more investment to the region (ADB 2013). A remarkable progress has been recorded through the GMS project. However, most of the achievements have been reached mainly at the national level. There are potential regional initiatives in many sectors for the GMS countries such as the energy sector, which can complement national and global actions. Regional cooperation can support each country in addressing some of the national energy challenges and contribute to global energy development. Since the global energy policy trends are now more focused on enhancing energy security and reducing the energy sector-related emissions towards sustainable development goals, the regional approaches can play a strategic and important role, especially in achieving energy supply diversification through interconnected energy infrastructure and a flexible flexible market. Moreover, advanced regional cooperation can assist countries in reducing knowledge and financial gaps.

Renewable Energy Investment in GMS

In the last decade, investment in renewable energy technologies and infrastructures has been showing a progressive growth, particularly since the movement to reduce climate change impact associated with the energy sector has been accelerated globally. This investment trend has also expanded the renewable energy technology market, reduced production cost, and improved technology performance. However, the maturity of renewable energy technologies varies depending on geographical location, available resources, and other technical factors, which makes the competitiveness of one technology, relative to conventional energy, different from another. Ideally, the one that is considered to be deployed first is the technology that has been closed to becoming commercial.

Besides setting national renewable energy targets and their supporting programmes, governments should also explore the incentives and flexible market frameworks that can attract more renewable energy investment. During the COVID-19 pandemic, although some renewable energy projects in GMS countries have been halted as a result of supply chain disruptions, the renewable energy option has shown more potential benefits than carbon-based energy system. According to the World Economic Forum (2020), there are three key factors increasing renewable energy development during the pandemic. First, appropriate regulatory framework and policy have been in placed to support the deployment of renewable energy which in some countries is prioritised through market regulation. Second, the improvement in renewable energy technologies have been proven and expected to be an ongoing process. Renewable energy has become the cheapest source of energy in some places, and it is expected that this trend will be followed by other places in the near future. Lastly, renewable energy has attracted investors as a choice for new power plants even for the post-pandemic recovery plan.

Proposal for Enhancing Renewable Energy Development in GMS

The level of economic growth, the amount of available renewable energy resources, diverse policy frameworks, and different priorities are some examples of country-specific variables that differentiate the level of renewable energy development among the GMS countries. Despite that, those variables are balanced out by the similarity and solidarity shared by all the five countries. Most importantly all the five countries of GMS possess reasonably similar critical issues on energy sector that need to be addressed urgently. The issues are energy security and energy access.

Identifying barriers and opportunities of renewable energy are a crucial initial step for the GMS countries to develop their national and regional sustainable energy plans. The interrelated energy challenges faced by the GMS countries require a systemic and thorough approach to be able to solve them. Since the most fundamental renewable energy challenges in the GMS lie against the uncertainty and inadequate policy framework and maturity level of some potential renewable energy technologies, the most appropriate priority actions for the GMS is first to develop a more supportive policy framework which is complemented by appetising incentives to attract more private-sector involvement and investment. The second is to ensure collaborations among key stakeholders in the energy sector such as the public sector or policymakers, energy producers, electricity entities, private sector, investors, and energy consumers. And lastly, the GMS countries need to enhance the expertise of institutions through capacity building and knowledge sharing, as well as to improve the research and development of renewable energy technology particularly at the local level. The priority actions need to be implemented simultaneously to ensure the effectiveness of each measure.

Figure 2. Proposal of priority actions to enhance renewable energy development in GMS

Roll out a supportive policy framework and appropriate incentives attractive for the private-sector involvement and investment	Ensure active collaborations among stakeholders and integrate the targets at national and regional level	Build and strengthen institutional capacities and capabilities in renewable energy systems and expand technological improvement

Roll out a supportive policy framework and appropriate incentives attractive for the private-sector involvement and investment

As mentioned earlier that realising the imperatives and urgency in the development of renewable energy is fundamental and should be ingrained in every individual's mindset. Thus, every key stakeholder in the energy sector needs to realise the importance of this development agenda, particularly in disclosing the veracious value of renewable energy in terms of its environmental and social sustainability and economic viability. The role of a national government is indeed crucial, as it is expected to be able to create the main foundation to support the deployment of the technology including designing an enabling environment for the private-sector involvement and investment. A supportive policy framework is also key in addressing some of the challenges in terms of local market constraints. The renewable energy technology in the GMS countries is relatively underdeveloped and still considered new compared to the conventional or fossil fuel-based energy system. Therefore, investment plays an essential role to cover some of the financial requirements to increase competitiveness and scale up renewable energy within the GMS. Policymakers can ensure the provision of facilities to scale up renewable energy investment which includes financing facilities to provide risk mitigation instruments, cover transaction fees, and design the structure of finance mechanisms. The sources of funding dedicated to clean and low carbon projects such as the green climate fund can be explored to provide useful resources for financing renewable energy projects in the GMS. Some actions in transforming the local market to be more attractive to investors should be considered by the policymakers.

First, the local market needs to be reformed. It is necessary to ensure that the local financial institutions are familiar with the financing scheme specifically to renewable energy projects and are able to provide such lending services to accelerate the project implementation. The contribution of policymakers is required in this process. Policymakers should engage and work closely with national or local financial institutions to help the institutions to build their capabilities and increase confidence in terms of renewable energy or clean energy financing. Second, the national market should be redesigned to maximise the mobility of capital investment. Policymakers together with electricity entities can standardise all the procedures such as procurement, tender, contracting and due diligence processes of renewable energy projects. Standardised procedures related to capital investment can include risks management as well. Mitigating risks is crucial and its instruments can attract more private investment. The financial instruments such as the fixed-income green bond could also be explored to enable more climate-friendly projects.

The GMS countries can also look for the opportunities coming from the regional ASEAN Green Bond Standards initiatives under the ASEAN Capital Markets Forum (ACMF) which facilitates the region's capital markets in tapping green finance


Source: unsplash

and meeting investors' interest in green investments. The ASEAN Green Bond Standards is also based on the green bond framework of the International Capital Market Association (ICMA), which has been internationally accepted and used widely for the development of national green bond guidelines or standards globally. These efforts are important to increase the commercial maturity of renewable energy technologies and projects in the GMS. The policy framework needs to be complemented by the incentives or supporting mechanisms such as feed-in tariffs and green certificates. The government's supports of institutional capacity building, facilitation for project developers and regulatory frameworks are key drivers to enable more private-involvement and investment in renewable energy development.

Ensure active collaborations among stakeholders and integrate the targets at national and regional level

Regional cooperation in the GMS is still considered lagging and it is mostly because of limited shared targets and different objectives of each national energy development. Multi-stakeholder's collaboration is one of the keys in the success of renewable energy development, which includes the contributions from the government, public and private sectors, and investors. Identifying the renewable energy development targets or any renewable energy supporting policy target is important for depicting national's interest and commitments, as this might be one of the vital considerations for investors. To accelerate the development of renewable energy and fill its technical and financial gaps, regional cooperation among the GMS countries needs to be strengthened. Besides the global scale mandate such as The Paris Agreement on climate change that urges each country to develop its nationally determined contributions (NDC) to the cleaner energy system, ASEAN also has set its aspiration targets of energy intensity reduction and renewable energy under the framework of ASEAN Plan of Action for Energy Cooperation (APAEC). Under the APAEC 2016–2025, ASEAN aims to achieve a 23% share of RE in the energy mix, including increasing the RE installed power capacity by 35% by 2025. Hence, aligning each country's target with a regional target can help the country to go beyond the national objectives. The GMS countries should also consider developing strategic subregional activities that can be aligned with the action plans for the clean energy development of ASEAN.

One of the examples is to integrate renewable energy power generation into the regional grid and strengthen the regional cooperation towards market integration. Renewable energy resources in the GMS countries are scattered across the region. Connecting the gap between energy supply and demand through the efficient utilisation of additional energy resources will make electricity more affordable. This can also make energy supply and demand in the subregion more secure. Regional power trade can benefit the countries in many ways, including reducing national investments in the power reserves and operational costs, providing a more reliable supply of electricity and mitigating power outages while increasing the flexibility for energy consumers to access the subregion's lowest cost and most sustainable source of electricity. In order to achieve higher opportunities from the subregional power trade, the GMS countries must harmonise the grid systems to allow the interconnection of power trade. According to a study conducted by the Asian Development Bank, the GMS countries have prepared a roadmap with phased development stages, which involve both infrastructure development and institutional building activities (ADB 2016). However, to date there is still low progress in the project-specific power purchase agreements in the GMS. To allow the renewable energy grid integration, the GMS should also target more investment in a smart grid system. Considering technological improvement and declining system cost of variable renewable energy such as solar PV and wind power, the smart grid option is also required to complement those technologies, as it can incorporate energy storage technologies storing solar and wind power for back up supply.

Build and strengthen institutional capacities and capabilities in renewable energy systems and expand technological improvement

Efforts in enhancing the policy and regulatory framework should be supported by the efforts in improving technical expertise and knowledge of several key stakeholders that have a significant role in the overall development of renewable energy. Appropriate knowledge and technical assistance are required to ensure the successful planning and implementation of renewable energy projects. The involvement of local institutions can foster the deployment of renewable energy in the sense that it can disclose more value of the renewable energy that can benefit wider stakeholders. The areas needed to improve might be depending on each country's priority, on what is lacking in each national system. As an example, in Lao PDR, although wind energy has a strong potential in terms of adequate windspeed in some areas, the actual project and practices are still limited since Lao PDR experiences limited technical assistance to advance the national grid system. The renewable energy development in the GMS countries, except for Thailand, are still considered underdeveloped or have not yet effectively explored.

Renewable energy is expected to increase rapidly in the near future due to its inevitable imperatives. It is also projected to be one of the vital energy sources that can replace conventional fossil-fuel energy. Therefore, to maintain a progressive and smooth transition, the gaps in technical knowledge need to be addressed as early as possible. Best practices and knowledge sharing among the GMS countries and even among ASEAN countries will help the subregion to accelerate renewable energy development. The information and knowledge regarding the importance of renewable energy development need to be shared broadly, not limited to only specific stakeholders to ensure knowledge transfer to the public or energy consumers. Regional cooperation can assist the GMS countries in identifying the most suitable and effective supporting instrument to support renewable energy projects towards the realisation of sustainable development and low carbon energy transformation.

Extensive technological improvement and investment will further lower the cost of solar and wind energy, which is still relatively high within the GMS countries. Knowledge and technical expertise to transform the existing electrical grid are required so that the grid system can be more flexible for variable renewable energy integration. While other renewable energy sources such as bioenergy are relatively more mature than the variable renewable energy sources, a comprehensive and extensive assessment on its environmental sustainability and economic viability has to be undertaken, particularly in the issues of supply security, agriculture-energy or food-energy nexus. Decentralised renewable energy system is very feasible for the GMS countries, as the energy resources are scattered across the subregion. Therefore, it is also necessary for the countries to identify suitable financing concepts for the off-grid and small-scale decentralised renewable energy projects.

Areas of knowledge that should be explored among the GMS countries include the policy design for policymakers especially to assess the appropriate incentives and financial instruments allowing more investment; feasibility studies of potential renewable energy technologies matching the needs of national energy targets; technical knowledge on energy infrastructure including the capacity building for local project developers; emerging technologies such as smart grid and grid expansion strategies suitable with the GMS; and financial and risk mitigation strategies for local financial institutions.

Conclusion

Despite the complex systemic requirements needed for the GMS to accelerate the development and deployment of renewable energy, the opportunities and solutions are available for the subregion to increase the competitiveness of renewable energy. Renewable energy technologies offer a wide range of potential social, environmental and economic benefits to the GMS, particularly in addressing notable energy issues such as energy security, energy access and sustainability.

The improvement in renewable energy development should be promoted while fossil fuel subsidies need to be cut. The actual cost of renewable energy should also reflect its positive environmental and social values. Furthermore, to accelerate the energy transition, it is suggested that the GMS countries align the regional efforts in renewable energy development with global energy efficiency and conservation agenda.

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Source: unsplash

10

Consolidating Cambodia's Clean Energy Opportunity

Anna Cain

Introduction

Embracing clean energy is a credible and achievable pathway for Cambodia to fulfil its economic development aspirations. As the lowest-cost source of electricity, clean energy generation is key to lowering Cambodia's electricity costs and attracting and retaining global businesses. Clean energy business models are finding energy savings to improve business competitiveness, with investors and providers keen to serve this market. However, it will be at risk without supportive and enabling policies and regulations, as well as if clean energy is not treated as a credible part of Cambodia's electricity mix.

This chapter explores the dynamics of clean energy through examining industry case studies, which show opportunities to accelerate clean energy deployment and the accompanying economic developments.

Cambodia's Energy Context

Cambodia's economy is expanding rapidly. The Kingdom achieved lower-middle-income status in 2015 (The World Bank 2020) and sustained economic growth exceeding 7% annually between 2014 and 2019 (Hollweg 2020). Electricity sector development has followed a similar trajectory, with electricity supplied to customers through the national electricity grid increasing dramatically, sustaining annual demand growth between 14.78% and 27.09% in the same period (EAC 2019). Cambodia's national electricity grid is seen as a key economic enabler in meeting the growing demands from businesses for reliable and affordable electricity while ensuring household customers also have adequate access.

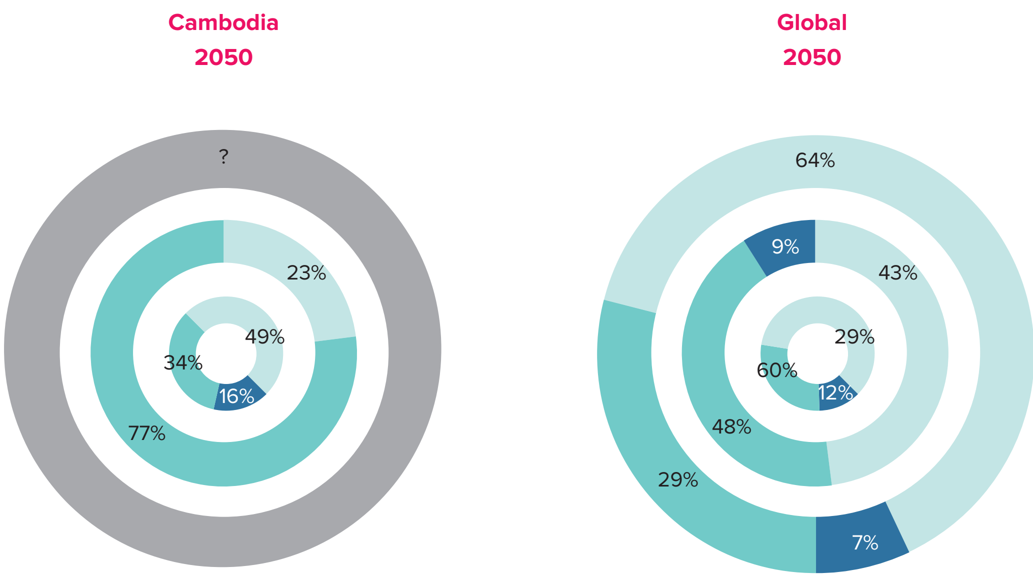
Clean energy is no longer a premium product. It has cemented itself as the affordable and reliable option that is available today, and countries with grids based on traditional generation such as Australia are redesigning their networks to ensure that clean energy can be integrated (de Atholia, Flannigan, and Lai 2020).

Source: Mekong River Commission for Sustainable Development

Cambodia has taken the first steps towards embracing clean energy. A 2018 regulation allows solar panels to be installed within commercial and industrial customer facilities (EAC 2018), and time of use tariffs and capacity tariffs have been introduced for industrial customers to encourage more efficient use of electricity and infrastructure (MME 2020). 410 MW of large-scale solar projects have been approved and will feed into Cambodia's grid by 2022 (Vannak 2019). Work is also being done by Cambodia's Ministry of Mines and Energy (MME), Electricity Authority of Cambodia (EAC) and Electricity du Cambodge (EdC) with Agence Française de Développement and Asian Development Bank (ADB) to modernise the grid (Monceaux 2019; ADB 2019). This will improve network monitoring and control and implement technology to forecast renewable energy output to improve its integration with other electricity generation sources.

Nevertheless, there is still more to be done to realise the economic opportunities that come with clean energy. Cambodia's forecast energy generation plan for 2030 does not appear to consider clean energy in a meaningful way, which is at odds with the global trend towards clean energy as seen in Figure 1.

Figure 1. Electricity mix trends –global and Cambodia



Source: EnergyLab 2020.

Cambodia is yet to announce a renewable energy target. It has low energy efficiency (it consumes the second most energy per GDP among ASEAN nations (UNDP 2020). And in response to electricity shortfalls in 2019, EdC has announced that by 2030 it will have sourced electricity from 9,335 MW of new fossil fuel power plants, including 2,400 MW of coal power imported from Laos, locking these technologies into the electricity mix for the next 30–40 years (EdC 2019).

In contrast, Vietnam, Thailand, Indonesia and the

Philippines have official renewable energy targets. They are prioritising energy efficiency and are restructuring their electricity sectors to maximise lower-cost renewable energy (Austrade 2020; Lexology 2020; IRENA 2017; Lagare 2020).

Clean energy is key to unlocking economic growth

Globally, clean and renewable electricity is increasingly a prerequisite for businesses when deciding where to locate their facilities. This is true for 1,315 companies, with a combined market capitalisation of US$24.8 trillion, which have made public commitments to sustainability (WMB 2020). They include major brands sourcing from Cambodia's key existing and emerging economic sectors, including garment, footwear, food and beverage, electronics, automotive, medicine, cosmetics, food production and retailing. Therefore, Cambodia's current electricity mix is ideal for attracting and retaining these brands (and their accompanying jobs). However, as Cambodia has signalled a move towards 80% fossil fuel electricity, this economic opportunity is at risk, as outlined in this H&M Group case study.

Case study: Decarbonisation a necessity for the garment sector

Peter Ford, Environmental Sustainability for H&M Group Cambodia and Vietnam

H&M Group has a strong presence in Mekong countries, sourcing clothing, footwear, accessories and home goods from Vietnam, Myanmar, and Cambodia, the latter from which we have sourced for over 15 years. In that time, we have built close relationships with suppliers and stakeholders and have actively sought to drive the sector to be more competitive, more efficient, more supportive of its workforce, more long term in its planning, and more responsive to global sustainability and best business practice.

Part of this work involves making sure that H&M Group's global sustainability commitments are achieved in Cambodia, which includes:

- RE100 -- to source 100% Renewable Electricity by 2030
- SBTi -- to limit global warming to less than 2 degrees Celsius, and ideally less than 1.5 degrees
- H&M Group -- carbon neutral across our supply chain by 2030, and carbon positive across the whole value chain by 2040
- H&M Group -- 100% certified sustainable, recycled or organic materials in all products by 2030, having already achieved this for cotton in 2020.

Renewable energy is proven to be cost-effective and reliable, requires less capital investment, and comes with far less risk to fuel security – 6 hours of sunlight reliably delivers itself in Cambodia each day for free! A desire for the world to learn and grow from the lessons learnt from this pandemic and not resort to the old normal means that long-term vision must follow the disruptions to global supply chains, changing consumer spending habits, and the increased focus on environmental protection.

This is why H&M Group's focus on environmental sustainability is a central factor in our business. It reflects the evolving demands of consumers globally for cleaner and greener products and will continue to have an important impact on future sourcing decisions for many companies.

For example, to reach our 2030 target to be carbon neutral will require investment in energy efficiency (to reduce consumption), installing rooftop solar (to reduce on-site GHG emissions), source more sustainable materials (to reduce global GHG emissions), and access to the greenest electricity supply available, in each country we source from. Only then will carbon credits be used to ensure carbon neutrality. Sourcing countries that continue to feature a fossil fuel-heavy energy grid, inadequately support rooftop solar and energy efficiency legislation etc. will see their sourcing value diminish compared to those countries already taking steps to address the climate emergency.

For Cambodia, improved government support for rooftop solar since February 2020 was an important first step in meeting the needs of industry, but renewable energy in the national grid must be equally supported, and projections for the Kingdom raise serious concerns – the shift from 40% fossil generation in 2019 to 80% by 2030. One solution being piloted in Vietnam is the USAID-supported DPPA project, that will de-risk private investment in solar projects feeding into the national grid while allowing certifiable renewable energy for factories. This is the first of its kind in the region and something that all governments should be scrambling to emulate to make their countries as attractive as possible.

Timid responses will not suffice in the post-covid19 world, and it should therefore be a priority for governments to prioritize renewable energy and energy efficiency as part of broader economic development actives. Consumers are demanding more sustainable products, and companies such as H&M Group are listening and acting.

Clean energy business as a Pathway to improving efficiency

Clean energy will be necessary if companies in Cambodia are to meet their sustainability targets. And it is these companies which are moving first and making demand for clean energy businesses and policies to be established in Cambodia. However, these drivers actually hide the primary value proposition of most clean energy business models – to overcome market failures by uncovering energy cost savings. Support for such business models means supporting Cambodia's economic efficiency and global competitiveness. These business models and how they might be supported are showcased in the following case studies. They relate to rooftop solar, energy-as-a-service and electric mobility.

Case study: Realising impact and opportunities for rooftop solar through policy

Thomas Jakobsen, Indochina Energy Partners

Indochina Energy Partners Pte. Ltd. (IEP) was established in 2017 in Singapore. We provide renewable energy installation, maintenance and financing solutions for commercial and industrial factory owners. IEP is the Southeast Asia representative office of Norsk Solar, a Norwegian developer of solar power plants, a subsidiary of the largest private developer of wind parks in Norway (NV Group). Norsk Solar has more than 850 MW of renewable energy projects commissioned.

Rooftop solar installations in the Commercial and Industrial sector (C&I) offer an excellent opportunity for adding power generating capacity with some features:

- Fast (a rooftop solar system can be commissioned within 3-5 months of agreements)
- Low/No expenditure for EdC
- Access to renewable energy for companies with international commitments
- High quality (if installed by credible companies) generator with 20+ year expected asset life to help meet growing electricity demands on the grid
- Mobilise private sector funding (reduce EdC expenditure)

Cambodian regulations on renewable energy are good for developing rooftop solar projects for three main reasons:

- The high (but still reasonable) electricity prices from EdC make rooftop solar competitive.
- The rules from 2020 are clear and fair on the economic consequences of installing rooftop solar for factories with only minor electricity demand in off-peak times.

- The rules link solar generation with electricity consumption.

This means that solar installation companies can assist government objectives of increasing clean energy and reducing electricity costs to customers in a way that is manageable by EdC.

Under the current regulations, the benefits of rooftop solar are limited to the system owners. However, a typical C&I customer does not operate on Sundays or public holidays providing the opportunity for unused solar power to be sold to EdC (we suggest a price of 6 – 7 US cents/kWh - very cheap compared to C&I electricity tariffs for consumption) and fed directly into the distribution network to power nearby load.

C&I customers paying upfront for solar installations incentivise low-cost, low-quality systems which may perform poorly and introduce a risk of electrical fires. We are able to finance C&I rooftop installations in the entire SE-Asian region. We would appreciate that the rules on equipment leasing and performance payments on delivery of power were simplified and clarified in Cambodia, thereby ensuring high quality, reliable systems are installed and operated.

Case Study: Energy as a service business model can unlock energy productivity gains to improve industry sustainability

Bradley Abbott, Project Lead – Promotion of Sustainable Energy Practices in the Cambodian Garment Sector, Global Green Growth Institute Cambodia

There is great, unrealised potential for sustainable energy investment in the Cambodian garment sector. Many of the energy productivity gains in the garment sector are accessible and profitable but require a more intensive technology management approach. These technology management services are ideal to package through a value-added, pay for performance "ESCO" business model.

The ESCO model can easily be integrated into existing vendor leasing and financial products that are already familiar to equipment suppliers. The ESCO model has been used by equipment vendors in the US, Europe and China for many years now and is a way for a vendor to differentiate themselves in the market. In the last five years, the ESCO equipment vendor model for rooftop solar PV in Vietnam and Thailand has gained popularity as renewables friendly electricity sector reforms have been implemented by the governments.

Examples of equipment markets that are compatible with the vendor-based ESCO model are:

Steam boilers
Distribution system leak reduction and condensate return optimisation. Payment can be based on measured energy savings, GHG reduction, or an increase in sustainability rating.

Air compressors
Leak repair, demand-based variable air volume delivery, pressure optimisation. Payment upon demonstration of measured savings or air delivery (ESCO pays for plant electricity supply costs)

Rooftop solar PV
Peak electricity demand reduction and control – payment is made upon delivery of energy (energy supply agreement).

Developing a thriving and sustainable ESCO market requires the introduction of structured instruments to the market to minimise transaction costs and improve the credibility of transaction partners. Building the credibility of transactions has facilitated the adoption of the ESCO approach in other markets through the introduction of structuring instruments like standards for energy audits, standardised energy savings calculation methodologies, adoption of standard measurement and verification protocols, development of model contracts, and alignment with sustainable energy finance protocols.

For example, in the Emirate of Dubai, standardisation of ESCO transactions has been accomplished through a “Super ESCO”. Etihad ESCO in Dubai was established by the energy and water utility and helped build market confidence in energy performance contracting by imposing a transaction structure. Etihad ESCO helped build the Dubai energy services market by aggregating projects for procurement and then imposing transaction instruments as a pre-requisite for project hosts and energy service companies to access concessionary finance and special guarantee funds.

In Cambodia, there is a great opportunity for using the ESCO approach in the garment sector, but also a great need for structuring transactions to build confidence in factories, investors, and lenders. Transaction structuring could be accomplished through a public agency energy fund, a major industry association, SME collective, or a bank. The key is to start simple and develop transaction models and norms that can successfully transition basic energy-related businesses into expanded energy service companies that facilitate access to finance and widen impact in the Cambodian market.

In partnership with the Garment Manufacturing Association of Cambodia and the French NGO Geres, GGGI is implementing the four-year, EU-funded Cambodia Switch Garment project to work with SME garment factories in improving access to finance and increase investment in sustainable energy projects.

Case Study: Business models unlock transport cost savings with electric motorbikes

Carl Wong, Co-founder and President, Oyika

In 2019, the number of registered vehicles on the road in Cambodia exceeded 5 million, with a year on year increase of over 600,000, more than 500,000 of which were motorcycles. While a handful of companies have started selling electric motorcycles, they remain extremely uncommon with estimated sales being less than 500 in 2019. This suggests significant opportunities for electric motorbikes within this market.

However, business models need to consider purchasing power in a country where annual median salaries are between US$100 and US$200 per month. Conventional environmental marketing positioning must necessarily take a back seat to price sensitivity.

The good news is that electric motorcycles both in the upfront purchase price and operating cost can be significantly lower than petrol motorcycles. An 800W electric-powered motorcycle capable of a range of 60 km and a top speed of 50 km per hour can be purchased for US$1,000, $200 - $300 less than a typical 110 cc petrol motorbike but with on-going operating costs only 15% of the petrol motorbike.

This significant price differential provides opportunities for electric motorcycle business models to overcome inherent electric vehicle limitations (limited range, long ‘refuelling’ times, limited speed and battery degradation not associated with petrol-driven motorbikes) and compete in this market.

The simplest of these and currently most common in Phnom Penh is a low-cost B2C retail model. Over the past 12 months, retailers have appeared in Phnom Penh selling an electric bicycle/moped vehicle for approximately $350. These vehicles travel at speeds of 25 to 30 km an hour with ranges of 30 to 40 km. Due to the low average traffic speed of 20 km an hour, speed (if marketed correctly), is not a significant impediment to sales. However, range is harder to overcome. These vehicles will only appeal to users with low daily mileage.

Delivery companies with high daily mileage requirements are well-positioned to benefit from

vehicle fleet electrification. However, they require a solution to the 4 to 8-hour charging times required by conventional electric motorbikes.
One such solution is through battery swapping. The battery swap business model provides a network of stations offering instant battery swaps and extends range through strategic station positioning. A battery swap company currently operates in Phnom Penh with a network of 11 charging/swap stations servicing both B2C and B2B customers.

These business models can be further strengthened through innovative financing structures that don't require deposits, fees and high-interest rates. Emulating an $0 upfront phone plan is one such example.

A systemic approach needed in energy sector

Businesses' drive for clean energy and its accompanying operational efficiency improvements must be consolidated at a systems-level to ensure that Cambodia's electricity grid remains fit-for-purpose. Generation and network investments have 20-30 year payback periods. Under Cambodia's energy sector structure, EdC takes the financial risk of these investments through electricity procurement contracts or loan repayments which are paid for through customer electricity tariffs (ADB 2018)(ADB 2018). It is important then that these investments reflect immediate and future needs while ensuring that electricity prices remain affordable.

This set of case studies set out Cambodia's opportunity to optimise grid investment by reducing energy intensity through energy efficiency standardisation, structuring energy procurement to secure cost-effective pricing without limiting the ability to source cheaper electricity in the future and ensuring that the value of low-cost wind and solar generation is maximised. The final case study on wind power is an example of the eagerness of the industry to invest in local, renewable energy projects and complement the solar power that has already been contracted. Together these provide a blueprint for Cambodia to meet its energy demands in a cost-effective way.

Case Study: Energy efficiency standards and labels for Cambodia

Susanne Bodach, International Specialist on Energy Efficiency, United Nations Development Program

Energy Efficiency Labels are designed to provide accurate and comparable information on the energy consumption of electrical appliances. This makes it easier for consumers to identify more energy-efficient products at the time of purchase. When buying more efficient equipment, consumers can save money on their energy bills while reducing greenhouse gas emissions and protecting the environment.

The energy label is the same for all products in each category, e.g., refrigerators, which makes all products comparable. The energy label classifies products from 1 to 5 according to the national standard, 5 being the most energy-efficient class, and 1 the least energy-efficient. All manufacturers that want to sell a product must follow a defined testing procedure and get the national energy label for their product.

Regulations on energy efficiency standards and labels also set minimum requirements on energy performance for each appliance category. This will ban the manufacturing and import of inefficient equipment into a country. The country especially benefits from reduced power demand growth in the residential sector. Neighbouring countries like Thailand and Vietnam have energy labels and standards place for several years. The Royal Government of Cambodia is currently finalising the first regulation on energy standards and labels which will cover refrigerators and air-conditioners.

Energy labelling and minimum efficiency standards for appliances are one of the most promising policy instruments. Introducing energy labelling for five appliance categories in Cambodia will result in 30% electricity savings in 2030 compared to the business-as-usual scenario. These savings are equivalent to 18 million US Dollar in reduced electricity bills, which is the same amount required for the construction of a new power plants of 100 MW according to the United Nations Energy Programme (UNEP, n.d.).

Case Study: Competitive tendering achieves lowest-ever PPA tariff for Cambodia…and shows what is possible with renewables

In 2019, ADB, in partnership with EdC, held its first-ever competitive process for awarding a Power Purchase Agreement (PPA). The process was based on a site that was pre-identified and supplied by EdC for a solar project. It received 26 bids, and after technical feasibility to avoid low-cost but poor-quality projects, 16 were shortlisted to bid their price. Following financial assessment and negotiations, a winning price of 3.877 USc/kWh was awarded, the lowest-ever PPA tariff in Cambodia and Southeast Asia (Zhang 2019). This demonstrated that 1) solar projects are the lowest cost electricity available, and 2) competitive processes can assist EdC to reduce its electricity sourcing costs and achieve its objective to reduce the electricity tariffs. ADB is supporting EdC with the second phase of this project in developing modelling for its 2040 Power Development Plan, expected to be ready by the end of 2020.

Enhancing conventional power purchase agreements to support the integration of variable renewable energy in the GMS

Dr. Stuart Thorncraft & Anthony Kubursy, IES

Power Purchase Agreements (PPAs) define terms and conditions for the sale of electricity. Typically covering a significant portion of a power project's expected lifetime, a PPA includes provisions that determine price structure, volumes of electricity sold, dispatch, metering and settlement regimes, as well as penalties for non-compliance. Importantly, PPAs provide project developers with a guaranteed source of revenue over a sufficiently long period to enable financing for the power project to be secured.

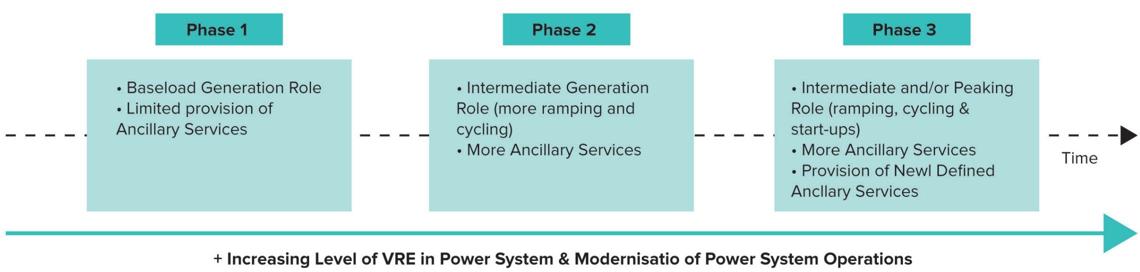
Many power projects in the Greater Mekong Subregion (GMS) utilise conventional PPA structures to procure generation supply. A conventional PPA refers to those regulating traditional thermal and hydro-based electricity generation technologies characterised by rigid long-term contracts that solidify the power project's role within a power system. For example, PPAs for coal-based power projects often assume that the project will serve a baseload role over its lifetime, possibly with minimum take-or-pay obligations on the electricity purchaser. A second example is a Peaking plant where the PPA will have availability payments over the power project's lifetime to ensure that adequate revenue can cover fixed operational costs, as it will only be required to generate electricity for a limited number of hours per year.

Conventional PPAs have served well as a legal and operational framework for the sale of electricity in developing GMS nations, which have to date been powered by traditional electricity supply mixes. However, as power systems in the region transition towards generation mix with higher levels of Variable Renewable Energy (VRE) resources, power system operations and the role of conventional generators are beginning to change and will continue to evolve in the future. International experience shows that the regimes for dispatching resources and managing Ancillary Services need to be revised and enhanced once VRE levels exceed around 20% share of the total generation mix. This will challenge the viability of conventional PPAs over their lifetime and lead to a re-evaluation of how PPAs for traditional generators could be improved.

As illustrated in Figure 1, modern PPAs for traditional power projects need to be designed with regard to how power systems will transform over time with higher shares of VRE generation. Modern PPAs should provide mechanisms that contractually enable the role of traditional generators to evolve as necessary. This is particularly relevant for GMS nations where Power Development Plans are based on expanding both traditional power projects (Coal, Gas and Hydro) and increased levels of VRE. While traditional power projects must be underwritten with PPAs that provide developers with revenue certainty, they also need to provide a mechanism that enables greater operational flexibility to ensure that future generation mixes will deliver stable, secure, and cost-effective outcomes as VRE is scaled up.

While the approaches to designing modern PPAs for traditional plants will vary by power system, one key enhancement is to avoid minimum take-or-pay obligations on the purchaser. Instead, a fixed cost recovery component coupled with a variable energy price can ensure that traditional power project developers will recover the fixed operations and capital costs of the project, without compromising the purchaser's ability to change the role of the generator over its lifetime. A second enhancement is to place greater emphasis within a modern PPA on the provision of, and fair compensation for Ancillary Services, including having stipulations for new Ancillary Services in the future should they be required (for example, as fast frequency reserves or synchronous power). In this way, a modern PPA serves as a contractual mechanism that encourages future traditional thermal and hydro plant technologies to be better suited for the integration of higher VRE shares in the GMS region.

Figure 2. Power project's role over the lifetime of a modern PPA



Source: EnergyLab 2020.

Case study: Wind power–adding low cost, clean and complementary energy to Cambodia's electricity mix

By Sophorn Chea, Development Manager, The Blue Circle Pte Ltd

Cambodia is a potential market for commercial wind projects, particularly on the Bokor Plateau and in the Northeast. Following 4 years of investigation, The Blue Circle ("TBC") has solicited more than 500MW to the Ministry of Mine and Energy (MME) and in 2019 our 80MW Bokor Wind Farm project was promulgated in the Power Development Plant 2020-2030, the first in Cambodia. The project is close to grid infrastructure and load centres, and it will create 500 jobs during the pre-completion period and will bring direct foreign investment to Cambodia. When completed, it will generate 225 GWh of clean electricity and save over 130,000-ton CO2eq annually. Thirty permanent operation and maintenance jobs will be created for over 30 years. The project relies on signing a PPA with EdC. Negotiations are ongoing.

Wind power will add resilience to Cambodia's electricity mix, complementing the daytime production from solar and the wet season production from hydro. Building the right infrastructure (transmission, generators…) that is flexible rather than following a path of inflexible baseload infrastructure will be key to harnessing these locally available energy resources, thus reducing reliance on imported electricity and fuels (which are highly volatile in price) and maximising direct investment into the Kingdom. Wind technology is proven to generate reliable and competitive clean, carbon-free electricity and the cost is cheaper than new coal and gas plants making it a highly financeable technology. Our (Cambodia's) neighbours are rapidly pursuing wind power through strong policy and incentives to draw benefits from this technology.

Conclusion

The case studies in this chapter provide insights into the views of businesses and industries keen to engage with the Cambodian economy and support its development. They highlight that Cambodia is favourably viewed by businesses for the current high levels of renewable energy in its electricity mix, that clean energy businesses are an opportunity to unlock cost savings to improve Cambodia's competitiveness, and that businesses and investors are present in the market and would welcome clear policies and regulations to assist them to capture these cost savings.

Cambodia is at a pivotal point. As demand grows, more electricity capacity is needed. However, signing up for high levels of coal, oil and gas is making Cambodia less attractive for businesses. Modernising its PPAs with traditional thermal and hydro plants provides a pathway for ensuring that Cambodia is not prevented from signing up for renewable energy which will be key to reducing electricity tariffs and attracting as well as retaining global business investment.

Reliable and affordable electricity is imperative for Cambodia's socio-economic development. Facing huge growth in demand, electricity procurement decisions taken today will affect the competitiveness of Cambodia's commercial and industrial sectors now and for decades to come. Countries all over the world, including Cambodia's closest neighbours, are prioritising clean energy generation and business models to reduce electricity costs and attract industry investment. Cambodia can do the same, and it has taken the first positive steps. However, energy procurement and investment must carefully incorporate long-term planning to ensure that Cambodia can fully benefit from the low energy cost future that can be provided by clean energy.

Acknowledgements

The author warmly thanks Peter Ford, Thomas Jakobsen, Bradley Abbott, Carl Wong, Susanne Bodach, Stuart Thorncraft and Anthony Kurbursy for their enthusiastic contribution to this work. The author is also grateful to Bridget McIntosh for her review and comments.

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Source: unsplash

11

Conclusion

Chheng Kimlong

Introduction

Many readers have opened this book or at least have glimpsed through the first few pages with these questions: Why has ASEAN, particularly the lower Mekong countries, despite its rapid economic growth since the beginning of the 21st century, still not achieved energy security? How will ASEAN be able to realise its energy security target? The answer revolves around the dilemma of exploiting natural reserves of non-renewable resources to meet immediate and long-term energy needs, knowing that more energy generation will be at the cost of natural resources and environmental quality. Other factors, such as the emergence of competing initiatives of energy cooperation, both bilateral and multilateral, international obligations for reducing environmental impacts, cost of technologies for renewable energy, and the dynamics of public-private sector cooperation in the region have explained the underdevelopment of the energy sector of the region.

Numerous factors have attributed to the rising energy demands in ASEAN and the Mekong region, including rapid economic growth, fast population increase, expanding private sector's involvement in production and manufacturing, as well as proliferation in services. As of today, the region's heavy reliance on non-renewable energy sources such as fossil fuels, including coal, oil, and natural gas and some renewable sources such as biomass including fuels, wood and charcoal in rural areas, will not be sustainable. Nonetheless, the region's huge potentials for renewable energy production, including wind, solar, hydropower, ocean wave energy, and biomass have yet to be tapped to realise its full capacities of renewable energy production by 2050.

Energy Potential and Challenges in ASEAN

The role of energy will remain critical as the backbone of economic growth. ASEAN's goals are to increase the electrification rate and to ensure member countries' energy security and sustainability. The region's growing demands for energy will have

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many implications at the national and regional levels. ASEAN has faced several energy challenges amid maintaining economic growth momentum while seeking to gain energy security, curbing climate change and reducing air pollution. ASEAN's energy demand is expected to increase triple from 2013–2040. At the same time, ASEAN's CO2 emissions from energy consumption, without reduction efforts, will grow by about 4.7 per cent on average annually over the 2013–2040 period.

Renewable energy technologies in ASEAN have yet to be fully developed, and fossil fuel-based energy systems will need to be replaced by the renewable energy ones. Many ASEAN countries still depend on imports of fossil fuels. There are barriers to accessing those technologies because the upfront cost of investment is high compared with the cheaper and dirtier technologies that produce high carbon emissions. As it appears, promoting energy efficiency, clean coal technology, nuclear safety, and doubling the share of renewables in the energy mix while trying to attain inclusive and sustainable development goals will prove challenging, particularly with emerging challenges stemming from rising fossil-fuel-based energy production, growing energy demands in industrial and service sectors relying on non-renewable energy sources, and constraints in financial cooperation within the region. The ASEAN Plan of Action for Energy Cooperation, 2016–2025, upgraded from the 1999–2004 ASEAN Plan of Action for Energy Cooperation, outlined the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline as two of seven key cross-border cooperation programmes. The following reasons explain key challenges for ASEAN.

- ASEAN's spectacular growth over the 2000–2020 period has pushed the energy demand to grow by about 2.5 times since 1990 and is expected to triple by 2035. The commercial and residential sectors' demand will grow at 2.5 per cent per year, pushing oil demand to grow more than double from the same period, equivalent to an average growth rate of 3.8 per cent per year while natural gas will grow almost fourfold or at an average growth rate of 5.1 per cent per year.

- Coal is predicted to have the fastest growth rate at 5.7 per cent per year during the 2013–2040 period, and its share will increase from 16 per cent to 25 per cent during the same period.

- Natural gas is predicted to grow at 4.4 per cent per year during the 2013–2040 period. Its share will increase from 21.5 to 23.8 per cent during the same period.

- ASEAN's expansion of energy infrastructure projects is slow, affecting the potential of industrial development and growth. At their micro-level, some ASEAN countries continue to face difficulty in expanding energy access to their rural population, with about 130 million people in ASEAN countries still lacking access to electricity.

Energy Potential and Challenges in the Mekong Region

For the Mekong region, there will be a 4 per cent annual growth in energy demand until 2040, a 50 per cent increase over the 2015 level. Electricity demand is estimated to double in 2040 from the 2010 level. Energy demand and electricity production will rise the fastest in 2035. Rising fossil fuel demand from the Mekong region will also result in increased carbon emissions and local air pollution. Energy-related carbon emissions will increase by 61 per cent, reaching 2.2 Gigatons. These energy security and environmental challenges could be addressed by promoting cross-border energy trade, wherein surplus energy from one country is shared with other countries in the Mekong region.

So far, the region is a net importer of energy. While the energy demand is on the rise due to rapid urbanisation and industrialisation, carbon emissions are high. From 1990 to 2015, electricity production in the Mekong region increased on average by about 8.2 per cent annually. The current total installed capacity of hydropower generation in the five Mekong countries has reached only 8 per cent of the exploitable potential resources. However, because the region is rich in renewable resources, the prospect for a clean energy mix and regional grid connectivity is high. The cross-border infrastructure of power stations and grids on a subregional basis have a potential for efficiency gains and cost reduction. The energy infrastructure development for the region can promote supply stability, economic efficiency, and carbon emissions reduction toward regional energy security.

Several country-specific barriers that often hinder the deployment of renewable energy include regulatory and policy frameworks, weak institutional, market, and financial capabilities and limited expertise on renewable energy technologies. Most notably, the GMS countries are at an early stage in developing their renewable energy resources. Their respective renewable energy potentials have not yet been explored effectively, as the region is still highly dependent on large hydropower and fossil fuels. Most of GMS countries' powers are being generated from gas and coal power plants. The Mekong region has insufficient indigenous fossil fuel resources to meet the growing demands. Hence, the imports of fossil fuels are expected to increase, causing important energy security implications. Solar energy is gaining popularity in the region. While the cost of solar power is still relatively high compared with conventional energy sources, further development will offer economy of scale with the use of newer, lower-cost technologies. Wind power, which will benefit from the extension of the transmission grids and feed-in adder or bonus systems, has also underdeveloped. Biomass energy is small-scale, and its expansion depends largely on the availability of agricultural land, while biogas from animal manure is small and unsustainable for off-grid farm communities.

The region has several frameworks on grid connectivity. For example, the GMS Strategic Framework signed in 1992 was the first effort by the lower Mekong countries plus China to formulate and adopt a development planning agreement which defined the vision, goals, and strategic trust for cross-border infrastructure connectivity. It has been followed by the ASEAN Plan of Action for Energy Cooperation 2016–2025, among others. However, the lower Mekong region's different levels of economic development, and the widening gap with richer ASEAN member countries have posed more challenges. Despite so, increasing renewable energy deployment for the region will bring about both challenges and opportunities. Below is a summary of the challenges for Mekong countries.

- Renewable energy technologies are yet to be enhanced to make them more commercially competitive. The challenges are interconnected; therefore, systematic and structured measures are necessary to guarantee progressive results in tapping the potentials of renewable energy development.

- Major technical and financial challenges in the development of renewable energy in the GMS have stemmed from inadequate regulatory frameworks. Most common system-based barriers are attributed to high dependence of its renewable energy sources on imports from the geo-political challenges and the immaturity of its technology.

- Due to its high dependence on fossil fuels, conventional energy systems and the uncertainty in the policy framework, GMS countries are not ready to fully adopt renewable energy technologies. The low use of the renewable energy system is due to technical and financial challenges, despite having remarkable renewable energy potentials, ranging from hydro, solar, wind, biogas, to biofuel.

- Renewable energy resources in the GMS are scattered across the region, so connecting the gap between energy supply and demand through the efficient use of energy resources is necessary to avoid energy market failure. In 2015, the total energy installed capacity in the lower Mekong region stood at 87 GW, making up 42 per cent of the ASEAN total energy.

- Environmental impacts are getting more severe, driven by the increased use of fossil fuels and petroleum to meet the energy need of the region. Therefore, it requires investments in clean and renewable energy sources and the promotion of cross-border energy trade in order to achieve energy security, reduce environmental pollutions, and enhance economic competitiveness.

Cooperation on ASEAN Renewable Energy Development

The region can leverage a number of regional mechanisms with many key external players as follows.

- ASEAN should advance the existing regional cooperation platforms in Mekong countries, such as ASEAN, GMS, the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation, and Bangladesh-China-India-Myanmar to promote regional cooperation on clean and renewable energy in the Mekong region. Other subregional mechanisms under the MRC, the GMS, Mekong-Japan Cooperation, Mekong-Lancang Cooperation, Mekong-Korea Cooperation, and Mekong-US Partnership should also be enhanced.

- Regional institutions and mechanisms play their parts in promoting green and renewable energy. Building a green energy community has been one of the key priorities the lower Mekong countries have pursued thus far with several external partners, including the US, China, Japan, and South Korea through various Mekong cooperation frameworks such as GMS, MJC, MKC, MLC, MUP and JUMPP.

Policy Interventions for the Region

- **Short- to medium-term cooperation**

It is in the best interest of the region to (i) enhance access to the energy of all sectors and communities particularly the poor in the GMS through the promotion of best energy practices; (ii) develop and utilise more efficiently indigenous, low carbon and renewable resources while reducing the subregion's dependence on imported fossil fuels; (iii) improve energy supply security through cross-border trade while optimising the use of subregional energy resources; and (iv) promote public-private partnership through small and medium-sized enterprises for subregional energy development.

In line with the GREEN ASEAN policy, the Mekong region shall devote their resources to investing in green technologies and low carbon-emitting technologies despite some known barriers such as access to the technologies, high cost of investment, and energy distribution and maintenance capabilities. Mekong countries need to gather momentum for greater investment in renewable energy technologies and energy use efficiency to enhance the regional economy, security and sustainable growth.

They need to tackle difficulties in the development of renewable energy in a sustainable and effective way. Policy coordination in promoting renewable energy potentials among countries in the Mekong region is also fundamental, specifically for hydropower development projects. Importantly, harmonisation must be considered not only on the framework of regional energy security and development but also on the region's food and water security.

- **Medium- to long-term cooperation on full integration in cross-border grid connectivity**

A few initiatives on regional cooperation, including the renewable energy support mechanism for bankable projects, off-grid rural electrification approaches, and renewable energy technical standards, have prevailed. Since 2015, six bilateral interconnections have been put in operation, linking Singapore and Malaysia; Thailand and Peninsular Malaysia; and Cambodia, Lao PDR, and Vietnam via Thailand. Since then, a new initiative has been announced by Lao PDR, Thailand, Malaysia, and Singapore to explore a possibility for multilateral cross-border power trade from Lao PDR all the way to Singapore. The lower Mekong countries can look into this interregional cooperation model under the framework of the ASEAN Plan of Action for Energy Cooperation 2016–2025. All in all, ASEAN should embrace the following.

- Promotion of energy efficiency, security and affordability as the objective of future energy development in ASEAN as well as in Mekong countries. As cross-border transmission progresses and the use of interconnections expands, the benefits from the entire system for the region will increase.

- Accelerating the interconnection projects in progress in the GMS and materialising the benefits of electric power interchange require meeting some prerequisite conditions. In this regard, the following region-wide actions are required: (i) overall optimisation and adjustment of power infrastructure development plans that fully integrate renewables, (ii) the harmonisation of technical standards and energy pricing mechanisms, and (iii) the establishment and authorisation of regulatory and consultative bodies to support Mekong-wide energy market integration.

- The expansion of renewables such as wind, solar, biomass, and geothermal will increase diversity, assuming that they do not completely displace fossil fuel sources. The impact of expanded renewable energy uptake in place of coal is not very clear from a net cost-benefit perspective.

Long-term cooperation on regional energy security

As one of the physical energy infrastructure projects in the Master Plan on ASEAN Connectivity, the APG is designed to enhance electricity trade across borders to meet rising electricity demand and improving access to energy services. Investment in renewable energy technologies and infrastructure has been showing progressive growth. This investment trend has also expanded the renewable energy technology market and reduced production cost while improving technology performance. Investment in energy security requires a holistic strategy and approach.

- ASEAN countries should develop a comprehensive renewable energy investment roadmap through removing barriers to integration and making new investments more cost-effective at the grid level through regulations, incentives, and capacity building for taking credit risks.

- The adoption of smart transport, housing, and manufacturing on a large scale will have a profound impact on both energy demand and the optimisation of energy supply at the national level. Therefore, a sound policy and market design will be critical in steering a digitally enhanced energy system along with more efficient, secure, and stable grid connectivity across the borders.

- Regional cooperation can support each country in addressing some of the national energy challenges and contribute to global energy development. Moreover, advanced regional cooperation can assist countries reducing knowledge and financial gaps.

- A regional fund for power market integration should be established by expanding the ASEAN Infrastructure Fund to drive private investments with the use of emerging digital and industry 4.0 revolution that can transform energy demand and supply in ASEAN.

- The maturity of renewable energy technologies varies depending on geographical locations, available resources, and other technical factors. Clean energy business models are finding energy savings to improve business competitiveness.

Supportive Policy Framework for Private-Sector Engagement

For the GSM countries to accelerate the smooth and effective energy transition, despite their different renewable energy targets, they should align the regional efforts in renewable energy development with the energy efficiency and conservation agenda.

1) The lower Mekong subregion should align its energy development plans with those of ASEAN or the GMS, such as the Roadmap for Expanded Energy Cooperation to embrace sustainable, secure, competitive and low carbon energy. Stakeholder engagement is key to economic viability. Along this way, the provision of facilities to scale up renewable energy investment should include financing facilities to provide risk mitigation instruments, cover transaction fees and design the structure of financial mechanisms.

2) To facilitate a progressive energy transition, ASEAN should consider decarbonisation of national and transboundary electrical grids through renewable energy development becasue clean and renewable electricity has become important among the key criteria for businesses to locate their facilities as well as for their corporate social responsibility roles to steward environmental sustainability.

3) For energy sector resilience and quality infrastructure development, the region should rely less on the limited global reserve of fossil fuel energy and unstable global fuel prices. It is essential for the Mekong region to accelerate cross-border connectivity and to promote open trade, facilitation, and cooperation in the energy sector and related industries in the requisite infrastructure.

4) Regional cooperation can assist the GMS countries in identifying suitable and effective instruments to support renewable energy projects to realise sustainable development and low carbon energy transformation. Regional economic cooperation shall factor in energy supply, management, and use to promotes the identification of the most cost-efficient and effective way of meeting energy security. The cooperation in the capital market and finance needs to ensure that the local financial institutions are familiar with the financing schemes that provide such lending services to accelerate the project implementation.

5) Enhancing the policy and regulatory frameworks and technical expertise in the overall development of renewable energy is required to promote technological improvement, investment and cost reduction. The region needs to address the barriers to regional power trade promotion which include a high degree of national market monopolization as well as a shortage of cross-border transmission lines and domestic grids. Moreover, they need to harmonise standards and protocols of electricity transmission and distribution, frequencies, voltages, information technology systems, and consumer protection policy as well as technical standards and regulations, including grid codes.

Way Forward for Renewable Energy Sustainability and Inclusiveness in ASEAN

The development of transboundary grids through the ASEAN Power Grid will maximise ASEAN's benefits in terms of cost and cooperation for sustainable, reliable and affordable energy. ASEAN needs to address the common energy challenges faced by the region and turn those challenges into opportunities for investment to improve energy efficiency and saving. Tapping on renewable sources will surely contribute to the regional economy, security and sustainable growth, which is achievable through the following.

1) For sustainability, ASEAN needs to reduce its dependence on fuel imports and improve fuel use efficiency and conservation measures. Also,

ASEAN will need to consider increasing the share of renewable energy in the total share of the energy consumption and the cleaner use of fossil fuel through clean coal technology and deployment of carbon capture, utilisation and storage. To achieve energy security in ASEAN, it will need to depend less on imports of crude oil to reduce external shocks so as to make ASEAN more resilient to external shock and at the same time lower carbon emissions.

2) Green technologies and low carbon-emitting technologies need to stay at the heart of ASEAN. The energy outlook for ASEAN will rely on energy resilience and green development strategy toward energy security. ASEAN's green growth-based future will need to come from renewable energy as ASEAN is endowed with resource potentials such as wind, solar, hydropower, biofuels and other renewable energy. ASEAN needs to find a framework to support the deployment of efficient and low carbon technologies. Technological development and financing mechanisms in renewable energy are key to reducing the lead time for the sector deployment.

3) For inclusiveness, the distributed energy systems (DES) which make use of renewable energy sources such as biomass, wind power, small hydro, solar power, biogas and geothermal power, as well as other thermal plants with small capacity look promising. The ASEAN region is also predicted to experience a significant rise of DES to meet energy demand. Small and very small power producers take part in supplying electricity, such as in Cambodia, Lao PDR, Myanmar, and some off-grid remote islands of Indonesia. Promoting energy access requires investing in the infrastructure of grid expansion and off-grid electricity systems, where DES can play an important role in the electric power distribution system in ASEAN's energy security as well as energy inclusiveness.

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