

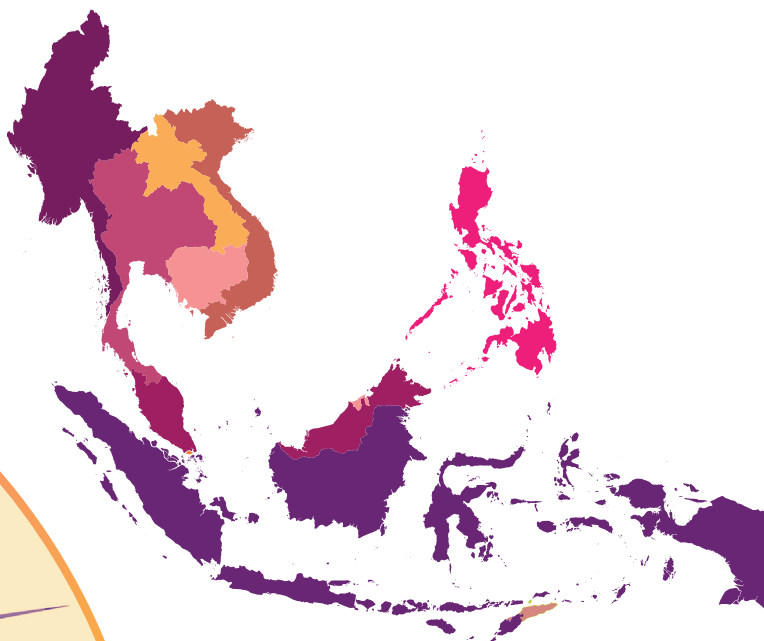


ASEAN Centre for Energy
One Community for Sustainable Energy



UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific

ASEAN RENEWABLE ENERGY REGIONAL APPROACH STRATEGIC REPORT



2023

ASEAN Renewable Energy Regional Approach

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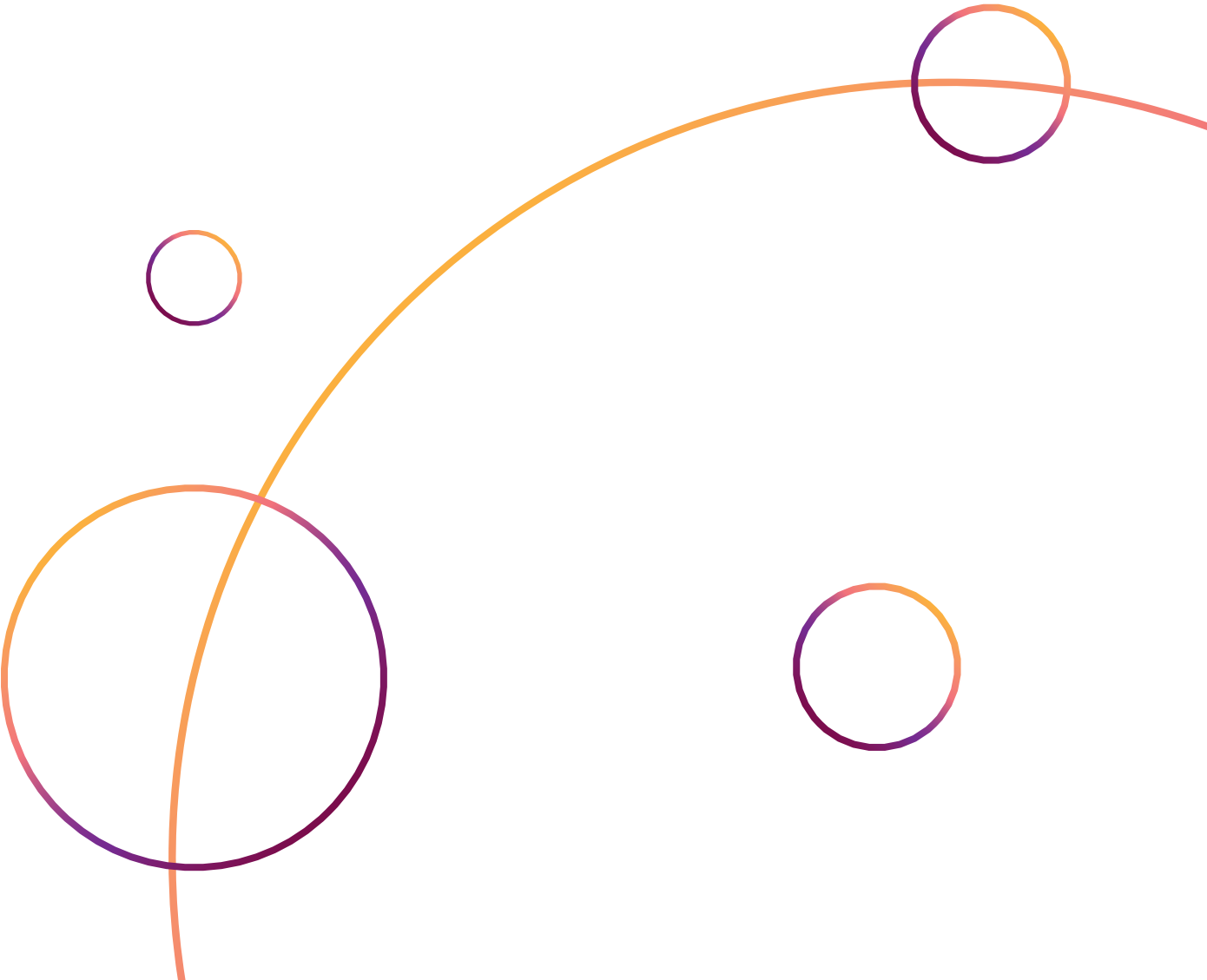
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ASEAN RENEWABLE ENERGY

REGIONAL APPROACH STRATEGIC REPORT





About ACE

Established in 1999, the ASEAN Centre for Energy (ACE) is an intergovernmental organisation within the ASEAN structure that independently represents the interests of the ten ASEAN countries in the energy sector. The Centre accelerates the integration of energy strategies within ASEAN, by providing relevant information and expertise to ensure the necessary energy policies and programmes are in harmony with economic growth and the region's environmental sustainability. It is guided by a Governing Council composed of Senior Officials on Energy leaders from each ASEAN Member State, and a representative from the ASEAN Secretariat. Hosted by the Ministry of Energy and Mineral Resources of Indonesia, ACE's office is located in Jakarta, Indonesia.

About UNESCAP

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53 member States and nine associate members, in pursuit of solutions for sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations.

The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development. ESCAP also provides support to partners at the national level. ESCAP offers national support rooted in and linked with implementing global and regional intergovernmental frameworks, agreements, and other instruments.

ESCAP pursues this objective by carrying out its work in close cooperation with other United Nations entities and intergovernmental organisations throughout the region, particularly in the areas of: (1) Macroeconomic Policy, Poverty Reduction, and Financing for Development; (2) Trade, Investment, and Innovation; (3) Transportation; (4) Environment and Development; (5) Information Communication Technology and Disaster Risk Reduction; (6) Social Development; (7) Statistics; and (8) Energy.

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Foreword

As one of the fastest-growing economies, ASEAN is projected to triple its energy demand by 2050, from the 2020 level, according to the 7th ASEAN Energy Outlook (AEO7). To ensure universal electrification and energy security, whilst still aligning with international commitments such as the United Nations' Sustainable Development Goals (SDG) and the Paris Agreement, the development of renewable energy (RE) sources has been strongly advocated by the ASEAN Member States (AMS) through multilateral dialogues, strategic initiatives and supporting policies.

Remarkably, the strong commitment of the AMS toward sustainable energy transition was proven by the ASEAN Plan of Action for Cooperation (APAEC) Phase II (2021 – 2025), during the 38th ASEAN Ministers of Energy Meeting (AMEM) in November 2020. At that meeting, the aspirational RE targets of a 23% share of the total primary energy supply (TPES), and 35% share of the total installed capacity by 2025, were set with dedicated action plans for each outcome-based strategy (OBS). It is expected that the APAEC Phase II will facilitate regional collaboration and engagement amongst the different dialogue partners (DPs), international organisations (IOs), the private sector, and academia to further RE deployment.

Since the establishment of APAEC Phase II (2021 – 2025), an acceleration of RE integration in the regional energy sector has been witnessed. According to the latest AEO7 data, the RE share of total installed capacity has reached 33.5% as of 2020, with only a 1.5% gap toward the target. Despite significant RE uptake, the RE share in TPES only accounted for 14.2% by 2020. Based on the findings from the ASEAN Interconnection Master Plan Study III (AIMS III), ASEAN still needs 83 GW of additional capacity to accomplish the 23% goal. Therefore, a holistic regional-scale approach that considers RE potential and socio-economic development should be promoted.

Against this backdrop, and on behalf of the ASEAN Centre for Energy (ACE), I am pleased to present the strategic report “ASEAN Renewable Energy Regional Approach.” The study is one of the collaborative activities between ACE and the Economic and Social Commission for Asia and the Pacific (ESCAP), which aims to identify the status and potential of different RE technologies in each of the AMS. This study evaluates the impact of RE uptake on the socio-economic development, and provides recommendations that tackle the bottlenecks in achieving APAEC targets. Furthermore, the study's findings are expected to lay the foundation for developing the RE Long-term Roadmap, which supports OBS-1, under the RE Programme Area of APAEC Phase II: Advance RE Policy and Decarbonisation Pathway.

As an intergovernmental organisation representing the interests of ten AMSs in the energy sector, ACE is dedicated to catalysing the integration of energy strategies within ASEAN, by providing relevant information and expertise to ensure the policies and programmes are harmonious with the region's overall economic growth and environmental sustainability. The study can also be seen as an indicator of

ACE's effort to facilitate multilateral collaboration and joint activities in the energy sector amongst AMS Focal Points, DPs and IOs.

The development of this study would not have been realised without continuous support from ESCAP – one of the regional commissions of the United Nations. The ASEAN RE Regional Approach report has marked an important milestone in the partnership between ACE and ESCAP. By generating the necessary funding resources and relevant technical assistance, the participation of ESCAP in the study has contributed to inclusive, resilient, and sustainable development in the ASEAN energy sector.

We would like to express our sincere thanks to the Renewable Energy Sub-sector Network Focal Points, consultants, researchers, and staff from ACE and ESCAP for their support, input and contributions to this study. It is hoped that this technical report will become a valuable reference to develop the RE Long-term Roadmap, as well as an input for government officials in the policy-making process to achieve energy security, affordability and accessibility in ASEAN.

Mr. Hongpeng Liu

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Table of Contents

About ACE.....	v
About UNESCAP	v
Acknowledgements.....	vi
Foreword.....	vii
Table of Contents.....	ix
List of Tables.....	xii
List of Figures	xiii
List of Abbreviations.....	xiv
Executive Summary	xvii
Chapter 1. Introduction	1
1.1. ASEAN Renewable Energy Long-term Roadmap.....	2
1.2. ASEAN Renewable Energy Regional Approach	5
1.2.1. Methodology	5
1.2.2. Primary Data Collection	6
1.2.3 Secondary Data Collection	7
1.2.4. Policy, Social and Technical Analyses.....	7
Chapter 2. Regional Energy Status	8
2.1. Brunei Darussalam	11
2.1.1. Electricity.....	11
2.1.2. Transportation, Energy Efficiency, and Cooking	11
2.2. Cambodia.....	12
2.2.1. Electricity.....	12
2.2.2. Transportation, Energy Efficiency, and Cooking	12
2.3. Indonesia.....	13
2.3.1. Electricity.....	13
2.3.2. Transportation, Energy Efficiency, and Cooking	14
2.4. Lao PDR.....	14
2.4.1. Electricity.....	14
2.4.2. Transportation, Energy Efficiency, and Cooking	15
2.5. Malaysia	16
2.5.1. Electricity.....	16
2.5.2. Transportation, Energy Efficiency, and Cooking	16

2.6. Myanmar	17
2.6.1. Electricity	17
2.6.2. Transportation, Energy Efficiency, and Cooking	17
2.7. The Philippines	18
2.7.1. Electricity	18
2.7.2. Transportation, Energy Efficiency, and Cooking	18
2.8. Singapore	19
2.8.1. Electricity	19
2.8.2. Transportation, Energy Efficiency, and Cooking	19
2.9. Thailand	20
2.9.1. Electricity	20
2.9.2. Transportation, Energy Efficiency, and Cooking	20
2.10. Vietnam.....	21
2.10.1. Electricity.....	21
2.10.2. Transportation, Energy Efficiency, and Cooking	21
Chapter 3. Importance of Regional Renewable Energy Approach	22
3.1. Enhancing Energy Security	24
3.2. Replicating Best Practices	25
3.3. Defining Stakeholders' Roles	25
3.3.1. ASEAN Ministries.....	26
3.3.2. ASEAN Centre for Energy	26
3.3.3. Private Sector and Developers.....	26
3.3.4. Financial Institutions and Multilateral Development Banks	26
3.3.5. UNFCCC and Donors	26
3.3.6. Development Agencies and NGOs	26
3.3.7. Universities and Research Institutions	26
3.3.8. Civil Society Organisations.....	26
3.4. Learning from Global Experience	26
Chapter 4. Ambitions, Challenges, and Opportunities	28
4.1. Brunei Darussalam	30
4.2. Cambodia.....	31
4.3. Indonesia.....	32
4.4. Lao PDR.....	33
4.5. Malaysia	34
4.6. Myanmar	35

4.7. The Philippines	35
4.8. Singapore	37
4.9. Thailand	37
4.10. Vietnam.....	38
Chapter 5. Preliminary Identification of ASEAN Renewable Energy	
Long-term Roadmap	40
5.1. Phase 1: Strengthen Enabling Environment for RE Development for APS 2050 targets	42
5.2. Phase 2: Regional Mechanisms for Climate Financing as per NDC	43
5.3. Phase 3: Research, Technology and Innovation.....	45
5.4. Phase 4: Investment Attractiveness.....	46
5.5. Phase 5: ASEAN Renewable Energy Facility established to achieve Paris Agreement for APS 2050.....	49
5.6. Phase 6: ASEAN Regional Interconnection (Mainland and Islands)	50
5.7. Phase 7: Catalyse Renewable Energy Investments to Exceed APS Targets.....	51
Chapter 6. The Way Forward	52
6.1. Follow AMS Examples.....	53
6.2. Strengthen Renewable Energy Investment for Economic Integration.....	53
6.3. Re-evaluate Fossil Fuel and Other Traditional Technologies.....	53
6.4. Focus on Climate Finance.....	54
6.5. Capacity Building for Top Decision Makers	54
6.6. Negawatt ASEAN.....	54
6.7. Improving Ambitions.....	54
References.....	55
Appendix	57

List of Tables

Table 4.1 – ASEAN’s SWOT Analysis for a Regional Approach	30
Table 4.2 – Brunei Darussalam’s SWOT Analysis for a Regional Approach.....	31
Table 4.3 – Cambodia’s SWOT Analysis for a Regional Approach	32
Table 4.4 – Indonesia’s SWOT Analysis for a Regional Approach.....	33
Table 4.5 – Lao PDR’s SWOT Analysis for a Regional Approach	34
Table 4.6 – Malaysia’s SWOT Analysis for a Regional Approach.....	34
Table 4.7 – Myanmar’s SWOT Analysis for a Regional Approach.....	35
Table 4.8 – The Philippines’ SWOT Analysis for a Regional Approach.....	36
Table 4.9 – Singapore’s SWOT Analysis for a Regional Approach	37
Table 4.10 – Thailand’s SWOT Analysis for a Regional Approach	38
Table 4.11 – Vietnam’s SWOT Analysis for a Regional Approach.....	39
Table 5.1 – Phase 1 Implementation Plan	43
Table 5.2 – Implementation Plan of Phase 2.....	44
Table 5.3 – Implementation Plan for Phase 3.....	45
Table 5.4 – Implementation Plan for Phase 4.....	47
Table 5.5 – Implementation Plan for Phase 5.....	49
Table 5.6 – Implementation Plan for Phase 6.....	50
Table 5.7 – Implementation Plan for Phase 7.....	51

List of Figures

Figure 1.1 – Flow Process for Developing ASEAN Renewable Energy Long-term Roadmap.....	2
Figure 1.2 – Working Group of ASEAN Renewable Energy Long-term Roadmap	3
Figure 1.3 – Group Photo of 1st FGD	3
Figure 1.4 – Outcomes of Closed Discussion in the 1st FGD.....	4
Figure 1.5 – Summary of the three project components.....	5
Figure 1.6 – Summary of the Methodology	6
Figure 1.7 – Total Reviewed Policy Documents.....	6
Figure 2.1 – Current ASEAN GDP in USD, 2012 – 2021.....	9
Figure 2.2 – ASEAN TFEC by Fuel (a) and by Sector (b), 2010 – 2020.....	10
Figure 2.3 – ASEAN TPES by Fuel and RE Share, 2010 – 2020	10
Figure 2.4 – Brunei Darussalam’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	12
Figure 2.5 – Cambodia’s Installed Capacity (a) and TFEC (b), 2010 – 2020	13
Figure 2.6 – Indonesia’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	14
Figure 2.7 – Lao PDR’s Installed Capacity (a) and TFEC (b), 2010 – 2020	15
Figure 2.8 – Malaysia’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	16
Figure 2.9 – Myanmar’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	17
Figure 2.10 – The Philippines Installed Capacity (a) and TFEC (b), 2010 – 2020	18
Figure 2.11 – Singapore’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	19
Figure 2.12 – Thailand’s Installed Capacity (a) and TFEC (b), 2010 – 2020	20
Figure 2.13 – Vietnam’s Installed Capacity (a) and TFEC (b), 2010 – 2020.....	21
Figure 3.1 – Regional Cooperation Initiatives in Southeast Asia	23
Figure 3.2 – Recap of ASEAN’s Installed Power Generation Technologies.....	24
Figure 5.1 – Preliminary ASEAN Renewable Energy Long-term Roadmap	42
Figure 5.2 – Conditional and Unconditional AMS Targets.....	44
Figure 5.3 – Work Process of NEOM Green Hydrogen Project	46
Figure 5.4 – Renewable Portfolio Standards of the Philippines	48

List of Abbreviations

ACE	ASEAN Centre for Energy
ADB	Asian Development Bank
AE07	7th ASEAN Energy Outlook
AIMS III	ASEAN Interconnection Masterplan Study III
ALARP	As Low As Reasonably Possible
AMEM	ASEAN Ministers on Energy Meeting
AMS	ASEAN Member States
APAEC	ASEAN Plan of Action on Energy Cooperation
APEC	Asia-Pacific Economic Cooperation
APG	ASEAN Power Grid
APS	APAEC Targets Scenario
ASEAN	Association of Southeast Asian Nations
ASEAN+3	ASEAN-China-Japan-Republic of Korea
ATS	AMS Targets Scenario
BAU	Business As Usual
BESS	Battery Energy Storage System
BIMP-EAGA	Brunei Darussalam–Indonesia–Malaysia–Philippines East ASEAN Growth Area
BNCCP	Brunei Darussalam National Climate Change Policy
BSP	Brunei Shell Petroleum
DOE	Department of Energy of the Philippines
EAS	East Asia Summit
EE	Energy Efficiency
EEP	Energy Efficiency Plan
EMA	Energy Market Authority of Singapore
ETM	Energy Transition Mechanism
EU	European Union
EV	Electric Vehicle
FGDs	Focus Group Discussions
FIT	Feed-In Tariff
GCF	Green Climate Fund

GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMS	Greater Mekong Subregion
GW	Gigawatt
GWh	Gigawatt-hour
IEA	International Energy Agency
IMT-GT	Indonesia–Malaysia–Thailand Growth Triangle
I-REC	International Renewable Energy Certificate
IRENA	International Renewable Energy Agency
ITA	International Trade Administration
LTA	Land Transport Authority of Singapore
LTMS-PIP	Lao PDR-Thailand-Malaysia-Singapore Power Integration Project
LULUCF	Land Use, Land Use Change and Forestry
KASA	Kementerian Sumber Asli, Alam Sekitar Dan Perubahan Iklim
Ktoe	Kilotonnes of oil equivalent
MEPS	Minimum Energy Performance Standard
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
MWh	Megawatt-hour
MyRER	Malaysia Renewable Energy Roadmap
NDC	Nationally Determined Contributions
NGOs	Non-Governmental Organisations
NREP	National Renewable Energy Programme
PDP	Power Development Plan
PDP8	Vietnam’s Power Development Plan VIII
R&D	Research and Development
RE	Renewable Energy
REC	Renewable Energy Certificate
RE-SSN	Renewable Energy Sub-Sector Network
RPS	Renewable Energy Portfolio Standard
SDG	Sustainable Development Goal
SMMR	Sustainable Mobility in Metropolitan Regions

SWOT	Strength, Weakness, Opportunity, Threat
tCO₂e	tonne of CO ₂ equivalent
TFEC	Total Final Energy Consumption
TPES	Total Primary Energy Supply
UNESCAP	United Nations Economic and Social Commission for Asia and Pacific
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
WWF	World Wildlife Fund

Executive Summary

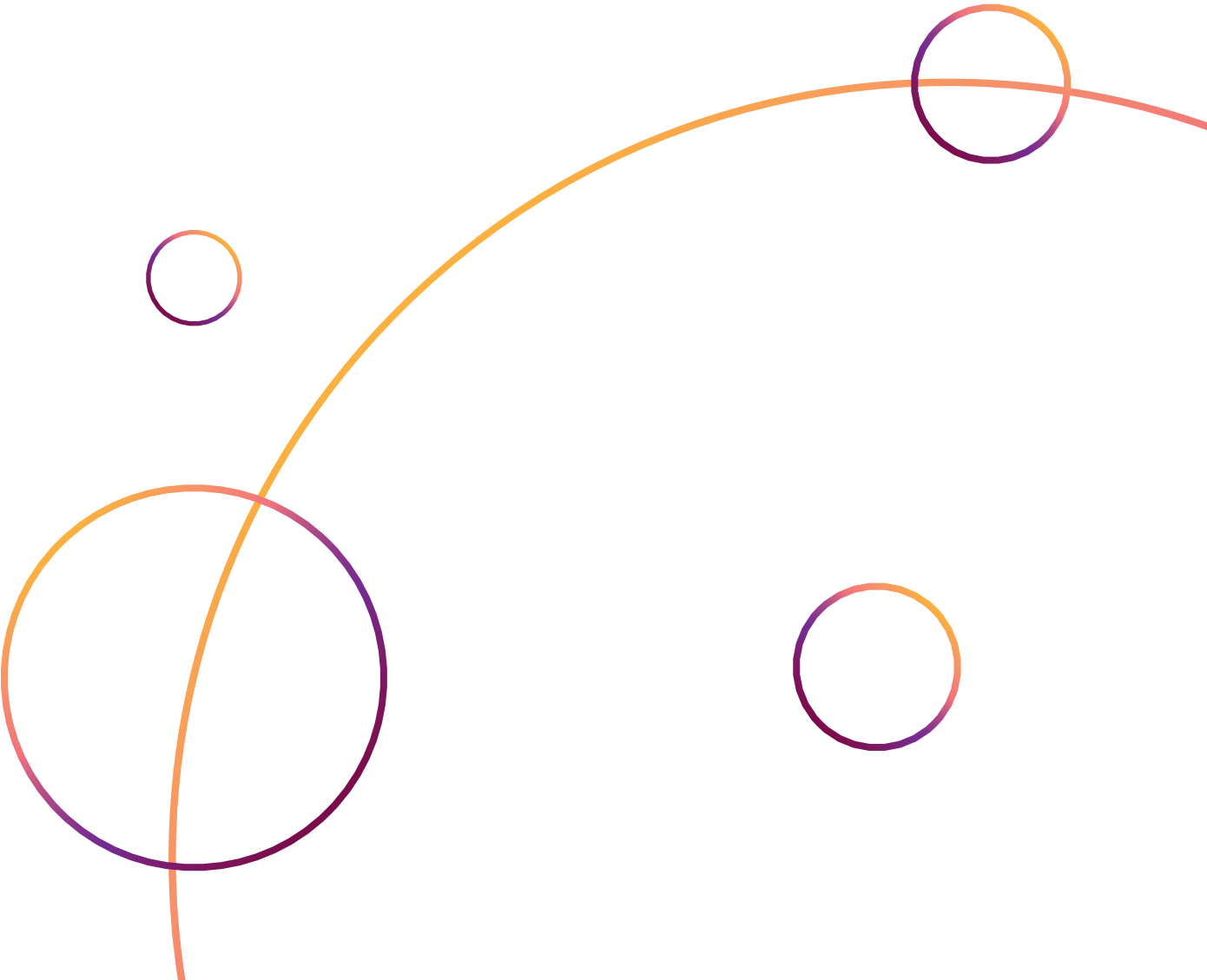
The ASEAN Renewable Energy Regional Approach captures the most ambitious scenarios available from the 7th ASEAN Energy Outlook (AEO7), ASEAN Interconnection Masterplan Study III (AIMS III), 2nd Edition of Renewable Energy Outlook for ASEAN (2nd RE Outlook), conditional targets of the Nationally Determined Contributions (NDC), and other national-level policy documents and roadmaps. This study seeks to demonstrate the most progressive regional energy cooperation in decarbonising the ASEAN energy system, which also considers country-specific merits and vulnerabilities,

The analysis is based on 85 official policy documents or studies, in particular 77 national policy documents and 8 regional energy outlooks. National energy indicators as of 2020 are also assessed to understand each ASEAN member state's historical energy trend. By evaluating the effective policies and energy indicators, the Strength, Weakness, Opportunity, and Threat (SWOT) analysis is performed at the country level to extract key insights at the regional level.

The presence of numerous regional and subregional cooperation notwithstanding – for example, the ASEAN Plan of Action for Energy Cooperation (APAEC) – the only energy-focused policy documents at the regional level that compile the output of high-level discussions have not translated well into member states' policies and governance. Inadequate human capacity, funding support, and infrastructure are the primary bottlenecks in streamlining different donor-driven programmes for regional integration goals. Brunei Darussalam and Singapore could facilitate the development of green financing initiatives for the region to achieve a common RE goal.

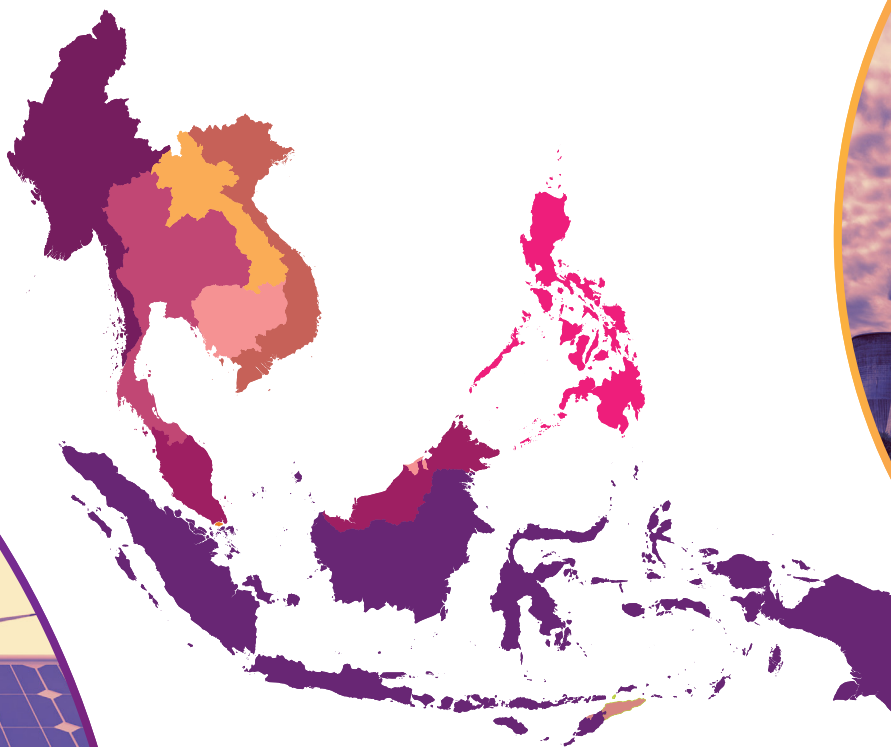
The AMS that have exercised different policy instruments to incentivise renewable energy adoption could exchange lessons learned and knowledge with the others. Indonesia could share its experiences in large-scale geothermal exploration and construction. Lao PDR could recommend best practices in developing large-scale hydropower and establishing bilateral power projects. Malaysia could share its experience transitioning from feed-in tariffs (FIT), to auction schemes that foster competitive solar prices. The Philippines could contribute its know-how in establishing a wholesale electricity spot market. Thailand could provide examples of building supply chains in biofuel and biomass production. Vietnam could recommend the best supportive environments to attract private participation in its domestic solar and wind market. Expertise and interactive sharing within ASEAN would be more effective in finding neutral and practical solutions, whilst encouraging transparency.

By the end of this report, the near-, medium-, and long-term targets and their respective action plans will be proposed, which will serve as the basis for developing the ASEAN Renewable Energy Long-term Roadmap. Seven phases over a 30-year period cover four fundamental elements of the regional approach. They establish enabling environments for RE investment, create RE investment facilities, extend energy interconnectivity within ASEAN and beyond, and increase RE ambitions to 100% by 2050.



CHAPTER 1

Introduction



ASEAN has diverse topographies, economies, cultures, and development. ASEAN Member States (AMS) are blessed with abundant renewable energy (RE) resources, which could strengthen the region’s sustainable development. Under the ASEAN Plan of Action for Energy Cooperation (APAEC) Phase II: 2021 – 2025, the AMS aspire to have a 23% RE share of the total primary energy supply (TPES), which was a reasonable target when it was introduced ten years ago in APAEC Phase I: 2016 – 2020. However, RE growth only reached 14.2% by 2020, leaving a nearly 10% gap to close in less than five years.

Besides the pressing need to rapidly increase RE deployment, ASEAN needs to define new milestones for regional energy cooperation beyond 2025. ASEAN must carefully consider each AMS’ socio-economic characteristics, national priorities, and exploitable RE resources to craft sensible objectives. The next APAEC could adopt higher RE, energy efficiencies, emission reductions, or green financing targets. Nevertheless, clear guidelines on when to assess more ambitious pathways, and how fast all AMS must mutually agree on the pace of progression, to ensure solid regional cooperation.

In APAEC Phase II: 2021 – 2025, the RE target was defined as a 35% share of total installed capacity by 2025. ASEAN is projected to overachieve this target if RE installed capacity reaches

33.5% in 2020 (ACE, 2021). What would be the proper response, when the RE capacity target is achieved, but not the TPES? Would increasing the RE capacity target be enough, when ASEAN’s economy is affected by surging energy prices due to Covid-19 restrictions and the Russia-Ukraine geopolitical conflict?

The ASEAN Renewable Energy Regional Approach is developed amongst the other regional studies, such as the AEO7, AIMS III and 2nd RE Outlook. It identifies the connection between them, and significant findings for the formulation of the ASEAN Renewable Energy Long-term Roadmap. The study also reviews the existing national energy policy documents and roadmaps to understand the AMS strengths, weaknesses, opportunities, and threats. The study is expected to be the reference for the AMS in determining the near-, medium-, and long-term steps to realise robust energy transition.

1.1. ASEAN Renewable Energy Long-term Roadmap

The concept of the ASEAN Renewable Energy Long-term Roadmap was introduced in the 29th Annual Meeting of Renewable Energy Sub-Sector Network (RE-SSN) in May 2022. The roadmap development process involves four initial stages, as described in Figure 1.1, and it follows a working group arrangement, as illustrated in Figure 1.2.

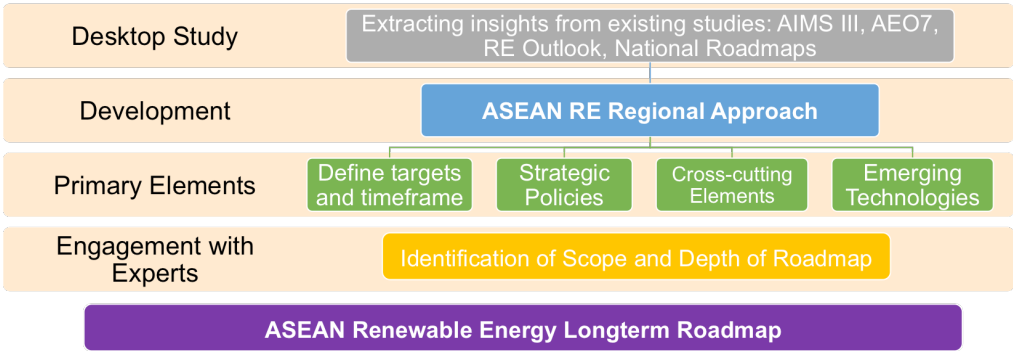


Figure 1.1 – Flow Process for Developing ASEAN Renewable Energy Long-term Roadmap

The ASEAN Renewable Energy Approach study covers the desktop study, which identifies the outputs of AEO7, AIMS III, 2nd RE Outlook, national policy documents, or roadmaps, and the primary elements. The development of the ASEAN Renewable Energy Long-term Roadmap

will be an iterative process, wherein the scope and depth of the roadmap will be defined through several consultation meetings and Focus Group Discussions (FGDs), with RE-SSN focal points and working groups.

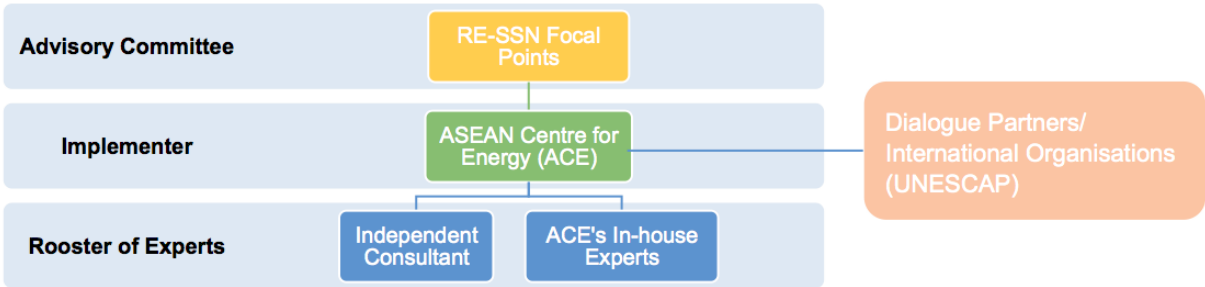


Figure 1.2 – Working Group for ASEAN Renewable Energy Long-term Roadmap

The first FGD was successfully conducted on 12 May 2022, on the second day of the 29th RE-SSN Associated Meetings. As captured in Figure 1.3, the FGD was attended by the RE-SSN focal points from seven AMS, with the exceptions of Cambodia,

Myanmar and Vietnam, and the experts from IRENA and UNESCAP. The RE-SSN focal points assumed the advisory committee role, consisting of 17 focal points from eight AMS. The advisory members will be updated in the next FGD.



Figure 1.3 – Group Photo of 1st FGD

The FGD was divided into two sessions. In the first session, the participants learned from IRENA and UNESCAP's experiences with the challenges in consolidating global and regional goals into a policy roadmap. The second session was exclusively dedicated to the RE-SSN focal points for discussion on their national RE policies and

priorities, and how they should be incorporated into the roadmap. The FGD was able to define the criteria for the long-term RE target, the strategic priorities of AMS, and the inclusion of cross-cutting issues and emerging technologies in the roadmap. The outcomes are summarised in Figure 1.4.

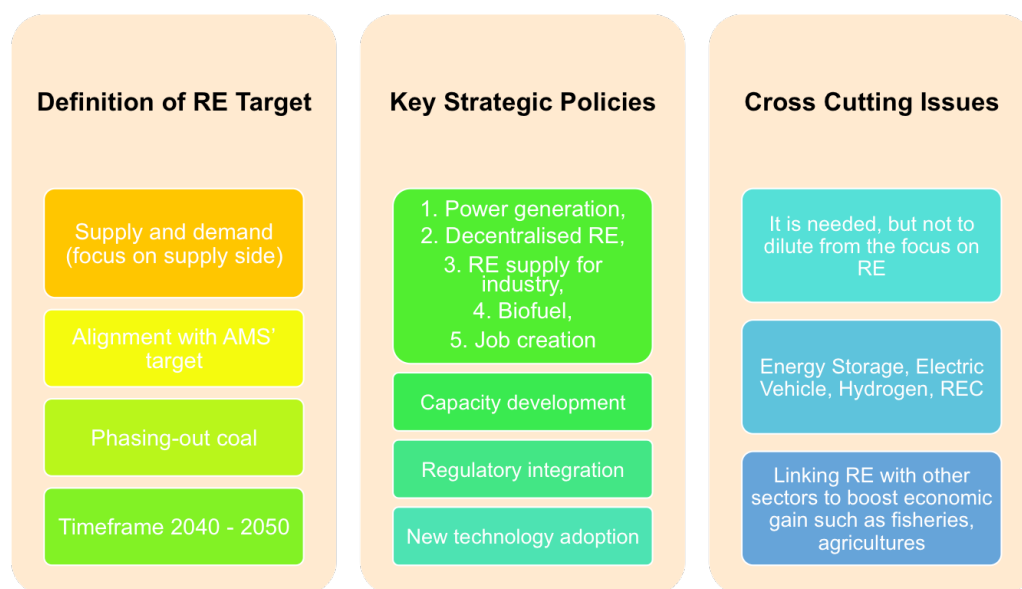


Figure 1.4 – Outcomes of Closed Discussion in the 1st FGD

The definition of an RE target should consider both supply and demand, emphasising the supply side. The regional target should harmonise AMS national targets as required, including coal phase-out and carbon neutrality. The roadmap should reflect ASEAN's RE targets and policies in the medium to long terms, with the timeframe between 2040 and 2050.

The advisory committee agreed on five strategic themes: (1) power generation; (2) decentralised RE solutions; (3) RE supply for industry; (4) biofuels; and (5) job creation. Several of the AMS highlighted selected themes that would co-benefit their national energy policies. For example, Indonesia is interested in power generation and decentralised RE; Lao PDR pointed out power generation, RE supply for industry, and biofuel; Malaysia

highlighted the importance of job creation; the Philippines prioritised power interconnection; and Thailand focused on decentralised RE and biofuel. Besides the five strategic pillars, the AMS underlined the critical need for capacity building, policy and regulatory integration, and adopting new and emerging technologies.

Cross-cutting issues, such as energy storage, electric vehicles (EV), hydrogen, and renewable energy certification (REC), received significant attention from the AMS. Most of the AMS agreed to include these topics in the roadmap; however, the roadmap should not dilute the focus on RE. Integration of RE in industry and other sectors (e.g., fisheries, agriculture) should be discussed in the roadmap, considering both the benefits and impacts on the local communities.

1.2. ASEAN Renewable Energy Regional Approach

ASEAN Renewable Energy Regional Approach incorporates three primary activities. The first component researches regional energy development, highlighting RE growth. The second analyses policy development in the region,

identifying policy and regulatory gaps, whilst exploring opportunities to create an enabling environment for RE in electricity generation, transportation, heating/cooling, and cooking. The third component lays out the regional strategic approach for the next 30 years, as the basis of the ASEAN Renewable Energy Long-term Roadmap.



Figure 1.5 – Summary of the three project components

This report aims to create a path for enhanced RE ambitions in the future, using the best scenarios available from the regional outlook, i.e. APAEC Target Scenario (APS) from AEO7, High RE Scenario from AIMS III, and 1.5°C Scenario from 2nd RE Outlook. Additionally, this study reviewed conditional targets from Nationally Determined Contributions (NDCs) and national policies, plans, roadmaps, regulations, and standards, as the primary references in developing the ASEAN Renewable Energy Regional Approach.

AEO7 provides comprehensive total energy supply and demand up to 2050, in which the greatest-ambition pathway is reflected by APAEC Target Scenario (APS). AIMS III investigates the optimum RE penetration, by means of cross-border interconnection and resource availability in the High RE Target Scenario. The 2nd RE Outlook explores drastic greenhouse gas (GHG) emission reductions to meet the Paris Agreement goal of keeping the global temperature rise below 2°C, and limited to 1.5°C. The most progressive

approach is demonstrated by the 1.5°C Scenario.

The NDCs of each country have a significant impact on the renewable energy sector. If international support is available, conditional targets that countries would undertake are used as references. A comprehensive list of available data, policies, regulations, and standards in the methodology section..

1.2.1. Methodology

National energy plans and NDCs capture the respective sovereign authorities and priorities of the AMS. A collective roadmap (2023-2050), derived from individual country plans and targets, will strengthen the overview of ASEAN's investment needs for the next decade. For the sectoral analyses, energy is sub-categorised into transportation, commercial/industrial, cooking, and residential sectors. The study assessments require five essential steps, as summarised in Figure 1.6.

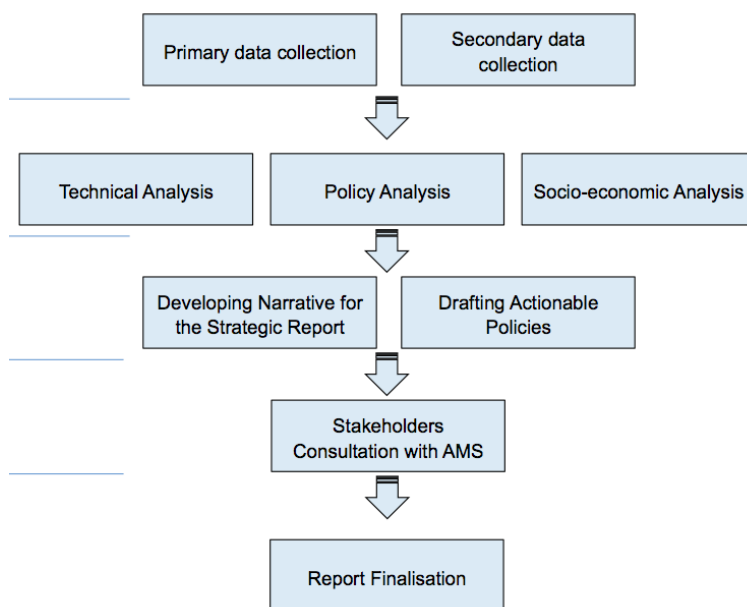


Figure 1.6 – Summary of the Methodology

1.1.2. Primary Data Collection

Two primary data sets were collected from AEO7, along with ten sets of NDC from the AMS. Two versions of NDC are observed in the case of Myanmar, as there were two versions released. The primary energy data sets are: final energy consumption, total energy demand, electricity demand, primary energy supply, electricity generation, installed capacity, energy efficiency targets, tariffs, hourly generation mix, energy trade (import/export), and electric vehicle penetration

and targets. The primary data sets from the latest NDCs are emission targets by 2025 and 2030, in the electricity, transportation, commercial/ industrial, and cooking sectors.

The primary and secondary data collection on policy was extensively carried out by reviewing 77 national policy documents and eight official energy outlooks or studies at the ASEAN level. The reviewed policy documents are summarised in Figure 1.7, and details are available in the Appendix.

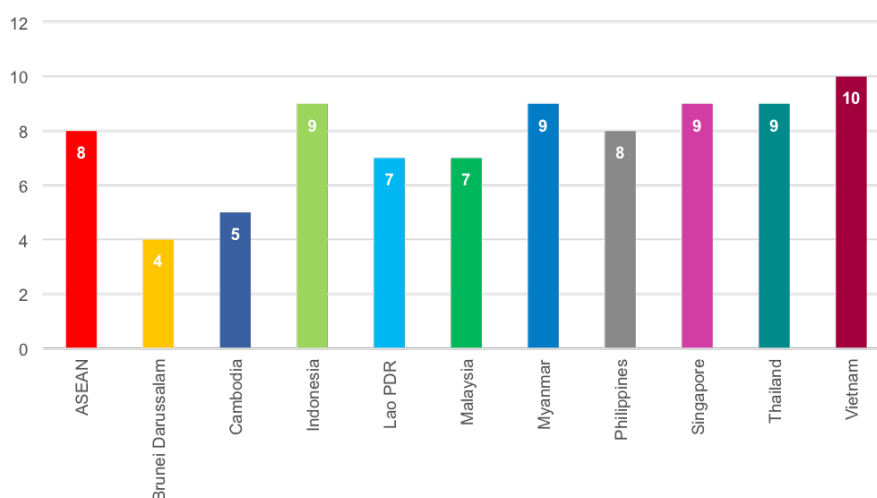


Figure 1.7 – Total Reviewed Policy Documents

1.1.3. Secondary Data Collection

The secondary data are collected from reputable studies in the region, performed by USAID, GIZ, IRENA, IEA, ADB, and WWF. The data sets are collected to cross-check the projections and assumptions for future RE scenarios. Further desk study on the new policies released in 2021 and 2022 will be added to the data list for roadmap development.

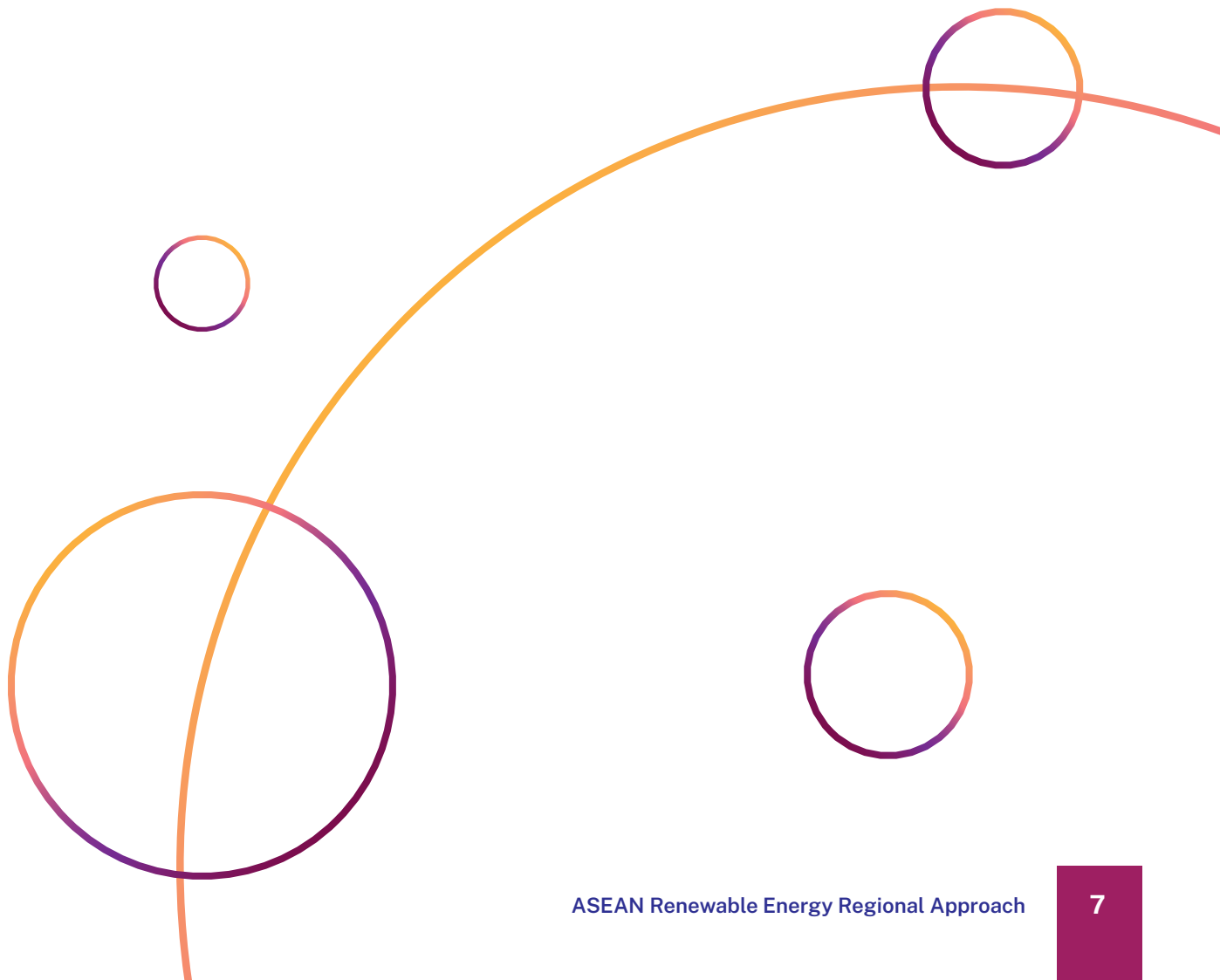
1.1.4. Policy, Social and Technical Analyses

Policy analysis is primarily conducted via desk research, by reviewing the shortlisted policy documents and cross-checking with AMS' presentations in recent workshops and high-level

meetings organised by ACE. The policy analysis maps existing policies in ASEAN, from 2010 to 2022, and identifies the regional- and country-level policy gaps to achieve APS targets.

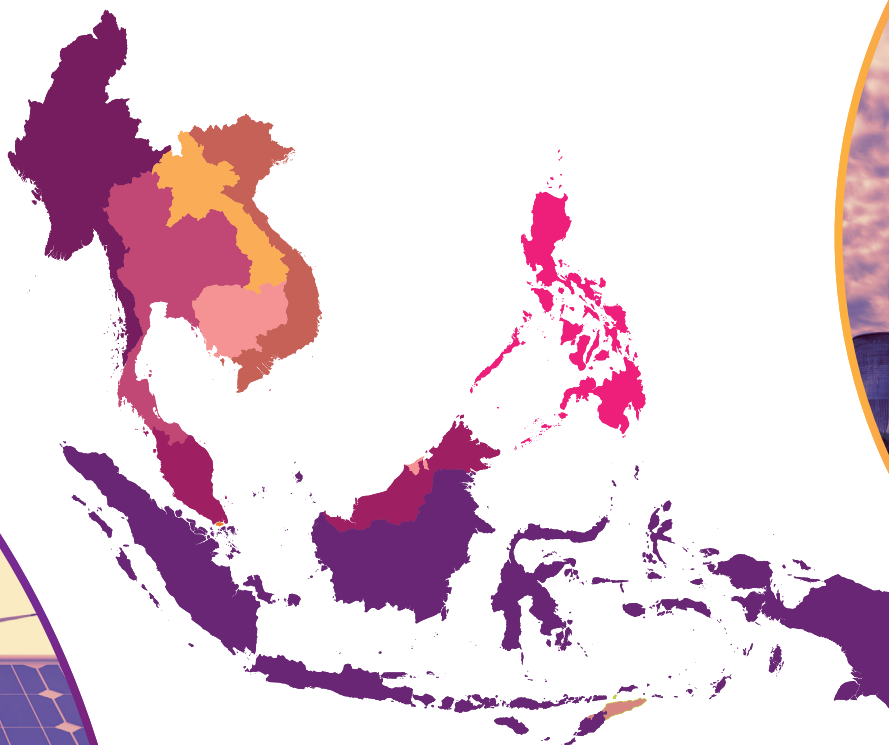
The socio-economic analysis focuses on job creation, gender inclusion, income-generating opportunities, land access and use, protecting natural habitats, access to services and infrastructure, health and well-being, and lifestyle. The analysis is conducted with a series of interviews with non-state actor experts.

Technical analysis is based on AE07's APS and AIMS III. The technical analysis forecasts future advancement of technology, which may further improve the stability of national and regional grids with higher RE.



CHAPTER 2

Regional Energy Status



ASEAN's economy has bounced back from the Covid-19 induced contraction, as can be seen in Figure 2.1. The pandemic severely impacted most of the AMS GDPs, with the exception of Lao PDR, Myanmar, and Vietnam, which still showed positive growth. By the end of 2021, all AMS had recovered with a promising GDP rise, notably Brunei Darussalam, Indonesia, Malaysia, Singapore, and Vietnam, each with >10% increases. Regional

GDP is recorded at USD 3.35 trillion (ASEAN Secretariat, 2022), placing ASEAN as the fifth largest economy after the United States, China, Japan, and Germany (World Bank, 2023). Intra-ASEAN GDP contributions are dominated by Indonesia (35.4%), Thailand (15.1%), Singapore (11.8%), the Philippines (11.8%), Malaysia (11.1%), and Vietnam (10.8%).

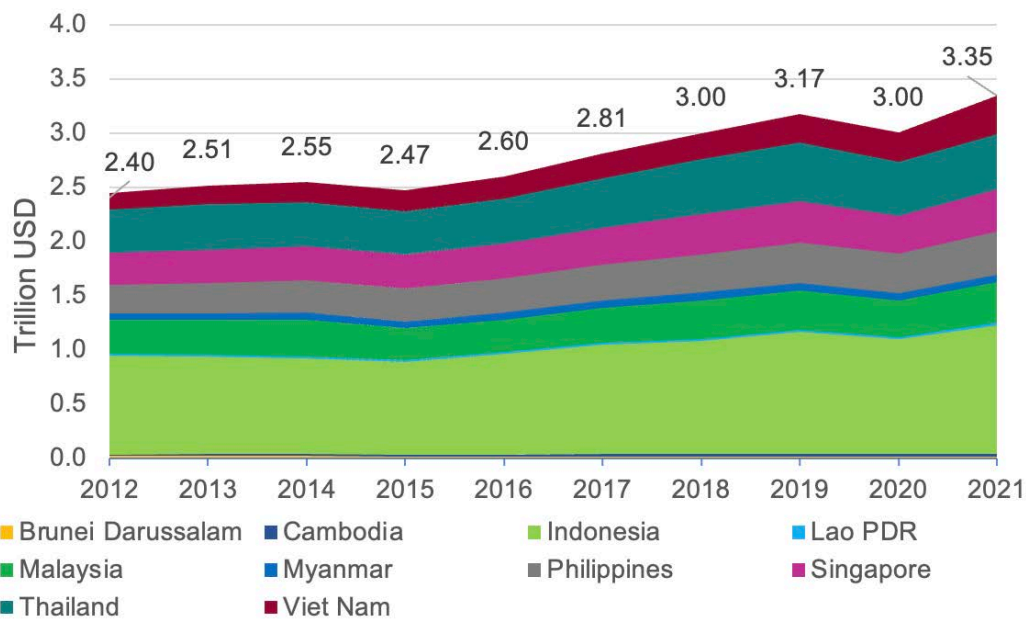


Figure 2.1 – Current ASEAN GDP in USD, 2012 – 2021

The region's economic growth has been accompanied by high energy consumption, as reflected in Figure 2.2. Over the past decade, oil, electricity and coal use were the top three in ASEAN's total final energy consumption (TFEC). Despite the demand drop in 2020, oil constituted the most significant share, with 43.8% of TFEC, followed by electricity (22.6%), coal (12.6%), natural gas (7.4%), modern biomass (6%), traditional biomass (5.1%), and biofuels (2.5%). However, as compared to 2010, electricity consumption increased by 67.4%, of which oil was only 27%, natural gas 24%, and coal 16.2%.

Notably, biofuel demand jumped seven-fold, from 1.4 Mtoe in 2010, to 9.6 Mtoe in 2020.

By comparison, industry, transportation and residential were the three primary energy consumers in the last ten years. Industry and transportation are energy-intensive sectors, with 38.6% and 34.8% shares of TFEC in 2020, respectively. The contributions of other sectors in the same year were residential (16.6%), commercial (7.6%), followed by agricultural and others (2.2%). Although transportation was in second place, its consumption growth was the most significant. This sector grew by 1.5 times,

from 90.5 Mtoe in 2010, to 134.2 Mtoe in 2020. Meanwhile, residential consumption declined by 2.3% from 2010, which might reflect an

improvement in energy-saving practices and use of energy-efficient appliances.

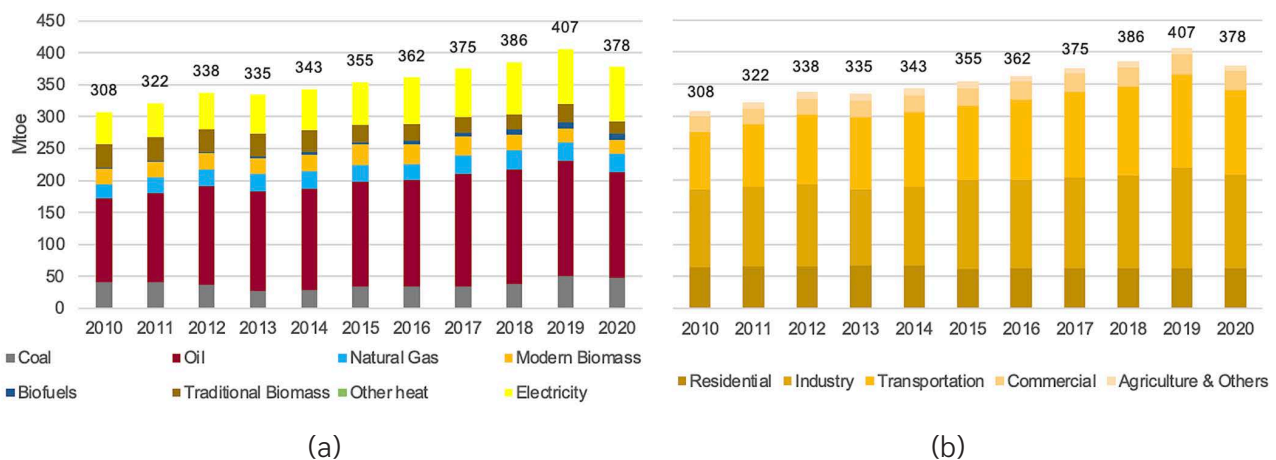


Figure 2.2 – ASEAN TFEC by Fuel (a) and by Sector (b), 2010 – 2020

On the supply side, fossil fuels dominated ASEAN’s energy mix in 2020, led by oil (33.2%), coal (28.2%), and natural gas (21.9%). The intensified commitment to decarbonisation notwithstanding, coal supply doubled from the 2010 level, and oil and gas increased by 19% and 4%, respectively. RE expanded by 1.5 times by 2020, from 59.5 Mtoe in 2010, to 93 Mtoe. Looking closer, solar

generation jumped in 2013, from 47.5 Mtoe to 125.6 Mtoe, and wind rose in 2014, from 9.6 Mtoe to 54.1 Mtoe. Moreover, exploited energy from hydro doubled, and biofuel increased by nine times from 2010 – 2020. Regardless, the overall RE share is considerably modest, with only 14.2% of TPES, as indicated in Figure 2.3.

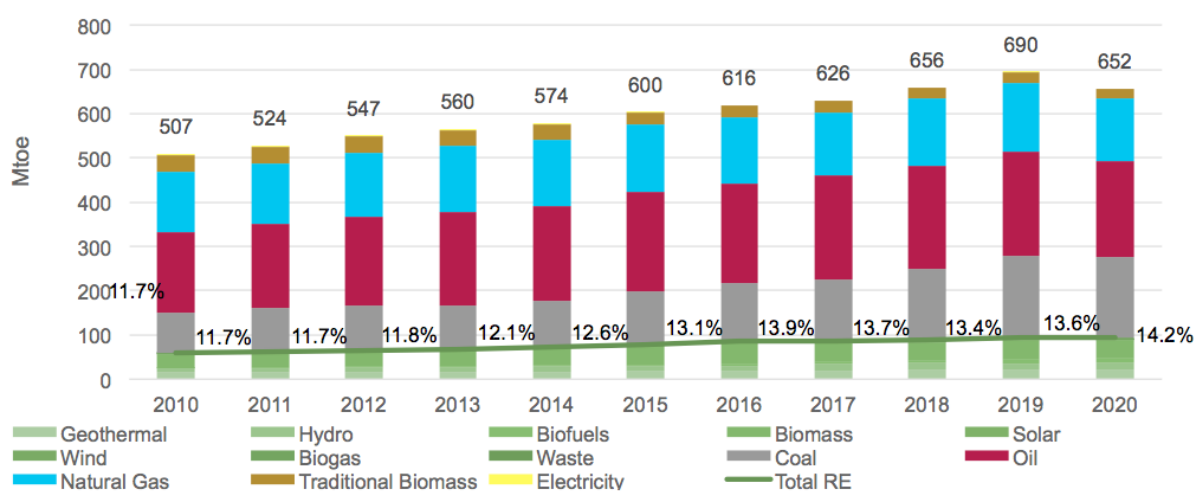


Figure 2.3 – ASEAN TPES by Fuel and RE Share, 2010 – 2020

Subsequent sections of this report will focus on the installed capacity trend for each member country, to evaluate electricity supply availability and its potential for an RE regional approach.

Understanding the national context is essential in identifying alternatives for enhanced regional energy market integration of the ASEAN Power Grid (APG). Examples include REC, carbon pricing, white certificates, biofuels, and RE supply chain trading. Electrification of the transportation and cooking sectors prompted the need to examine the connection between the electricity supply and TFEC, as a means of ensuring power sourcing from RE.

2.1. Brunei Darussalam

2.1.1. Electricity

Brunei Darussalam is the least populous country in the region and has the lowest generation capacity, with 1.2 GW in 2020, which meets 100% of the population's demand (ACE, 2021). The country's electricity generation relied heavily on oil and natural gas, with a small amount of solar generation. Brunei Darussalam's grid is currently not connected to any other AMS, though APG envisages a connection between Brunei Darussalam and Sarawak.

In 2020, Brunei Darussalam's National Climate Change Policy (BNCCP) adopted ten key strategies, with 2035 as the target year. Regarding RE, Brunei Darussalam targets a 30% share of total capacity. In December 2022, Brunei Shell Petroleum Company (BSP) fulfilled the International Renewable Energy Certificate (I-REC) standard to track power generation attributes from its 3.3

MWp solar farms, commissioned in April 2021 (Borneo Bulletin, 2022). The country also plans mandatory carbon inventory reporting and carbon pricing.

2.1.2. Transportation, Energy Efficiency, and Cooking

Figure 2.4 shows that the transportation sector accounted for most of Brunei Darussalam's energy consumption, as compared to other industrial and residential segments. BNCCP will pursue an electric vehicle (EV) share increase of up to 60% of total annual vehicle sales by 2035. Accordingly, the Electric Vehicle Joint Task Force was established in 2019, to ensure the implementation of the EV policy. The policy objective is included in Brunei Darussalam's first NDC, and its COP-26 net-zero announcements for 2050.

Brunei Darussalam seeks to reduce total energy consumption by 63% from the business-as-usual (BAU) levels by 2035, according to their INDC. This target is superseded by BNCCP Strategy 5 in the first NDC, which targets a 10% GHG emission reduction through better supply and demand management. Several measures have been considered, such as requiring a minimum efficiency of 48% for all new power plants, removal of partial load operations, minimising transmission and distribution loss, and diversifying the electricity supply with RE. According to BNCCP Strategy 1, the country plans to rejuvenate oil and gas facilities to achieve zero routine flaring and implement As Low As Reasonably Possible (ALARP) policies in other industries. As a developed country, Brunei Darussalam has reached 100% clean cooking access, with most households having gas or electric stoves.

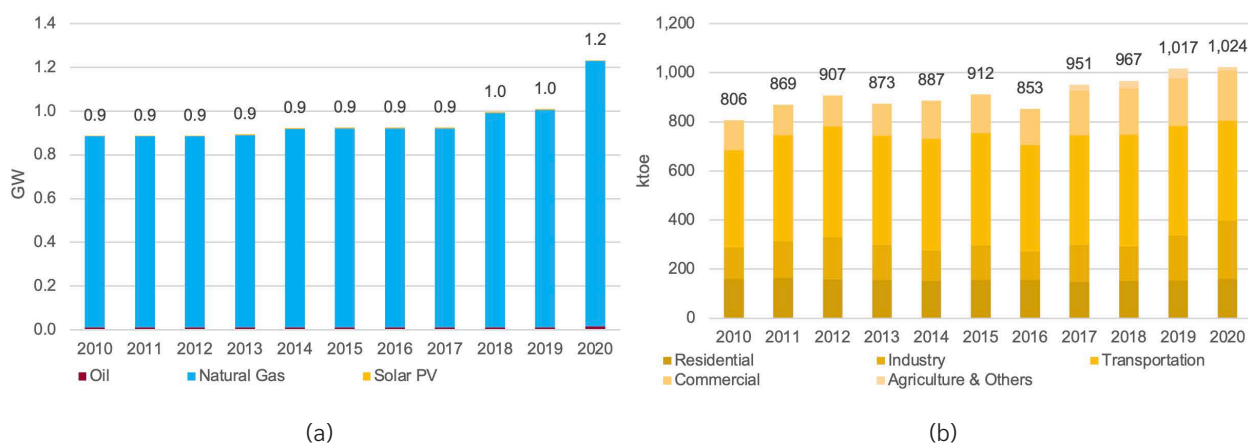


Figure 2.4 – Brunei Darussalam's Installed Capacity (a) and TFE (b), 2010 – 2020

2.2. Cambodia

2.2.1. Electricity

Cambodia's power capacity expanded significantly to meet growing demand over the past decade. Figure 2.5 captures the exponential increase, from 0.4 GW in 2010, to 3 GW in 2020. Hydro, coal and oil accounted for the majority of installed capacity at 1.3 GW, 675 MW, and 659 MW, respectively. Hydropower leapt by 15 times in 2011, from 13 MW to 207 MW. Coal capacity jumped eight-fold in 2013, from 13 GW to 113 GW. The country began installing solar farms in 2017, with capacity rising from 10 MW to 297 MW in 2020. Cambodia's grid is currently connected to Lao PDR, Thailand and Vietnam. These connections will be expanded to increase capacity.

At COP-26, Cambodia updated its first NDC and released its Long-term Strategy for Carbon Neutrality soon after. Cambodia targeted a 25% RE share of power generation capacity by 2030, and 35% by 2050. Cambodia also committed to not adding new coal generation capacity beyond already committed projects, using natural gas as a dispatchable transition fuel. It is further investing in storage infrastructure and LNG imports as a

substitute for coal in the industrial and power sectors. Cambodia is working with ADB to create a new Power Development Plan (PDP) for 2021 – 2040. The country intends to also introduce new policy schemes, such as free land leases with tax and customs duties exemptions, to boost foreign investment in solar development.

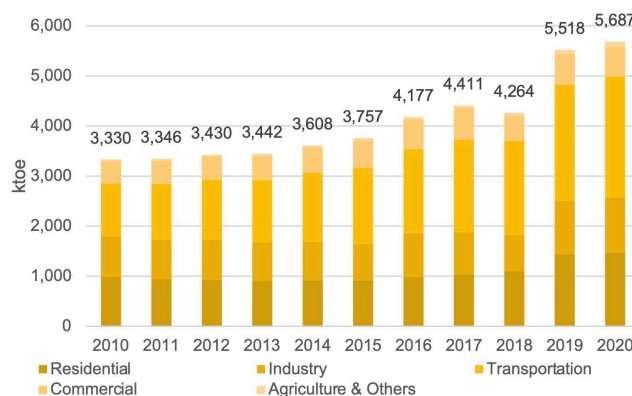
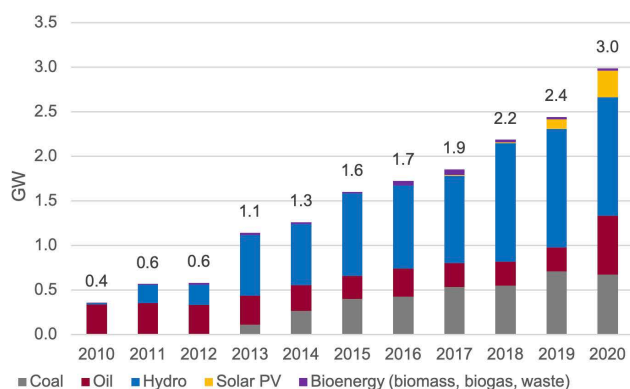
2.2.2. Transportation, Energy Efficiency, and Cooking

The transportation sector consumes the most energy in Cambodia. Aligning with its net-zero targets by 2050, the country is aiming for EV penetration of 70% for motorcycles, and 40% for cars and urban buses by 2050. Increasing the fuel efficiency of internal combustion engine vehicles is also targeted, including broader use of public transportation to reach 30% of the urban population by 2050, and 80% CNG penetration for interregional busses.

Residential, commercial, and industrial are the three largest consumers after transportation. In the first updated NDC, Cambodia has conditionally targeted electricity use reduction of 1.2 TWh (29.7%) by 2030, via application of electrical appliance labelling and minimum

energy performance standards (MEPS). Furthermore, the first updated NDC advised a 2% energy consumption reduction in residential and commercial buildings, a 10% electricity use savings in commercial buildings, and 2.3% power use decrease through more efficient motors and boilers.

Biomass is still the primary energy source for cooking in Cambodia. The World Bank energy access diagnostic report shows that 66.7% of the interviewed households use biomass in their primary stove, with 62% using firewood and 5% using charcoal. Clean fuel stoves, primarily LPG, are more common than electricity in urban areas (Ruto Dave et al., 2018).



(a) (b)
Figure 2.5 – Cambodia's Installed Capacity (a) and TFE (b), 2010 – 2020

2.3. Indonesia

2.3.1. Electricity

Indonesia has the region's largest population (270.2 million) and the highest TFE (122.5 Mtoe) as of 2020. To keep up with growing energy demand, the installed capacity doubled from 34 GW in 2010, to 76.1 GW in 2020, as seen in Figure 2.6. The capacity expansion was largely driven by coal development, which tripled from 13 GW in 2010. In 2020, RE held only 13.7% of total installed capacity, a modest share when compared to the three giants: coal (52.7%), natural gas (27.3%), and oil (6.4%). Indonesia is not currently connected to any other AMS. Like Cambodia, Indonesia announced its net-zero pledge at COP-26. Its updated NDC states a conditional target of 21.65 GW RE production by 2030, whilst the

committed RE capacity in the latest PDP (RUPTL 2021 – 2030) is only 7.4 GW. Besides RE scale-up, the country is considering the utilisation of solar rooftop, waste-to-energy, small-scale biomass, and co-firing in existing coal power plants, with a 30% biodiesel mandatory blend in the first phase (through 2030). In the second phase (up to 2035), Indonesia will prioritise geothermal deployment, green hydrogen, battery energy storage systems, and 40% biofuel blend. In the final phase (up to 2050), Indonesia will pursue green hydrogen production to replace natural gas for high-temperature heating processes, a higher RE share than fossil fuels, and biofuel use at 40%. Presidential Regulation No. 112 of 2022 was issued to further accelerate RE development for the electricity supply mix.

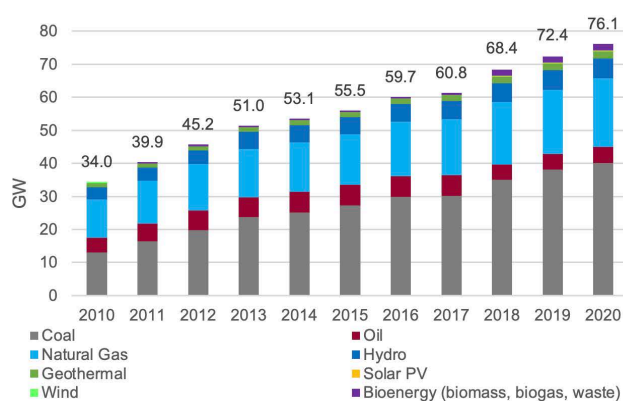
2.3.2. Transportation, Energy Efficiency, and Cooking

Indonesia's transportation sector consumed 40.5% of TFEC in 2020, and was consistently the most energy-intensive sector over the last decade. The electric vehicle roadmap was introduced in 2020, along with other programmes to promote EV use in Indonesia's road transportation fleet. The notable targets are: (1) 2,400 public charging and 10,000 battery swapping stations by 2025; (2) 19,000 registered 4-wheeled and 750,000 2-wheeled EVs by 2025; and (3) 2 million electric cars and 13 million electric motorbikes by 2030.

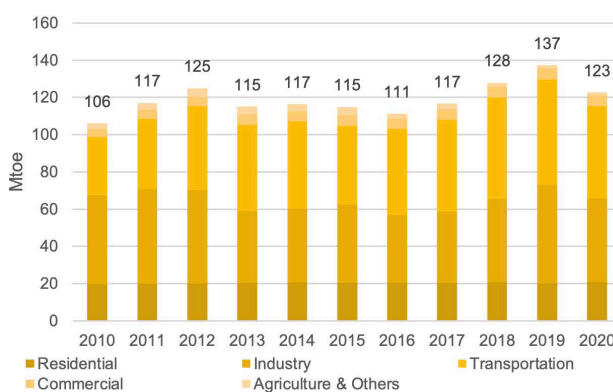
Since 2010, energy efficiency improvements in Indonesia have saved an additional 8% of energy use in 2018. Economic activity has

shifted from energy-intensive industrial, to less-intensive manufacturing and service sectors, resulting in additional energy savings (IEA, 2021). With Presidential Regulation No. 22 of 2017, the government has set out to reduce energy intensity by 1% per year to 2025, with TFEC reduction of 52.3 Mtoe by 2025, and 87.1 Mtoe by 2030.

Indonesia's LPG consumption has skyrocketed since the introduction of the kerosene-to-LPG conversion programme in 2007. Clean cooking has burdened the government's budget with the import and subsidising of LPG. The government introduced a plan using induction stoves (MECS et al., 2021) to target conversion of 22% of cooking energy to electricity by 2030.



(a)



(b)

Figure 2.6 – Indonesia's Installed Capacity (a) and TFEC (b), 2010 – 2020

2.4. Lao PDR

2.4.1. Electricity

Lao PDR is a landlocked country with a predominantly hilly topography, with mountain ranges in the northeast and northwest, and several river valleys, making hydroelectric power the country's primary source of electricity. Hydro is also an essential energy commodity for electricity export. Total installed capacity

expanded five-fold from 1.9 GW in 2010, to 10.4 GW in 2020. Hydropower has predominantly supplied its capacity mix over the last ten years. In 2015, Lao PDR built a 1.9 GW coal power plant, and expanded bioenergy eight-fold to diversify its power supply. In 2017, solar capacity increased ten-fold, from 1.1 MW to 11 MW. Lao PDR has been a long-term RE power supplier to its neighbouring countries, and its grid is connected to Thailand and the northern region of Vietnam.

Lao PDR is committed to achieving net-zero emissions by 2050. The country is set to increase solar and wind capacity to 1 GW, and biomass to 300 MW, with international support. This is in addition to an unconditional commitment to add 13 GW of hydropower for both domestic use and export by 2030. Lao PDR seeks to ramp up biofuel production to supply 10% of transportation fuels by 2030. In addition to RE, the country is pursuing universal electricity access with 98% household electrification by 2025.

2.4.2. Transportation, Energy Efficiency, and Cooking

Figure 2.7 shows that transportation is Lao PDR's second-fastest growing sector, after the industrial sector, with 28.6% of TFEC in 2020. In its latest NDC, the country set a conditional target of 30% EV penetration for 2-wheelers and passenger cars in the national vehicle mix by 2030. Furthermore, the government introduced a new policy in 2021 aiming to increase the share of electric vehicles to

1% by 2025, and 30% by 2030, to minimise fuel imports and harmful gas emissions (SMMR, 2022).

Lao PDR is in the early stages of energy efficiency implementation, and the government has indicated a desire to reduce final energy consumption by 10% in all sectors by 2025 (ADB, 2019). This vision was formalised as a conditional NDC target, seeking a 10% reduction in TFEC by 2030, as compared to the BAU scenario, and 20% by 2040. Lao PDR's unconditional target is to introduce 50,000 energy-efficient cook stoves using biomass pellets by 2030.

The majority of the population (67%) lives in rural areas. Most low-income households in both rural and urban areas depend on wood and charcoal for cooking. Cooking fuel accounts for 70% of the nation's energy consumption (Switch-Asia, 2017). The government is striving to scale up the number of households using biogas by 50,000 in 2025, to reduce LPG imports, use of charcoal and firewood, and electricity use for heating.

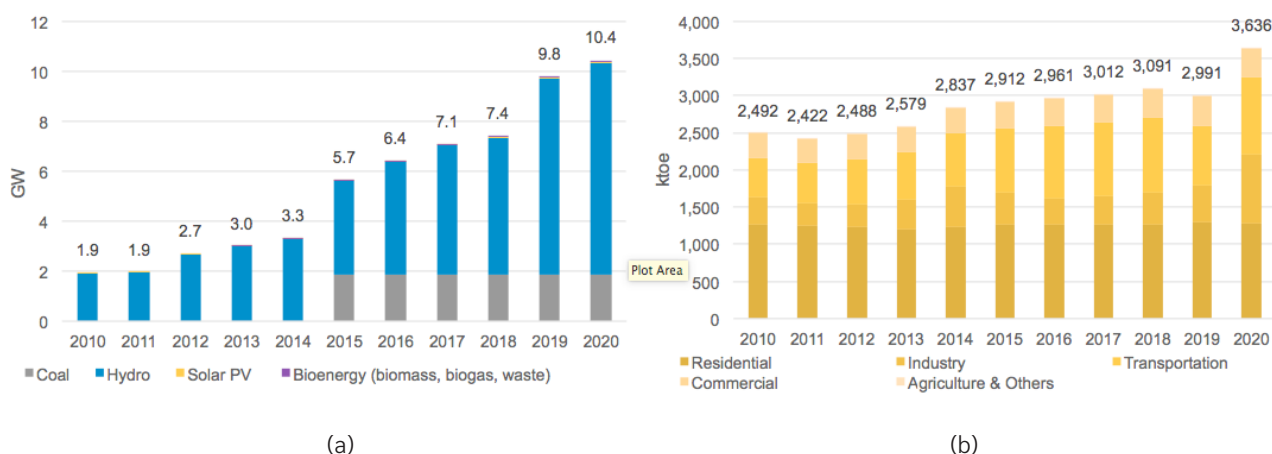


Figure 2.7 – Lao PDR's Installed Capacity (a) and TFEC (b), 2010 – 2020

2.5. Malaysia

2.5.1. Electricity

Malaysia consistently ranks amongst the highest population and GDP in the region. Its electricity generation primarily originates from coal and gas, along with a sizable contribution from hydro and solar. Total installed capacity reached 34.4 GW in 2020, which was comprised of coal (37.4%), natural gas (37.6%), hydro (18%), solar (4.5%), bioenergy (2.1%), and oil (0.4%). Solar deployment began with 32.8 MW in 2012. It grew 47-fold, reaching 1.6 GW in 2020. At the same time, bioenergy increased 15-fold, from 50 MW in 2010, to 762 MW in 2011.

Malaysia's grid consists of three subsystems that are not interconnected. They are Peninsular Malaysia, Sabah, and Sarawak. Peninsular Malaysia is already connected to Singapore and Thailand. Sarawak is currently linked to West Kalimantan, and will be connected to Sabah and Brunei Darussalam. Sabah is not currently connected to any other AMS, but will be interconnected with Sarawak and Kalimantan.

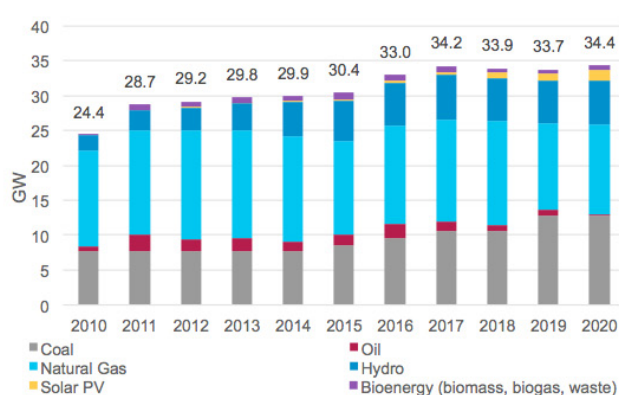
Malaysia Renewable Energy Roadmap (MyRER) was released in 2021. In it, RE share is set to increase to 31% of the power capacity mix by 2025, whilst ensuring the penetration of intermittent RE does not exceed 24% of peak demand in Peninsular

Malaysia and 20% in Sabah. By 2035, RE share is expected to reach 40% of total installed capacity, whilst solar penetration is limited to 20% of peak demand to ensure system stability.

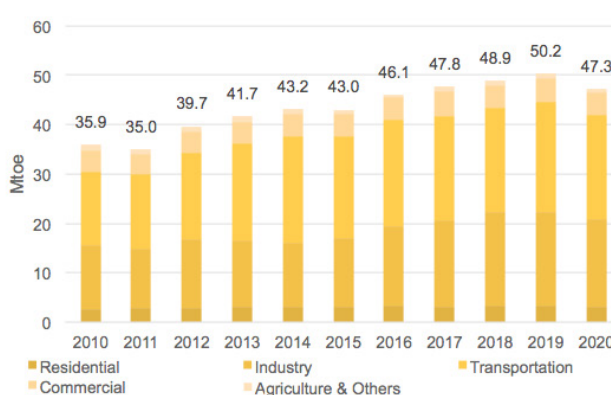
2.5.2. Transportation, Energy Efficiency, and Cooking

Malaysia's transportation sector represents the most significant component of final energy demand, with 21.1 Mtoe in 2020, as indicated in Figure 2.8. Under the Low-Carbon Mobility Blueprint, the government established a national target of 9,000 AC charging points, and 1,000 DC charging points installed by 2025. The percentage of EV share is targeted to increase by 38% in 2040, under the Low Carbon National Aspiration Plan (KASA, 2021). Malaysia's Third National Communication and Second Biennial Update Report stated that the projected number of EVs will reach 443 by 2020, 963 by 2025, and 1,683 by 2030, with hybrid vehicles reaching 108,098 by 2020, 201,484 by 2025, and 322,532 by 2030.

Under the Low Carbon National Aspiration, Malaysia targets industrial and commercial energy efficiency savings of 11%, and residential energy efficiency savings of 10% by 2040 (IEA, 2022). With a 100% electrification rate, World Bank data shows more than 95% of Malaysia's population has had access to clean cooking since 2000.



(a)



(b)

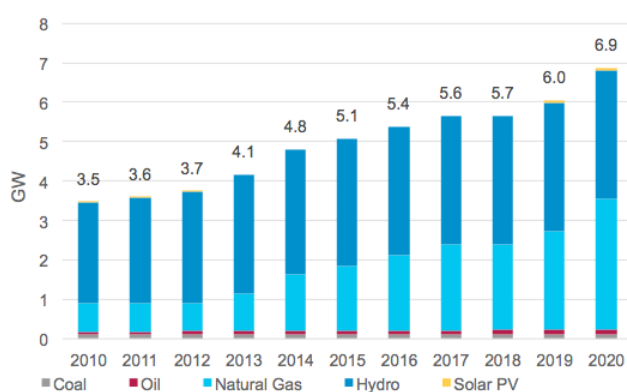
Figure 2.8 – Malaysia's Installed Capacity (a) and TREC (b), 2010 – 2020

2.6. Myanmar

2.6.1. Electricity

Myanmar has one of the lowest electrification rates in the region, with most of the existing electricity generated from hydropower, which made up 47.6% of the total installed capacity in 2020. The other half of the supply is contributed by natural gas, with 48.4%. Solar accounts for 40.1 MW, or 0.6% of the power capacity mix, which was added in 2019. Myanmar is a rapidly developing nation. Its installed capacity doubled from 3.5 GW in 2010, to 7 GW in 2020. Its national grid is not connected to any other AMS. Under APG, Myanmar is expected to be linked to Lao PDR and Thailand.

In the latest NDC, Myanmar conditionally aspires to a 48% RE share in the electricity generation mix by 2030, whilst its unconditional target is 39%. Myanmar is committed to a partial net-zero goal, to conditionally achieve net-zero emissions from land use, land use change, and forestry (LULUCF) by 2040.



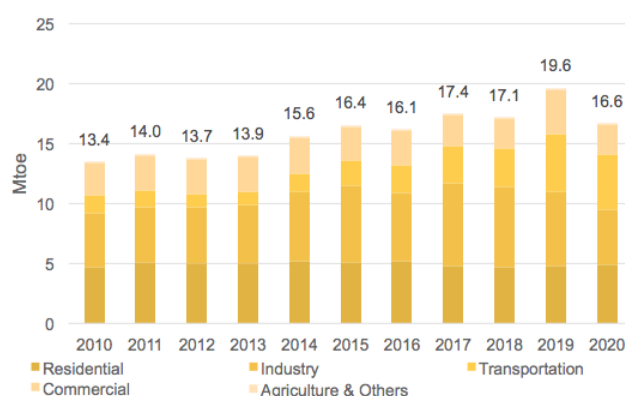
(a)

2.6.2. Transportation, Energy Efficiency, and Cooking

Figure 2.9 shows that energy consumption in the transportation sector grew fastest in the past decade. To promote the use of electric vehicles, the Myanmar government has eliminated the customs tariff for importing EVs. Whilst there is no specific target for EV penetration, five charging stations will be installed along the national highway as a pilot project, each accommodating up to 50 EVs.

Myanmar committed to a 20% policy target for energy efficiency by 2030, with a cumulative reduction of 0.133 million tCO₂e, as a conditional energy efficiency target.

Myanmar has one of the lowest access rates to clean cooking in the region. As of 2018, only 28% of the population had access to clean cooking. Electricity and LPG are the significant sources of electricity in urban areas; charcoal and biomass are still used in both rural and urban areas. The latest NDC iterates Myanmar's Fuel-Efficient Cook Stoves programme, targeting almost 4 million emission-free cookstoves distributed by the Dry Zone Greening Department (13.5%) and the Department of Agriculture (86.5%).



(b)

Figure 2.9 – Myanmar's Installed Capacity (a) and TFEC (b), 2010 – 2020

2.7. The Philippines

2.7.1. Electricity

Electricity generation in the Philippines comes from a diverse mix of sources. Coal and oil made up the two largest sources, with 41.6% and 16.1% share of total installed capacity in 2020. The remainder came from gas (13.1%), hydro (14.4%), geothermal (7.3%), solar (3.9%), wind (1.7%), and bioenergy (1.8%). Despite its modest share, solar and wind capacity sharply increased in 2014, from just 34 MW to 306 MW. Similar to Indonesia, the Philippine grid is developed around the central islands of Luzon, Visayas, and Mindanao. Luzon is connected to Visayas, whilst Mindanao has no interconnection with the other two island networks. The Philippines are not linked to any other AMS.

The Philippines plan to install 35% RE in the power generation mix by 2030, and 50% by 2040. Regarding bioenergy, the country implemented a 5% biodiesel mandate in 2022, and increased the mandatory bioethanol blend to 10% by 2040. Unlike most AMS, the Philippines have not formalised a net-zero ambition.

2.7.2. Transportation, Energy Efficiency, and Cooking

Transportation remains the most energy-intensive sector in the Philippines, as indicated in Figure 2.10. As part of a comprehensive roadmap for electric vehicles, a 21% increase in the number of EVs is projected by 2030 (Bernie Cahiles-Magkilat, 2020). An additional 3.3 million EVs are projected by 2040 (equivalent to 10% of total road vehicles), with the primary contribution from 2.2 million electric motorcycles.

The Philippines' Energy Efficiency Roadmap plans to reduce energy intensity by 40% by 2030, equating to a reduction of 10.7 Mtoe against the BAU baseline, and a decrease in energy consumption of 1.6% per year. By 2040, the annual energy savings by sector will be: transportation 1.9%, industrial 1.3%, residential 1.2%, commercial 1.9%, and agricultural 0.9%.

Biomass accounted for 60.9% of household energy consumption, with a higher share of wood fuel primarily used for cooking and heating purposes (DOE, 2018). According to 2018 data, the population with access to clean cooking had increased slightly, but 57.6 million people still did not have access to clean cooking (ADB, 2021).

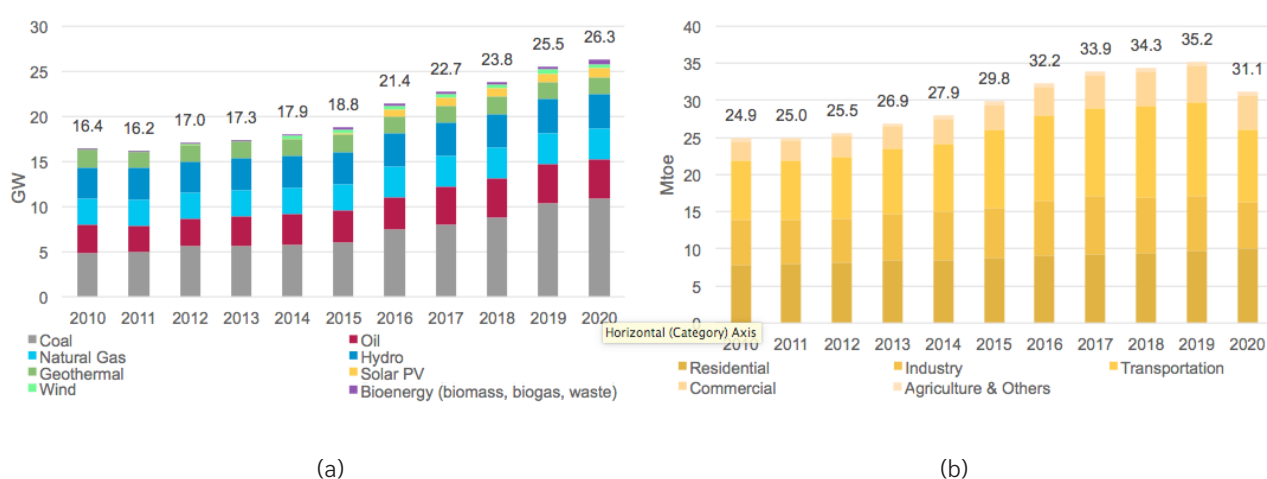


Figure 2.10 – The Philippines Installed Capacity (a) and TFEC (b), 2010 – 2020

2.8. Singapore

2.8.1. Electricity

Singapore, one of the most economically developed countries in the region, generates electricity using gas, oil, solar, and bioenergy, with a total installed capacity of 12 GW in 2020. Figure 2.11 shows that Singapore decreased its oil capacity over the past decade, and replaced it with gas and solar. Despite solar's small share of just 2.1% in 2020, its capacity increased 113-fold, from 2.9 MW in 2010, to 329 MW in 2020. Additionally, Singapore recently began importing up to 100 MW of renewable hydropower from Lao PDR, by way of the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP). The country intends to increase power imports by up to 4 GW by 2035 (EMA, 2022).

The Singapore Green Plan 2030 guides solar energy deployment, seeking to reach at least 2 GW by 2030. Generating capacity is projected to meet around 3% of electricity demand, or enough to power 350,000 households annually. Singapore also plans a 200 MW energy storage system after 2025, which could power more than 16,000 households per day.

2.8.2. Transportation, Energy Efficiency, and Cooking

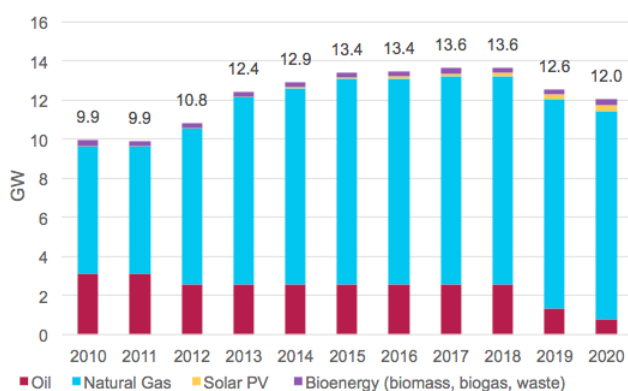
Singapore plans to replace its 400 diesel buses with electric buses by 2025, and a 100% cleaner-

energy public bus fleet (5,800 units estimated) by 2040. The country is further considering phasing out internal combustion engine vehicles by 2040, shifting to cleaner-energy alternatives such as electric or hybrid, beginning with no new registrations of diesel cars and taxis from 2025. With tax and incentive schemes to promote EVs, 60,000 EV charging points will be installed across the island by 2030, including 40,000 in public car parks and 20,000 on private premises (LTA, 2022).

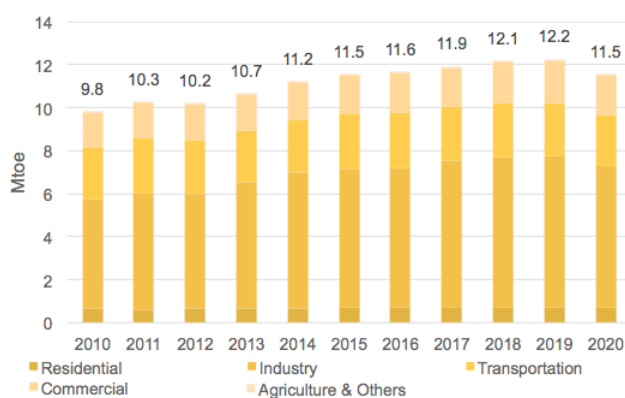
Singapore's Energy Conservation Act aims to improve energy intensity by 35% by 2030, from 2005 levels. More detailed measures were introduced in the Singapore Green Plan 2030. This plan seeks to reduce the energy consumption of the desalination process up to 2 kWh/m³, and transform Singapore's integrated waste treatment facility to 100% energy self-sufficiency by 2025.

Moreover, Singapore aims to reduce energy consumption by more than 8 million MWh per year by 2030, reducing HDB's total energy consumption by 15%, and ensuring 80% of new building construction will be of the Super-Low Energy type from 2030.

Singapore has provided universal access to electricity and clean cooking as a developed country. Electricity and LPG are the primary sources of energy for cooking.



(a)



(b)

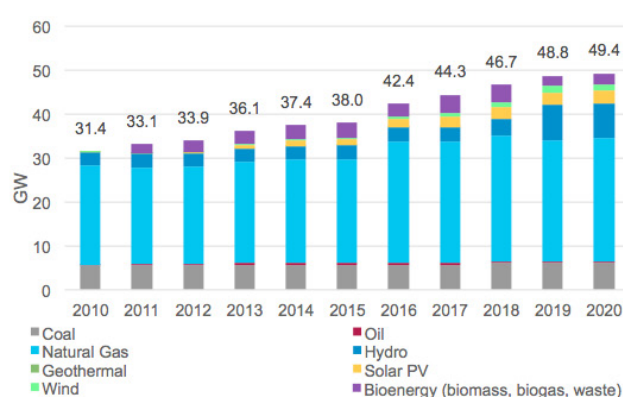
Figure 2.11 – Singapore's Installed Capacity (a) and TFEC (b), 2010 – 2020

2.9. Thailand

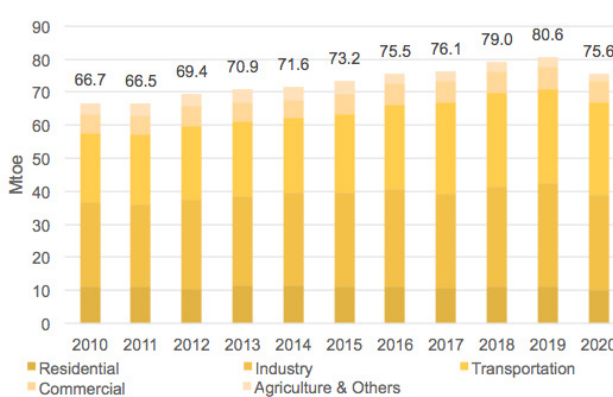
2.9.1. Electricity

Thailand has one of the region's most robust economies and the third-highest energy demand. In 2020, about 56.5% of the power capacity was based on natural gas, 12.4% on coal, 16.3% on hydro, 5.8% on solar, 4.5% on bioenergy, and 3% on wind. The country has the largest installed wind power capacity in the region, at 1.5 GW. Its solar capacity is the second greatest in ASEAN, with 2.9 GW. The country has maintained universal electricity access since 2013. Thailand is currently connected to Cambodia, Lao PDR and Peninsular Malaysia, and its grid will be extended to Myanmar under APG.

Thailand's overall RE share is expected to reach 30% of TFEC by 2037. RE electric generation is targeted to reach 15% to 20%, heating 30% to 35%, and biofuel 20% to 25%. Thailand is amongst the AMS that have announced carbon neutrality ambitions by 2050, and net-zero greenhouse gases by 2065. By the end of 2022, Thailand also promoted the bio-circular-green economic model as the primary objective of the Asia-Pacific Economic Cooperation (APEC) meeting.



(a)



(b)

Figure 2.12 – Thailand's Installed Capacity (a) and TFEC (b), 2010 – 2020

2.9.2. Transportation, Energy Efficiency, and Cooking

Energy consumption in the transportation sector is the fastest growing, as indicated in Figure 2.12. The Thai government intends to promote EV use and production through a tax cut and subsidy programme. Thailand intends to be an Asian EV production hub, targeting 30% of total auto production by 2030 (ITA, 2022). The Thailand EV Roadmap further notes a production target of 725,000 EV cars, 34,000 EV public buses and trucks, and 675,000 EV motorcycles by 2030.

Thailand has developed its Energy Efficiency Plan (EEP) 2018, and an EE action plan to promote energy efficiency. The EEP2018 sets a target of 30% energy intensity reduction by 2037, and seeks to save 54,371 ktoe from all demand side sectors by the end of the plan (UNFCCC, 2021).

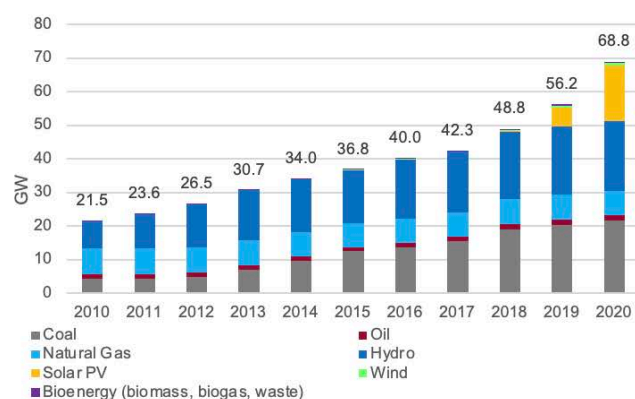
The majority of the population in Thailand cooks with LPG. Despite having access to electricity, the people in rural areas still cook with biomass. According to World Bank data, 84% of the Thailand population had access to clean cooking in 2020.

2.10. Vietnam

2.10.1. Electricity

Vietnam's electricity demand has grown rapidly in the last decade, in tandem with the economy. The installed capacity tripled from 21.5 GW in 2010, to 38.8 GW in 2020. The primary electricity sources are coal and hydro, with 31.3% and 30.2% respectively of total power capacity in 2020. The remaining shares are solar (24.2%), natural gas (10.4%), oil (2.5%), wind (0.8%), and bioenergy (0.5%). Vietnam has the region's highest capacity solar installations, with 16.7 GW. Vietnam's solar boom is one of the world's best records. Its capacity jumped from just 86 MW in 2018, to 5.8 GW in 2019. The country's grid is connected to Cambodia and Lao PDR.

According to the latest draft of Vietnam's PDP (PDP8), the country intends to increase RE to 151.2 GW by 2045, which will be primarily achieved by onshore and offshore wind installations (Hang Nguyen Thanh, 2022; Monika Merdekawati et al., 2022). A FIT was proposed at USD 8.5 cents/kWh for onshore, and USD 9.8 cents/kWh for offshore. Total approved wind projects reached 3.98 GW in 2022, representing 84 discrete projects. Despite the FIT's success, the government will replace the scheme with an auction model to foster competitive pricing.



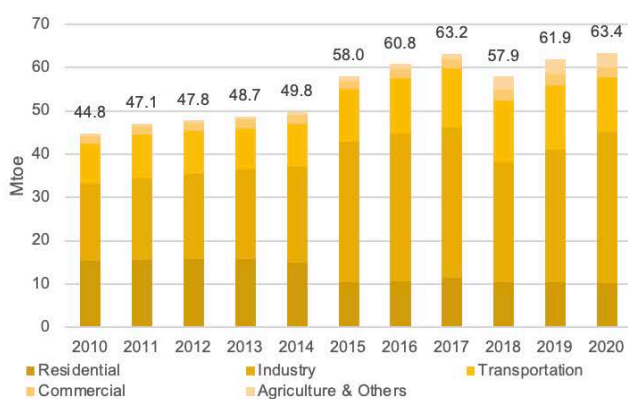
(a)

2.10.2. Transportation, Energy Efficiency, and Cooking

Vietnam's newly approved transportation strategy will ensure that 100% of road vehicles use electricity or green energy by 2050. Beginning in 2030, the production and import of vehicles that run on fossil fuels will be restricted and eventually halted (Hang Nguyen Thanh, 2022).

According to the Vietnam Low Carbon Options Assessment for Energy Sector Components, residential energy savings could amount to 20,000 GWh/year by 2030. Most of these savings would come from improved heating and cooling (27.4%) and more efficient lighting (65.9%). Vietnam's National Energy Efficiency Programme 2019 – 2030 (Decision 280/QD) advised energy intensity reduction of 5% to 7% in TFEC as compared to BAU by 2025, and 8% to 10% by 2030.

More than a quarter of Vietnam's population still relies on wood fuel and charcoal for cooking. However, from 2000 to 2018, Vietnam saw a 51% increase in the population with access to clean cooking (ADB, 2021). Furthermore, the country's Renewable Energy Development Strategy up to 2030 with Outlook to 2050 (Decision 2068/QD) recommended traditional biomass shifting to high-performing stoves with a 60% share by 2025, and near 100% by 2030.

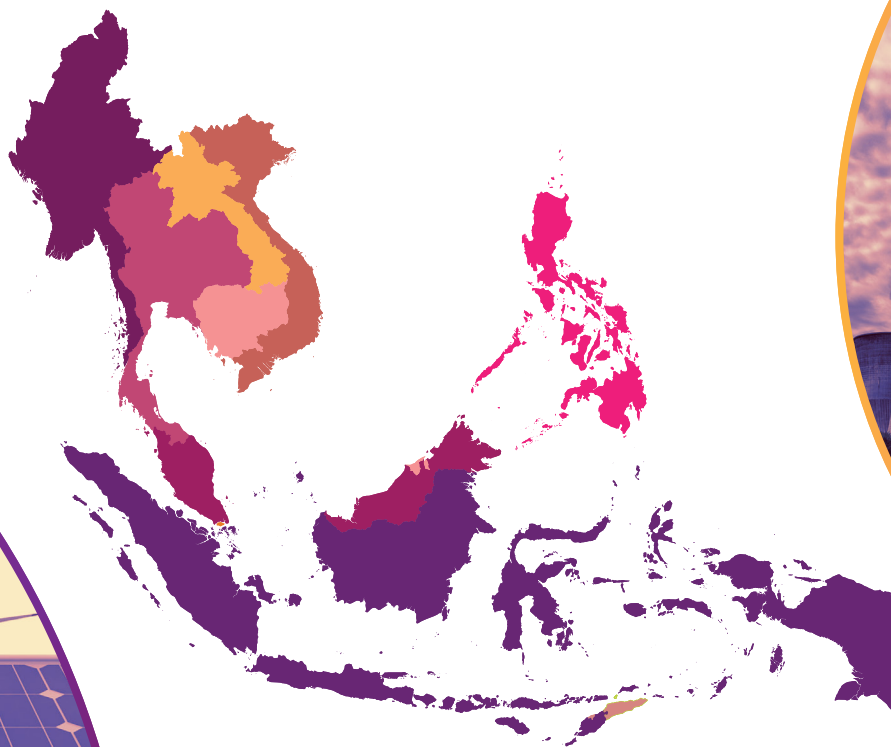


(b)

Figure 2.13 – Vietnam's Installed Capacity (a) and TFEC (b), 2010 – 2020

CHAPTER 3

Importance of Regional Renewable Energy Approach



A regional approach is a coordinated energy cooperation that considers country-specific circumstances and characteristics. Extending the regional approach to renewable energy will benefit the participating countries. For ASEAN countries, such as Brunei Darussalam and Singapore, the cooperation would open up opportunities to diversify their energy supply, especially in light of their limited RE resources. For developing countries, knowledge sharing, technology transfer, and financial support would help them tackle emerging challenges and adopt best-practices policies.

In Southeast Asia, regional cooperation involving official stakeholders from government agencies, state-owned utilities, and specialised regulatory authorities occurs in several constellations, with their specific missions, scopes and activities. Notable cooperation initiatives in the region include the Greater Mekong Subregion (GMS), the Brunei Darussalam, Indonesia, Malaysia, Philippines East ASEAN Growth Area (BIMP-EAGA), The Indonesia, Malaysia, Thailand Growth Triangle (IMT-GT), and the ASEAN, ASEAN+3, and East Asia Summit (EAS). Figure 3.1 provides an overview of existing regional cooperation initiatives.

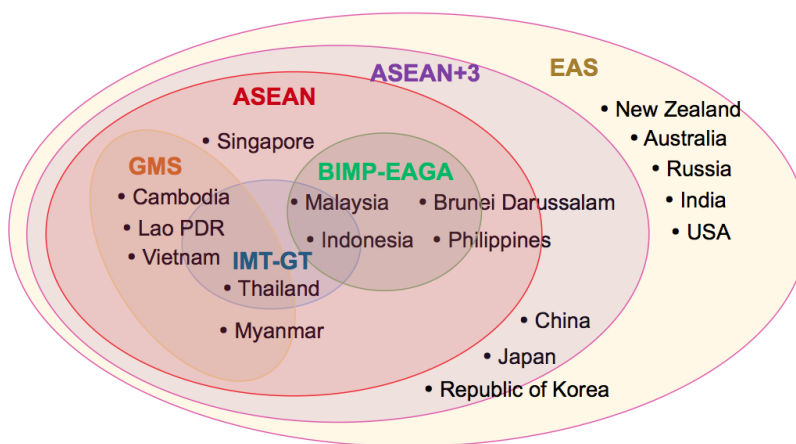


Figure 3.1 – Regional Cooperation Initiatives in Southeast Asia

Regional cooperation is gaining attention in the energy sector, due to heightened discussions on climate change mitigation. Many cooperative efforts are underway in these regional and subregional organisations. The outcomes will vary from capacity-building programmes and energy-related studies, to infrastructure projects. A few familiar dialogue partners and international organisations might have contributed to different projects, but with overlapping topics or objectives. Nevertheless, the prominent guideline for regional energy cooperation is the APAEC, which has existed since 1999.

Considering the solid political presence of APAEC, the ASEAN Regional Renewable Energy Approach is intended to be the primary reference for the AMS in accelerating decarbonisation, whilst making it more cost effective and time efficient. Therefore, both AMS and donors know what has been done, what the current priorities are, and the subsequent regional focus. In the future, the AMS could be better informed and agile in tackling any energy-related problems by utilising advanced clean energy technologies and proven policy measures.

As important as a country’s strategic energy plan is, meeting its own energy needs for economic development, environmental management, and emission reduction commitments, a well-coordinated and consulted regional roadmap can help achieve not only a country’s targets, but also improve its resilience and overall economy, in addition to energy security in the long term.

The ASEAN Regional Renewable Energy Approach will provide a time-bound comprehensive pathway for shared and common knowledge of each AMS’s vision and objectives, in line with economics, peace and sustainable development goals. The roadmap will also strengthen sustainable energy development for improved resilience, energy security, and other benefits, which will be discussed in more detail in subsequent sections.

1.1. Enhancing Energy Security

As observed in Chapter 2, the AMS power generation mix reflects their merits and vulnerabilities. For example, only Indonesia, Malaysia, the Philippines, Thailand, and Vietnam installed more than five energy technologies by 2020. Five AMS depend on natural gas as their fuel for electricity generation, three AMS depend on coal, and three AMS depend on hydro. In comparison, ASEAN gas reserves are about 3.1 trillion cubic meters, 1.6% of global reserves, which are distributed in Indonesia (41.9%), Malaysia (29%), Vietnam (19.4%), Brunei Darussalam (6.4%), and Thailand (3.2%) (BP, 2021b). ASEAN coal reserves are about 39.3 billion tonnes, or 3.7% of global total, that are available in Indonesia (88.8%), Vietnam (8.6%), and Thailand (2.8%) (BP, 2021a).

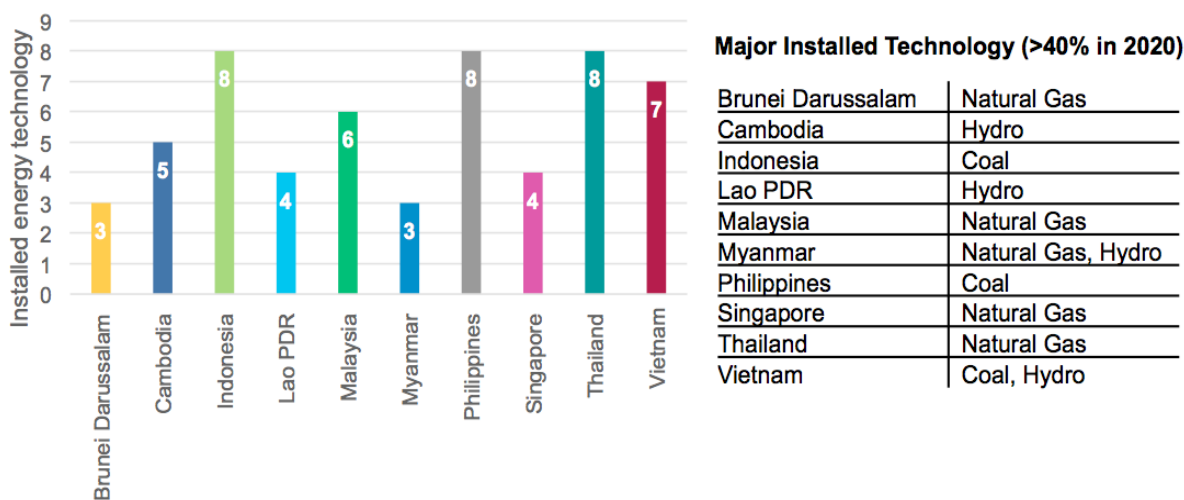


Figure 3.2 – Recap of ASEAN’s Installed Power Generation Technologies

The ASEAN electricity system was still based on fossil fuels as of 2020, and will be in the future if no accelerated energy transition occurs. With limited coal and gas reserves, ASEAN’s energy sector will increasingly need imported supplies, and hence will be more exposed to the risk of volatile prices. With a more diversified power generation mix, the

AMS might recover faster from price volatility. Given its limited power options, the AMS must be ready for the worst case scenario. Increasing regional cooperation in RE can enhance the energy security of the ASEAN region and reduce the dependence on fossil fuels.

Brunei Darussalam and Singapore have limited

natural endowments, but solid financial capacity. Investing in other AMS's clean energy and cross-border interconnection projects offers potential revenue and future energy supply security. A perfect example is the commissioning of a 100 MW hydro-electric generator, with power exported from Lao PDR through LTMS-PIP. On the other side, Lao PDR benefitted from increased economic activity, which will boost government income to expand other RE-based generation projects, grid infrastructure, or energy storage facilities.

The AMS need to shift their dependence on fossil fuels to RE. Hydropower may be the largest untapped resource in ASEAN with access to advanced technologies. Indonesia and the Philippines are rich in geothermal resources, with Thailand having its biomass production. Moreover, with grid improvements the AMS could utilise more intermittent RE resources, such as Malaysia and Thailand with solar, and Vietnam with its solar and wind. ASEAN countries could earn national experience, develop regional best practices, and become global examples by enhancing energy cooperation.

3.2. Replicating Best Practices

Besides solving resource constraints, the regional approach could improve AMS' governing capability. Indeed, developing RE and infrastructure projects is complex in nature. It is costly, requires multi-sectoral collaboration, and is technically complicated.

Several of the AMS have accumulated significant experiences in adopting selected RE technologies and employing different policy measures over the past decade. For example, Malaysia successfully transitioned from FIT-based measures to the auction model, and drove down solar project costs. Lao PDR has commissioned many bilateral electricity exports, and built large-scale

hydropower plants. Vietnam's FIT has attracted many large-scale wind projects in the past year. Sharing the expertise within AMS would be cheaper and more effective, since these regional experts might better understand local cultures and circumstances.

In addition to expertise, private sector investment is crucial to ramp up RE deployment on a meaningful scale for the regional energy transition. Encouraging the private sector to fund infrastructure facilities requires policies and procedures that can minimise political, social and future costs and revenue uncertainties. Accountability and transparency are two fundamental elements to building a sound environment for investment and a clear regulatory framework for good governance. Singapore is ranked second best of 190 countries in the World Bank's Ease of Doing Business. Malaysia and Thailand, which are placed 12th and 21st, could offer many valuable examples. ASEAN generally needs to improve, because the remaining AMS are not amongst the top 50, as of May 2019, with Brunei Darussalam (66th), Vietnam (70th), Indonesia (73rd), the Philippines (95th), Cambodia (144th), Lao PDR (154th), and Myanmar (165th) on the list.¹

3.3. Defining Stakeholders' Roles

Regional energy cooperation has been evolving in ASEAN, primarily driven by the AMS and multiple stakeholders that value the energy sector's economic, environmental and social dimensions. A robust regional approach must carefully assess the potential roles and contributions of each stakeholder.

¹ <https://archive.doingbusiness.org/en/rankings?region=east-asia-and-pacific>

3.3.1. ASEAN Ministries

The AMS ministries are critical stakeholders for generation, interconnection, transportation, efficiency, and clean cooking. The Ministries and Departments related to energy, transportation, environment, and finance are identified as the most important stakeholders. Each of the AMS' heads of state are recognised as critical contributors to bold and innovative approaches. These stakeholders also decide whether government guarantees will be included in project agreements.

3.3.2. ASEAN Centre for Energy

ASEAN Centre for Energy (ACE) is the regional hub for facilitating research, guidance, standards, capacity building, and technical components. ACE's transformation into a respectable think tank in the region is vital in providing evidence-based policies and strategies for the AMS.

3.3.3. Private Sector and Developers

The private sector and developers are the primary drivers for RE investment and applications. They are also the primary beneficiaries of streamlined services (e.g. improved one-stop shop). Private industries and developers must practice environmental and social safeguards in planning and implementing projects.

3.3.4. Financial Institutions and Multilateral Development Banks

These stakeholders' confidence in a profitable RE business is vital. Primary stakeholders evaluate access project risks and decide whether the projects are economically feasible.

3.3.5. UNFCCC and Donors

UNFCCC and donors (e.g. GCF, CountryAids) are essential stakeholders in channelling technical

assistance (e.g. NDC partnership) and financial assistance via lending facilities. Blended finance or concessional loans from donors will de-risk the project for developers and project lenders.

3.3.6. Development Agencies and NGOs

Agencies and NGOs are able to support ACE in conducting analyses, building capacity for the intended market segments, and offering financial support.

3.3.7. Universities and Research Institutions

Universities and institutions involved in research and development activities are crucial to providing alternative and innovative solutions for technological constraints, such as grid stability, storage technologies, manufacturing capabilities, and life-cycle analysis.

3.3.8. Civil Society Organisations

Civil society organisations are able to provide free prior informed consent consultations and policy advocacy.

3.4. Learning from Global Experience

The European Council is committed to reducing GHG emissions by 80% to 95% by 2050, as compared to 1990. To achieve this goal, the European Commission in 2011 developed *A Roadmap for Moving to a Competitive Low-carbon Economy in 2050*. The roadmap seeks to in-line the member countries' efforts to achieve the EU objective on reducing GHG emissions. Through comprehensive modelling, the roadmap analysis shows a cost-effective and gradual transition requires a 40% domestic reduction by 2030, to achieve an 80% reduction by 2050.

In response to a request from the European Council in 2012, the *Energy Roadmap 2050* was

developed to explore the challenges posed by delivering the EU's decarbonisation objective, whilst simultaneously ensuring competitiveness and security of the energy supply. The roadmap confirms that the EU's low-carbon target is economically feasible, but requires immediate and intermediate action. The roadmap is a foundation for demonstrating that more efforts must be made for current policies to meet the commitment.

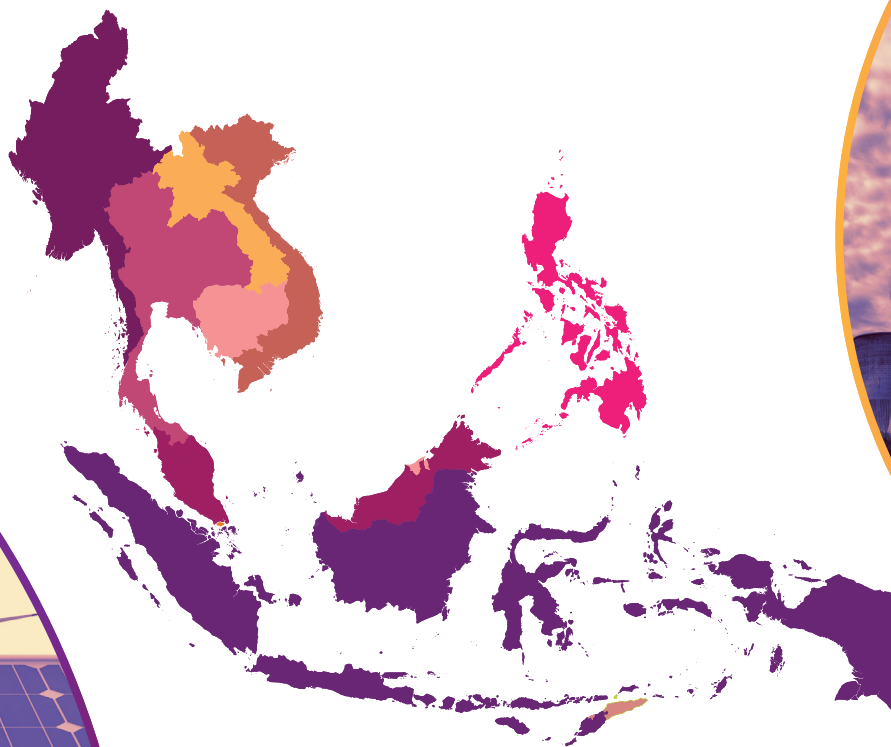
The *Renewable Energy Roadmap for Central America*, developed by IRENA in 2022 comprises a series of scenarios that consider the countries' current economic situations, energy intensity, national and regional power sector contexts, and ongoing initiatives, plans and pledges to reduce sectoral emissions. The roadmap report provides a comprehensive pathway for developing a sustainable and cleaner regional energy system.

In 2015, IRENA published *Africa 2030: Roadmap for a Renewable Energy Future*, which laid out the strategies for RE deployment in Africa by 2030, offering a cost/benefit comparison of different renewable technology options. The roadmap covers the entire continent, but the policies, regulations and actions differ from country to country. The African countries' national energy plans are formulated to increase power generation capacity and expand energy access, taking into consideration RE as part of the plan.

However, the implementation of the programme faces political and economic challenges. Regional cooperation can help overcome those challenges. The regional energy plan is intended to promote interconnection and the development of a harmonised regional energy market, which will necessitate close collaboration amongst African countries.

CHAPTER 4

Ambitions, Challenges, and Opportunities



The highest ambition for RE achievement is levelled at ASEAN. The most progressive RE scenarios are referenced, from national targets such as the conditional NDC targets, and regional targets like the APS scenario from AEO7, High RE scenario from AIMS III, and 1.5°C scenario from 2nd RE Outlook. An assumption is made that the AMS will most likely improve national targets and roadmaps after each iteration of regional energy outlooks, and whether the AMS receive technical and financial support from the international community.

Each of the AMS' strengths, weaknesses, opportunities, and threats (SWOT) were evaluated to identify ASEAN-level ambitions, challenges and opportunities. Table 4.1 summarises ASEAN's SWOT analysis to implement a practical regional approach, whilst SWOT analysis at the country level is provided in the subsequent sections.

The AMS' NDCs state a clear commitment to increase RE ambitions. Most AMS have instituted several policy instruments to incentivise RE deployment, such as FIT, net metering, tax relief/exemptions, and climate funding. All AMS plan to participate in future APG initiatives, whilst six of the AMS have implemented cross-border power imports or exports. Aggressive RE targets could be achieved with international support through NDC, as eight AMS are eligible.

Fundamental issues hindering ASEAN from achieving bolder RE actions are a lack of willingness to phase out coal-fired plants and future income from coal exports. Additionally, nationwide elections often imply changes in political priorities and diplomatic stances, and are thus seen as a critical risk by investors. Ongoing initiatives are usually halted, whilst the business players prefer to wait and see what the new administration will announce for its multi-year plans.

The lack of comprehensive policy compliance, and the economic differences between the various AMS pose a challenge for regional grid integration and power trading. Since there is a significant difference in the dynamic performance of various national grids, the safety of the connected countries' grids is impacted. The least-developed AMS are heavily reliant on international donor funding and financing to increase their energy access and improve energy infrastructure. There is a risk that donors will use funding support to advance individual agendas and influence policy decisions.

Regional integration requires aligning policies and regulations in specific areas within member states, especially with regard to energy, trade and environment. ASEAN has little to no influence on its member states' local governance and policies. Regional RE integration will not be beneficial unless each of the AMS have adequate infrastructure and funds to support implementation. This could also be an opportunity to reduce the impact of other aid that may harm regional integration goals. The more developed AMS should devote funds and financing for other member states to improve infrastructure and achieve common goals.

The ASEAN region has a wide range of renewable resources that can be advantageous in the transition to a low-carbon economy. Singapore is expanding its solar generation capacity. Vietnam has large wind and hydropower generation capacities, as do Malaysia and Lao PDR, whereas the Philippines and Indonesia have geothermal. This might accelerate regionalised decarbonisation and the 100% target for renewables.

Table 4.1 – ASEAN’s SWOT Analysis for a Regional Approach

STRENGTHS - AMS shows commitment to increasing renewable energy in NDC. - ASEAN will achieve or exceed 2025 RE targets in APS. 6 AMS have Feed-in Tariff, 70% for Net Metering. - More than 90% of ASEAN’s population have access to grid electricity. 8 AMS use tax relief/exemptions for renewable energy. 8 AMS have regulations/targets developed for EV. 7 AMS have climate funding (pipelined or active) 1 AMS has already incorporated APS targets in the national plan. 6 AMS import/export energy via interconnection. - All AMS plan to participate in regional interconnection. 2 AMS have published R&D plans for renewable energy. 8 AMS are eligible for international support through NDC. 1 AMS has an established Green Energy Option Programme.	WEAKNESSES - Only 2 AMS have laid out the required international technical and financial support for conditional targets in their NDCs. - Ongoing attention to and interest in coal-fired power. Coal is included in “Coal Phase Out” scenarios. - Regional renewable energy project pipelines for future investment not available. - Energy markets need to be initiated in most of the AMS. - Standardisation and digitisation at the regional level are needed.
THREATS Political stability of some AMS may profoundly affect future investment.	OPPORTUNITIES - Existing experience within ASEAN could be shared amongst the AMS to strengthen an enabling RE environment. - Climate finance can be strategically mobilised for all AMS. - Research, development and innovation must be prioritised for the short and long terms. - Investment attractiveness must be strengthened at the national and regional levels. - A financing facilities for RE implementation could be established at the regional level. - Interconnection plans could be strengthened to increase RE share. - RE targets in ASEAN could be improved by catalysing more RE investment.

4.1. Brunei Darussalam

Brunei Darussalam is located on the island of Borneo at a strategic point to interconnect with East Malaysia and Indonesia under APG. The past two years witnessed important government decarbonisation moves, such as a new RE target (30% by 2035) and EE target (29.7% by 2030), the establishment of FIT and net metering, EV targets and a task force, and MEPS adoption. The country

could employ further improvements, such as identifying climate support via an NDC partnership and allocating a budget for RE investment and EV infrastructure.

Lack of clear RE development and climate investment plans are considered the major bottlenecks in Brunei Darussalam. Considering

the RE installed capacity was only 0.1% of the total in 2020, a comprehensive roadmap to close the considerable gap by 2035 is crucial. Further

identification of Brunei Darussalam's ambitions, challenges and opportunities is provided in Table 4.2.

Table 4.2 – Brunei Darussalam's SWOT Analysis for a Regional Approach

STRENGTHS - Geographically positioned to interconnect with East Malaysia. - Brunei National Climate Change Policy (BNCCP) Strategy 4 sets RE targets of 30% by 2035. - FIT, net metering, and REC established. - Will reduce CO2 emissions from morning peak-hour vehicle use by 40% from the BAU level by 2035. - EV to reach 60% of transportation by 2035. - Electric Vehicles Joint Task Force (EVJTF) was formed in early 2020 to shift investments to EV. - Minimum Energy Performance standards available. - Urban Planning Tools for Climate Change Mitigation and the urban planning solution in three sub-cities by MLMUPC. - Energy efficiency measures in place to reduce 1.2 TWh (29.7%) of electricity use by 2030 via MME.	WEAKNESSES - Out of 1.2 GW installed capacity in 2020, only 1.3 MW is solar. - No indication of technical and financial support is needed for the NDC conditional target. - No strong indication or clear implementation plan for RE and climate investments. - No R&D for future emerging technologies for the national or interconnected grid. - No mention of APS targets in the national plan. - No national grid stability test or study was found for solar and wind (intermittent RE).
THREATS n/a	OPPORTUNITIES - Identify climate support required via NDC partnerships. - RE investments for electricity and EV.

4.2. Cambodia

Cambodia has ongoing cross-border imports with Lao PDR, Thailand and Vietnam. The country has increased its RE target to 25% of the energy mix by 2030, and added a specific requirement to install at least 150 MW of solar capacity by 2023. Waste-to-energy development is being pursued through municipal solid waste (MSW) treatment. More EE measures have been identified, such as electricity use reduction targets, urban heat island effect (UHIE) mitigation, MEPS, and labelling.

Despite hydro and solar share being more than half of its energy mix (54.4%) in 2020, Cambodia

needs to diversify its power capacity mix to other RE sources and gradually phase out coal- and oil-based power plant use. The country could also leverage international support by identifying the needed technical assistance to meet the conditional target in its NDC. The government must strengthen existing cross-border power trading by setting RE import targets, encouraging R&D activities for interconnection or grid technology, and designing a legal framework for RE investment. More details on Cambodia's ambitions, challenges and opportunities can be found in Table 4.3.

Table 4.3 – Cambodia’s SWOT Analysis for a Regional Approach

STRENGTHS • Identity climate support required via NDC partnerships. • Existing experience with cross-border imports with Vietnam, Thailand and Lao PDR. • 25% of RE in the energy mix by 2030. • At least 150 MW of installed solar capacity added by 2023 (2017 baseline: 10 MW). • National roadmap indicates the pipeline for future investment. • Implementation of “passive cooling” measures in the cities (addressing urban heat island effect), public buildings, and commercial buildings. • Cities (Phnom Penh and Siem Reap) analysed for mitigating Urban Heat Island Effect (UHIE) and projects have been implemented. • 2% of the existing public and commercial buildings have been retrofitted with passive cooling measures by MLUMCP. • Urban Planning Tools for Climate Change Mitigation and an urban planning solution in three sub-cities by MLMUPC. • Application of electrical equipment labelling. • MEPS (Lighting, Cooling & Equipment). • Reduce 1.2 TWh (29.7%) of electricity usage by 2030 via MME.	WEAKNESSES • Of 3 GW given as installed capacity in 2020, only 0.3 GW was solar (2020). Hydro contributed 1.3 GW (total hydro + solar + wind is 54.4%). • Technical assistance required for NDC conditional targets not mentioned. • No RE investment legal framework found. • No interconnected RE targets mentioned. • No R&D for future emerging technologies for national or interconnected grid.
THREATS • Even in the APS, the % of total RE decreased from 65% in 2022 to 61% in 2030.	OPPORTUNITIES • Composting of biodegradable organic fraction of municipal solid waste (MSW) supplemented with separation of organic waste (at source). If 10% of all MSW generated is composted by 2030, MOE could be used for waste-to-energy. • Study and strengthen grid stability and define import targets.

4.3. Indonesia

Indonesia’s grid has been connected to Sarawak since January 2016, and cross-border interconnections are being extended to support the new capital project. In the past two years, the country has been active in leading regional and subregional initiatives, such as the Energy Transition Mechanism (ETM), the G20 presidency in 2022, and the ASEAN presidency in 2023. The

government has also announced its net-zero goal for 2060, and has since aligned its PDP and other policies to phase out coal, increase RE, and promote EVs. However, Indonesia could set its energy transition priority above the low-hanging fruit. For example, it could convert small-scale diesel power plants to fully RE-based or hybrid systems.

Indonesia has EE measures in place; however, its energy policies are primarily oriented to create enabling conditions for the supply side, rather than demand. The country also has no monitoring framework; hence, different governmental bodies

often issue similar or overlapping targets or regulations. A few policy objectives that might be counterproductive are biomass co-firing, which might motivate more coal projects. A detailed SWOT analysis of Indonesia is available in Table 4.4.

Table 4.4 – Indonesia’s SWOT Analysis for a Regional Approach

STRENGTHES • RUPTL increased RE target to 20.9 GW by 2030 (raised from 16 GW in 2019 version). RE accounts for 51.6% of 40,575 MW in 2030 target. Fossil fuel target reduced to 20GW. • Net-zero emissions by 2060. • Indonesia, the Philippines and Vietnam joined the Energy Transition Mechanism facilitated by ADB to phase out coal. • Indonesia has a target of at least 1.2 million electric bike adoptions and 35,000 electric car adoptions by 2024, 2.5 million EV users by 2025. • Clear investment targets in the new RUPTL: IDR 128.7 trillion per year. • The Khatulistiwa grid is currently connected to Sarawak.	WEAKNESSES • EE measures are defined (especially MEPS), however, the country seems to create more enabling conditions for supply, rather than for demand (EE in industrial, commercial and residential). • No monitoring framework found. • Java and Sumatra are not connected. Also, they are not connected to any other AMS. • No R&D for future emerging technologies for national or interconnected grid. • No mention of APS targets in the national plans.
THREATS • RUPTL indicates interest and plan for nuclear power by 2040. • Co-firing biomass and coal could lead to more coal projects.	OPPORTUNITIES • Convert existing 5,200 units of small-scale diesel power plants (scattered across 2,130 locations) into RE-based and gas-fired power plants. • Jobs created for RE sector. • Mahakam to connect with Sabah, Malaysia.

4.4. Lao PDR

Lao PDR has extensive experience in hydropower development, and has been a long-running power supplier for its neighbouring countries. Its grid is currently interconnected with Thailand and Vietnam. More extensions and grid improvements are planned under APG. Beyond hydropower, the country set conditional targets of 1 GW for solar and wind, and 300 MW for biomass by 2030, which will require support of USD 4.7 billion. The government also outlined 30% EV penetration

for 2-wheelers and passenger cars by 2030, and a 10% biofuel target.

Despite Lao PDR’s strong RE-based generation, the country includes coal-fired power plants in its future energy mix. With electricity as a primary trading commodity, increasing future demand from neighbouring countries might motivate more coal-fired power generation. Further identification of Lao PDR’s ambitions, challenges and opportunities is presented in Table 4.5.

Table 4.5 – Lao PDR's SWOT Analysis for a Regional Approach

STRENGTHES • Extensive experience in hydropower development • 30% EV penetration for 2-wheelers and passenger cars in national vehicle mix by 2030. • Biofuels to meet 10% of transportation fuels. • 10% reduction in final energy consumption, as compared to BAU scenario. • USD 4.7 billion in support required for conditional targets. • 1 GW of solar and wind, and 300 MW biomass investment as planned in NDC.	WEAKNESSES • Coal-fired power considerations in SDG7 roadmap and NDC. • USD 4.7 billion climate finance requirement only achieves an additional 10% of solar and wind by 2030. • Interconnected with Thailand and Northern Vietnam.
THREATS • Coal Phase Out scenario has coal-fired power plans. • Lao PDR interconnection may orient toward exporting coal fired power (e.g. to Singapore).	OPPORTUNITIES • Replace coal investments with RE, as Lao PDR has strong established hydropower.

4.5. Malaysia

Malaysia has experimented with different policy instruments and incentive schemes to boost its RE development, offering many valuable lessons for other AMS. The country has set an ambitious unconditional target of 45% carbon reduction, which aligns with its priority of increasing RE investment. Peninsular Malaysia is currently connected to Singapore and Thailand. Similar integration is observed in Sarawak and Sabah, which will be connected to Brunei Darussalam

and Indonesia's Kalimantan provinces as part of APG.

Due to its developed status, Malaysia is not eligible for international support and has less access to climate fund opportunities. Therefore, the government must improve the enabling conditions for RE investment to attract more private sector participation, beginning with streamlining the approval process for permitting and land acquisition. A detailed SWOT analysis of Malaysia is available in Table 4.6.

Table 4.6 – Malaysia's SWOT Analysis for a Regional Approach

STRENGTHS • Currently connected to Singapore via a 230 kV subsea cable, and to Thailand via an HVDC. • Unconditional 45% carbon reduction target. • RE investment is priority in 12th Malaysia Plan. • Government support and enabling conditions for RE investment are available. • RE development has been supported by FIT, LSS, net metering, and Self consumption (SELCO). • RE inventive schemes have been introduced: Green Technology Financing Scheme (GTFS), Green Investment Tax Allowance (GITA), and Green Income Tax Exemption (GITE).	WEAKNESSES • No R&D for future emerging technologies for national or interconnected grid. • No mention of APS targets in the national plans. • Securing land (for solar) and long approval process (for hydro) are identified as primary challenges for RE development.
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THREATS	OPPORTUNITIES
n/a	- Sarawak will be connected to Brunei and Sabah. Sabah plans connections to Sarawak and Kalimantan as a part of the APG. - Very few climate fund opportunities were utilised.

4.6. Myanmar

Myanmar has increased its RE ambition to 48% by 2030, as a conditional NDC target. This would require USD 1.29 billion in international support. The national energy deficit has prompted households to install rooftop solar as a backup. However, strong EE measures might be essential for national energy security at this time. The government could also utilise this momentum to facilitate more private financing for solar projects

in the commercial and industrial sectors.

Myanmar has great potential for improvement in many areas. However, the recent political conflicts halted many energy programmes, such as the 1+ GW solar auction. The country currently faces a national energy deficit and may not improve until conflicts are resolved. For more details, Table 4.7 presents Myanmar's SWOT analysis.

Table 4.7 – Myanmar's SWOT Analysis for a Regional Approach

STRENGTHS	WEAKNESSES
- Increased RE targets to 48% by 2030, in conditional NDC targets. - Rooftop solar is highly popular due to national energy deficit. - EV tax exemptions have been recently renewed. - USD 1.29 billion in support outlined for the conditional targets. - Energy investment mentioned in Myanmar Investment law. - Two regional GCF projects include Myanmar.	- Ambitious 1+ GW solar power auction was facing difficulties due to conflicts. - Needs stronger investment interest in solar from commercial and industrial sectors. - No approved energy financing from climate fund yet. - Ease of doing business index is very low (165/190 in 2019).
THREATS	OPPORTUNITIES
Country's energy profile may not improve until conflicts are resolved.	- Energy deficits and inflation calls for self-consumption/ generation and strong energy efficiency measures. - Private financing for solar in commercial and industrial sectors.

4.7. The Philippines

Similar to Malaysia, the Philippines' experience is extensive in applying RE policies. The National Renewable Energy Programme (NREP) has established strong FIT, net metering, Renewable Portfolio Standards (RPS), Green Energy Option Programme, and RE trust fund to encourage R&D.

The country has also exercised the wholesale electricity spot market over the past ten years. The government has targeted 35% RE by 2030, and 50% by 2040, as well as clearly defined RE investment priorities for generation, off-grid, storage systems, and smart grid.

With a robust enabling environment for RE investment, the Philippines could make several changes to improve the ease of doing business. Examples include setting up guidelines for awarding RE contracts and registration, a one-

stop-shop platform, competitive RE zones, clean energy finance and investment roadmap, and facilitating investor dialogues. Table 4.8 captures the Philippines' ambitions, challenges and opportunities.

Table 4.8 – The Philippines' SWOT Analysis for a Regional Approach

STRENGTHS • 35% RE planned by 2030, and 50% by 2040. • National Renewable Energy Programme (NREP) established strong FiT and net metering protocols. • RE certificates established. • Renewable Portfolio Standards (RPS) established for on-grid. • Mandated participants (MP) established in NREP. • RPS off-grid rules established. • Green Energy Option Programme established. • RE Market launched in 2019 (Section 8 of RE Act) • RE investment theme defined (generation, off-grid RE, storage systems, smart grids/digitalisation) • Issued the first green bond in 2016 • 4 climate fund financed projects on going. • Grid stability modelling completed with PLEXOS. • One of the few AMS to set up fund for R&D - NREP designates the RE Trust Fund for R&D for future. (Section 28 of RE Act)	WEAKNESSES • Not connected to any other AMS. • Challenges in connecting main grids due to archipelagic nature.
THREATS • n/a	OPPORTUNITIES • Ease of Doing Business and Efficient Government Service Delivery Act • Energy Virtual One-Stop Shop • Guidelines Governing the Awarding of RE Contracts and Registration • Framework for Decentralised Power Systems • Updating Valuation Parameters for Least Cost Pricing • Competitive Renewable Energy Zones • Clean Energy Finance and Investment Roadmap • Implementation of Support Activities • Investor Dialogues • Regional Peer-Learning Activities

4.8. Singapore

Singapore is rated second-best in the world for ease doing business. The country has announced a net-zero goal by 2050 (previously 2nd half of the century), 2 GW solar by 2030, up to 4 GW low-carbon electricity imports by 2035, and the phasing out of unabated coal by 2050.

Singapore is the first in ASEAN to adopt a carbon tax scheme, and it plans to adopt a carbon trading scheme to strengthen decarbonisation efforts. Sharing Singapore's accumulated best practices

could elevate the capacities of other AMS.

As noted in Table 4.9, Singapore has several opportunities for improvement. The country could extend interconnection within ASEAN and with Australia to achieve 4 GW of low-carbon electricity imports. The government could be the R&D powerhouse for sustainable energy solutions, such as storage technology, smart grid, and advanced manufacturing capabilities.

Table 4.9 – Singapore's SWOT Analysis for a Regional Approach

STRENGTHS • Net zero by 2050. • 2 GW of solar by 2030. • Phase out unabated coal for power generation by 2050. • Import 4 GW low-carbon electricity by 2035. • Energy Market Authority has prepositioned Singapore for new low-carbon alternatives. • Has active carbon tax scheme. • Plan to utilise carbon market to address residual and hard-to-abate carbon.	WEAKNESSES • Limited locally sourced energy resources.
THREATS • n/a	OPPORTUNITIES • Import cleaner energy from beyond Singapore's border. • Create a multi-layered grid to manage growth and improve grid reliability. • Interconnection with ASEAN and beyond (Australia). • Plan to become technology front runner and living lab for sustainable energy solutions (Planning Paradigm 2). • Plan to maximise solar and use energy storage to manage intermittency.

4.9. Thailand

Thailand is amongst the few AMS that have comprehensive experience in implementing RE policies and incentives. The country has defined clear RE targets, in terms of TREC and installed capacity, EV targets and infrastructure improvement, and energy intensity reduction

to reach carbon neutrality by 2050 and net zero by 2065. Thailand also has robust R&D activities in biofuel and biomass for heating. Its strategic location allows interconnection with the neighbouring countries of Cambodia, Lao PDR, and Peninsular Malaysia.

Table 4.10 summarises Thailand's SWOT analysis. The country could leverage APG by increasing RE-based power imports and exports to neighbouring

countries. More cross-border electricity trade will strengthen Thailand's energy security and contribute to economic growth.

Table 4.10 – Thailand's SWOT Analysis for a Regional Approach

STRENGTHS • 37% TFEC by 2037. • 36% of RE installed capacity by 2037. • 25% of transportation by 2037, with 1.2 million EV and 690 charging stations by 2036. • Committed to carbon neutrality by 2050, and net zero by 2065. • 4 existing RE projects funded by GCF. • FIT and Net Metering established. • R&D for biofuel and strengthen biomass for heating. • Recognises ASEAN power grid plan in RE Outlook. • Recognize APS 2025 targets. • Connected to Lao PDR, Cambodia and Peninsular Malaysia. • Reduce energy intensity by 30% by 2036.	WEAKNESSES • Natural gas still hold dominant role with 56.5% share of total installed capacity by 2020.
THREATS • n/a	OPPORTUNITIES • Import/export power with neighbouring countries via grid interconnection. • Interconnection with Myanmar.

4.10. Vietnam

Vietnam has demonstrated rapid RE deployment in the past five years, from 86 MW solar capacity in 2018, to 16.7 GW in 2020. The country is also quite progressive in pursuing its net-zero goal by 2050. PDP8 has undergone multiple revisions since 2021, to reflect the most ambitious pathway.

However, coal is still considered in the latest PDP8 draft.

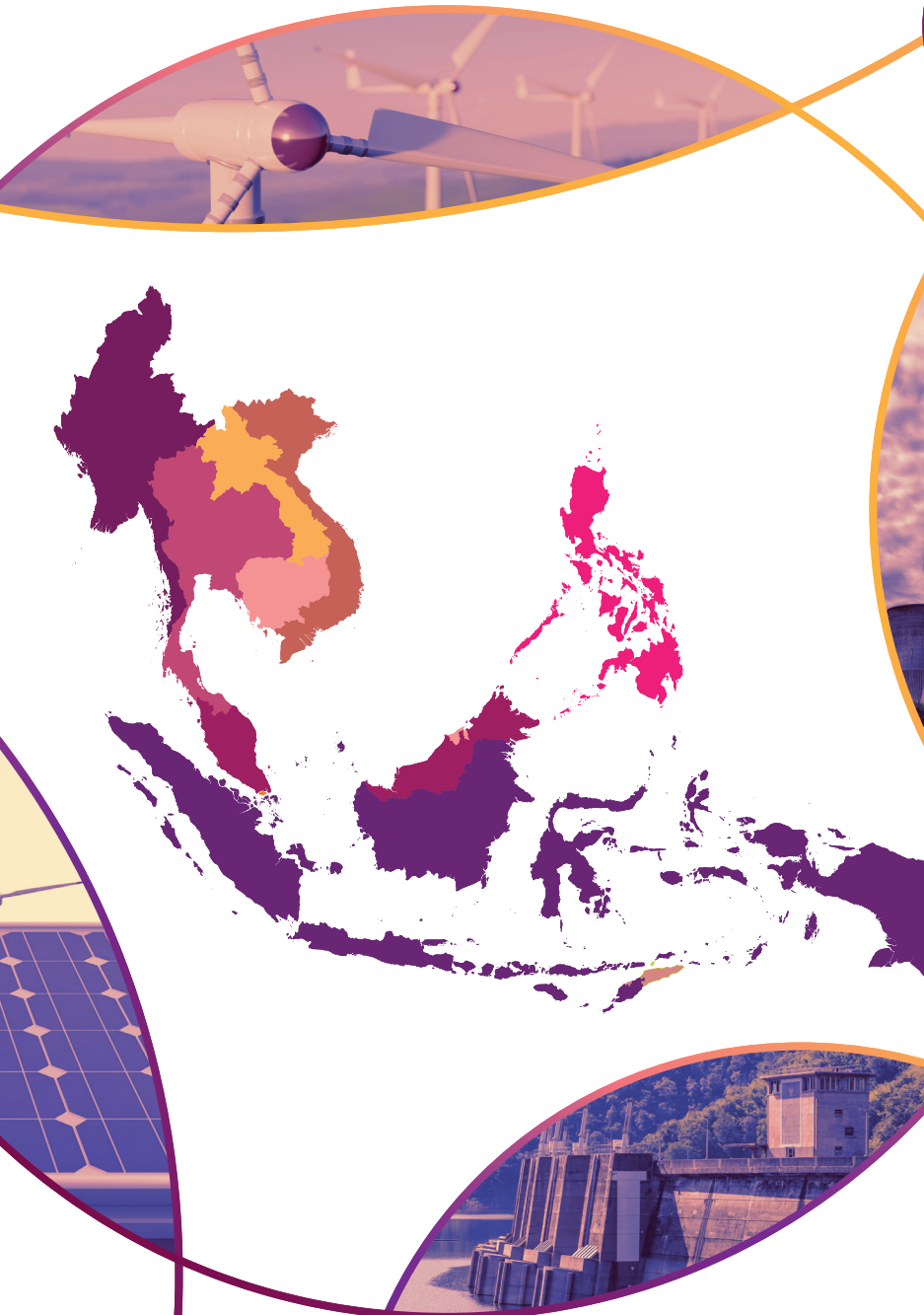
Table 4.11 shortlists Vietnam's SWOT analysis. The country could improve by applying a competitive electricity market and improving enabling conditions for RE investment.

Table 4.11 – Vietnam's SWOT Analysis for a Regional Approach

STRENGTHS • 29% of RE by 2030. • Net zero by 2050. • Reduced coal-fired power. • Identified USD 128.3 billion in RE investment for 2021-2030, and USD 192.3 billion for 2031-2045. • GCF projects ongoing. • Connected to Cambodia and Lao PDR.	WEAKNESSES • PDP8 will still include coal-fired power.
THREATS • n/a	OPPORTUNITIES • Investment opportunities in RE sector. • Competitive electricity market.

CHAPTER 5

Preliminary Identification of ASEAN Renewable Energy Long-term Roadmap



By assessing regional energy indicators and performing SWOT analysis, we identified seven fundamental phases over 30 years for the ASEAN Renewable Energy Regional Approach. This regional approach could serve as the baseline for developing the ASEAN Renewable Energy Long-term Roadmap, by adding specific programmes or initiatives for each action plan, to cater to each of the AMS' national priorities. Figure 5.1 presents the preliminary outline for the ASEAN Renewable Energy Long-term Roadmap.

In the first five years, the regional approach is dedicated to building the minimal enabling environments for RE investment in the developing AMS, and improving the existing frameworks in AMS with more advanced RE policies in place. Four focal points for the regional approach in the first five years are:

1. Phase 1: Strengthen Enabling Environment for RE Development for APS 2050 targets;
2. Phase 2: Regional mechanisms for climate financing as per NDC;
3. Phase 3: Research, Technology and Innovation; and
4. Phase 4: Investment Attractiveness.

In years 5 through 10, efforts will be dedicated to establishing the regional RE investment platform

to achieve Paris Agreement and APS scenarios by 2050, called ASEAN Renewable Energy Facility. This facility is intended as a platform to exchange lessons learned for RE implementation, develop business models, and discuss regional investment priorities. The facility is expected to exist within current APAEC governance, with a rotating chair position amongst the AMS. The outcome from this facility will be the primary reference for discussions with potential partners.

The years 10 through 30 are allocated to mobilising financing and dialogues to realise more RE integration between the AMS, and on various islands. The AMS are expected to develop a regionally standardised RE market, grid codes, cross-border interconnection standards, and digitalisation, to create a transparent energy market. The island grid systems will adopt smart RE systems on a smaller scale, implemented for APG. Thus, the AMS will have resolved the grid stability issue due to RE penetration by 2050, and be able to maximise RE share to 100%. In summary, the focus of years 2030 through 2050 are:

1. Phase 6: ASEAN Regional Interconnection (Mainland and Islands); and
2. Phase 7: Catalyse Renewable Energy Investments to Exceed APS Targets.

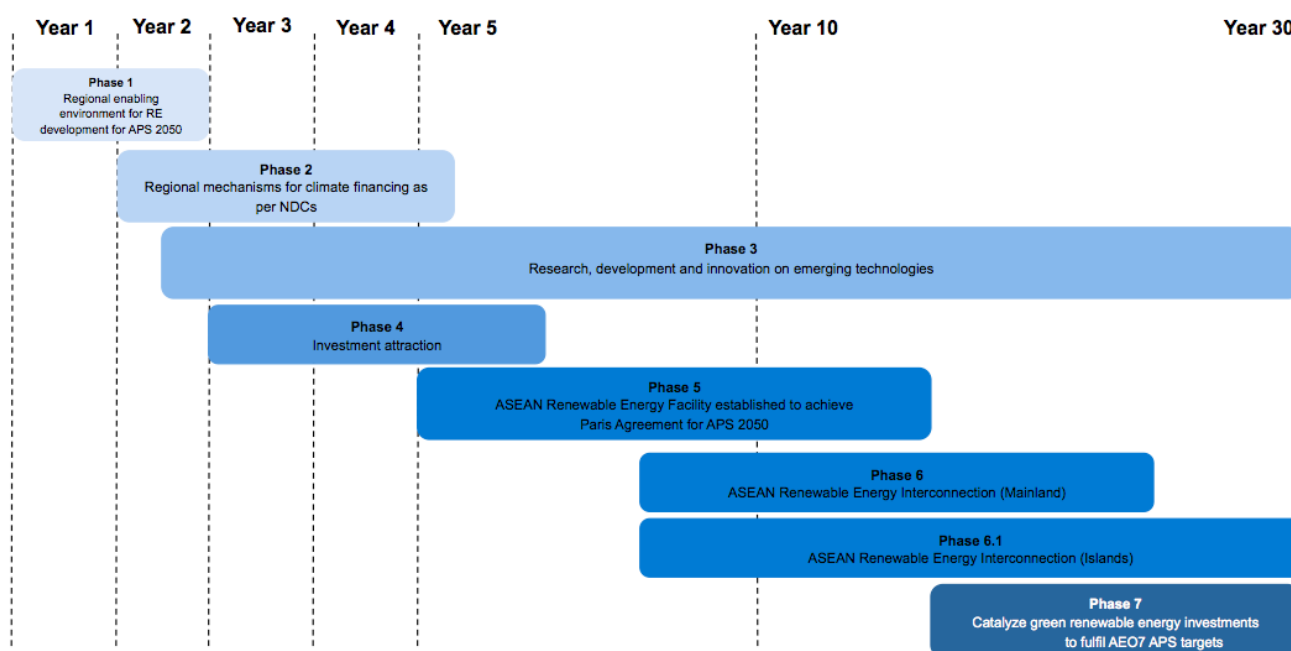


Figure 5.1 – Preliminary ASEAN Renewable Energy Long-term Roadmap

5.1. Phase 1: Strengthen Enabling Environment for RE Development for APS 2050 targets

The AMS have diverse rates of advancement in policies, regulations, national roadmaps, and technology. The economy's growth and political stability also affect energy growth in power generation, energy efficiency, transportation, and so forth. According to SWOT analysis, Singapore, Malaysia, Thailand, the Philippines, Indonesia, and Vietnam are currently leading in enabling environments for RE investment, as compared to Brunei Darussalam, Cambodia, Lao PDR, and Myanmar. Thus, this phase will strengthen the enabling environment for RE implementation throughout the AMS, by offering experience, lessons learned, and policy successes from the more advanced AMS.

As implemented at national and sub-national levels, the AMS currently have different grid codes, voltages, and frequency standards.

Unlike most European Union nations, the power sockets for household use are vastly different. EV penetration in the AMS is likely to grow faster if the same methodology and components could service charging, repair and maintenance. EV buyers will be more confident if charging stations are standardised along the interconnected roads. The recommended standardisations only cover the components and charging stations. It does not include the major changes in transportation methodology, such as left and right-hand driving.

These high-level activities cover the regional approach and collaboration. Each AMS is expected to adapt to local needs and conduct activities at the national level. Table 5.1 details the Phase 1 implementation plan, including the roles of stakeholders, and indicators to monitor progress.

Table 5.1 – Phase 1 Implementation Plan

Targets: By 2025, AMS will adopt regional enabling environment and standardisation guides at the national level to strengthen RE Investment.	
Expected Timeline: 1 - 2 years	
1.1. Regional Enabling Environment for RE Implementation	
Actions	1.1.1. ASEAN investment guidelines developed for the AMS to create a more robust enabling environment. 1.1.2. ASEAN guidelines for FIT, Net Metering, RE portfolio standards, RE certification, and Green Energy Options developed from successful case studies and lessons learned from AMS (e.g. the Philippines, Indonesia, Vietnam, and Malaysia). 1.1.3. ASEAN “One-stop Shop” service guide developed.
Indicators	Policies and regulations developed/strengthened.
Stakeholders	AMS ministries, regional MDBs, regional private sector and developers, donors
1.2. Develop Regional Standardisation for Energy Sector	
Actions	1.2.1. ASEAN guide for the standardisation of EVs and charging stations initiated. 1.2.2. ASEAN standards for MEPS for energy efficiency developed.
Indicators	Draft standardisation guides reviewed by AMS ministries. Final standards adopted by AMS.
Stakeholders	AMS ministries, regional MDBs, regional private sector and developers, donors, regional researchers, NGOs

5.2. Phase 2: Regional Mechanisms for Climate Financing as per NDC

The AMS’ NDCs indicate respective implementation targets set by countries based on their own resources and capabilities as being unconditional or conditional targets. Conditional targets denote countries would undertake the goals if international means of support are provided.

Conditional targets are higher than unconditional. It is strategically beneficial to accurately quantify the required international support for each country, for individual conditional targets. Thus, ASEAN must strengthen its efforts to support the AMS, to consolidate climate finance requirements in the region and encourage the AMS to strive for conditional targets.



Figure 5.2 – Conditional and Unconditional AMS Targets

ASEAN Renewable Energy Facility working groups should be established to realise increased RE implementation. The regional and sub-regional working groups would seek to prioritise ASEAN’s mandate on RE and complement other climate

finance projects. By cross-sharing experience and capacity, the AMS can maximise climate support for the RE sector. Table 5.2 details the Phase 2 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Table 5.2 Implementation Plan of Phase 2

Targets: By 2026, ASEAN regional and sub-regional WGs, and the AMS will have sufficient technical and financial capacity, with support to channel climate funds	
Expected Timeline: 3-5 years	
2.1. Maximise Climate Finance by Increasing NDC ambitions	
Actions	2.1.1. ASEAN climate finance requirements consolidated. 2.1.2. ASEAN guidelines to quantify conditional target budgets developed.
Indicators	Updated NDC in 2025.
Stakeholders	AMS ministries, regional MDBs, regional private sector and developers, donors
1.2. Regional and Sub-regional WGs for Channelling Climate Funds	
Actions	2.2.1. Climate funds mapped at the regional level to catalyse RE implementation. 2.2.2. Sub-regional working groups identified to strategically prepare climate funds. 2.2.3. Regional working groups established to channel ASEAN-level climate funds. 2.2.4. Priorities at AMS and sub-regional groups identified for climate fund applications. 2.2.5. Experience sharing/capacity building workshops among AMS.

Indicators	Climate fund proposals.
Stakeholders	AMS ministries and other accredited entities - regional MDBs, regional private sector and developers, donors, NGOs

5.3. Phase 3: Research, Technology and Innovation

The stability of the national grid or the future interconnected grid could be strengthened by incorporating a diverse range of emerging technologies into the generation mix. Research, development, and innovation are critical for improving grid stability and complementing cheaper, variable power sources, such as solar and wind. In 2023, ASEAN's innovation, testing, and implementation will focus on Battery Energy

Storage systems (BESS), pump storage, and green hydrogen.

Some AMS are already investing in research, development and innovation for energy technologies (e.g. Singapore, the Philippines etc.). ASEAN should approach the activities regionally, so that new technologies are identified, researched and tested, and the findings and knowledge are disseminated amongst the other AMS. Table 5.3 details the Phase 3 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Table 5.3 – Implementation Plan for Phase 3

Targets: By 2025, AMS will have strengthened capacities to periodically pilot next-generation storage, transportation, energy efficiency, and cooking projects using renewable energy	
Expected Timeline: 18-20 years (continuous)	
3.1. Research and Development on Emerging RE technologies	
Actions	3.1.1. ASEAN identifies emerging technologies to increase stability and agility, and to reduce costs for regional RE development. 3.1.2. Tested technologies and research are shared amongst AMS members.
Indicators	New technologies identified and prioritised.
Stakeholders	AMS ministries, Universities/Research Centres

INFORMATION BOX

Innovative Renewable Energy in Saudi Arabia

The NEOM Green Hydrogen Project is the largest commercial hydrogen facility in the world that is powered entirely by renewable energy. The project is a partnership between NEOM, Air Products, and ACWA Power. Each partner has an equal amount of control over the project. The

project is based on proven, world-class technologies and will include the innovative integration of around four gigawatts of renewable power from onshore solar, wind and storage. When it opens in 2026, it will use technology from ThyssenKrupp and electrolysis to make 600 tonnes of clean hydrogen daily. It will also use technology from Air Products and air separation to produce nitrogen and up to 1.2 million tonnes of green ammonia per year. When the project is finished, it will reduce the effects of 5 million metric tonnes of carbon emissions each year.

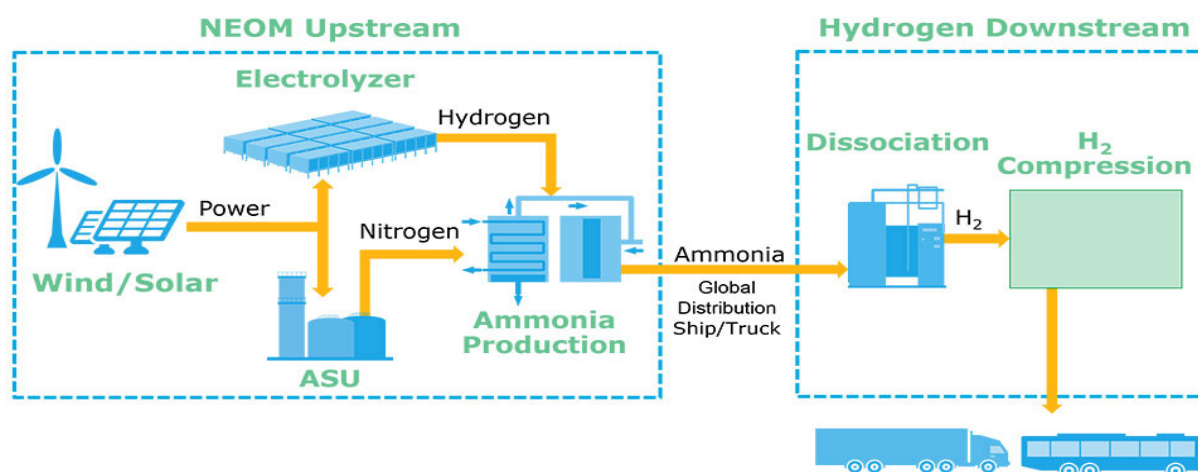


Figure 5.3 – Work Process of NEOM Green Hydrogen Project

5.4. Phase 4: Investment Attractiveness

After the enabling environment is strengthened (Phase 1) and climate finance mechanisms are prepared (Phase 2), it is assumed that the AMS are ready to cooperate at the ASEAN level to mobilise RE investments. As the SWOT analysis emphasises, national-level investment frameworks should prioritise RE investment, and the consolidated investment gap should be published and updated regularly, as ASEAN-level investment must be in line with Sustainable Development Goals, strong compliance, inclusive planning, and regional guidelines for stakeholder consultation to ensure safeguards. ASEAN standards for compliance, environmental and social assessments, and free and prior informed-consent consultations would

increase stakeholders' trust in energy planning and implementation.

Digitisation of public data for future investors, as well as incentives and exemptions, will attract more investment at the regional level. The easier investment conditions, and the more streamlined services and procedures are created (Phase 1), the more it will facilitate ASEAN hosting an annual investment summit. The discussion on government guarantees related to power purchases is happening at the country level. Whilst many of the AMS already practice FIT, meetings at the ASEAN level will support the knowledge and experience exchange between the AMS, and explore alternative de-risking mechanisms. Table 5.4 details the Phase 4 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Table 5.4 – Implementation Plan for Phase 4

Targets: By 2024, ASEAN and AMS will have streamlined processes and incentives at the regional level to host investment summits.	
Expected Timeline: 18-20 years (continuous)	
4.1. RE Investments are Prioritised in AMS Investment Policies and Framework	
Actions	4.1.1. Interministerial task forces at the national level established to streamline RE investment processes. 4.1.2. ASEAN pipeline for RE investments published. 4.1.3. ASEAN guide for stakeholder consultations developed.
Indicators	Regional and national investment guides.
Stakeholders	AMS ministries (energy, transportation, finance, environment).
4.2. Annual Regional Investment Summits	
Actions	4.2.1. AMS consolidates annual RE investment targets for domestic and international investments. 4.2.2. Regional guidebook for incentives and exemptions for RE investments published annually. 4.3.3. Regional Investment Summit hosted annually.
Indicators	Workshop concepts.
Stakeholders	AMS ministries and other accredited entities – regional MDBs, regional private sector and developers, donors, NGOs
4.3. RE Investment Guarantees and De-risking Mechanisms Identified	
Actions	4.3.1. AMS discussions at the regional level to find solutions for government guarantees and regulations. 4.3.2. Alternative approaches for de-risking RE investments identified for the AMS which are not able to provide guarantees.
Indicators	Workshop concepts.
Stakeholders	AMS ministries (energy and finance)

INFORMATION BOX**ASEAN Example – The Philippines**

The National Renewable Energy Programme of the Philippines uses a whole-of-nation approach to reach RE goals and foster RE's positive social and economic benefits. The DOE is asking other government agencies to work with it to develop programmes that will help promote RE. The

DOE is also working with different local government units (LGUs) to make it easier for national RE policies and programmes to be put into action on a local level. The transition to clean energy may be a long process, but it is not lonely. With the help of the private sector and other stakeholders, the sector has grown by leaps and bounds. With the RE Act's policy tools in place, the Renewable Portfolio Standards (RPS) for on-grid were set up. To meet the RPS On-Grid Rules, the MP must use RECs generated from any or all of the following: (i) allocation from FIT-eligible RE facilities; (ii) Power Supply Agreement PSA with RPS-eligible facilities; (iii) purchase or acquisition of RECs from the RE Market; (iv) generation from net-metering installations; (v) RE facility for own use; and (vi) energy sales.

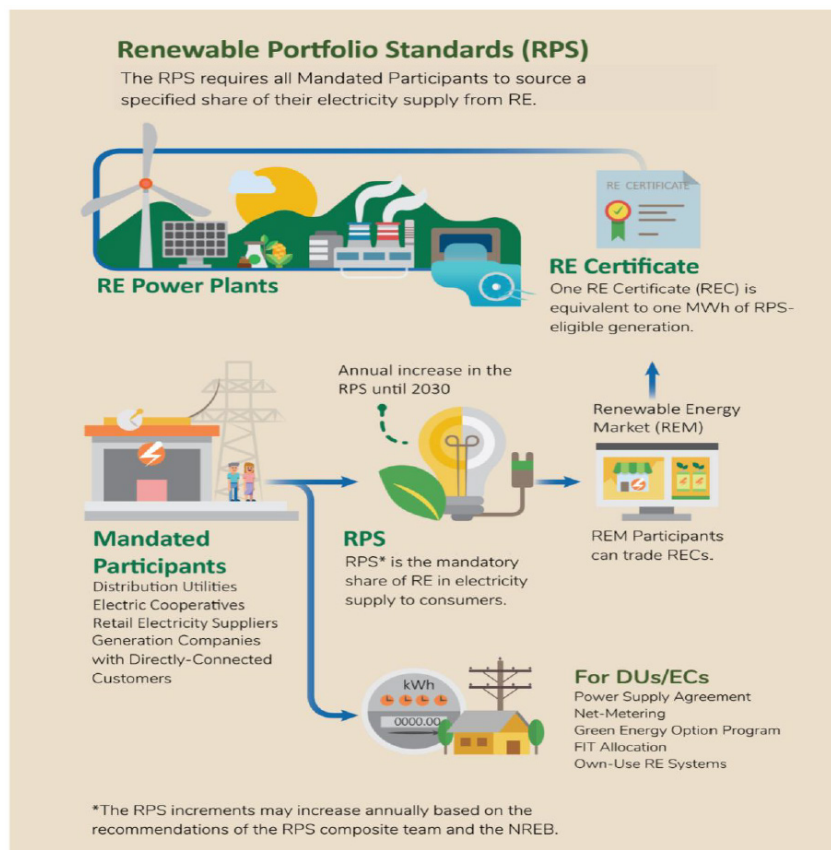


Figure 5.4 – Renewable Portfolio Standards of the Philippines

5.5. Phase 5: ASEAN Renewable Energy Facility Established to Achieve Paris Agreement for APS 2050

ASEAN M&E for Economic Integration has already identified renewable energy as one of the priorities for economic integration. Whilst AMS ministries conduct annual planning and monitoring, additional monitoring of common priority indicators for renewable energy would benefit the regional approach. The review and reflection of priority indicators should be every five years, to ensure the RE targets are maximised for each plan iteration. Table 5.5 details the Phase 5 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Multiple climate finance facilities are set up for the AMS, and many experiences and lessons could be extracted from existing projects. The ASEAN Renewable Energy Facility, dedicated to all 10 AMS, would be beneficial as different AMS has diverse experiences and readiness for RE implementation. From readiness assessments, gender assessments and action plans to develop a business case, the AMS can learn from other countries' experiences. ASEAN also has the structure and experience in rotating chairs and the secretariat. Thus, energy facilities could be supported by the existing structure. Potential partners and donors could be consulted on the mission and expected results from the facility, to secure buy-in from future partners.

Table 5.5 – Implementation Plan for Phase 5

Targets: By 2025, AMS have clear implementation targets and milestones to consolidate at the regional level and track progress for AE07. By 2027, ASEAN Renewable Energy Facility launched and catalyses RE projects in generation, energy efficiency, and electric vehicle penetration.	
Expected Timeline: 10 years	
5.1. Renewable Energy Regional M&E Indicators Developed	
Actions	5.1.1. AMS utilise the M&E tool from Monitoring ASEAN Economic Integration and identifies priority indicators for the renewable energy regional approach.
Indicators	Key indicators for renewable energy
Stakeholders	AMS ministries,
5.2. ASEAN Renewable Energy Facility	
Actions	5.2.1. Government and philanthropic donors and multilateral co-funders mapped. 5.2.2. Existing GCF programmes for ASEAN strengthened to mobilise ASEAN facilities. 5.2.3. Facility structure and members developed. 5.2.4. First round of applications received and reviewed by the Facility. 5.2.5. Financial institution partner/lending facility identified.
Indicators	Facility concept note. Facility structure. Applications received.
Stakeholders	AMS ministries, the facility secretariat, multilateral partners

5.3. Resource Mobilisation for the Facility	
Actions	5.3.1. Consultation meetings with major donors are conducted. 5.3.2. Donor feedback incorporated into the Facility concept. 5.3.3. Gender and social inclusion incorporated.
Indicators	Feedback from consultation meetings. Revised and final concept.
Stakeholders	Donors and other non-state actor partners.

5.6. Phase 6: ASEAN Regional Interconnection (Mainland and Islands)

AEO7 identified interconnection as part of the future energy outlook, and AIMS III indicates in the High Renewable Energy Scenario that the share of renewable energy could be increased in the electricity sector using an interconnected grid. The North Interconnection is geographically easier to implement, and the East and South Interconnections could gradually be completed with domestic and international financing.

ASEAN has existing bilateral interconnections between member states. However, grid codes and guidance on interconnection standards should be developed to enhance the RE market. Cross-border exchanges on energy commodities are not

limited to electricity trade, but could be applied in REC, carbon trading, and RE financing. Digitisation is crucial for the development of a transparent energy market. Table 5.6 details the Phase 6 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Implementing an interconnection network should follow a robust environmental and social assessment and planning consultation with local stakeholders (i.e. local communities, indigenous peoples, habitat experts, forestry experts, wildlife experts, and local authorities). Grid networks tend to follow the shortest path and have the risk of negatively impacting and fragmenting habitats and wildlife. A sustainable infrastructure plan for interconnection paths should be developed in collaboration with non-state actors.

Table 5.6 – Implementation Plan for Phase 6

Targets: By 2030, the ASEAN Energy Market will prioritise renewable energy trading, and AMS will increase RE ambitions in country-level roadmaps and NDC. By 2050, the fully interconnected AMS will improve their GDP with access to reliable energy and revenue from exported energy.	
Expected Timeline: 15 years	
6.1. Regional Interconnection	
Actions	6.1.1. Technical assistance provided for AMS to identify suitable grid modelling using licensed or open-source tools (e.g. Flextool, PLEXOS, etc). 6.1.2. ASEAN Renewable Energy Market Working Group established to develop market policies and regulations. 6.1.3. ASEAN regional interconnection standards developed. 6.1.4. Digitisation of public grid information developed.

Indicators	Renewable energy imported/exported in 2030, 2040 and 2050.
Stakeholders	AMS ministries, TSOs, Utilities, Independent Power Producers
6.2. Sustainable and Nature-conscious infrastructure	
Actions	6.2.1. Regional and national consultation meetings for infrastructure planning conducted with the state and non-state actors. 6.2.2. Least impact infrastructure plan developed for interconnection paths.
Indicators	Consultation meetings with relevant stakeholders.
Stakeholders	NGOs (wildlife, habitat, forest, rivers), CSOs, Indigenous Community leaders

6.6. Phase 7: Catalyse Renewable Energy Investments to Exceed APS Targets

At this point, it is assumed that the enabling environments are strengthened at both ASEAN and individual AMS levels (Phase 1), regional efforts on channelling climate finance to build capacity and exchange knowledge amongst the AMS have been completed (Phase 2), the ASEAN Renewable Energy Facility has catalysed more renewable implementation and decreased contract price (Phase 5), and interconnection

projects have enabled more RE in the regional energy mix (Phase 6).

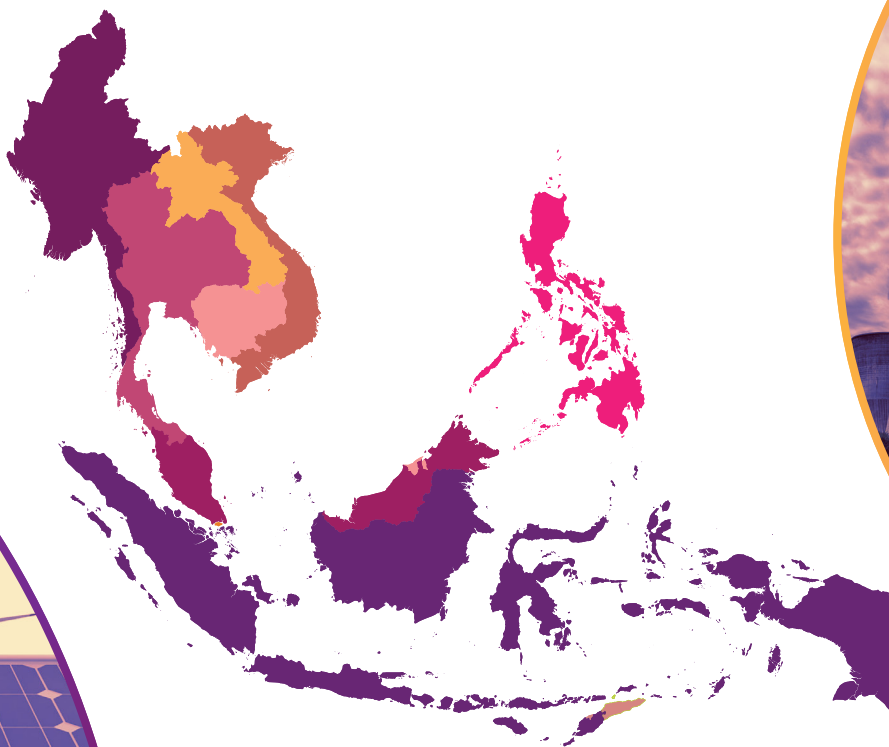
In Phase 7, the myth of RE on-grid stability is assumed to be resolved, and investment requirements to complement the existing ASEAN interconnected grid have been increased. With the development of emerging technologies to improve stability, the ASEAN RE target should be increase by up to 100% for power generation and electric vehicles. Table 5.7 details the Phase 7 implementation plan, including the roles of stakeholders and indicators to monitor progress.

Table 5.7 – Implementation Plan for Phase 7

Targets: By 2050, RE investment in ASEAN fulfilled its potential and the new APS target of 100% RE for ASEAN developed.	
Expected Timeline: 15 years	
7.1. Research and Development on Emerging RE technologies	
Actions	7.1.1. Review of M&E indicators (Phase 4) on investment attractiveness (Phase 3) and ASEAN clean energy facility (Phase 5) conducted. 7.1.2. New ASEAN Energy Outlook developed with 100% RE for generation, improve energy efficiency, 100% EV penetration and clean cooking developed. 7.1.3. Regional Renewable Energy Investment Framework strengthened to achieve AEO's APS targets.
Indicators	Investment accumulated in ASEAN.
Stakeholders	AMS ministries

CHAPTER 6

The Way Forward



The ASEAN Renewable Energy Regional Approach sought to strengthen regional energy cooperation for decarbonising ASEAN's energy system by adopting the most ambitious scenarios of AEO7, AIMS III, 2nd RE Outlook, and conditional targets of the NDCs. The observation on country-level energy statuses and policies shed light on AMS's potentials and challenges in contributing to regional approaches from technical and governance perspectives. Revamping the enabling environment for RE investment, setting up RE investment facilities, upgrading energy interconnectivity within ASEAN and beyond, and elevating RE ambitions to 100% are four fundamental activities of realising the ASEAN RE Long-term Roadmap.

In the journey to finalising the ASEAN RE Long-term Roadmap, the following seven insights must be considered by the AMS.

6.1. Follow AMS Examples

Whilst strengthening the enabling environment, ASEAN's regional knowledge should be widely utilised. Singapore, Malaysia, the Philippines, Thailand, Indonesia, and Vietnam have established more robust policies for RE and created a competitive RE market in the region, but the other AMS are yet to utilise the experience and lessons learned gathered from fellow AMS in recent years.

For example, a bilateral knowledge exchange programme between the Philippines and Myanmar would be beneficial for setting up FIT, net metering, REC, and so forth.

A collaboration between Thailand and Lao PDR would transfer knowledge and understanding of the systems and grid codes, strengthening future interconnection projects.

In recent years, the AMS tend to collaborate more with countries outside of ASEAN for technical assistance and support. Under APAEC 2016-2025, the AMS which require technical assistance should seek support from experienced AMS. For example, Vietnam's PDP8 and Net-Zero Pathway could be strong examples.

6.2. Strengthen Renewable Energy Investment for Economic Integration

Both SWOT analysis and the design of roadmaps indicate that investments in renewable energy in the electricity, transportation, and energy efficiency sectors will be vital to achieving the APS. AEO7 projected the investment required for five years to be USD 109 billion. If AIMS III's High Renewable Energy Scenario is the target, the RE percentage in the electricity sector alone will be 504 GW. The investment required for the energy sector to keep pace with economic integration will be prominent, and thus decision-makers should promote RE.

6.3. Re-evaluate Fossil Fuel and Other Traditional Technologies

ASEAN can take a lesson from many developed European countries, where Transmission and System Operation Experts resisted the idea of intermittent RE in the system. Whilst many AMS keep coal-fired power as an option in all scenarios, it may take attention away from RE, as companies will keep lobbying and distracting from RE development. Though the AMS will decide on their respective generation mix, a regional scenario of no coal-fired power should be considered and modelled.

6.4. Focus on Climate Finance

The AMS' NDCs emphasise the ambitions for RE. Climate finance and technical support mechanisms (e.g. Green Climate Funds, NDC partnerships, etc.) could be prioritised for each AMS. To achieve that, the AMS are required to list the technical and financial assistance necessary to accomplish the conditional targets. Specifically, the countries yet to develop conditional targets must prioritise the targets.

6.5. Capacity Building for Top Decision Makers

For bold decisions and great leaps into the new RE era, capacity building for AMS's top decision-makers (i.e. Prime Ministers and Presidents) would be beneficial. In addition to technical benefits, RE provides socio-economic benefits, such as job creation, which are a primary focus for national leaders. Taking the examples of national climate mandates, many state leaders are involved in national climate targets and thus, increasing climate plans and actions at the national level.

6.6. Negawatt ASEAN

ASEAN can practice the Negawatt approach, by consuming better instead of producing more. This common-sense approach facilitates the discovery of a new hidden, but significant resource. The “production” potential of negawatts is greater than half of the current world production of energy, with currently available and reliable solutions offering numerous related benefits, such as absence of pollution, decentralisation, creation of jobs, responsibility, solidarity, peace, and more.

6.7. Improving Ambitions

For the next edition of the ASEAN Energy Outlook, a dedicated portion of emerging technology should be included in the mix. For example, green hydrogen, batteries, and pump storage would support AMS grids in 2023, or in future interconnection. Due to competitive prices for RE contracts and power purchase agreements, a least-cost model with maximum RE should be conducted. Multiple studies on the AMS support a 100% RE future by 2050. Similar modelling targeting as close to 100% with grid stability tests and cost analysis should be conducted.

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Appendix

Reference List of Policy Documents

Area	Policies, Plans and Roadmaps
ASEAN	• ASEAN 7th Energy Outlook by ACE • ASEAN Interconnection Master Plan III by USAID • ASEAN Renewable Energy Outlook by IRENA • Power Sector Vision for Greater Mekong Sub-Region by WWF • Interconnection Study for Low Carbon, Low Conflict and Low Cost in GMS by WWF • Decarbonisation of ASEAN Energy by ERIA • Roadmap to Energy Efficient Buildings in ASEAN by IRENA • Draft ASEAN EE&C Policies and Measures for Transportation Sector by ACE
Brunei Darussalam	• Energy White Paper and Renewable Energy Target 2014 • Labelling programme for air conditioners 2014 • MEPS for non-inverter type and single-phase air conditioners 2014 • Nationally Determined Contributions 2020
Cambodia	• Programme for the Development of Rural Electrification of Electricité Du Cambodge (2020) • National Climate Change Strategic Plan (2014-2023) • Cambodia's National Cooling Action Plan (2022) (COP27) • Nationally Determined Contributions • Long-term Strategy for Carbon Neutrality
Lao PDR	• National Policy on Sustainable Hydropower Development in Lao PDR 2015 • Renewable Energy Development Strategy in Lao PDR 2011 • Law on Investment Promotion 2009 • National Policy on Environmental and Social Sustainability of the Hydropower Sector in Lao PDR 2006 • The Power Sector Policy and Targets (2020) • SDG 7 Roadmap for Lao PDR • Nationally Determined Contributions
Indonesia	• Application of Minimum Energy Performance Standards for Energy Consuming Appliances and Equipment (MEMR 2021 Regulation No.14/2021) • MEPS and Labelling for Air Conditioners (MEMR Decision No. 103/2021) 2021 • MEPS and Labelling for Fans (MEMR Decision No. 114/2021) 2021 • MEPS and Labelling for Refrigerators (MEMR Decision No. 113/2021) 2021 • MEPS and Labelling for Rice Cookers (MEMR Decision No. 115/2021) 2021

Indonesia	• Roadmap for Accelerated Development of New and Renewable Energy (2015-2025) • Regulation on Hydro No.17 (2019) • RUPTL – RENCANA USAHA PENYEDIAAN TENAGA LISTRIK (Indonesia Business Plan 2021) • Nationally Determined Contributions
Myanmar	• TA-8356 National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar (2016) • The Foreign Investment Law (2012) • National Electrification Plan 2014 (for 2030)' • Tax exemptions on electric vehicles • National Electricity Law 2021 update • Myanmar Energy Master Plan • Myanmar Electricity Master Plan • Myanmar National Electrification Plan • Nationally Determined Contributions
Malaysia	• Nationally Determined Contribution (NDC) to the Paris Agreement: Malaysia 2021 • 2 Minimum Energy Performance Standards and Labelling for Air Conditioners with Cooling Capacity = 7.1kW (2018) • Minimum Energy Performance Standards and Labelling for Air Conditioners with Cooling Capacity = 7.1 kW (2018) • Minimum Energy Performance Standards and Labelling for Refrigerator 2018 • 4 Minimum Energy Performance Standards and Labelling for Washing Machine (2018) • Minimum Energy Performance Standards and Labelling for Washing Machine 2018 • National Energy Efficiency Action Plan 2016-2025 (2016) • Malaysia Renewable Energy Roadmap (MyRER) • Nationally Determined Contributions
The Philippines	• Act 11245: The Energy Efficiency and Conservation Act 2019 • 2 Republic Act 10963-Senate Bill 1592-Excise tax 2018 • Republic Act 10963-Senate Bill 1592-Excise tax 2018 • DC2016: Philippine Standards and Labelling Program 2016 • 4 DOE DC2016-04-0005 PPR 01: air conditioners labelling 2016 • DOE DC2016-04-0005 PPR 01: air conditioners labelling 2016 • Accelerating Household Electrification through Regulated Solar Home Systems 2014 • The Philippine Energy Plan (PEP) 2020-2040 • National Renewable Energy Report NREP • Nationally Determined Contributions

Singapore	• Smart services for efficient energy consumption - including smart meters 2019 2 EE Funding for Qualifying Costs for Energy Assessment in Industries 2018 • EE Funding for Qualifying Costs for Energy Assessment in Industries 2018 • Energy conservation (prescribed regulated goods) order 2017 2018 4 MEPS for Motors (IE3) 2018 • MEPS for Motors (IE3) 2018 • Requirements for Energy Efficiency Opportunities Assessment (EEOA) for New Ventures (NV) 2018 • Singapore's National Climate Change Strategy (2012) • Sustainable Singapore Blueprint (2015) • Energy 2050 Committee Report • Nationally Determined Contributions
Thailand	• Eco-Car programme-Excise tax 2016 • Thailand Alternative Energy Development Plan (AEDP 2015-2036) 2015 • Feed-in Tariff for Very Small Power Producers (VSPP) (excluding solar PV) 2014 4 Feed-in tariff for distributed solar systems 2013 • Feed-in tariff for distributed solar systems 2013 • Biodiesel blending mandate 2012 • The Thailand Power Development Plan (2015-2036) • Thailand Smart Grid Roadmap (2015-2036) • Renewable Energy Outlook 2017 • Nationally Determined Contributions
Vietnam	• MEPS and Labelling for compact fluorescent light bulbs TCVN 7896:2015 (applied by 24/2018/QD-TTg) 2020 2 MEPS and Labelling for Computer screen: TCVN 9508: 2012 (applied by 24/2018/QD-TTg) 2020 • MEPS and Labelling for computer screen: TCVN 9508: 2012 (applied by 24/2018/QD-TTg) 2020 • MEPS and Labelling for Electric Fans: TCVN 7826:2015 (applied by 24/2018/QD-TTg) 2020 4 MEPS and Labelling for Electric rice cookers: TCVN 8252:2015 (applied by 24/2018/QD-TTg) 2020 • MEPS and Labelling for electric rice cookers: TCVN 8252:2015 (applied by 24/2018/QD-TTg) 2020 • MEPS and Labelling for electromagnetic ballasts for fluorescent lamps: TCVN 8248:2013 (applied by 24/2018/QD-TTg) 2020 • Vietnam Renewable Energy Development Strategy (2015) • National Power Development Plan (2021- 2030) • Draft Power Development Plan VIII 2022 • Vietnam's Green Growth Strategy for 2021-2030, vision towards 2050 • Nationally Determined Contributions



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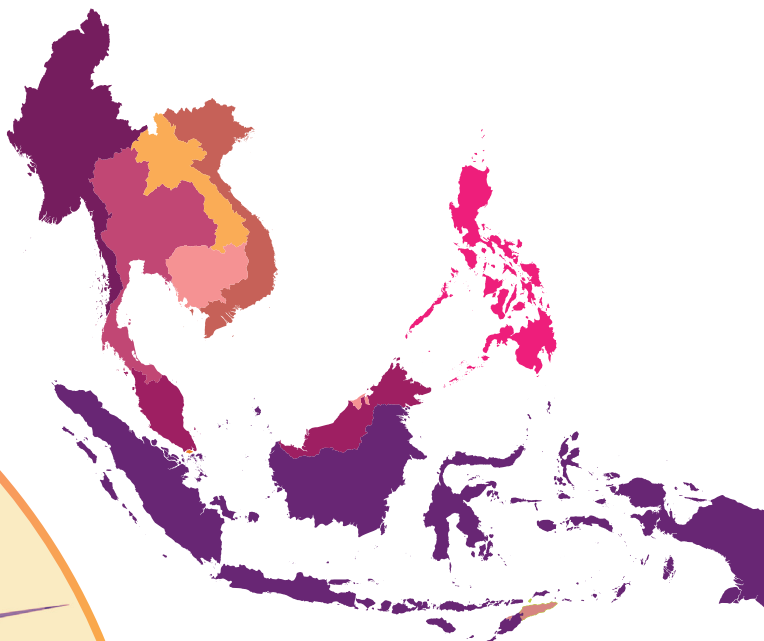
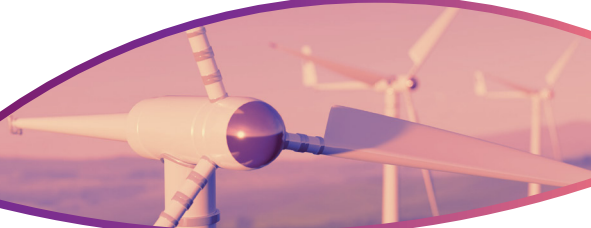
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