ASEAN State of Climate Change Report

Current status and outlook of the ASEAN region
Toward the ASEAN climate vision 2050

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one vision
one identity
one community

ASEAN State of Climate Change Report

Profile

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967. The Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.
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Foreword

The year 2021 marks a crucial milestone in our fight to combat climate change. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) provides us with undeniable evidence that climate change is real and is impacting our daily lives, especially the most vulnerable sectors of our society.

As we move towards the 26th Session of the Conference of the Parties (COP26) of the United Nations Framework Convention on Climate Change (UNFCCC) this November, it is timely to reflect and strategise how we can further raise our commitments to contribute to the global and regional climate agenda. The road towards carbon neutrality by 2050 is a daunting task and requires extensive planning and collaborative efforts within and outside ASEAN.

Over the years, ASEAN has demonstrated commitment to addressing climate change, including through multi-sectoral dialogue and relevant activities involving key partners in various sectors, such as agriculture, forestry, energy, transport, disaster management, and finance. The ASEAN Joint Statements on Climate Change to UNFCCC COPs attests to our region's aspirations and renewed commitments to contribute towards global climate targets. Moreover, under the chairmanship of Brunei Darussalam in 2021, ASEAN has identified climate change as one of its regional priorities. These initiatives have enabled ASEAN to foster strong partnerships with regional and global partners to support building local capacities, initiate sustained climate investments, and facilitate knowledge and technology exchanges.

The ASEAN State of Climate Change Report (ASCCR) is the result of our endeavour conducted through close coordination with the Institute for Global Environmental Strategies (IGES) and with significant contribution from the Government of Japan. In essence, the report provides an overview of the region's current status on climate capacity, outlines how actions can be further improved, as well as identifies opportunities for cooperation and collaboration to support ASEAN's efforts towards achieving the 2050 net zero transition targets. Furthermore, the ASCCR hopes to improve mutual exchange of information and expertise, which would allow ASEAN Member States (AMS) to harmonise and align each other's efforts towards a climate resilient region.

Notably, the ASCCR also underscores the importance of raising capacities on climate science in ASEAN. To support the speedy and just transition to net zero, there is a need to significantly boost AMS' access to climate finance as well as knowledge and technology transfer on key priority areas, such as adaptation and mitigation measures, disaster risk reduction, and clean energy transition. Finally, the report also touches on the value of pushing efforts to support the region's post-pandemic recovery under the ASEAN Comprehensive Recovery Framework. This reaffirms the region's

strong commitment to alleviate the adverse impact of the COVID-19, and advance the implementation of regional and local priorities towards a more sustainable and resilient future.

I hope the valuable insights in this publication will generate renewed interest and productive dialogue among policymakers, the business sector, civil society, academia, local communities, and other key stakeholders in ASEAN to further promote collaborative actions as well as innovative solutions to combat climate change in the region.

DATO LIM JOCK HOI
Secretary-General of ASEAN

Preface

The issue of climate change is a major concern to ASEAN, as Southeast Asia is one of the most at-risk regions in the world to the impacts on climate change. In response to the impacts of climate change, the ASEAN Member States (AMS) have proactively taken measures to address the issue at national, regional and global level, as reflected in AMS' national reports, ASEAN Community Vision 2025, and active participation in the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement. Significant amount of data and information on the status of climate change issues in AMS, as well as AMS' efforts and initiatives to respond to them, have been produced. However, there is yet a coordinated effort at ASEAN level to collate, consolidate and synthesize them into a coherent report to provide information on the state of, trends in, and prospects for climate action in the region. Furthermore, AMS have agreed to explore the possibility of developing a harmonised approach to measuring, reporting and verifying greenhouse gas emissions as a first step towards further regional collaboration on, among others, carbon markets.

The ASEAN State of Climate Change Report (ASCCR) aims to provide an overall outlook on the state of play of climate change in the context of ASEAN region, which could support AMS and ASEAN's policy decision making process. The report is expected to support and contribute to the global stocktaking exercise that will take place every five years from 2023 onwards under the Paris Agreement, to assess collective progress towards achieving the purpose of the Agreement and its long-term goals. Specifically, the report aims to:

a) provide an overall outlook of the state of play of climate change issues, including the adaptation and mitigation efforts and cooperation taken at the national, regional and global level in the context of ASEAN,

b) provide an analysis of the gaps, needs, challenges, lessons learned and best practices in addressing climate change in the region and among AMS,

c) provide recommendations on key priorities / potential areas of cooperation for the development of regional strategy for climate change adaptation and mitigation in ASEAN to strengthen regional climate action;

The report is designed to inform and guide the region and AMS towards ambitious climate change targets, through a framework for transparency and transformative action to mitigate and adapt to climate change. The report also constitutes an important step towards an ASEAN climate action vision, which specifically includes priority actions by 2030 and key enabling environment up to 2050.

The development of the ASCCR was initiated and coordinated by the ASEAN Secretariat, together with the Institute for Global Environmental Strategies (IGES), under the purview of the ASEAN Working Group on Climate Change (AWGCC)

and the ASEAN Senior Officials on Environment (ASOEN). It was made possible with immense support from the Government of Japan through Japan-ASEAN Integration Fund.

National think-tanks from each AMS were identified through rigorous process to gather data and information as well as develop national-level reports on the status of climate change in each AMS, while IGES as the implementing agency played a critical role in putting together the report from regional perspective in close consultation and with valuable inputs from AWGCC, relevant ASEAN sectoral bodies, international organisations and dialogue / development partners. I wish to take this opportunity to acknowledge the contribution of each and every one of those who have been involved in the development of this report.

The ASCCR takes a co-production approach through in-country and regional consultation meetings and consultation, which will be elaborated further in Section 2. The approach brought together all stakeholders to (i) identify key gaps, lessons and good practices in terms of national climate change interventions for adaptation and mitigation, (ii) formulate a desirable methodology and framework; (iii) work on prioritised regional climate actions based on key commonalities and differences among AMS; and (iv) identify capacity building opportunities and appropriate regional frameworks so that AMS and the ASEAN region can enhance transparency and move towards more ambitious adaptation and mitigation interventions.

The COVID-19 pandemic struck the global community during the development of the ASCCR, so considerations on green and resilient recovery were taken into account when identifying regional priorities and actions, to complement the ASEAN Comprehensive Recovery Framework as part of ASEAN's post-pandemic response.

I hope that the report will serve as a valuable resource for AMS and ASEAN in formulating and advancing collective climate change policies and actions to realise climate-friendly and resilient community.

KUNG PHOAK
Deputy Secretary-General of ASEAN
for ASEAN Socio-Cultural Community

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The report is developed through commissioned work by the Institute for Global Environmental Strategies (IGES) in consultation with the National Focal Points (NFPs) of the ASEAN Working Group on Climate Change (AWGCC) and the national think-tanks in each AMS. ASCCR would not be finalised without distinguished works done by the IGES team, the National Focal Points (NFPs) of the ASEAN Working Group on Climate Change (AWGCC) and each national think-tank during the extremely challenging period of the COVID-19 pandemic.

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Glossary

ACCEPT	ASEAN Climate Change and Energy Project
ACRF	ASEAN Comprehensive Recovery Framework
AFOLU	Agriculture, Forestry and Other Land Use
AIIM	Acquaint–Integrate–Involve–Motivate
AMS	ASEAN Member State(s)
APAEC	ASEAN Plan of Action for Energy Cooperation
APAN	Asia Pacific Advanced Network
APG	ASEAN Power Grid
AP-PLAT	Asia-Pacific Climate Change Adaptation Information Platform
AWGCC	ASEAN Working Group on Climate Change
BECCS	Bioenergy with Carbon Capture and Storage
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CCA	Climate Change Adaptation
CCU	Carbon Capture and Utilisation
CCUS	Carbon Capture, Utilisation and Storage
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CIX	Climate Impact X
CMA	Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement
CSO	Civil Society Organisation
DACCS	Direct Air Capture with Carbon Capture and Storage
DALY	Disability Adjusted Life Years
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DX	Digital Transformation
EbA	Ecosystem-Based Adaptation
EE	Energy Efficiency
ENSO	El Niño Southern Oscillation
ETC	Energy Transitions Commission
ETF	Enhanced Transparency Framework
EV	Electric Vehicle
FCV	Fuel Cell Vehicle
GCF	Green Climate Fund
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GST	Global Stocktake
ICE	Internal Combustion Engine
INDC	Intended Nationally Determined Contribution
IO	International Organisation
IPCC	Intergovernmental Panel on Climate Change

IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
L&D	Loss and Damage
LCOE	Levelised Cost of Electricity
LDC	Least Developed Country
LTMS-PIP	Lao PDR-Thailand-Malaysia-Singapore Power Integration Project
LTS	Long-Term Strategy
LULUCF	Land Use, Land-Use Change and Forestry
M&E	Monitoring and Evaluation
MRV	Monitoring, Reporting and Verification
MSME	Micro, Small, and Medium-sized Enterprises
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NbS	Nature-based Solutions
NC	National Communication
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organisation
NSA	Non-state and Subnational Actors
ODA	Official Development Assistance
PA	Paris Agreement
PaMs	Policies and Measures
PPP	Public-Private Partnerships
PPPP	Public-Private-People Partnerships
RCP	Representative Concentration Pathway
RE	Renewable Energy
REC	Renewable Energy Certificate
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RPS	Renewable Portfolio Standard
SDG	Sustainable Development Goal
SSP	Shared Socioeconomic Pathway
SST	Sea Surface Temperature
UNFCCC	United Nations Framework Convention on Climate Change
VRE	Variable Renewable Energy

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Executive Summary

The ASEAN State of Climate Change Report (ASCCR) provides an overall outlook of the state of play of climate change issues in the ASEAN region. ASCCR is also a forward-looking report, which includes recommendations on making the transition toward 2030 and on to 2050 for both adaptation and mitigation, considering ASEAN's development context and the long-term goals of the Paris Agreement.

The challenges confronting the ASEAN region as well as the current commitment of ASEAN to contribute to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement (PA) are discussed. Recognising the dual challenges to meet reporting requirements under the Enhanced Transparency Framework (ETF) and to make progress towards the ambition of the PA goals of limiting global average temperature increase to well below 2 degrees Celsius (°C), preferably to 1.5°C, compared to pre-industrial levels, the report develops a methodology to assess the current progress of actions and the need to strengthen them through 2030 and on to 2050 based on the concepts of "transparency" and "transformation".

Further, the report presents the current status and outlook of the ASEAN region's development context relevant to greenhouse gas (GHG) emissions, the impacts of climate change as well as vulnerability to them, and climate change adaptation and mitigation measures. The report also provides viable goals and pathways to develop an ASEAN vision for climate action toward 2050, to reach the PA goals, and carry out the related actions in the region needed to achieve this vison.

A diverse set of regional actions for adaptation and mitigation are recommended, grouped into four categories ("Acquaint", related to transparency; "Integrate"; "Involve"; and "Motivate", related to transformation), as prioritised by the ASEAN Member States (AMS) for the next decade, while essential actions for 2030-2050 are also suggested. Hence, ASCCR illustrates necessary measures through 2030 and on to 2050, and if these are combined with sufficiently enhanced capacities, they would increase the feasibility to meet the PA goals for adaptation and mitigation, including by achieving net-zero GHG emissions as early as possible in the latter half of the 21st Century.

As for overarching responses, adaptation and mitigation actions should be synergised wherever possible, especially at the level of implementation of practices on the ground. This will help to ensure that solutions are cost-effective as well as enhance societal well-being. Examples include climate-smart agriculture and nature-based solutions (NbS), including ecosystems-based adaptation (EbA), such as agroforestry, protecting mangrove forests, and strengthening forest management through certification and "reducing emissions from deforestation and forest degradation"[1] (REDD+) that contributes to enhancing forest carbon stocks. Appropriate hydropower reservoir management will also protect local communities from riverine floods and other extreme events, while contributing to climate change mitigation. Furthermore, "climate-proofed" energy infrastructures such as electricity generators, power grids and associated buildings that have incorporated adequate mitigation and adaptation measures need to be located or relocated in places which are less exposed to climate change to sustain their mitigation and adaptation synergies.

1. Note that REDD+ is officially an abbreviation for "Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries" (See Glossary).

In response to the COVID-19 pandemic, financial flows need to support a green and resilient recovery. Fiscal spending can also help to leverage private finance while utilisation of regional/international funds is also essential. Finance will be the key to achieving a recovery compatible with the pathway to the PA goals for adaptation and mitigation, by providing enough funding for technology development and diffusion as well as human capacity building for development and climate change intervention. In order to secure and mobilise public and private funding, ASEAN programmes for sustainable and resilient recovery from COVID-19 (e.g. the ASEAN Comprehensive Recovery Framework) need to integrate strategies for green recovery and just transition which involve specific programmes to reskill the workforce and assist in smooth reemployment in industries related to clean energy, climate smart agriculture and sustainable forest management.

In terms of adaptation to climate change, AMS are highly vulnerable to climate change impacts, regardless of mitigation progress. The ASEAN region is already experiencing significant climate change impacts with the growing intensity and magnitude of extreme weather events and increasing economic, environmental and social damage. Future climate change impacts will undermine decades of development progress, so the region needs to prioritise resiliency as well as adaptation interventions.

The region has been making steady progress in several areas relevant to climate change adaptation and disaster risk reduction (DRR). Importantly, the region's policies and institutional environment in relation to climate change adaptation (CCA) and DRR are at the forefront of this improvement, setting up a good enabling environment for robust implementation of CCA and DRR. While progress at the national policy and institutional level is commendable, this progress needs to percolate down to the grassroots level. Community-based DRR plans are being implemented, but CCA needs to be implemented at this level as well. Devolving power to local institutions needs to take place at a rapid pace to provide them with the needed autonomy in undertaking locally appropriate adaptation actions, matched by accelerated capacity strengthening at the local government level.

Regarding science and technology, some AMS have made good progress in strengthening climate science in terms of climate change projections, downscaling projections, climate change risk assessments and vulnerability assessments, particularly in priority sectors, such as water resources and agriculture. However, these are yet to be scaled up beyond specific river basins and sectors and to the rest of the region. Countries that have made significant progress in climate change risk assessments, adaptation planning, climate-smart agriculture, etc., are well placed to share this expertise with the rest of the AMS. This report identifies areas for regional cooperation as well as what kind of enabling environment is needed for the cooperation to succeed.

As specific matters related to the AFOLU/LULUCF sector in the region, nature-based solutions (NbS) and investing in natural capital provide important entry points to resilient livelihoods and sustainable adaptation. There is a need to acknowledge and promote local and indigenous knowledge of climate adaptation across the region, and a need for early consideration and integration of adaptation in different sectors at various stages such as during planning, decision-making and management.

These suggestions can provide a good basis for the ASEAN Working Group on Climate Change (AWGCC) to develop a climate change cooperation plan for the region including with other sectoral bodies, partners and local authorities and communities. Implementing plans targeted at the above aspects are expected to enhance adaptive capacity and resiliency at all levels from local to regional.

Concerning mitigation, AMS have proactively taken measures in the areas of GHG inventory and monitoring, reporting and verification (MRV) for GHG emissions and reductions and sector policy planning in the course of developing their nationally determined contributions (NDC). A key challenge is how to raise the level of ambition of the NDCs and related long-term national strategies and policies. To do so, it is vital to strengthen the science and information base with novel technologies related to, but not limited to, digital transformation (DX), which directly contributes to enhancing transparency of climate change interventions at local, national and regional levels. Capacity building in preparation for the national reporting requirements under the Enhanced Transparency Framework (ETF) and regional-level tracking exercises/systems on GHG emissions and near- to long-term climate change interventions are expected to promote science-policy integration and thus drive transformation of the socioeconomic systems. This is dependent on appropriate management, along with efforts for multi-stakeholder engagement and substantial incentives and assistance with regard to finance and technology. Modelling capacity development for long-term projections on mitigation measures all the way through to 2050 and beyond is a vital requirement for developing regional/national long-term strategies toward net-zero GHG emissions.

Developing a long-term mitigation strategy for ASEAN will be key to informing and guiding sectoral and cross-sectoral policy planning in AMS in line with the pathway towards the PA goals. Stepping stones to frame the future ASEAN community include not only clean energy transition involving the sectors of power, industry, transport and buildings, but also the transition of the land-use system in the AFOLU/LULUCF sector based on NbS. In the energy sector, there is an ASEAN near-term energy target for renewable energy (RE) expansion and energy intensity reduction until 2025, but after that, the future course of actions to be taken by AMS is not necessarily informed by the PA goals but is more based on current policy trends. An ASEAN-wide collective long-term vision and/or target may encourage AMS to explore more ambitious emission reduction measures in a cost-effective manner by sharing knowledge and experience on best practices and emerging mechanisms, such as effective carbon pricing and RE trading via the ASEAN regional power grid. In the AFOLU/LULUCF sector, national development and mitigation strategies and plans need to prioritise REDD+ programmes, or more broadly sustainable forest management, thus enabling interventions to resolve the root causes of deforestation such as population pressure and expansion of agricultural areas affected by global supply chain of agricultural/forestry products.

Climate change mitigation through switching to renewable/low-carbon energy produces multiple co-benefits including improving access to electricity, enhancing energy security, providing local green jobs, reducing indoor and outdoor air pollution, and improving development potential. Actions to pursue co-benefits, such as combatting local air pollution, will expand the possibilities for substantial climate actions in the short and long run.

For the transition to net-zero energy and land systems, it is important to distinguish “transient” technologies that will be diminished or ultimately phased out and technologies that will keep playing a central role in achieving net-zero emissions, such as RE, taking into account national circumstances. Various sectoral technology options for decarbonisation need to be assessed with proper methodologies, including modelling frameworks that can show the pathway beyond 2050. Such technologies include, but are not limited to, RE (solar, wind, hydropower, geothermal, etc.) with battery and enhanced grid systems, high energy efficiency appliances, bioenergy (waste and primary resources), decarbonising technologies for industry, electric or hydrogen-related mobility (land, aviation, and shipping), materials with lower lifecycle GHG emissions, carbon capture, utilisation and storage (CCUS), hydrogen, sustainable forest management options, and afforestation and reforestation. In formulating a regional vision or strategy, it will be important to take into account trends in the global and regional markets of low- and zero-carbon technologies, cost reduction trends, and multiple co-benefits that will contribute to the long-term sustainable development of the ASEAN region.

Regarding energy transition, trade-offs between energy intensity reduction and emission intensity reduction need to be recognised and reflected in ASEAN's energy and climate strategies. The level of ambition of the energy mix, which is related to emission intensity reduction, is farther from the PA target trajectory than the demand-side ambition as measured by energy intensity reduction. In addition, energy supply and demand and GHG emissions need to be tracked (e.g. on a per-capita basis) to steadily plan and implement mitigation actions in the context of the different levels of economic development among the AMS. Enhancement or reshaping of national RE policies and implementation is needed, and the ASEAN Plan of Action for Energy Cooperation (APAEC)'s RE target of 23% in total primary energy supply by 2025 is critical for the transition through 2030 and on to 2050.

Looking ahead all the way through 2030 and on to 2050, the following bullet points show prioritised actions at the regional level over the next 10 years, which are expected to be incorporated into and linked with the regional climate change actions plans and national/local policy frameworks in each AMS. It should be noted that the table only shows the top three actions for each group of AIIM (Acquaint–Integrate–Involve–Motivate) actions. The other prioritised actions for each group are elaborated further in the report. The Acquaint group of actions mostly aims to enhance transparency of climate actions, while the other three groups of actions (i.e. Integrate, Involve and Motivate) basically contribute to promoting transformation and raising the level of climate ambitions[2].

Adaptation

Actions to promote transparency of adaptation

Acquaint

1. Promote risk and vulnerability assessment as a basis for adaptation planning
2. Develop best practice guidelines and roadmap for diffusion of adaptation technologies
3. Strengthen the scientific information base

Actions to promote transformation of adaptation to achieve increased ambition

Integrate

1. Mainstream adaptation into sectoral and development planning
2. Promote adaptation and mitigation co-benefits
3. Develop regional, national and local adaptation plans

Involve

1. Sustain actions through public-private-people partnerships (PPPP)
2. Promote multi-stakeholder processes
3. Promote regional cooperation on adaptation

Motivate

1. Set adaptation goals
2. Develop climate risk transfer system
3. Enhance technology diffusion on adaptation

2. The top three prioritised actions for each group of AIIM (Acquaint–Integrate–Involve–Motivate) actions by 2030 were prioritised and targeted at regional-level cooperation although most can also be applied to other levels from national to local.

Mitigation

Actions to promote transparency of mitigation

Acquaint

1. Strengthen the scientific information base
2. Enhance collaboration on co-benefits research and actions
3. Establish a knowledge centre hub on MRV for ASEAN and AMS

Actions to promote transformation of mitigation to achieve increased ambition

Integrate

1. Adopt an interdisciplinary approach for combating air pollution
2. Accelerate regional power interconnectivity to promote RE in the region
3. Promote green recovery from the COVID-19 pandemic

Involve

1. Establish networks, groups of scientists, and communities of practice for mitigation
2. Promote regional cooperation on mitigation through specific regional activities/frameworks
3. Promote education and awareness raising for clean technology diffusion at all levels

Motivate

1. Set long-term mitigation goals/targets and roadmaps at regional, national and local levels
2. Facilitate mitigation planning including addressing sectoral challenges
3. Enhance access to international mitigation finance

Regarding adaptation, the Acquaint group of actions includes promoting risk and vulnerability assessments, and strengthening scientific information base, and thus this group provides an important base for science-based decision making in the region. Similarly, the Motivate group of actions, including setting adaptation goals, finance, and reskilling the workforce, provides impetus to stakeholders to engage in the Involve group of actions. Further, the Integrate group of actions such as formulating adaptation plans enables to integrate all synergistic activities and achieve a harmonious adaptation progression in the region.

Regarding mitigation, the Acquaint group of actions, such as strengthening the information base, tracking regional progress towards the PA long-term goal, and strengthening modelling capacity for long-term projections, provides a basis for science-based decision-making in the region. The Involve group of actions will connect science with policymaking by facilitating science-policy integration and multi-stakeholder involvement. The Integrate group of actions such as integration of mitigation with air pollution prevention, RE promotion through the ASEAN Power Grid, and green recovery, expand opportunities to reap co-benefits across various strategies in an interdisciplinary and transdisciplinary manner. The Motivate group of actions include long-term mitigation goals, business innovation, finance and carbon pricing, afforestation programmes, technology development and diffusion, and reskilling of the workforce (just transition) and as such, this group accelerates transformative actions at the regional and national levels toward achieving net-zero GHG emissions.

The AIIM group of actions at the regional level explores key opportunities to accelerate the sectoral transitions for both adaptation and mitigation. Regional-level AIIM actions also aim to contribute to upgrading current national policies and/or establishing new policies, whether sectoral or cross-sectoral, since the proposed multidimensional transformation is largely led by the enhancement and redesign of national policies.

By around 2030, and forging ahead to 2050, ASEAN will need to change/strengthen the intensity of the AIIM group of actions to stay on track toward the PA goals for adaptation and mitigation as elaborated comprehensively in the report. Enhancement, deepening and coordination of regional, national and local policy will be done by taking advantage of socioeconomic development achieved by all actions related to the sustainable development goals (SDGs) and by seriously considering the trends in the global and regional markets of technologies on clean and resilient energy, climate smart agriculture and sustainable forest management.

In conclusion, the prioritised regional actions for adaptation and mitigation will contribute to upgrading and redesigning AMS' national policy frameworks, effectively changing the flow of finance, diffusing relevant technologies, reshaping the market and local community, and transforming entire society toward the direction of the PA goals. Going forward, while meeting a variety of development needs unique to each AMS, ASEAN aims to operationalise the collective adaptation and mitigation potential of the region for climate-friendly and resilient economic transformation toward 2050 and beyond.

Introduction

1 ASEAN State of Climate Change Report

1.1. Unprecedented regional challenge

There has been significant growth in both the global economy and population over the last few decades, with this growth predominantly led by Asia[3]. In line with this, the ASEAN region has been on track to meet a range of development goals. Indicators for the sustainable development goals (SDGs) in ASEAN Member States (AMS) on poverty reduction, good health and well-being, quality education, industry, and affordable and clean energy showed a steady improvement by 2015 relative to 2000 (ESCAP, 2017; 2019). However, there are still many challenges to be overcome in the ASEAN region, such as persistent hunger, inequality, particulate pollution in cities, and deforestation (ESCAP, 2016; 2017; 2019). ASEAN's population is projected to reach 770 million by 2040 and its economy is likely to become the world's fourth largest economy by 2030 (ERIA, 2019). The India–ASEAN–China corridor is expected to be the world's "golden arc", driving global growth and trade. Digital transformation (DX) and the fourth industrial revolution (Industry 4.0) are set to provide the region with major opportunities such as empowering micro, small and medium-sized enterprises (MSMEs) and individuals with enhanced access to markets, finance and technology, accelerating the modernisation of agriculture, improving national resource management, and moving forward on smart cities through projects such as ASEAN's Smart Cities Network (ERIA, 2019).

ASEAN joins the rest of the world in standing at a historical turning point in combatting climate change. Greenhouse gas (GHG) emissions in the region have been increasing in line with industrialisation based on fossil-fuel energy and associated land-use change resulting in the loss of tropical forest and peatland rich in biodiversity. Given the current policy and the Nationally Determined Contribution (NDC) targets, GHG emissions will continue to rise in the years up to 2030 globally (Zhou et al., 2020) (UNEP, 2020), leading to a temperature rise of 2.1-3.9°C by 2100 relative to pre-industrial levels (CAT, 2021)[4]. The ASEAN Center for Energy (ACE) predicts that the region's energy-related GHG emissions will increase by 34-147% between 2017 and 2040 (ACE, 2020). Climate change impacts will intensify unavoidably due to accumulated global emissions in the atmosphere over time. The costs incurred from damage wrought by climate change will be many times larger than investments needed to mitigate such damage. Moreover, the COVID-19 pandemic has proved to be a huge challenge to the overall ASEAN community on many levels in terms of development, with positive and negative implications for climate change interventions. In the same way that the first industrial revolution used fossil fuel energy to transform society, the ASEAN region must turn global trends towards a "decarbonising revolution" (IGES, 2020) to pursue net-zero emissions as soon as possible in the latter half of the 21st century. This will be an unprecedented challenge in this era of human history known as the Anthropocene (Crutzen, 2006) (Lewis & & Maslin, 2015).

Given the dual crises of climate change and the COVID-19 pandemic, it is time for the ASEAN community to work in concert with the global community to pursue a resilient and green recovery to achieve the long-term goal of net-zero emissions (ASEAN, 2020)[5]. This aspirational vision inevitably calls for social transformation[6] at all levels from regional to individual. It will be necessary to review and/or redesign policy frameworks so that ASEAN Member States

3. Global population has seen a 2.5-fold growth and the economy has seen a 65-fold growth between 1960 and 2019.

4. The possibility of continued warming on a so-called "Hothouse Earth" pathway (Steffen, 2018) reiterates the need for deep emission reductions as soon as possible.

5. The ASEAN Comprehensive Recovery Framework (ACRF) and its implementation plan stipulates five strategies on health systems, human security, Intra-ASEAN market and economic integration, DX, and sustainable and resilient recovery (ASEAN Secretariat, 2020). Adding green recovery perspective will be necessary to align this framework and plan with the course of actions toward net-zero emissions.

6. Transformation in this report refers to actions that lead to a level of change that cannot be achieved by implementing ongoing actions. This may involve qualitative changes in identities, awareness, motivation and governance, and may also involve enhancing interlinkages/synergies between multi-functions (e.g. multi-level/sectoral networking). Often transformation is used interchangeably with leapfrogging. Importantly, this report assumes that higher ambition is realised if, and only if, a higher level of transformation is ensured.

(AMS) and the ASEAN region can mitigate and adapt to climate change. Redesigned policy should focus on the region's vulnerability to climate change in geographical, socio-economic and human development contexts, as well as considering newly emerging risks from infectious diseases such as COVID-19. Globally, alongside governmental policy, non-state and subnational actors (NSAs) such as cities, municipalities, regions, business and international cooperative initiatives will play a more substantial role than ever before with huge potential for emission reductions (UNEP, 2018).

To date, AMS have proactively taken measures to address climate change at the national and regional level as Parties to the UNFCCC and the Paris Agreement (PA) (ASEAN, 2020), under the ASEAN Community Vision 2025 (ASEAN, 2015). The ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties (COP) to the UNFCCC (ASEAN, 2019) reaffirmed AMS's commitment to the UNFCCC and the PA by:

- Implementing measures to address climate change under the ASEAN Socio-Cultural Community (ASCC) Blueprint 2025;
- Promoting sustainable management of forests through the Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+)[7];
- Reducing energy intensity in line with the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025;
- Launching the ASEAN Regional Strategy on Sustainable Land Transport, the ASEAN Fuel Economy Roadmap for the Transport Sector 2018-2025 with a focus on light-duty vehicles, and the Guidelines for Sustainable Land Transport Indicators on Energy Efficiency and Greenhouse Gas Emissions in ASEAN;
- Strengthening ASEAN's capacity in managing climate-related disasters through existing mechanisms under the ASEAN Agreement on Disaster Management and Emergency Response (AADMER);
- Implementing Phase 2 of the Plan of Action of the ASEAN Disaster Risk Financing and Insurance (ADRFI) and establishing the Southeast Asia Disaster Risk Insurance Facility (SEADRIF) with a focus on strengthening AMS's financial resilience by improving disaster risk assessment, financing and insurance solutions; and
- Promoting collaboration with ASEAN dialogue, sectoral dialogue, development partners and other external parties to enhance climate action in the ASEAN region.

One of the key requirements for each country under the PA is related to transparency, namely, submitting regular reports and updates on targets, plans, strategies and related progress of climate actions including policy measures. This transparency framework under the UNFCCC was upgraded under the PA, and has been named the Enhanced Transparency Framework (ETF) (PA, Article 13). Under the ETF, biennial reporting requirements for mitigation actions will be reinforced while those for adaptation will remain voluntary and flexible[8] (BOX 1). Apart from this country-based reporting requirement, the PA has set a mechanism to update and enhance the ambition of national climate action and international cooperation for climate action (PA, Article 14.3), known as the global stocktake (GST). This will assess collective progress on achieving adaptation and mitigation measures every five years after 2023. Notably, the GST will provide an opportunity to examine the ambition of targets such as the NDCs in line with the long-term goals of the PA, namely a 2°C or 1.5°C target for mitigation. GST will also review ambition for achieving the global goal for adaptation,

7. REDD+ programmes economically incentivise preventing deforestation and forest degradation as well as enhancing forest sinks in developing countries.

8. For the details of the requirement upgraded, please see WRI (2019) and Weikmans, Asselt, Roberts (2020).

namely “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change” (PA Article 7.1). In this way, enhanced transparency of national climate actions under the ETF is expected to fill ambition gaps in the medium- to long-term climate targets through tangible transformation at national, regional and global levels (Weikmans, Asselt, Roberts, 2020).

However, some AMS do not have sufficient capacity for reporting even under the existing transparency framework, suggesting that more opportunities should be created to improve capacity in terms of transparency (e.g. strengthening the capacity of national experts on GHG Inventory (GHGI) and technical expert review). Under the ETF, all AMS face new challenges in reporting additional elements such as indicators to track progress towards the implementation and achievement of its NDC, projections of future GHG emissions with methodology and assumptions, and estimates of GHG emission reductions by policies and measures (PaMs). Thus, all AMS need to be ready for these mandatory reporting requirements for mitigation listed in BOX 1 (especially the requirements with a “shall” claim). Although a certain level of flexibility is provided, it is important for all AMS to aim to meet all these requirements as they face up to long-term challenges to combat climate change.

Moreover, it is of vital importance to recognise that there are still large gaps in implementation and ambition compared to the global goals for both adaptation and mitigation under the PA, as shown in, but not limited to, NDC GHG emission reduction targets in 2030 and emission trends up to now. To make progress on ambition for the medium- to long-term climate targets, there have to be multi-fold transformative changes across a wide range of areas at the regional and country levels, such as society, economy, politics, governance, technology, finance and human development. Transparency must be ensured through appropriate human capacity and knowledge and information, based on impacts, vulnerability and climate change interventions of adaptation and mitigation[9].

9. Steffen et al. (2018) underscores the significance of a deep transformation by stating that “[s]uch action entails stewardship of the entire Earth System—biosphere, climate, and societies—and could include decarbonisation of the global economy, enhancement of biosphere carbon sinks, behavioral changes, technological innovations, new governance arrangements, and transformed social values”.

BOX 1. Reporting requirement under the Enhanced Transparency Framework (ETF) of PA

The ETF stipulates that all countries submit a biennial report to the UNFCCC called the Biennial Transparency Report (BTR). BTR mandates developing countries to report GHG Inventories and mitigation actions necessary to track progress (e.g. actions, and policies and measures (PaMs) to meet NDC targets, indicators to track progress, projections and GHG emission reductions), with flexibilities provided for developing countries that need them depending on their capacities. Meanwhile, BTR only encourages countries on the reporting of adaptation (requirements are limited to "should" or "may" rather than "shall"). Reporting requirements common to both mitigation and adaptation include financial support needed/received, financial support provided/mobilised, technology support needed/received, capacity support needed/received, support needed/received for transparency-related capacity building. It can be noted that these are all "should" requirements. It is important to understand that ETF requests or requires each country to biennially report the progress of actions to achieve NDC targets, which could provide countries with critical opportunities to update and/or upgrade future national targets.

Table 1. Comparison of Non–Annex I/Developing Country Reporting Requirements

Main information required	National Communications (NCs)	BURs (Before PA)	BTRs (Under PA)
Adaptation			
Impacts, risks, and vulnerabilities	Should / Encouraged	No requirement	**Should** provide (a) **Current and projected climate trends and hazards**; (b) **Observed and potential impacts** of climate change, including sectoral, economic, social and/or environmental vulnerabilities; (c) **Approaches, methodologies and tools**, and associated uncertainties and challenges
Adaptation strategies	Encouraged	No requirement	**Should** provide (a) **Implementation** of adaptation actions; (b) **Adaptation goals, actions, objectives**, undertakings, efforts, plans (e.g., national adaptation **plans** and subnational plans), strategies, policies, priorities; (c) How best available **science**, **gender** perspectives and indigenous, traditional and local knowledge are integrated into adaptation; (d) **Development priorities related to climate change adaptation and impacts**; (e) Any adaptation actions and/or economic diversification plans leading to **mitigation co-benefits**; (f) Efforts to **integrate climate change into development** efforts, plans, policies and programming, including related capacity-building activities; (g) **Nature-based solutions** to climate change adaptation; (h) **Stakeholder involvement**
Implementation of adaptation	Should	No requirement	**Should** provide information on (a) implementation of **actions and steps** taken to formulate, implement, and update national and regional programmes identified in current and past adaptation **communications** and **NDCs**; (b) Coordination activities and changes in regulation, policies and planning
Monitoring and evaluation (M&E)	No requirement	No requirement	**Should** report on the establishment or use of domestic systems to monitor and evaluate the implementation of adaptation actions
Loss and damage	No requirement	No requirement	**May** provide, as appropriate, information on action and support
Good practices and lessons learned	No requirement	No requirement	**Should** provide the following information, as appropriate, related to cooperation, good practices, experience and lessons learned

Mitigation			
National GHG Inventories	Encouraged / should (only methodologies)	Encouraged / should (only methodologies)	**Shall** submit a national inventory document and common reporting tables, with flexibilities for developing countries.
Mitigation Actions/ Information Necessary to Track Progress			
Scope	Shall	Should	**Shall** provide a **description of its NDC**, against which progress will be tracked. **Shall** provide information on **actions, PaMs for the achievement of its NDC**
Methods	Encouraged	No requirement	**Shall** identify the **indicators** selected to track progress towards the implementation and achievement of its NDC **Shall** provide **information** to track progress of its NDC
Level of detail	Encouraged	Shall	**Shall** provide the information on its **actions and PaMs**. **Shall** provide, to the extent possible, estimates of expected and achieved **GHG emissions reductions** for its actions, policies and measures in the tabular format
Projections	No requirement	No requirement	**Shall** report **projections**, with flexibility instead to encourage the reporting

Source: Authors with information from UNFCCC (2020) and WRI (2019)

1.2. Call for developing an ASEAN vision to tackle climate change

Climate ambition in the ASEAN region needs to be in harmony with the long-term development objectives of each AMS. Member states also need to account for the societal changes and impacts from the COVID-19 pandemic, underscoring the significance of green recovery. Given the urgent multiple developmental and societal needs of the ASEAN community, it is essential to develop a holistic ASEAN regional narrative, or an ASEAN vision, to realise more transparent and ambitious climate actions, to make use of opportunities for impactful capacity building, and to realise real transformation in line with the long-term goals of the PA.

1.3. Objective

To facilitate ASEAN cooperation on climate change, the ASEAN Working Group on Climate Change (AWGCC) was established in 2009 (ASEAN Secretariat, 2021). The role of the AWGCC is to implement relevant actions set out in the ASEAN Socio-Cultural Community (ASCC) Blueprint 2009-2015 and the ASCC Blueprint 2025, through the formulation and implementation of AWGCC Action Plan. AWGCC also functions as a consultative and collaborative platform to enhance regional cooperation and action to address the adverse impacts of climate change, formulate the region's interests, concerns and priorities in the ASEAN Joint Statements on Climate Change (ASEAN, 2019), and promote coordination and collaboration amongst various ASEAN sectoral bodies dealing with sectors impacted by climate change.

The ASEAN State of Climate Change Report (ASCCR) thus identifies some essential actions and relevant capacity development opportunities for AMS and ASEAN over the next 10 years, which are likely to be a critical period for long-term sustainable transition. Furthermore, the ASCCR identifies further actions required after 2030 up to 2050 to enhance transparency and realise multi-fold transformation, maintaining the momentum of ambition for climate action in the region and ultimately meeting the long-term goals of the PA. More specifically, the ASCCR has the following main objectives:

- Providing an overall outlook on climate change issues in a regional context, focusing on adaptation and mitigation actions (policies and measures, etc.) at various levels including national/within region/among AMS (regional)/global, and giving a perspective on how AMS and ASEAN are contributing to the goals of UNFCCC and the PA;
- Providing an analysis of the gaps, needs, challenges, lessons learned and good practices in addressing climate change in the region, including an assessment of support required for reporting on the implementation of NDCs and MRV processes;
- Providing recommendations on key priorities / potential areas of cooperation to develop regional strategy for climate change adaptation and mitigation, thereby strengthening regional action on climate change;
- Supporting and contributing to the global stocktaking exercise under the PA, including through building capacity among government officials and national think tanks; and
- Recommending or promoting cooperation among AMS to develop their own national climate change-related reports and to manage their own adaptation and mitigation actions.

1.4. ASEAN's pathway to the PA goals

Figure 1 is a snapshot of the ASEAN climate vision or a narrative of the transformative pathway toward 2050, which aims to achieve the goals of PA in terms of mitigation (temperature goal of 1.5°C or 2°C by achieving net-zero emissions early in the latter half of the century) and adaptation (enhancing adaptive capacity). The pathway needs to ensure national/regional development priorities such as SDGs relevant to climate change interventions. A critical feature of the pathway is that it targets higher transparency and higher ambition simultaneously, reflecting the limited time and chance to limit the global average temperature increase at well below 2°C or 1.5°C, as well as the urgent need for reinforced adaptive capacity and resilience against severe and intensified climate change. Considering the PA temperature goal, the adaptive capacity goal should be at a minimum in line with the 1.5-2°C range. There is no doubt that achieving the PA goal will require unprecedented efforts. ASEAN is now ready to forge ahead to achieve this long-term endeavour.

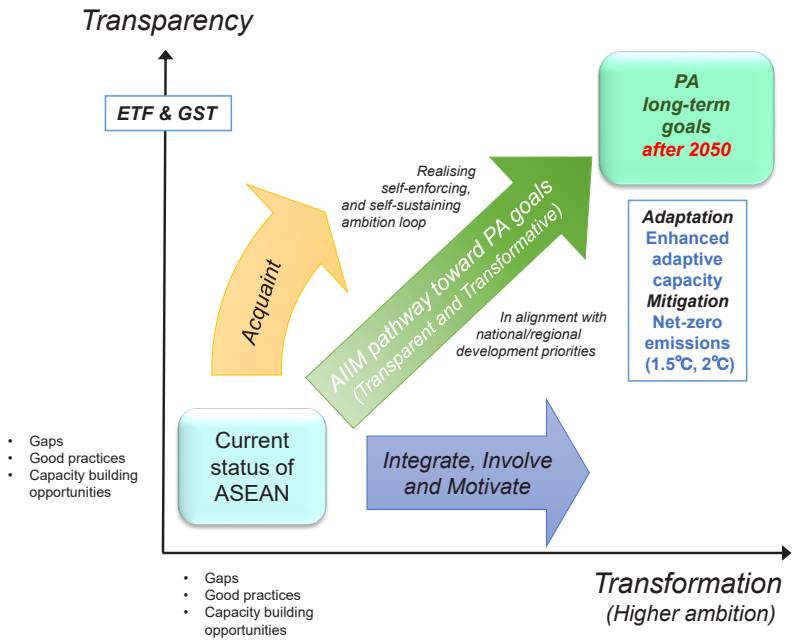

Figure 1.
ASEAN climate vision toward 2050. This shows a narrative for the AIIM pathway to be more transparent and transformative in order to achieve the Paris Agreement goals of adaptation and mitigation. The Acquaint−Integrate−Involve−Motivate (AIIM) pathway toward PA goals is defined (see Figure 2 for details). Source: Authors based on the series of consultations with collaborators.

As shown in Figure 1, this report targets two broad climate policy objectives to achieve the PA goals: (i) meeting the transparency-related reporting requirement under the ETF (see BOX 1); and (ii) raising the ambition of national policy (e.g. NDCs, NAPs, and LTS) to meet climate goals through a multi-dimensional transformation of systems. These two objectives are termed "transparency" and "transformation" and are defined below:

Transparency

Transparency in the ASCCR refers to the extent to which the reporting requirements under UNFCCC and the PA (i.e. ETF) are met. Enhancing transparency will necessitate the advancement of science and the availability of information

and knowledge for various actors to take concrete action. Enhanced transparency can be the basis for good governance, can increase efficiency of a system or institution, and can also be a prerequisite for transformation.

Transformation

Transformation in the ASCCR refers to actions leading to a level of systematic change that cannot be achieved by ongoing actions, which help AMS increase their level of ambition for climate change interventions so that they achieve PA goals. Transformation may include, but is not limited to, qualitative changes in identities, awareness, motivations and governance. This term is often used interchangeably with leapfrogging. Transformation can enhance ongoing actions or introduce new actions to improve adaptation and mitigation.

As described in Section 4, the pathway is more specifically characterised by four indicative categories of action. This report calls this the "Acquaint–Integrate–Involve–Motivate (AIIM) pathway". As Figure 2 shows, the "Acquaint" group of actions aims to promote transparency, while the other three groups of actions inspire transformation of society and the environment involving both leapfrogging and a reconfiguration of energy and land systems. Transparency and transformative changes are not mutually exclusive. However, transparency can induce transformative actions in a self-enforcing and more targeted manner through a more robust information and scientific knowledge base, by broadening opportunities, and by mobilising international/regional financial resources. This loop in the AIIM pathway ensures that ambition progresses in a self-sustaining manner. The "Integrate", "Involve" and "Motivate" groups of actions are more directly linked with raising ambition through transformative changes in institutional and policy systems to accelerate finance and technology development and diffusion.

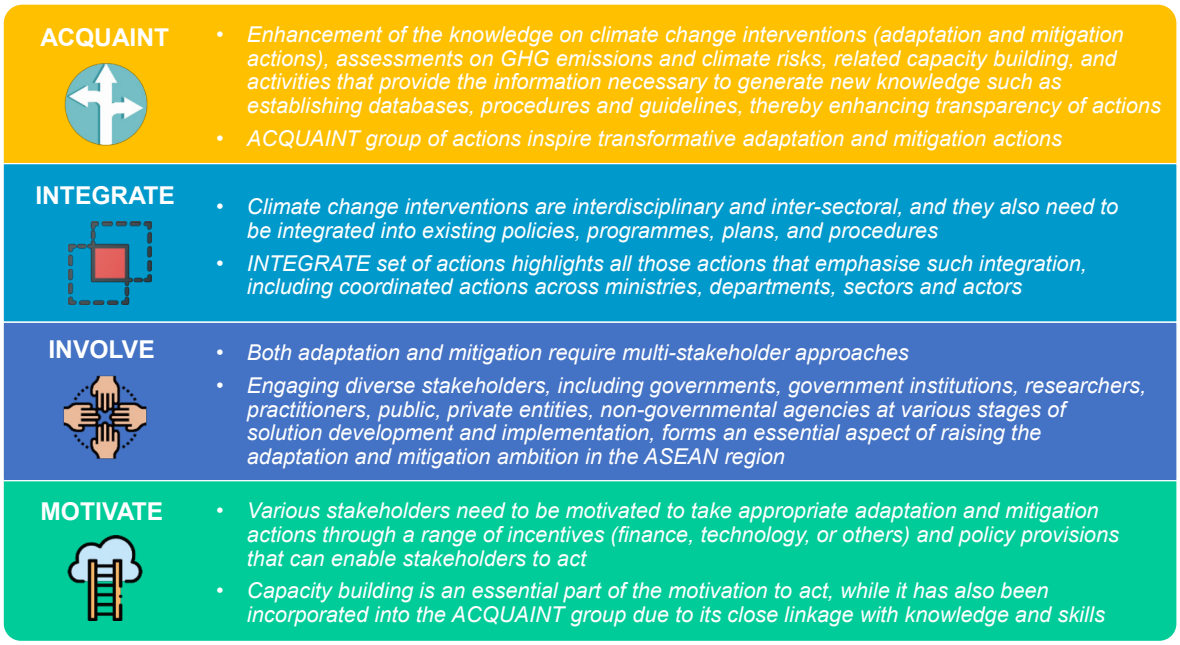

Figure 2.
Acquaint–Integrate–Involve–Motivate (AIIM) pathway to raise ambition toward 2050. The Motivate group of actions aims to "Meet" the PA goals. Source: The image has been retrieved from "Flaticon.com".

Strictly speaking, actions to enhance transparency are more process-oriented such as providing a science and information base to facilitate science-policy integration. On the other hand, actions to promote transformation are more outcome-oriented, enabling socioeconomic and biophysical systems to transition to a goal through sound policy

implementation and upgrading ambition. Moreover, actions to enhance transparency and promote transformation are mutually dependent at their root and both contribute to the integration of systems and involvement of stakeholders. Thus, the ASCCR highlights the fact that enhanced transparency would expand opportunities for multidimensional transformation through various channels as explained in Section 2.1. Periodic stocktaking of ambitions through GST will give a chance to review and enhance transparency and this will further be linked to raising ambition. The ASCCR presents a pathway for sustaining ambition loops through the channels of transparency and transformation to meet the goals of the PA.

1.5. Structure

Section 2 shows the methodology for the assessment in this report. Section 3 presents the current status and outlook of the ASEAN region, from the viewpoint of developmental contexts relevant to climate change interventions, GHG emissions, vulnerability to and impacts of climate change, as well as climate change adaptation and mitigation. The report assesses gaps, good practices and lessons learned for climate ambition and policy implementation. Moreover, the report assesses medium- to long-term visions and strategies. Section 4 sheds light on how to develop an ASEAN vision for climate action up to 2050. Keeping this vision in sight, the region is expected to achieve PA climate goals by identifying key opportunities for regional coordination and/or harmonisation. Actions are categorised into the AIIM groups featuring the pathway for ASEAN and AMS to periodically raise ambition to pursue PA goals. Regional actions for adaptation and mitigation are prioritised by AMS for the next 10 years, and this report identifies what actions will be necessary for the period 2030-2050. Section 5 concludes by presenting highlights of ASCCR and ways forward.

BOX 2. What is the ASEAN State of Climate Change Report (ASCCR)?

- ASCCR shows where we are and where we are heading in terms of climate change interventions.
- ASCCR is a forward-looking document, which shows how to transition toward 2050 in terms of both adaptation and mitigation, considering ASEAN's developmental context and the long-term goals of the PA.
- ASCCR identifies key regional and national actions over the next 10 years, a critical period for long-term sustainable transition.
- ASCCR identifies necessary actions from 2030 to 2050 based on scientific knowledge.

Methodology

2 ASEAN State of Climate Change Report

2.1. Rationale of approach: need for capacity building to synergise transparency and transformation

Given the spirit of the PA and the urgent need to ensure that future targets are more transparent and ambitious, it is important to explore ASEAN's regional pathways to achieve this transformative change. Weiksman et al. (2020) show several pathways whereby enhanced transparency will lead to more progress being made on raising the ambition of climate change interventions such as adaptation and mitigation. Such pathways include: (i) pressure put on the national government by stakeholders such as domestic organisations, other countries, the international community, and non-state actors; (ii) extent of international support received, as detailed in the documentation of support needs; and (iii) self-enforcement. AMS must figure out ways to cooperate, based on sound self-enforcing actions for capacity building within the region. It is also vital to gain support from international funding sources[10].

The World Resources Institute (WRI, 2019) states that "we recognise that full implementation and fulfillment of the goals of the Paris Agreement will require capacity building beyond the transparency framework." This distinguishes requirements for enhancing transparency from what will be necessary for full implementation of the targets in line with PA goals. Moreover, WRI (2020) reveals that in order to enhance mitigation targets in its NDC, a country needs to take stock of current progress and compare it with long-term objectives in the following areas:

(i) Current GHG projections, socioeconomic trends and sectoral indicators

(ii) Current national policies, and long-term national development plans

(iii) Subnational and non-state commitments

(iv) Development objectives

(v) Mitigation finance

Although these findings are limited to the scope of mitigation[11], they reveal that an investigation will be necessary to identify capacity building opportunities beyond transparency with a focus on socioeconomic trends and development objectives from a long-term standpoint. Therefore, the ASCCR uses the approach set out in Section 2.2 below to respond to the following fundamental question:

What are the capacity development opportunities and/or regional actions for adaptation and mitigation that will enable each AMS, and the ASEAN region as a whole, to be more transparent and more transformative/ambitious in the long term, while simultaneously meeting developmental needs and objectives?

10. This is in line with the ASEAN Community Vision 2025 (ASEAN, 2015) and its complementary report (ASEAN, 2019) that calls for actions for both adaptation and mitigation to achieve a sustainable community under a stable climate, by pointing out the need for: a) enhanced human and institutional capacity on vulnerable and marginalised communities; b) multi-stakeholder and multi-sectoral approaches; c) innovative financing mechanisms; d) strengthened efforts by government, private sector and community; e) mainstreaming climate change risk management and GHG emissions reduction on sectoral planning; and f) global partnerships and implementation of the frameworks of the UNFCCC, or PA. These reflect the will of ASEAN on transformation from all dimensions for both mitigation and adaptation.

11. (As shown in a presentation by Myanmar on 21 December) Transparency on the adaptation side or availability of information and knowledge is the basis of feasibility of transformative actions, since any adaptation actions require observations and projections of the climate, climate risks and impacts as well as vulnerability. However, assessment of capacity building opportunities targeted at the transformative adaptation actions, beyond transparency, can be beneficial in developing recommendations for establishing the ASEAN future vision and actions.

2.2. Approach

The ASCCR takes a co-production approach for creating a methodological framework through in-country and regional consultation meetings. This approach aims to develop the necessary capacity for all relevant stakeholders. The first step is to engage designated national think-tanks and national focal points (NFPs) in domestic consultations to figure out key gaps, lessons and good practices in terms of national climate change interventions for adaptation and mitigation. The second step is to hold a series of three regional consultation meetings, bringing together all stakeholders (national think-tanks and NFPs in all Member States) to (i) formulate a desirable methodology and framework; (ii) work on prioritised regional climate actions based on key commonalities and differences among AMS; and (iii) come up with capacity building opportunities and appropriate regional frameworks so that AMS and the ASEAN region can enhance transparency and move towards more ambitious adaptation and mitigation interventions. Importantly, this process by itself can also contribute to the capacity development of all stakeholders, thereby becoming a driver for transformation in the ASEAN region.

Figure 3 shows the assessment framework and process as set out in the ASCCR. Section 3 identifies current key gaps and capacity building opportunities in AMS and across the region. Furthermore, based on scientific knowledge on future climate change and GHG mitigation pathways until 2100 as well as existing and planned official long-term visions/strategies in AMS, the report sheds light on essential regional and national actions (recommendations) on how ASEAN and AMS can enhance transparency and raise ambition by 2030 and up to 2050. To give more structure to how regional actions are prioritised, the report categorises actions into Acquaint–Integrate–Involve–Motivate (AIIM) groups as shown in Figures 1 and 2. A survey was carried out targeting AMS to find out what their priority actions are up to 2030, and a regional consultation meeting for AMS was held to decide on essential actions for the period 2030-2050. In this way, the ASCCR shows how ASEAN may need to maintain/change the course of climate change interventions after 2030 and up to 2050, in order to enhance transparency and make transformative changes to raise ambition. Importantly, the AIIM pathway to ASEAN's overall goal in line with PA goals comprises the ASEAN Climate Vision 2050 which will be formulated based on the findings of this report.

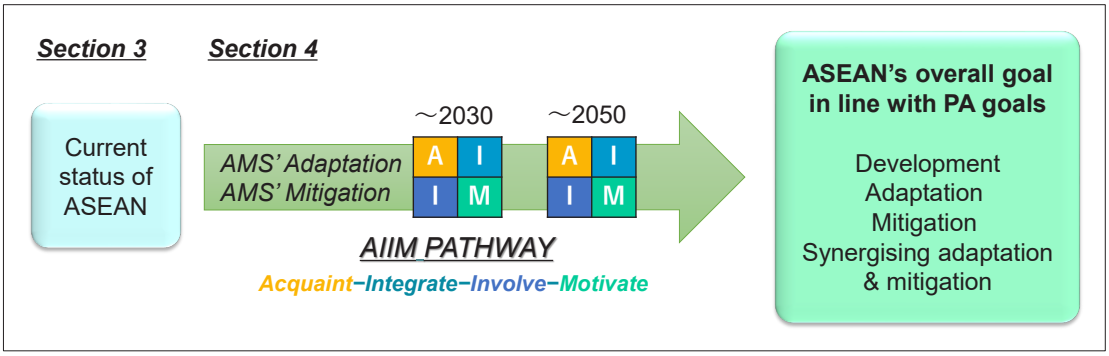

Figure 3.
Assessment framework and process in ASCCR. The AIIM groups of actions at the regional level for adaptation and mitigation toward 2030 were prioritised by all AMS based on a survey during the process for developing ASCCR. The AIIM groups of actions for the period 2030-2050 were further identified through the regional consultation meetings, and may require substantial modification on the pathway toward the ASEAN goal in line with PA goals.

It should be noted that recommendations on prioritised actions by 2030 and up to 2050 are related to: (i) regional cooperative policies and programmes; (ii) regional/sub-regional coordination of national policies; and (iii) national policies of AMS. Figure 4 represents the background assessment process for developing the ASCCR.

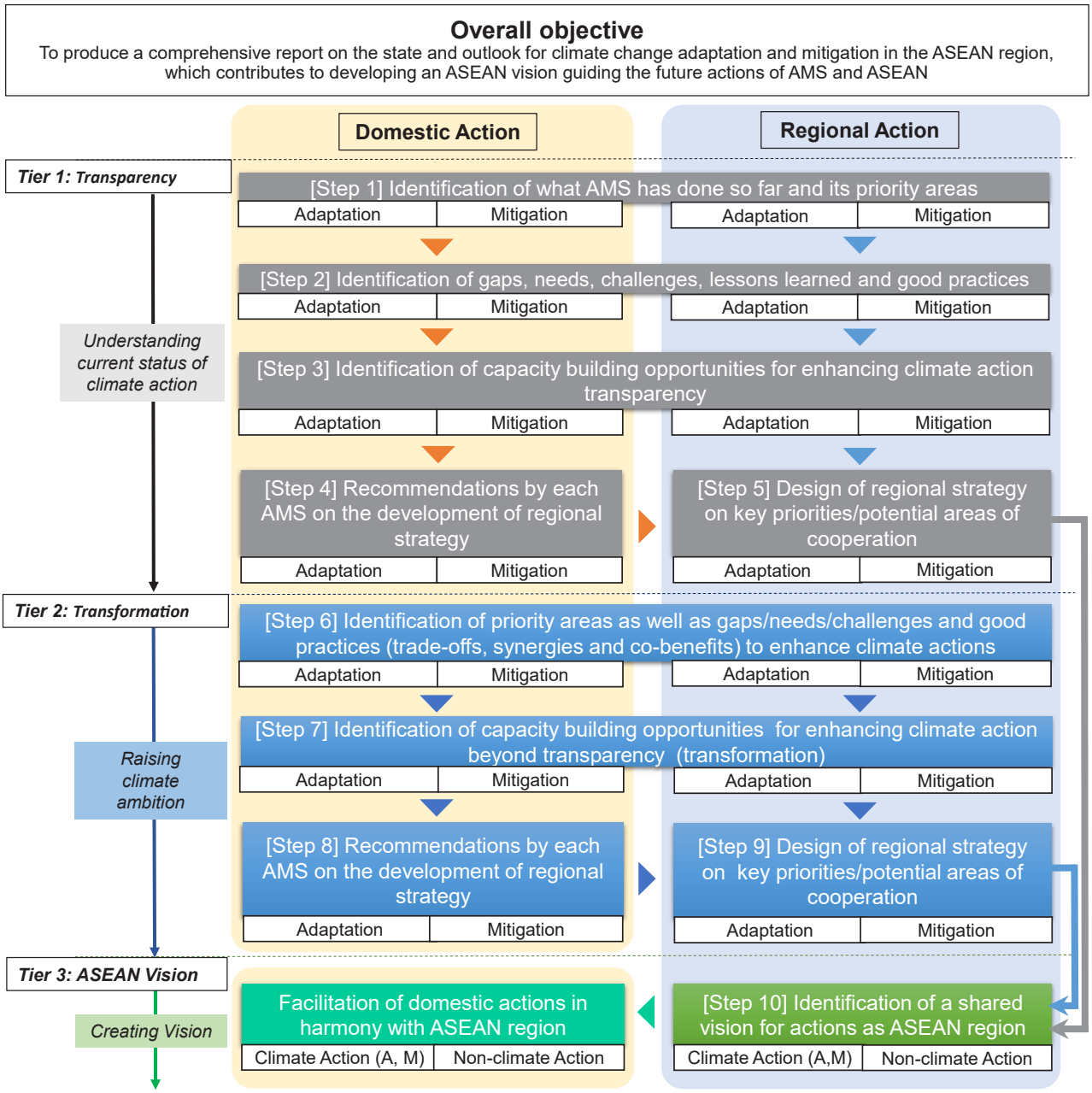

Figure 4. 3-tier assessment framework ([Step 1]-[Step 10]) of ASCCR.
Note: Tier 1 is meant for enhancing transparency, Tier 2 is for enhancing the ambition of climate actions/targets, and Tier 3 is for creating a vision toward shared actions to synergise the cycle of enhancing transparency and raising climate ambition. The outcome of Tiers 1 and 2 ([Step 5] and [Step 9]) will lead to the final outcome of the project in Tier 3 ([Step 10]).

Current status and outlook of the ASEAN region

3

ASEAN State of Climate Change Report

3.1. Developmental context

3.1.1. Current Status

Key message

The region is rapidly integrating in terms of economy and culture. This provides immense economic and social opportunities for the region while also having implications for transboundary climate risks.

The climate change mitigation and adaptation goals of ASEAN countries are closely linked with their developmental goals. This makes it important to have awareness of the developmental contexts of the region, as it will help inform on their climate change needs and actions. Such an understanding also underscores why climate change interventions need to be supportive of the developmental goals as well as to ensure synergy between them.

The ASEAN region has a total population of 660.6 million (Table 2), or 8.6% of the global population, and is growing annually at 1.08% on average (World Bank, 2020; Asian Development Bank, 2020; United Nations, 2020). Indonesia is the most populous country, followed by the Philippines, then Vietnam. Nearly 54% of the region's population is urban, and urbanisation itself is accelerating. Singapore is a largely urbanised country, followed by Brunei Darussalam (78%) and Malaysia (77%). In 2019, urbanisation in the region grew by 2.2%—with the highest rates in countries such as Lao PDR (3.3%), Cambodia (3.2%) and Vietnam (2.9%)—making the region one of the most rapidly urbanising ones globally. If these trends continue, urbanisation will reach 67.8% in 2050 (United Nations, 2018).

These trends also partly reflect the region's rapid economic development in recent decades. Its total GDP doubled during 2009 to 2019, when it stood at USD 3.17 trillion, or 3.62% of global GDP, and annually grows at 4.4%, with the highest rates reported from Cambodia, Vietnam, Indonesia and Lao PDR. As a whole the region's GDP is on course to outgrow that of Japan and the EU by 2030, when it will be the fourth largest single market in the world (Foreign and Commonwealth Office, 2012; PricewaterhouseCoopers, 2020). Factors contributing to this economic growth include the high proportion of young and educated in the population, rapid regional integration and rich natural resources.

Over the past decade there has been a shift in the sectors contributing to overall GDP in ASEAN countries, notably in the reduced share of agricultural GDP (Figure 5). However, with the exception of Singapore and Brunei, agriculture is still one of the top five contributing sectors and is the key sector for Cambodia and Lao PDR. Manufacturing contributes most to overall GDP in Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. Although mining is the top contributor in Brunei and appears among the top five in Malaysia, Indonesia and Vietnam, its share has declined in the recent past in these countries. Conversely, the share of financial services in overall GDP is on the rise in Brunei, the Philippines, Singapore and Thailand. In Brunei, the contribution of financial services has increased from 5.0% in 2018 to 5.3% in 2019.

The trade of goods and services is one of the main contributors to rapid economic growth in the region; total imports and exports stood at USD 1.71 and 1.85 trillion respectively in 2019, indicating net positive exports from the region.

Investments in the region are also rising—in 2019 gross national investments stood at 28.4% of the region's total GDP, with Brunei, Indonesia, and Myanmar reporting some of the largest proportions of gross domestic investments. In Brunei, the share of Gross Capital Formation (GCF) to GDP was 38.7% in 2019. In the same year, the region attracted foreign direct investment (FDI) with a value of USD 175 billion, or 6.4% of the region's GDP. FDI in the region has grown by 2.4 percentage points since 2009, with Singapore, Indonesia, and Vietnam as the main beneficiaries.

Trends indicate the region is undergoing rapid regional economic integration, both due to accelerating trade within and outside the region and the rapid pace of integration with the rest of the world. With aggressive trade promotion policies adopted by governments in the region, trade performance is expected to grow further in the future. Formation of the ASEAN Economic Community (AEC) in 2015 established one of the largest single markets in the world outside of the European Union, and AEC is expected to further expand economic cooperation among the countries, contributing to major economic and social development gains in the near future.

Economic growth in the region has also contributed to social development, as can be seen from improvement in various developmental indicators—in particular, poverty reduction, peace and stability, food and nutritional security, education, women empowerment, employment generation, and inclusiveness. Although the gains are not uniform across the region, the environment is now more congenial to exchanging best practices, which will help build upon the gains to date.

Table 2. ASEAN region in snapshot

Country	Population (million)	Poverty (% population)*	Urban population (% of total)	Unemployment rate (%)	GDP (USD billion)	GDP, PPP (USD billion)	GDP per capita (USD)	GDP per capita, PPP (USD)	GDP growth (%)	GDP per capita growth (%)	Trade (% GDP)	Imports (USD billion)	Exports (USD)	FDI, net inflow (USD billion)	FDI (% GDP)	Gross national investment (% GDP)
Brunei Darussalam	0.459	-	78	9.2	13.5	28.0	31087	64673	4	-3	109	6.8	7.8	0.4	2.8	34.8
Cambodia	16.5	12.9	24	1.1	27.1	75.4	1643	4571	7	6	124	16.9	16.5	3.7	13.5	22.9
Indonesia	270.6	10	56	4.3	1119.2	3329.2	4136	12302	5	4	37	211.5	206.0	24.9	2.2	34.6
Lao PDR	7.2	18	36	0.6	18.2	58.4	2535	8151	5	3	0	6.6	5.2	0.6	3.1	-
Malaysia	31.9	6	77	3.4	364.7	943.3	11415	29526	4	3	123	210.6	238.3	7.7	2.1	23.6
Myanmar	54.0	24.8	31	1.6	76.1	289.4	1408	5355	3	2	0	23.1	23.1	2.3	3.0	32.5
Vietnam	96.5	7	37	1.9	261.9	807.8	2715	8374	7	6	210	271.4	279.7	16.1	6.2	28.2
Thailand	69.6	10	51	0.7	543.6	1338.8	7808	19228	2	2	110	274.9	324.8	6.1	1.1	25
Singapore	5.7	-	100	3.8	372.1	578.2	65233	101376	1	0	319	541.8	645.6	105.5	28.3	27
Philippines	108.1	17	47	2.5	376.8	1003.0	3485	9277	6	5	69	151.7	106.8	7.7	2.0	27

Source: Authors with data from World Bank (2020); Asian Development Bank (2020) * poverty as defined by the respective national governments

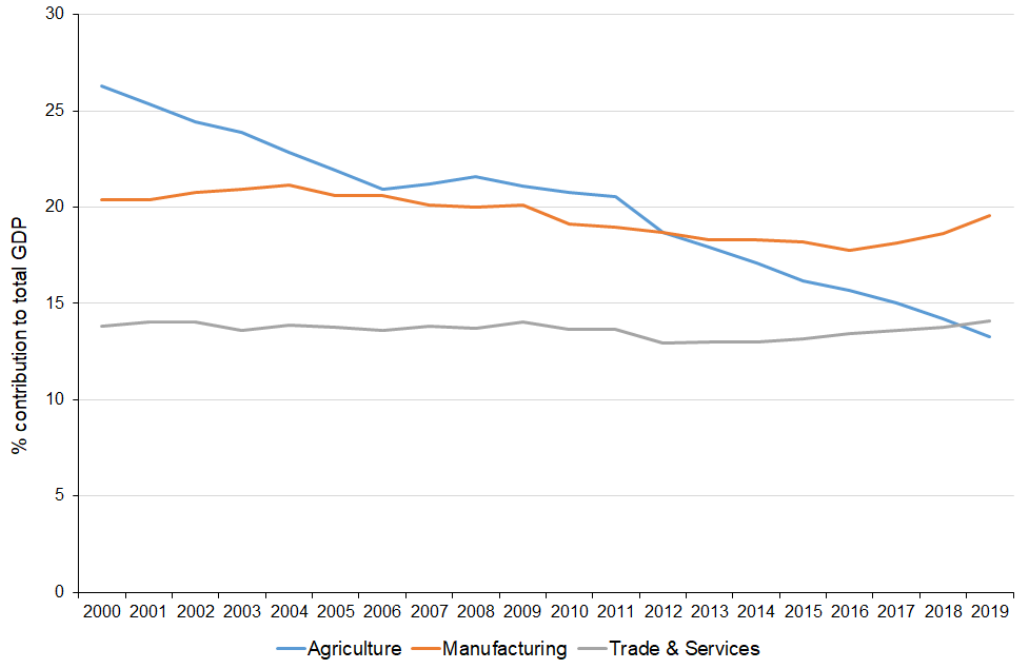

Figure 5.
Shifts in percentage contribution to GDP in the agriculture, manufacturing, and trade & services sectors in ASEAN (Based on data from World Bank (2020))

COVID-19 and its implications

The impacts of COVID-19 are far-reaching for the ASEAN region. Total deaths stood at 1.19 million and 27,730 respectively by the beginning of December 2020 (WHO, 2020). While the infection rate (0.2%) is about half that of the rest of Asia (0.4%), the region has recorded a marginally higher death rate (2.3%), and lower recovery rate (87%) than the rest of Asia (1.7% and 89% respectively). The region has also conducted fewer tests (3.7%) compared to the rest of Asia (10%). Effects of the pandemic can be seen in the region's economy, society and environment, and forecasts (ADB, 2020) indicated net negative economic growth during 2020, largely due to the related lockdowns, loss of employment, reduced operations in production and service sectors, and reduced consumer demand. Overall, economies in the Southeast Asian region were expected to contract (-3.8%) during 2020 due to the pandemic, and the IMF projections for 2020 put the region's economic growth at -3.4% (IMF, 2020). The COVID-19 pandemic has also affected the FDI prospects for ASEAN countries, and the World Investment Report (2020) projected a reduction in the range of USD 260–330 billion in 2020, a drop of 30–45% since the previous year (UNCTAD, 2020).

Societal impacts of the pandemic are multifold. Restrictions on mobility have affected the lives and livelihoods of the poor, wage labourers, and those dependent on agriculture and manufacturing jobs. In many countries the pandemic coincided with the planting and harvesting of major staple food crops, leading to probable production failures (ADB, 2020), effects on incomes of farmers as well as cropping operations of subsequent seasons. The pandemic has affected the food security of millions, due to impacts on supply chains and resulting rise in food prices (Figure 6). A nexus between the impacts of the pandemic and other natural disasters was also reported, as countries that had been affected by droughts and floods in 2018 and 2019 experienced exacerbated impacts of the pandemic on society. This is also the case with a nexus between the impact of the pandemic and air pollution in the sense that city dwellers facing severe air pollution experienced higher impacts due to the pandemic (Varkkey, 2020) (Ali & Islam, 2020).

Figure 6.
Trend in food price index (Base year = 2015) in Southeast Asia during 2020 (Based on data from FAO (2020))

Regarding the projected drop in ASEAN GDP in 2020 (average of -2.7%) (IMF, 2020), while economic growth could return in 2021 at a rate of 5.7% (Figure 7), this largely depends on progress made in combatting the pandemic as well as mitigating its economic impacts through relief and mitigation measures of each country. The region therefore stands at a crossroads in safeguarding the developmental gains made to date, as a prolonged pandemic could jeopardise prospects for further development as well as even take the region a few steps back while measures to mitigate the pandemic's impacts are underway.

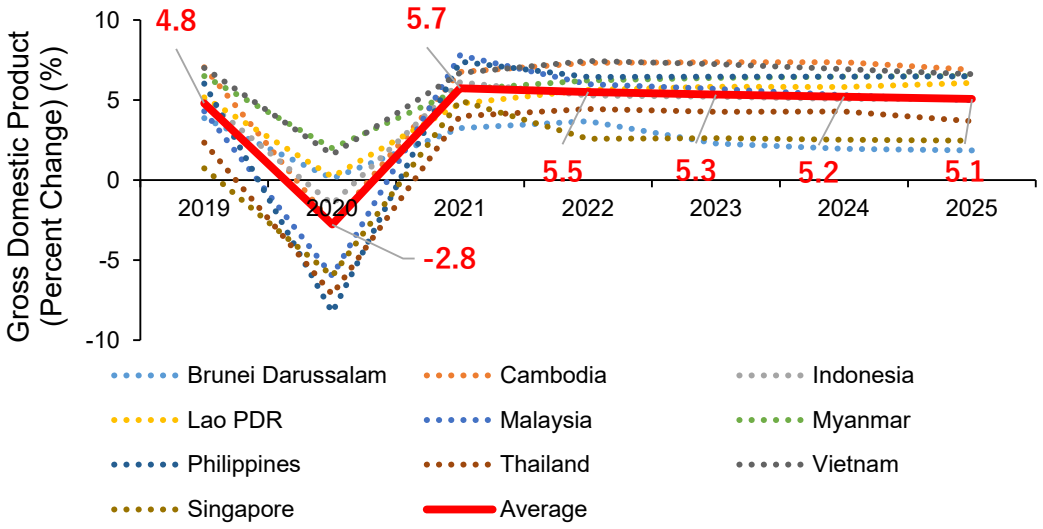

Figure 7.
Economic impacts of COVID-19 (Based on data from IMF (2020))

To help deal with impacts from the pandemic in the form of stimulus packages, AMS have supplied a total of USD 318.2 billion (about 10.1% of its 2019 GDP), with Thailand and Indonesia injecting the largest amounts (Figure 8). These packages are primarily earmarked for job protection and keeping businesses afloat, and do not highlight green measures (ASEAN Secretariat, 2020).

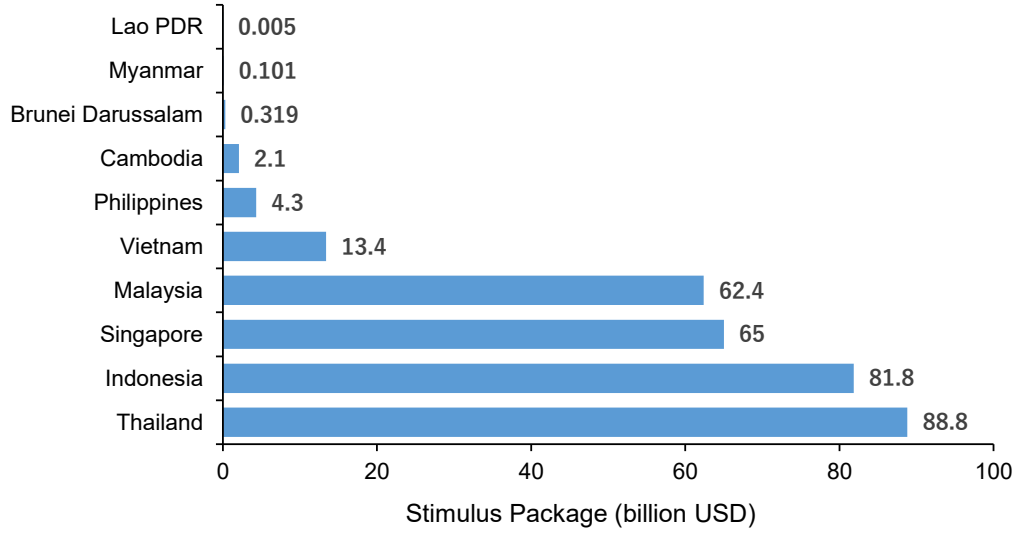

Figure 8.
ASEAN COVID-19 stimulus package, by country (Based on data from ASEAN Secretariat (2020))

In terms of the impacts on energy, Malaysia, the Philippines, Indonesia and Thailand reported drops in national electricity demand due to the lockdown effect. The COVID-19 pandemic has also forced some AMS to delay or postpone accelerated energy efficiency development (Table 3). Despite the pandemic, however, demand for renewables saw growth globally, though several renewable energy projects in the ASEAN region face potential delays due to changes in energy markets and disruption in the supply chains of clean energy technologies.

Table 3. Status of Energy Efficiency Development in the ASEAN region

Country	Impact on Energy Efficiency Development
Indonesia	Ministerial budget for green energy and energy efficiency reduced
Malaysia	Postponement of Energy Efficiency Law legalisation until 2021
Myanmar	Delay in development of efficient power plant
Philippines	Extension of Annual Energy Efficiency and Conservation Reports (AEECR) for designated establishments until 15 April 2021
Singapore	Government measures for RE and EE projects under construction, with special provision made under the COVID-19 (Temporary Measures) Act of 2020 allowing for relief from obligations and construction timelines where delays are materially caused by COVID-19 and impacts therefrom on the economy
Thailand	Downsizing of the Energy Conservation Fund Committee for 2020, from 10 billion TBH to 5.6 billion TBH

Source: ASEAN Centre for Energy (2020)[12]

Regarding other impacts of COVID-19, these include effects on GHG emissions, air quality, and society. People switched to teleworking and online conferencing; online sales rose; and logistics saw increased activity, including in last-mile delivery. However, even if economies return to former levels (Figure 7), lifestyle change is expected to impact GHG mitigation actions in the long term. The clean air experienced in cities during the lockdowns has also motivated cities in the transition toward decarbonisation.

12. ASEAN Centre for Energy (2020), "ASEAN Energy Efficiency Sectoral Trends including the impact of Covid-19 on the ASEAN energy efficiency pathways"

3.1.2. Outlook

Key message

While several positive factors will work in favour of sustainable development for the region in the medium to long-term future, there are systemic issues such as poor development of resilient infrastructure that need to be addressed.

While COVID-19 represents a recent challenge to the developmental prospects of the ASEAN region, several positive aspects can help push it towards sustained economic and social development in the years to come. These factors include a large vibrant and young proportion of the population that is quality conscious, demanding quality goods and services, prospects for inclusive growth, digital services including in the financial sector, and regional economic integration through the formation of the AEC. For these positive factors to bear fruit for the region, some of the existing constraints, such as poor infrastructure, both hard and soft, need to be overcome. Investment is needed in productive hard infrastructure such as roads and bridges that can enable millions to access markets, in health services, and improvements in social welfare measures including social security. While literacy rates have improved over the years, the quality of education, especially in the high skills and higher education areas, needs improving. Further, along with economic development, a new challenge of achieving economic equality may arise.

Looking forward, ASEAN countries have a long road ahead but are moving in the right direction towards the developmental ambitions they have set (Table 4). The region is already poised to face the challenges head-on. Some countries have already showcased their ability to close the developmental gap during the recent past, and these serve as important motivators for other AMS to emulate. Indeed, it would appear that ASEAN is more intent today than ever to close the gaps with advanced economies within and outside the region. There is also potential to build upon the successes in attracting foreign direct investment, which could turn the region into a thriving manufacturing hub for rest of the Asia and the world, as well as place it ahead of its immediate neighbours. Expansion could also occur in the areas of manufacturing and service sectors, tourism, and food exports.

In terms of recovery/stimulus packages in ASEAN, it is unclear at this stage whether such packages will include low-carbon measures or not. Regardless of such packages however, enhancement of existing policies and measures will be vital for sustainable transition of the region. To achieve net-zero emissions by mid-century, immediate investments leveraged by fiscal policy to recover “green” from the COVID-19 impacts will be a crucial factor.

To strengthen medium- and long-term climate ambition in the ASEAN region, AMS need to immediately set clear policy direction by putting priority on green recovery, and allocate financial resources from recovery packages to clean energy investments and sustainable forest management programmes contributing to the mitigation from the Land Use, Land-Use Change and Forestry (LULUCF) sector. This will help AMS redesign the whole set of policies and measures while mobilising private finance to promote technology development and diffusion.

Table 4. Medium to long-term development ambitions outlined by ASEAN countries

Country	Development ambition	Target year	Document	Reference
Brunei	To be in world's top 10 in quality of life and per capita income	2035	Vision 2035	Government of Brunei Darussalam (2020)
Cambodia	To be a developed country	2050	Prime Minister Hun Sen's statement	Xinhua (2018)
Indonesia	To become an advanced and prosperous nation among the world's largest five economies	2045	The Vision of Indonesia 2045	Afifa (2019)
Lao PDR	To be an upper-middle-income country	2035	The 8th Five-Year National Socioeconomic Development Plan, 2016-2020	Ministry of Planning and Investment (2016)
Malaysia	To elevate the country's status to a developed economy	2020	The 11th Malaysia Plan	Ministry of Economic Affairs (2019)
Myanmar	To be a peaceful, prosperous and democratic Myanmar	2030	The Myanmar Sustainable Development Plan, 2018-2030	Ministry of Planning and Finance (2018)
Philippines	To become a prosperous middle-class society free of poverty	2040	Our Ambition 2040	National Economic and Development Authority (2017)
Singapore	To chart Singapore's low-carbon and climate resilient future	2050	Charting Singapore's low-carbon and climate resilient future	National Climate Change Secretariat (2020)
Thailand	To be a developed country with security, prosperity and sustainability in accordance with the Sufficiency Economy Philosophy	2037	National Strategy 2018-2037	Office of the National Economic and Social Development Council (2018)
Vietnam	To be in the top three ASEAN countries in industry; to be a modern industrialised country	2030 & 2045	The Political Bureau Resolution No. 23-NQ/TW	Nguyen (2020)

Vu K. (2020) based on various references.

3.2. GHG emissions, energy, and economy in ASEAN

3.2.1. Current Status

Key message

ASEAN's GHG emissions have continued to rise due to increasing energy-related CO_2 emissions and GHG emissions from the AFOLU/LULUCF sector. Decoupling of the growth in GDP and energy-related CO_2 emissions is observed only in a handful of AMS. It is vital to reduce energy intensity through lower energy demand and further energy savings, and to reduce emission intensity by promoting renewable energy expansion.

GHG emissions (energy and LULUCF) by region/country:

Figure 9 shows CO_2 emissions from fuel combustion and GHG emissions from LULUCF with the share of GHG emissions by LULUCF category in 2016. The ASEAN region emits more GHG emissions from fossil fuel combustion (1,485 $MtCO_2$) and LULUCF (965 $MtCO_2eq$) (top-right, in left figure of Figure 9), while reflecting substantial emissions from forest land and cropland. Indonesia's deforestation and peatland exploitation are together leading ASEAN to become a large net emitter of GHGs from LULUCF, while Vietnam sees net negative GHG emissions from LULUCF. In CO_2 emissions from fuel combustion, Indonesia, Thailand, Malaysia, Vietnam and Philippines are the larger emitters in ASEAN. It is evident that in order to reach net-zero emissions in the future, ASEAN needs to adopt low- to zero-carbon energy sources in its long-term strategy to enhance energy management and to enhance the sink functions in land systems, both in forest and cropland.

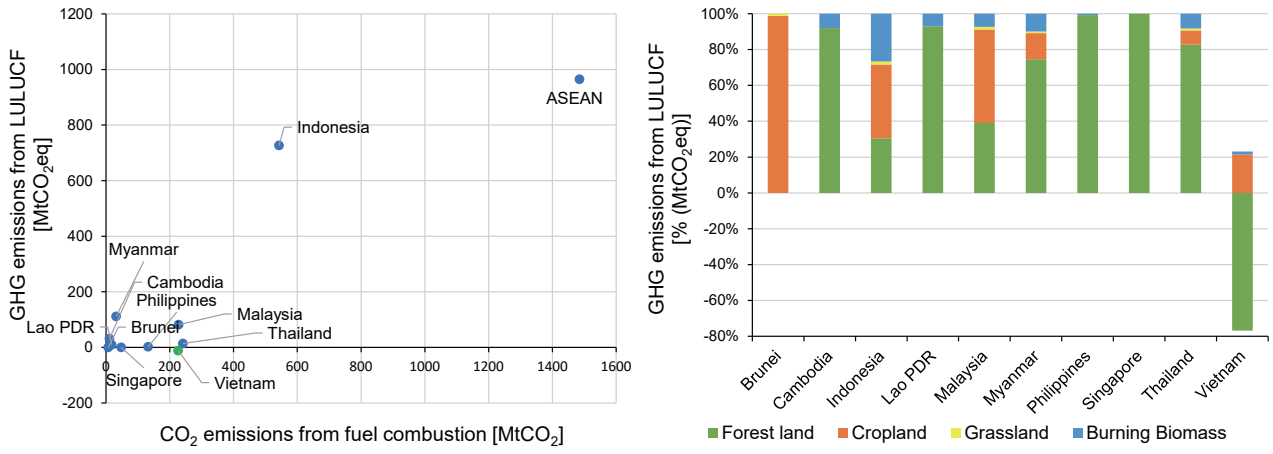

Figure 9.
CO_2 emissions from fuel combustion and GHG emissions from LULUCF by country/region (left) and GHG emissions share by LULUCF category (right) in 2018 Source: Authors with data from IEA (2020) and FAO (2020).

CO_2 emissions from energy use by sector

Over the past two decades, CO_2 emissions from energy use in ASEAN have seen a linear increase, led by sectors such as electricity and heat production, manufacturing industries and transport (Figure 10). In particular, the power sector is the largest source of (direct) CO_2 emissions in all AMS except for Cambodia, in which the transport sector has larger emissions. Sectoral CO_2 emissions in the ASEAN region are similar to world averages, which means that decarbonisation in the sectors of power, industry and transport is a shared goal for climate change mitigation.

Land-Use Change and Forestry (LULUCF) sector. This will help AMS redesign the whole set of policies and measures while mobilising private finance to promote technology development and diffusion.

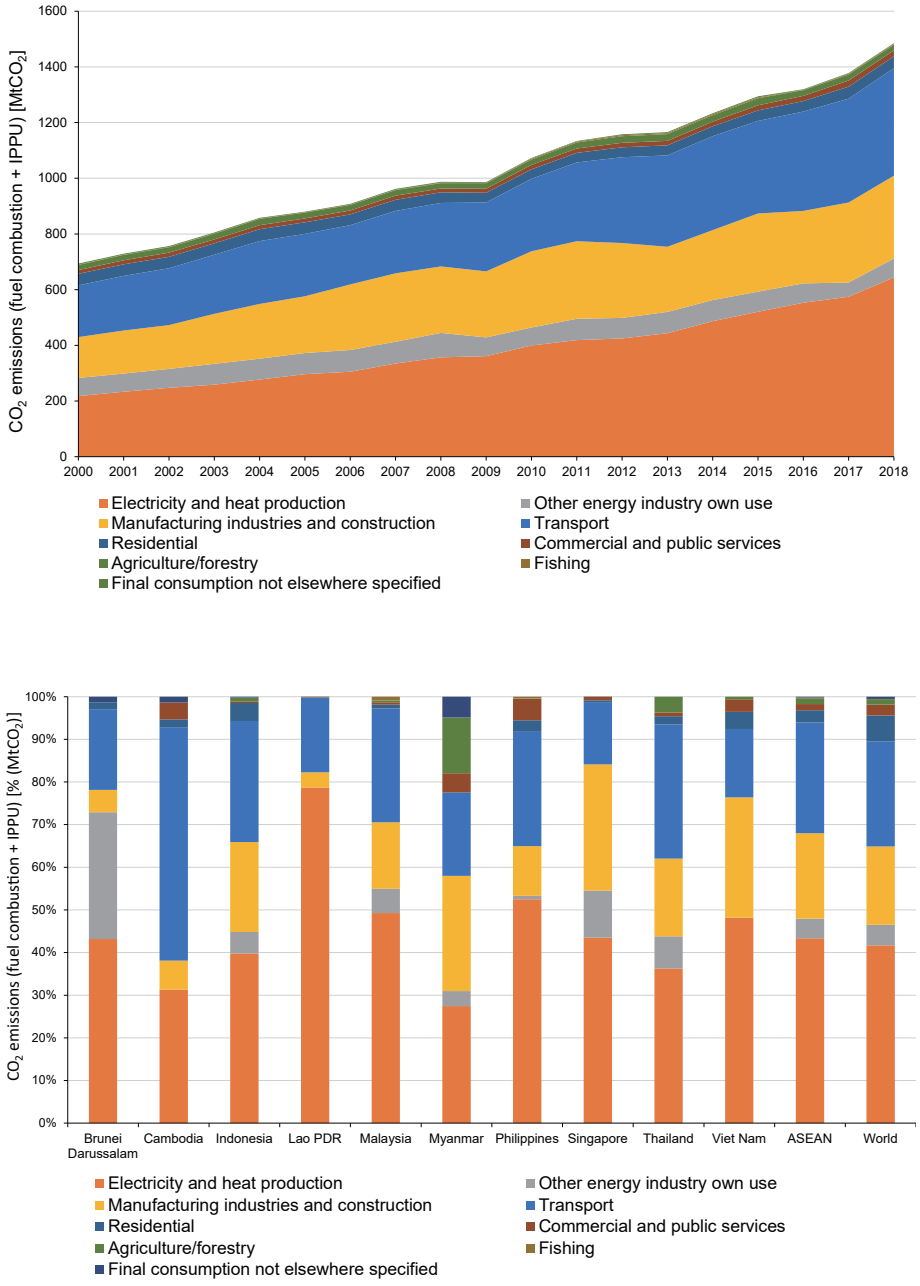

Figure 10.
Sectoral CO_2 emissions from fuel combustion in ASEAN since 2000 (left) and country-wise sectoral share of CO_2 emissions in 2018 (right). Source: Authors with data from IEA (2020).

GDP and energy-related CO_2 emissions by region/country

Aiming at transforming the energy and land systems towards net-zero emissions, it is vital to understand the developmental stage of AMS together with their emission profiles. As shown in Figure 11, per capita CO_2 emissions from fuel combustion during 1990–2018 increased with economic growth in the ASEAN region and in most AMS, while emissions from Singapore have slightly decreased despite its economic growth over the same period due to an increase in RE. This reflects the fact that economies at the stage of initial industrialisation involve more CO_2 emissions from fossil fuel use than those with more dependence on the service industry. Given the limited time to achieve net-zero emissions by around 2050 as shown in Section 3.2.2, the ASEAN region and most AMS that are rapidly industrialising need to peak out their CO_2 emissions earlier than Singapore and Brunei, which can be realised through decoupling growth from CO_2 emissions as soon as possible. To enable this leapfrog-type move, it is necessary to take advantage of all opportunities for transformative actions and decarbonising technologies on a massive scale, as discussed in Section 4.

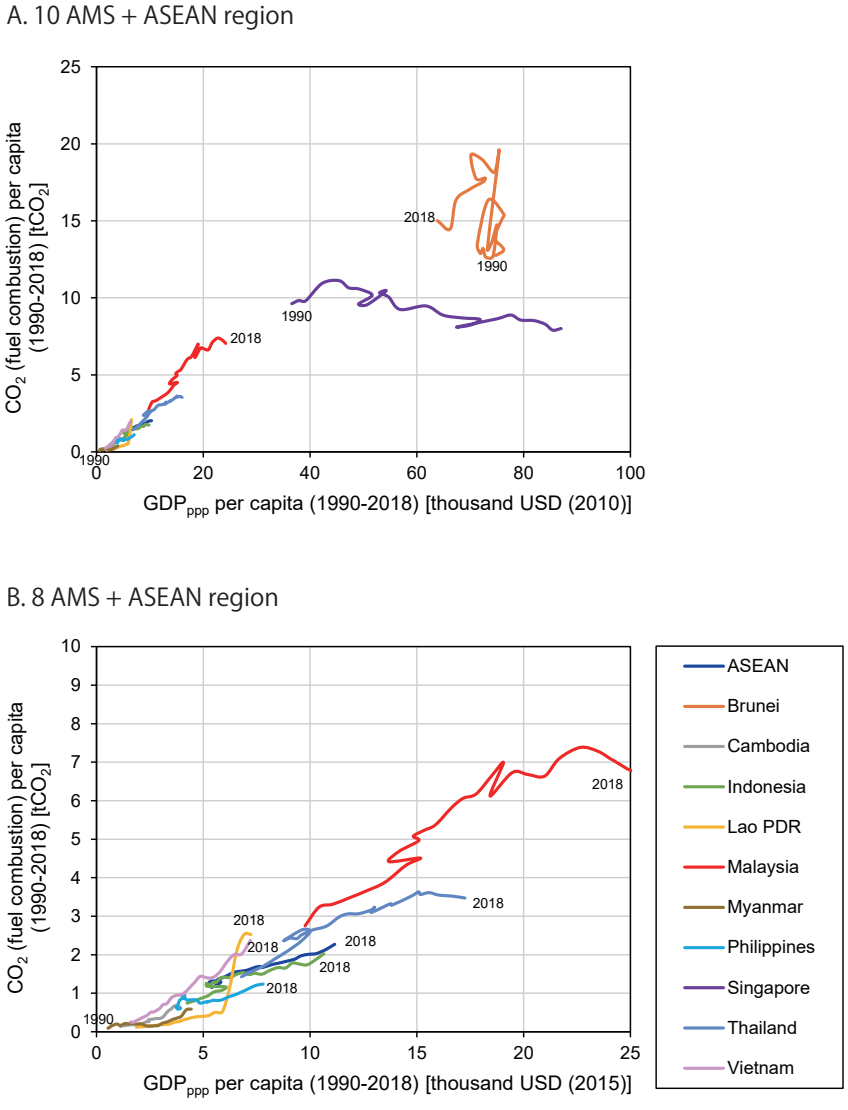

Figure 11.
Relationship between GDP (2010 USD) per capita and CO_2 per capita during the period from 1990 to 2018 (A shows all AMS and ASEAN, while B is a zoomed version of A). Data for Cambodia is between 1995 and 2018 due to data availability. Source: Authors with data from IEA (2020) for CO_2 and World Bank (2020) for population and GDP (PPP).

Key indicators for energy transition in the ASEAN region and AMS

To achieve net-zero emissions, long-term energy intensity improvement and decarbonisation of energy systems are required. In other words, a country needs to achieve transformation of both energy demand and energy supply sides, which can be measured by reductions in energy intensity (TFC/GDP) and emission intensity (CO_2 emission/TFC), respectively. As shown in Figure 12, during 1990–2018, energy intensity in the ASEAN region and AMS dropped, while emission intensity rose over the same period, pointing to a clear trade-off between energy intensity and emission intensity improvement. Thus, each AMS needs to diligently reduce both simultaneously. While energy intensity can be reduced through use of energy-efficient technologies, greater reductions are brought about through structural change of the economics of the service industry via behavioural change, to bring about a reduction in demand. Reducing demand through lifestyle changes, accompanied by a shift in norms toward more environmentally-conscious behaviours are also vital to reduce energy intensity. Reduced emission intensity can be achieved when energy systems are decarbonised, for example, through increased use of low-carbon energy sources in the power sector and application of low-carbon industry processes. Importantly, phasing-out fossil fuels or scaling-up the switch in fuels from fossil-fuel based energy to renewable/low-carbon energy is the key to achieving decarbonisation of the energy sector. Given the persistent trade-offs, a fundamental paradigm shift of the current policy, i.e. RE policy and fossil fuel subsidy policy needs to be among the top priorities. A comprehensive list of essential actions that need to take place in the ASEAN region is presented in Section 4.2.4, while essential mitigation technologies are given in Section 3.5.1 (Technology development and transfer).

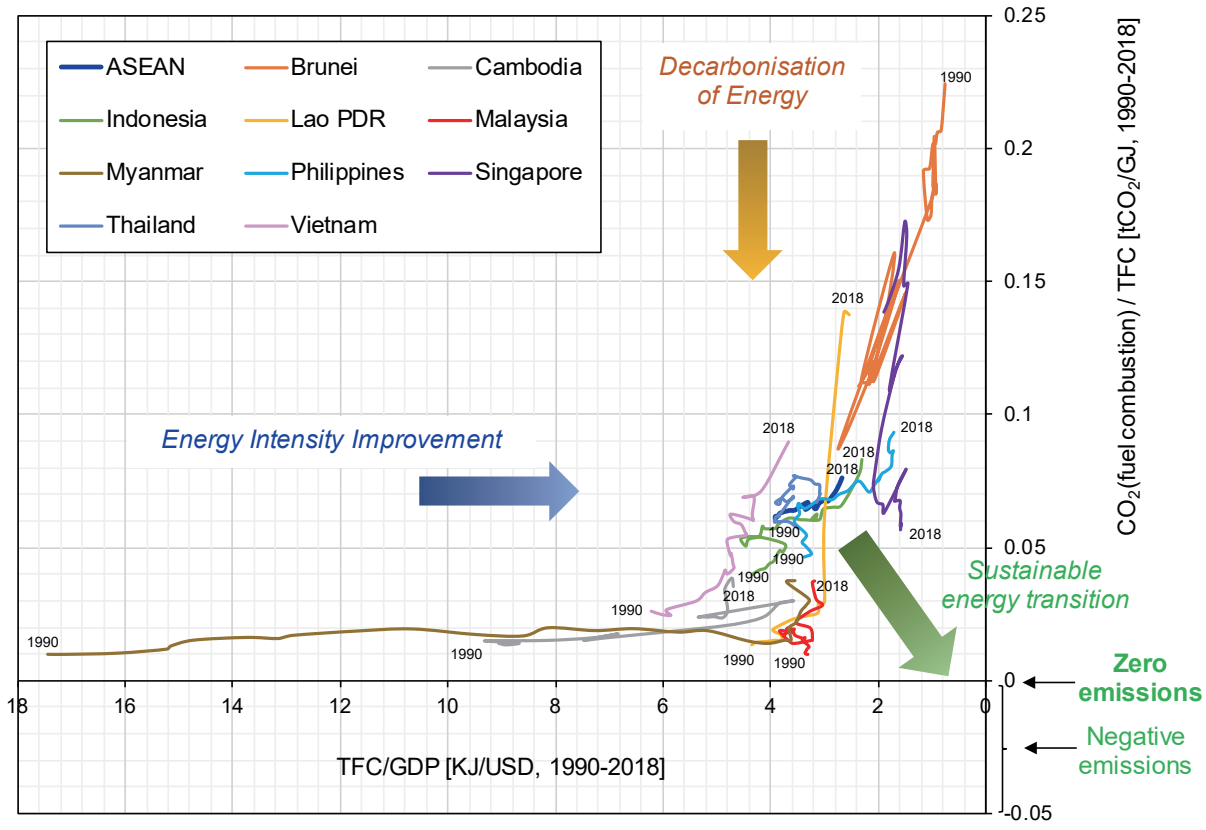

Figure 12.
Relationship between energy intensity and CO_2 emissions intensity in the ASEAN region and AMS during the period from 1990 to 2018 (2000-2018 for Lao PDR and ASEAN, and 1995-2018 for Cambodia). Source: from IEA (2020) for CO_2 and Total Final Consumption (TFC) and World Bank (2020) for population and GDP (PPP)

Renewable energy (wind and solar)

Increasing renewable electricity is key to reducing CO_2 emissions intensity in Figure 12. Figure 13 shows the aggregated renewable electricity capacity for wind and solar in 10 AMS (left), and in ASEAN, China, Republic of Korea and Japan (right). Among the AMS, Thailand, the Philippines, Malaysia and others have steadily increased their installed capacity of wind and solar electricity, and in Vietnam, solar PV sharply increased in 2019 (Figure 13). In the same year, total wind and solar electricity capacity reached 13 GW in ASEAN while in China, Japan and Republic of Korea it reached 415 GW, 65 GW and 12 GW, respectively. Within AMS, offshore wind has only been introduced in Vietnam to date (Figure 14). It is evident that much room remains for deploying variable renewable energy (VRE) such as wind and solar in the ASEAN region, to reduce its emission intensity.

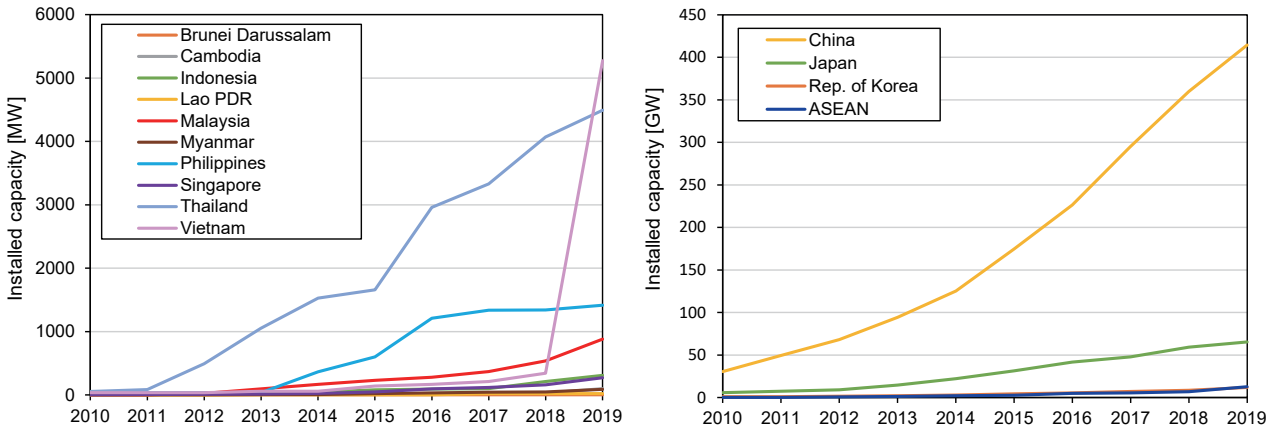

Figure 13.
Aggregated renewable (wind and solar) electricity capacity of AMS (left) and ASEAN+3 consisting of China, Republic of Korea and Japan (right) during 2010-2019. Source: IRENA (2021)

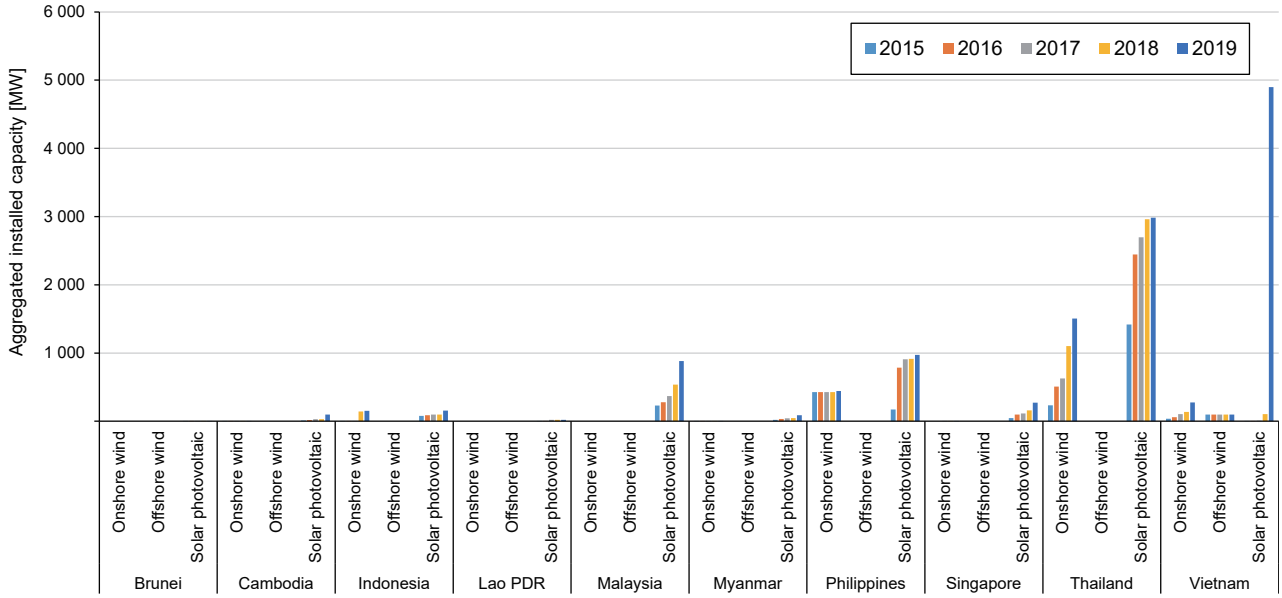

Figure 14.
Aggregated renewable electricity capacity of AMS for onshore/offshore wind and solar PV between 2015 and 2019. Source: IRENA (2021)

3.2.2. Outlook

Key message

Based on the latest NDC targets up to 2030, GHG emissions in the ASEAN region are estimated to keep on increasing in the same period. To keep the PA temperature goal within reach, ASEAN needs to achieve peak emissions as soon as possible after 2030 and net-zero GHG emissions as soon as possible after 2050.

GHG emissions

Figure 15 shows the range of GHG and CO_2 emission (fuel combustion + LULUCF) pathways under the 1.5°C and 2°C scenarios for ASEAN to achieve net-zero emissions during this century. These pathways were derived using four indicative Integrated Assessment Models (IAMs)[13] with the objective of minimising the global total cost of energy and land systems over the period up to 2100. Their average is displayed by a solid line. These results are derived based on the effort-sharing principle of cost effectiveness on a global scale. Hence, the results are interpreted as economically optimum pathways for ASEAN, where all countries and regions cooperatively reduce emissions with appropriate harmonisation of climate policy such as carbon pricing[14].

In terms of emission pathways consistent with the global 1.5 °C target, ASEAN needs to achieve net-zero CO_2 emissions by 2050 on average across models, while it needs to achieve net-zero GHG emissions by 2065 on average. Modelling results also show the need for emissions to peak out sooner, if possible. In the near- to medium term for ASEAN, there are gaps in emissions or ambition between the 2030 NDC targets for GHG emissions and 1.5°C- and 2°C-compatible emissions, as shown in Figure 15[15], thus efforts to overcome the ambition gaps of NDC pledges and current policy will be important[16].

13. IAMs integrate the energy, economy and environment (climate change) system modules to assess the long-term transitions of energy and land systems for given global warming scenarios. The energy system modules of IAMs are bottom-up technology- explicit modules and allow for an economically rational choice over a set of technological options in the power, industry, transportation, and building sectors to meet the constraints of a 1.5°C-compatible carbon budget, i.e. 400 $GtCO_2$ during the 21st century.

14. With regard to the emission pathways for major global regions under different effort-sharing principles such as responsibility and equality, please refer to Parra et al. (2017), Robiou du Pont et al. (2016; 2017), and Fyson et al. (2020). It should be noted that they do not show estimates for ASEAN but only selected countries.

15. ASEAN's aggregated GHG emissions meeting NDC targets are calculated based on the updated NDC as of 30 August 2021 (see Appendix Table 2). GHG emissions in 2030 for countries not pledging absolute emission targets were calculated based on official documents indicating relevant data on GHG emissions per capita, population, GHG intensity (emissions per GDP), and GDP growth for 2030.

16. See Roelfsema et al. (2020).

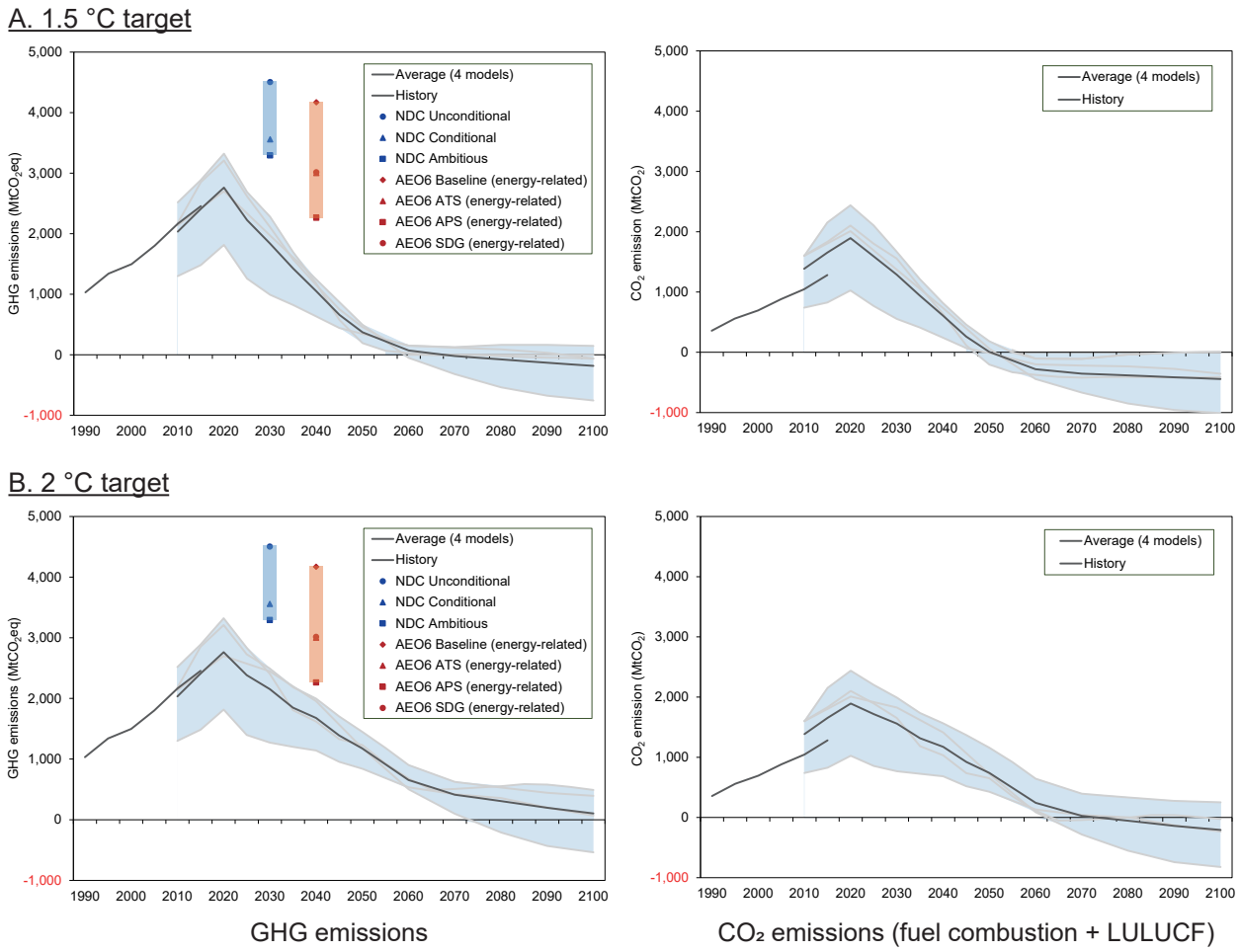

Figure 15.
Historical and future GHG and CO_2 emissions pathways in ASEAN to meet the 1.5°C and 2°C targets on a global scale. CO_2 emissions include emissions from fuel combustion, industrial processes, and LULUCF. Four models whose simulation results shown are AIM/CGE 2.1, MESSAGEix-GLOBIOM 1.0, REMIND-MAgPIE 1.7-3.0, and WITCH-GLOBIOM 4.4. The model results for the 1.5°C target assume a scenarios in which national climate, energy and land policies are implemented until 2020 with a transition to a globally cost-effective implementation of a carbon budget for the period 2011–2100 of 400 $GtCO_2$ afterwards, corresponding to a chance of >66% for staying below 1.5°C in 2100. Source: Future emission pathways are from CD-LINKS Scenario Explorer hosted by (IIASA, 2020) and historical emissions are from EC (2019)[17].

17. Estimations of the models were aggregated for the ASEAN region, prorated by GDP (PPP) projections of countries for the SSP2 scenario. GDP data is from IIASA (2018). AEO6 stands for the 6th ASEAN Energy Outlook (ACE, 2020), and its four scenarios on energy-related GHG emissions in 2040 are shown: Baseline, ATS (ASEAN Member States Target Scenario), APAEC Targets Scenario (APS), and SDG scenarios. Note that AEO6 scenarios do not include CO_2 from LULUCF and non-CO_2 GHGs from the sectors other than energy. The NDC Ambitious scenario incorporated Cambodia's aspirational NDC scenario assuming large-scale forest carbon sinks, on the basis of the NDC Conditional scenario which assumes acquisition of international financial support.

Energy demand

For the region to transform toward net-zero emissions, energy demand in every sector needs to be reduced as much as possible. Figure 16 shows final energy consumption by sector (building, transport, and industry) in ASEAN, as well as that growth is anticipated in all sectors up to 2100. In total, NDC-level energy demand pathways will be in the upper range in ASEAN, which highlights the so-called ambition gaps between NDC-level demand reduction efforts (represented by WEO Stated Policies Scenario (IEA, 2019)) and the 1.5 °C-consistent efforts. ASEAN's two scenarios (AMS Targets Scenario and ASEAN Progressive Scenario (ACE, 2017)) are on track with the 1.5 °C energy demand pathways except for the transport sector. These results show that much effort is needed to reduce energy demand in all sectors in order to approach net-zero emissions.

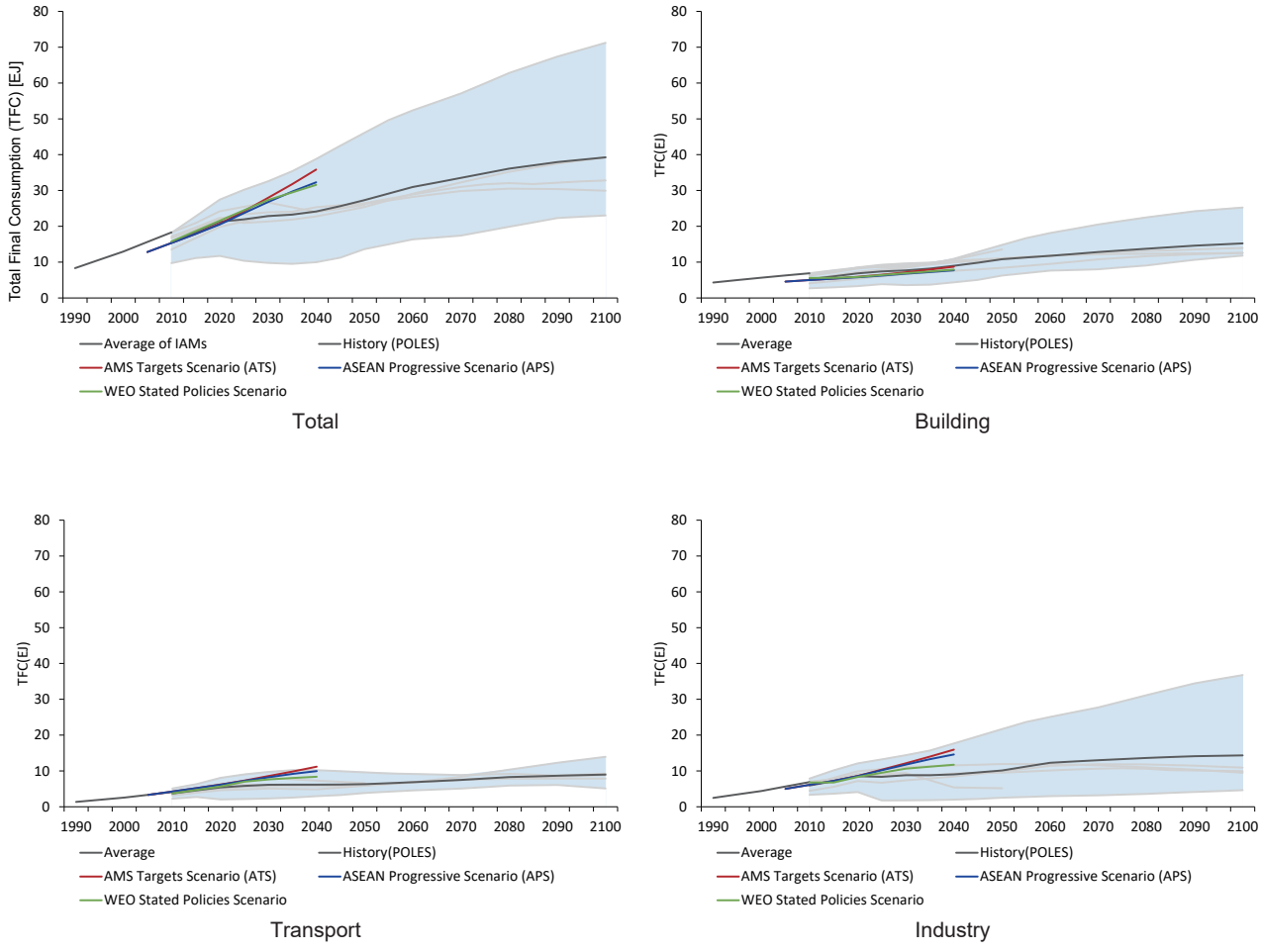

Figure 16.
Final energy consumption by sector (building, transport and industry) in ASEAN under the 1.5°C scenario. Source: Future energy consumption is from CD-LINKS Scenario Explorer hosted by IIASA (2020), ATS and APS scenarios are from ACE (2017), and WEO scenario is from IEA (2019).

Energy supply (Electricity Mix)

In terms of energy supply, the electricity mix is of vital importance, as CO_2 emissions from the power sector account for nearly half of total emissions in 2018 (16). In particular, electricity consumption in 2050 is 3.5–10 times larger than that in 2018 along with the increase in ASEAN's final energy consumption over the same period, as shown in Figure 17. ASEAN is to phase out fossil fuel-fired power without CCS after 2050 under the scenario that realises net-zero CO_2 emissions in around 2050. Even with CCS, however, coal-fired power needs to be phased out by 2050, as observed in most IAM results. Considering the possible lock-in of carbon intensive infrastructure and higher risk of stranded fossil fuel assets (UNEP, 2020), ASEAN and all AMS need to immediately prepare strategies or plans to begin phasing out coal power plants. Importantly, if CCS is not seriously scrutinised as a viable option, ASEAN needs to prepare strategies to switch from fossil-fired power to renewable/low-carbon energy. Among renewables, wind and solar will be the major sources, followed by hydro, biomass-fired power with CCS (BECCS) and geothermal. Regardless of whether ASEAN depends on nuclear energy even after 2050 or not, clean energy (low-carbon) transition toward the above-mentioned renewable energies or some portion of CCS application for gas- and biomass-fired power will be required in the energy transition. Decentralised RE system expansion in urban and remote rural areas, which can be combined with electrification and DX of the end-use sectors (IGES, 2020), may offer a possible technology combination option for decarbonisation in the future ASEAN community.

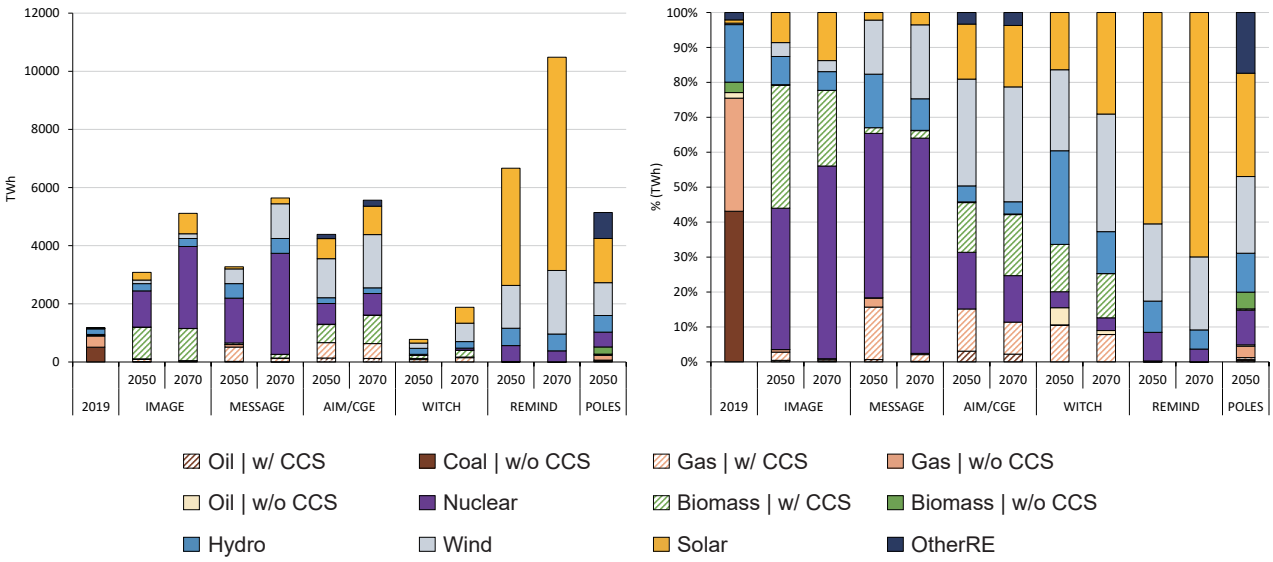

Figure 17.
Current and future electricity generation (left) and its share (right) in ASEAN under the 1.5°C scenario. Source: Historical electricity generation is from IEA (2020) while future electricity generation is from CD-LINKS Scenario Explorer hosted by IIASA (2020). Estimations of the models were aggregated for the ASEAN region, prorated by GDP (PPP) projections of countries for the SSP2 scenario. GDP data is from IIASA (2018).

3.3. Vulnerability to and impacts of climate change

3.3.1. Current status

Key message

The region is highly vulnerable to climate change impacts due to a variety of factors including high levels of poverty in some countries, high dependency on climate-sensitive sectors for livelihoods, long coastlines, existence of multiple natural hazards etc.

ASEAN is one region that is highly vulnerable to climate change impacts. According to the Global Climate Risk Index (CRI) 2020[18], countries such as Myanmar, the Philippines, Vietnam and Thailand were in the top 10 most affected by extreme climate events during 1999–2018 (Eckstein, Kunzel, Schafer, & Winges, 2019)—with Myanmar highest ranked by CRI score (10.3), followed by the Philippines (CRI 17.67), Vietnam (29.83) and Thailand (31.00).

The following underlying factors are responsible for high climate change vulnerability in the ASEAN region. Further details are given below:

(i) High level of extreme poverty in the region

(ii) High dependency of national economies and societies on sectors that are directly affected by climate change, i.e. agriculture and other natural resources

(iii) Pre-existing stress suffered by region due to disaster loss and damage including from droughts, typhoons and floods

(iv) Regional and global integration with implications for the globalisation of local risks through global supply chains and transboundary rivers

(v) Extensive coastline with numerous coastal cities and highly concentrated economic activities in coastal areas

(vi) High propensity of migration within the region

(vii) High deforestation in parts of ASEAN, with negative implications for local resilience and environmental feedback effects

18. The CRI is developed by Germanwatch and quantifies the impacts of extreme climate events.

High levels of extreme poverty in the region

Although the ASEAN region has made significant progress in poverty reduction, several countries still have high levels of extreme poverty (Table 2). Countries such as Vietnam, Lao PDR, Cambodia and Myanmar have made rapid achievements in addressing extreme poverty in the past decade; however, such gains need reinforcing to completely eradicate poverty and improve the economic resilience of those at the bottom of the pyramid. Most available projections indicated that the region would achieve its SDG 1 targets either within 2020 or soon after (Pavon, 2019). While some countries may be able to meet these expectations, the social and economic impacts of the COVID-19 pandemic could potentially widen the gap further to developmental gains made in the region to date.

High dependency on agriculture and other natural resources

Economies in the region are slowly diversifying to be less dependent on agriculture and natural resources for economic development. However, some countries highly depend on such resources as they provide over 20% of their national GDP. It is these countries, as well as the agriculture-dependent communities within them that have a high propensity to be affected by climate change impacts.

High pressure from disasters

A number of disasters are experienced by ASEAN countries every year, with significant economic and human losses. A total of 33,325 deaths resulted from natural hazards and an estimated 222 million people were affected during 2009–2020 (EM-DAT, 2020). During the same period, the estimated economic loss was USD 97.3 billion. While data on insured losses is difficult to obtain, available data suggest an insured loss of around USD 11.3 billion during the same period. The Philippines ranked first in terms of number of people affected by natural hazards, followed by Thailand and Vietnam (Figure 18). Myanmar reported the highest loss from extreme weather-related events (0.83% of GDP), followed by the Philippines (0.57%), Pakistan (0.53%), Vietnam (0.47%), Bangladesh (0.41%), Thailand (0.87%), and Nepal (0.40%) (Eckstein, Kunzel, Schafer, & Winges, 2019). These statistics show the pre-existing propensity of the region to be severely impacted by natural hazards. Considering factors such as climate change affecting the degree, severity and duration of many natural hazards like droughts, floods and typhoons, and the migration of people to vulnerable regions such as coastal areas and flood basins, there may well be an increase in the impacts of natural hazards on business-as-usual scenarios in the future.

Regional and global integration

ASEAN is the second largest open market after the EU, as a result of efforts to ensure the free flow of goods, services and people within the region, with net positive implications for regional economic integration. However, this integration faces an existential threat in connection with its 'rice basket of the world' status. Nearly 28% of the global rice crop and 31% of Asia's rice is produced in the region, thus any variability in rainfall patterns can have serious food security implications for the region and beyond. For example, during the 2008 global food price crisis, some ASEAN countries imposed bans on rice exports, which led to price hikes for importing countries (Childs & Kiawu, 2009). Further, ASEAN is emerging as the second largest manufacturing hub outside China with connections to global supply chains. The experiences from the Bangkok floods of 2011 indicated the disruptive potential of these events on the regional and global economy (Prabhakar & Shaw, 2020). As a transboundary river, the Mekong River greatly helps integrate the region and provides an opportunity for cooperation among the river's adjoining countries. With increasing water demand along the river, high variability in river flows, high risk of large-scale floods and increasing depletion of fish stocks, there is potential for even greater cooperation among the Mekong countries, upon which the future prospects of the region rely.

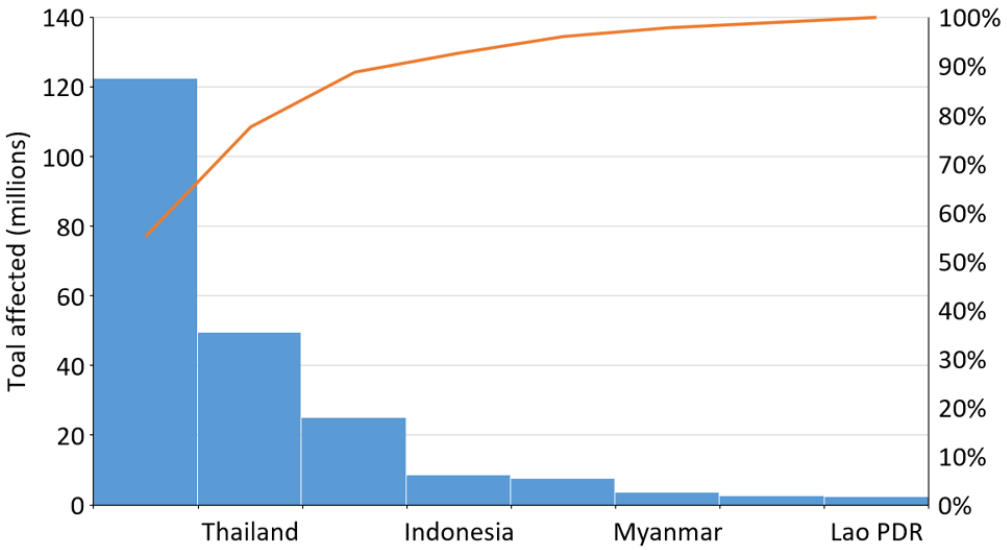

Figure 18.
ASEAN countries in the order of total number of affected people by natural hazards (EM-DAT, 2020)

High levels of economic activity on coasts

Southeast Asia has one of the longest coastlines in the world at 234,000 km (PEMSEA, 2013). An estimated 77% of the region's population lives in coastal areas, where major cities and key ports linked with the region's prosperity can be found. These areas provide over 60% of GDP for some countries. An estimated 229 million people live in vulnerable areas of the coasts, i.e. areas falling below the high tide line, constituting 39.4% of the total population in the ASEAN region (Kulp & Strauss, 2019). Indonesia has the largest population living below the high tide line (72 million), followed by Vietnam (60 million), the Philippines (36 million), Thailand (22 million), Myanmar (18 million), Malaysia (12 million), Cambodia (7.1 million), Singapore (1.9 million) and Brunei (0.22 million) (Kulp & Strauss, 2019). In the extreme climate change scenario of RCP 8.5[19], nearly 90% of the population in Vietnam, 54% of the population in Thailand, 24% in the Philippines, and 21% in Indonesia will be severely affected by sea level rise. Some studies have clustered countries depending on their vulnerability to sea level rise in the region (David, et al., 2008). According to David et al., cluster 1 is characterised by very high coastal population (Vietnam), cluster 2 indicates moderate exposure (Thailand, Malaysia and the Philippines), cluster 3 indicates small coastal exposure (Cambodia and Singapore), and cluster 4 indicates very high population and wetland area exposure (Indonesia). This indicates the high vulnerability of coastal cities and coastal-based economies to sea level rise.

High propensity to migration

One of the benefits of regional integration in ASEAN has been the ability of people to migrate freely within the region. However, while free mobility has opened up new and gainful economic opportunities and cultural integration for millions of people, it also has the potential to stress certain pockets of the region that are already experiencing high population densities, with consequences such as natural resource degradation, competition and congestion. With large sections of the migrant population settling in locations that are highly vulnerable to disasters and sea level rise, the growing level of internal migration could soon represent a vulnerability for the region. There is therefore a need to ease pressures caused by migration as well as address potential problems that could lead it into causing vulnerability.

High deforestation rates

Forests provide multiple ecosystem services that stretch beyond the boundaries of forests and countries where they are located, including cleaning of air, enriching groundwater aquifers, and normalisation of temperatures. Locally, forests provide direct economic and resilience benefits to local communities. Dependency on forest usufructs (i.e. common ownership/usage rights) during natural disasters is extensively covered in the literature. Some of these services are critical for the ASEAN countries that depend on healthy ecosystems for social and economic development. High deforestation rates, coupled with very high habitat and biodiversity losses of up to 40% by 2100 (Estoque, et al., 2019) can threaten and leave the region bereft of the key functions forests provide to communities and countries in the region, making them highly vulnerable to natural phenomena and variability.

19. Representative Concentration Pathways (RCPs) are climate scenarios that include time series of emissions and concentrations of the full suite of GHGs and aerosols and chemically active gases, as well as land use/land cover. There are four scenarios (i.e. RCP2.6, RCP4.5, RCP6.0 and RCP8.5) and RCP8.5 is the highest global warming scenario whose radiative forcing reaches greater than 8.5 W m2 by 2100 (IPCC, 2021).

3.3.2. Outlook

Key message

The region is facing a serious climate change scenario in the medium to long-term. The diverse nature of climate change impacts in the region means that a one-size-fits-all strategy will not work for the region; rather, there is a need to implement solutions that fit local conditions.

Projected climate change and loss and damage

There is ample literature on climate change and impact projections for the Southeast Asian region, including that of the Asia chapter in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Hijioka, et al., 2014). An elaborate discussion of future climate change and impact projections for the ASEAN region is outside the scope of this report and hence a succinct discussion is provided to convey that the ASEAN region is looking at significant impacts of climate change, necessitating pragmatic climate change adaptation (CCA) and mitigation actions.

Table 5 presents the climate change projections and Table 6 shows projected loss and damage in the ASEAN region. Table 7 shows the climate change impacts on crop productivity, and Table 8 shows the climate change impact of the sea level rise and heat stress in the ASEAN region. Key observations from the available evidence are:

(i) The projected climate change varies from country to country within the ASEAN region given its wide geographical area, signifying the need to understand local behaviours and local impacts of climate change.

(ii) Climate change can vary considerably within a country, so regional behaviours and characteristics need to be understood and taken into consideration to identify and put appropriate adaptation measures into action.

(iii) The region is highly vulnerable to sea level rise and coastal inundation, due to large populations and economic assets in coastal areas.

(iv) There is an increase in the number of extreme events, such as extreme precipitation events, number of hot days, extreme floods, and changes in behaviour of typhoons and droughts in terms of their severity, duration and onset.

(v) There is very little evidence on projected loss and damage; only a few countries have information on such projections, with more focus on loss and damage related to floods and sea level rise.

(vi) Climate change impacts on crop productivity are significant in the ASEAN region, and are especially pronounced in the RCP8.5 scenario. However, in the case of rice crop, the CO_2 fertilisation effect (increased CO_2 leading to reduced fertilisation) is prominent.

(vii) The region will face significant economic impacts due to sea level rise. Countries such as Indonesia, Thailand and Vietnam will face more severe damages compared to the other AMS. Further, the numbers of people affected is also significantly higher in these countries.

(viii) Heat stress impacts are significantly higher in countries such as Myanmar, the Philippines, Thailand and Vietnam, and the impacts are much more pronounced in the RCP8.5 scenario. There is therefore a need to introduce adaptation practices to deal with heat stress in the near future due to these significant impacts.

Table 5. Projected climate change in the ASEAN region

Country	Observed			Projections until 2100			
	Temperature	Precipitation	Observed extreme events	Temperature	Precipitation	SLR	Projected extreme events
Brunei Darussalam	0.6 °C rise between 1970 to 2014	10.8 mm increase per year until 2100 (RCP8.5)	Frequent and significant flash floods, forest fires, strong winds and landslides	0.5 °C per decade in the next 30 until 2100 (RCP8.5)	10.8 mm per year until 2100 (RCP8.5)	0.44-0.45	Increase in sea level rise in next 30–50 years. Increase in unpredictable extreme rainfall events resulting in flash floods and landslides
Cambodia	0.8 °C since 1960	General increase in rainfall	Riverine and extreme rainfall floods, high rainfall variability, and droughts were observed	1.6 °C (SRES-B1); 2.5°C (SRES A2)	3–35% increase (SRESA2)	1.7 cm/ year (SRES A2)	Increase in extreme rainfall events, droughts, and floods
Indonesia	0.01–0.06 °C per year since 1950	-2–3% since 1990	Extreme rainfall events, increase in floods, storms, and droughts	Increase by 0.75 °C (RCP2.6) and 2.7°C (RCP8.5)	10–30% in Sumatra, Borneo by 2080	0.5 m by 2040 (RCP4.5)	Increase in ENSO episodes, coastal flooding, wildfires
Lao PDR	0.05 °C per year in the past 40 years	Increased	Increase in extreme rainfall events, drought, and flood events	1.4–4.3 °C	10–30% in eastern, southern parts	Not relevant	Increase in extreme flood and drought events
Malaysia	0.13–0.24 °C per decade since 1969	Unclear long-term trend	Increase in rainfall intensity	1.2–1.6 °C (SRES) by 2050	7.1% to 10.6% increase by 2050	0.11–0.21 m (SRES) by 2050	Frequent extreme dry spells, extreme rainfall events, extreme floods in specific river basins
Myanmar	0.3–0.8 °C from 1971 to 2000	Increased during March-Nov. & decreased in rest	Increasing intensity and landfall of cyclones, droughts, and floods	1.2–2.5 °C (A1T scenario) & 2.8–3.5°C (A2 scenario)	10% increase during March to November	0.2–0.6 m	Increase in extreme hot days
Philippines	0.62 °C during 1958-2014	Increased intense rainfall	Increase in extreme rainfall events, increase in hot days, droughts, forest fires, change in typhoon behavior	1.8–2.2 °C (A1B)	-9.5% to 27.8% (A1B)	0.2 m	Increase in extreme rainfall events, hot days, change in typhoon behavior, storm surge in coastal areas
Singapore	0.25 °C per decade from 1948 to 2015	Increased at average rate of 67 mm per decade from 1980 to 2019	General uptrend in annual average rainfall from 2192 mm in 1980 to 2727 mm in 2014	1.4-2.7 °C (RCP4.5), 2.9-4.6 °C (RCP8.5) (mean daily temperature change for the years 2070-2099, relative to the period of 1980-2009)	Increasing trends in both intensity and frequency of heavy rainfall events	0.30-0.74 m (RCP4.5), 0.45-1.02 m (RCP8.5), by 2100 relative to the period of 1986-2005	Increased contrast between wet months and dry months, with increasing trends in both intensity and frequency of heavy rainfall events
Thailand	1.04 °C during 1970–2009	64.8 mm in East-Coast Gulf	Increase in hot days, extreme flood events	0.9–1.8 °C (RCP2.6), 2.0–3.1 (RCP8.5)	(-)66 to 193 mm (RCP2.6), (-)19 to 191 mm (RCP8.5)	1–2m	Increase in hot days, increase in high rainfall events
Vietnam	0.62 °C during 1958–2014	2.6% during 1958–2014	Increases in droughts, extreme rainfall events, super typhoons and typhoon period	1.7–2.4 °C (RCP4.5), 3.0–4.0 OC (RCP8.5)	5–15% (RCP4.5), 20% (RCP8.5)	0.53 m (RCP4.5), 0.73 m (RCP8.5)	Increase in strong and very strong typhoons, the intensity of droughts, number of hot days

Source: Authors, compiled from following references: Ministry of Natural Resources and Environment (2016); Ministry of Energy, Science, Technology (2020); Syafrina, Zalina, & Norzaida (2017); Ministry of Natural Resources and Environment (2018); Bappenas (2010); World Bank (2020); Climate Change Commission (2012); Centre for Climate Research Singapore (2014); Directorate General of Climate Change (2017); Lao People's Democratic Republic (2013); Ministry of Energy, Science, Technology, Environment and Climate Change (2018); Climate Change Commission (2014); Ministry of Natural Resources and Environment (2018); Ministry of Natural Resources and Environment (2019); National Climate Change Secretariat (2015).

Table 6. Reported loss and damage associated with climate change in Southeast Asian nations

Country	Key climate risk	Projected loss and damage	Reference
Indonesia	Sea level rise	Environmental losses were estimated for full inundation (scenario A with 4m RSLR): loss of 90% (USD 2.8–3.5), and 25% (USD 90–113) to the present art and fishery values per hectare, while amenity service is expected to lose up to 50% (USD 3,700–5,400) of its present value. Recreation value of the coastal ecosystems in three selected sites (Marina and Maron beaches, and Plumbon estuary) will decrease by 70% (USD 15,460–19,820) per hectare. However, in scenario B (RSLR of 1.1 m) with a 50% inundated area, these losses are 40% less than for scenario A	Mehvar, Filatova, Syukri, Dastaheib, & Ranasinghe (2018)
Lao PDR	Floods	Climate change may result in a change of -7 to+5% in hydropower production, +35 to +520% in flood damages, and +15 to +160% in water supply deficit during 2078–2098	Giuliani, Anghileri, Castelliti, P.N.Vu, & Sessa (2016)
Vietnam	Floods in central Vietnam	Flood damage was estimated to be USD 18.8–20.7 million from 2020s to 2080s in Central Vietnam. Economic losses for both irrigation and agriculture were estimated at USD 4.2 million. Losses in residential and industrial sectors were estimated at nearly USD 2.9 million and USD 1.4 million, respectively	Dao, Kuntiyawichai, & Plermkamon (2017)
	Floods	Average annual damage for tangible costs in study area is determined as about 3.5% of GDP for flooded area in Central Vietnam	Vu & Ranzi (2016)

Source: Authors, compiled from listed references

Table 7. Projected climate change impacts from climate models on crop yield (t/ha) in the ASEAN region by 2050

Country	Rice				Maize				Soybean			
	Rainfed (t/ha)		Irrigated (t/ha)		Rainfed (t/ha)		Irrigated (t/ha)		Rainfed (t/ha)		Irrigated (t/ha)	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Brunei Darussalam	6.6 (6.2-6.8)	6.9 (6.6-7.2)	6.9 (6.7-7.1)	7.3 (7.1-7.6)	0.2 (0.1-0.3)	0.1 (0.04-0.3)	0.5 (0.3-0.6)	0.4 (0.2-0.5)	0.7 (0.3-1.0)	0.4 (0.1-0.7)	0.9 (0.5-1.4)	0.7 (0.2-1.2)
Cambodia	7.1 (6.5-7.8)	7.5 (6.8-8.2)	8.2 (7.8-8.6)	8.4 (7.7-9.1)	0.5 (0.002-0.12)	0.02 (0.001-0.05)	0.4 (0.2-0.6)	0.2 (0.1-0.3)	0.3 (0.2-0.5)	0.3 (0.2-0.4)	0.2 (0.1-0.2)	0.1 (0.03-0.1)
Indonesia	7.1 (6.9-7.3)	7.5 (7.1-7.8)	7.9 (7.7-8.3)	8.4 (8.2-8.6)	2.3 (1.9-3.0)	1.9 (1.5-2.7)	2.4 (1.8-3.0)	2.1 (1.4-2.8)	1.1 (0.9-1.6)	1.0 (0.8-1.4)	1.3 (1.0-1.5)	1.1 (0.8-1.3)
Lao PDR	4.8 (4.7-4.9)	5.3 (4.9-5.7)	5.4 (5.2-5.5)	5.9 (5.3-6.3)	1.0 (0.7-1.5)	0.7 (0.2-1.2)	2.7 (2.4-3.3)	2.3 (1.7-2.9)	1.0 (0.8-1.3)	0.8 (0.6-1.2)	1.0 (0.6-1.4)	0.7 (0.2-1.1)
Malaysia	7.9 (7.6-8.3)	8.3 (8.0-8.7)	8.1 (7.9-8.2)	8.6 (8.4-8.8)	3.3 (2.3-4.8)	2.5 (1.4-4.2)	4.7 (4.0-5.7)	4.0 (2.8-5.3)	1.2 (1.0-1.5)	0.9 (0.6-1.3)	1.5 (1.0-1.9)	1.2 (0.7-1.8)
Myanmar	5.4 (4.7-5.9)	5.5 (4.7-6.1)	6.5 (6.2-6.8)	6.7 (6.1-7.2)	1.1 (0.8-1.4)	0.9 (0.7-1.5)	2.4 (2.0-2.7)	2.0 (1.6-2.4)	0.8 (0.6-1.1)	0.7 (0.5-1.1)	1.1 (0.9-1.4)	0.9 (0.7-1.3)
Philippines	5.4 (5.1-5.5)	6.1 (5.6-6.5)	5.7 (5.5-5.8)	6.4 (6.3-6.6)	2.4 (1.7-3.0)	2.2 (1.2-3.2)	3.6 (3.2-4.0)	3.5 (2.8-4.2)	1.1 (1.0-1.3)	1.0 (0.9-1.2)	1.1 (0.9-1.3)	0.9 (0.7-1.3)
Singapore	7.2 (6.7-7.6)	7.7 (7.1-8.1)	7.1 (6.6-7.6)	7.6 (7.3-7.7)	1.8 (1.3-2.9)	1.5 (0.4-3.3)	2.0 (1.4-3.4)	1.6 (0.5-3.6)	0.8 (0.5-1.0)	0.6 (0.2-0.9)	0.6 (0.5-1.0)	0.6 (0.2-1.2)
Thailand	6.3 (6.0-6.6)	6.8 (6.4-7.3)	6.5 (6.3-6.7)	6.9 (6.3-7.3)	0.5 (0.2-0.7)	0.3 (0.1-0.4)	1.0 (0.6-1.3)	0.7 (0.3-0.9)	0.6 (0.4-0.8)	0.4 (0.3-0.6)	0.4 (0.1-0.6)	0.2 (0.04-0.3)
Vietnam	7.2 (7.1-7.4)	7.5 (7.0-8.0)	7.8 (7.6-8.0)	8.1 (7.3-8.5)	1.6 (1.0-2.1)	1.5 (0.7-2.0)	4.2 (3.2-5.3)	3.8 (2.9-4.6)	1.4 (1.1-1.7)	1.4 (1.2-1.8)	1.1 (0.9-1.6)	1.0 (0.5-1.4)

Note: Numbers outside of parenthesis show the average value across climate models, whereas those in parenthesis show the breadth of numbers comprising the minimum and maximum values across models. 5 climate models were used. Crop yield is estimated based on the assumption about adaptation such as change in sowing dates and change to crop varieties with different growing periods. Source: AP-PLAT Data (MOEJ and NIES, 2021); and Iizumi et al. (2017).

Table 8. Projected climate change impacts from climate models on sea level rise and heat stress in the ASEAN region by 2050

Country	Sea Level Rise						Heat stress	
	Inundated area (Km2)		Affected population		Economic impact (Billion USD)		Heat mortality (Number of deaths per 1,000 Km^2)	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Brunei Darussalam	7	95	60 (60-60)	53 (50-60)	78 (78-78)	62 (54-88)	0.88 (0.5-1.44)	0.86 (0.47-1.35)
Cambodia	1495 (1364-1784)	1474 (1343-1784)	205703 (183950-265700)	213745 (190640-280910)	676 643-766)	660 (486-1054)	4.26 (3.16-4.88)	4.11 (2.36-5.4)
Indonesia	20671 (20304-21260)	19968 (18642-20541)	1540802 (1527442-1561680)	1644018 (1371680-1837870)	3155 (3142-3176)	2783 (2045-4821)	3.06 (1.55-6.83)	2.70 (1.03-3.75)
Lao PDR	0	0	0	0	0	0	2.38 (1.88-3.43)	2.85 (1.74-4.18)
Malaysia	2689 (2662-2726)	2630 (2513-2684)	105103 (104460-105870)	104495 (100910-107000)	1743 (1738-1749)	1465 (1224-2109)	1.13 (0.91-1.4)	1.06 (0.57-1.69)
Myanmar	3851 (3654-4269)	3649 (3471-3725)	471695 (456590-513090)	427150 (379000-568780)	1261 (1227-1356)	682 (449-1334)	1.23 (0.7-1.69)	1.18 (0.55-1.75)
Philippines	4720 (4626-4815)	4606 (4292-4815)	315440 (310500-320760)	342158 (279600-375550)	1198 (1176-1243)	652 (496-1042)	5.50 (4.16-7.49)	5.67 (4.34-8.01)
Singapore	128 (128-128)	128 (128-128)	89170 (89170-89170)	89350 (84790-90870)	1630 (1630-1630)	1382 (1202-1922)	0.22 (0.03-0.4)	0.31 (0.06-0.65)
Thailand	2012 (1933-2122)	1985 (1869-2164)	680468 (670570-694160)	615013 (563350-761530)	3157 (3135-3188)	2482 (1817-4431)	6.90 (5.37-8.18)	6.84 (3.67-10.02)
Vietnam	37810 (36700-38334)	37720 (36700-38353)	17517443 (16174133-18097448)	16685083 (15044492-19245000)	6482 (6241-6585)	8621 (8146-9490)	7.82 (4.93-11.14)	7.85 (4.08-11.79)

Note: Numbers outside of parenthesis show the average value across climate models, whereas those in parenthesis show the breadth of numbers comprising the minimum and maximum values across models. 4 climate models were used for sea level rise, while 8 climate models were used for heat stress. Inundated area in Brunei Darussalam is the results estimated by the LiDAR (Light Detection and Ranging) model. Source: AP-PLAT Data (MOEJ and NIES, 2021); Takakura et al. (2019) for heat stress; and Tamura et al. (2019) for sea level rise.

Sectoral impacts

This section provides a brief overview of climate change impacts on priority sectors of the AMS (Table 9). A review of the latest National Communications indicates that AMS face a range of climate change impacts that threaten their development prospects. The priority impacts reported were in the sectors related to agriculture, water resources, fisheries and animal husbandry, coastal zones, urban infrastructure, forests and biodiversity, energy and human health.

Some of the common impacts include negative impacts on agriculture and food production, decline in freshwater resources, threat to coastal infrastructure due to sea level rise and associated saline water intrusion, changes in forest species composition and related impacts on forest biodiversity, negative impacts on rural livelihoods largely associated with agriculture and natural resources, and negative impact on human and animal health due to the spread of infectious diseases and change in air quality. Increased water scarcity associated with droughts, increased floods, landslides, high temperatures, sea level rise and associated saline water intrusion, increased frequency of rainfall events are some of the common factors behind the impact projections. These factors interact with the pre-existing vulnerabilities and development contexts of countries, and produce some of the significant impacts that these countries face in the future.

In general, most of the countries can sufficiently create impact assessments based on the available evidence, though opinions vary widely as to the nature and extent of the evidential basis behind the projected impacts. However, most countries are at the preliminary stages of developing impact projections, as capacities for undertaking quantitative assessments are still being developed. Hence, it can be seen that some impact assessments are highly specialised and highly developed due to their focus on specific geographical regions within countries, which are often limited to watersheds or river basins, while others are qualitative extrapolations based on downscaled GCM projections of temperature and rainfall patterns. It also needs to be noted that all-encompassing impact assessments are still not available for many countries in the region. Therefore, the economic implications of the projected impacts are still evolving in the region, hence related economic impact figures for most countries at the sectoral or overall national GDP level are usually not available.

Impact assessments for water resources and agriculture are relatively well developed, followed by forest and biodiversity, coastal zones and human health, with some cases having more quantitative assessments than in other sectors. Social impact is the least developed impact assessment, while technical assessments are well developed for natural resources. Impact assessments in the energy sector are also largely lacking. Transboundary impacts of climate change have received negligible attention in the current impact assessments. While a few countries have clarified and detailed specific climate change scenarios that demonstrate these impacts, linkages between specific climate change scenarios and projected impacts were generally not clearly established for other countries. This could be due to the mixed-methods approach (i.e., combination of quantitative and qualitative assessments) these countries may have taken in identifying the projected impacts.

Table 9. Major impacts of climate change in key sectors as reported in the latest National Communications

Country	Major impacts in key sectors	Source
Brunei	Key sectors: Agriculture, water resources, fisheries, health, forestry, biodiversity	
	• Rainfed rice crop may be affected by reduced rainfall • Delayed rainy season may affect soil salinity and agricultural production • Sea water intrusion can damage coastal ecosystems, affecting fisheries • Increased sea temperatures can damage corals • Bushfires during dry periods from February to March can affect respiratory health • Possible impact on dengue spread	Energy and Industry Department (2017)
Cambodia	Key sectors: Agriculture, coastal zones, energy, human health, industry, infrastructure, tourism, water resources, fisheries, livelihoods, poverty, biodiversity	
	• Up to 70% reduction in wet season rice production in SRES-A2 scenario • Up to 40% reduction in dry season rice and other dry season crops • 20–60% reduction in overall crop production in SRES-B1 scenario • Most of the lowland forest will be exposed to long dry periods under B1 and A2 scenarios • Sea level rise can impact coastal ecosystems, cause loss of wetlands, erosion, salt water intrusion and raising of water tables; 1m rise in sea level will inundate 25,000 ha of agricultural land • Expansion of malaria transmission zones under high and low emission scenarios	National Council for Sustainable Development (2015)
Indonesia	Key sectors: Agriculture, water, energy security, forestry, maritime and fisheries, health, public service, infrastructure, urban systems	
	• Impact on mangrove zone, with impact on shrimp production • Coral bleaching with significant impact on fisheries • Coastal flooding with impact 42,000 ha of land • Destruction of coastal ecosystems, loss of fishing zones, saline intrusion, forced displacement of coastal communities, damage to coastal infrastructure, damage to agricultural crops • Drastic reduction in surface runoff and reduction in freshwater availability • Increased incidence of dengue fever • Decreasing agricultural production by 32% as long dry seasons affect annual and perineal crops • Economic loss of IDR 8,638 billion in the scenario of SLR+tides+wave+Land Subsidence (3.03–3.91) m • Potential drastic impact on agriculture production due to changes in pest incidence patterns	Directorate General of Climate Change (2017)
Lao PDR	Key sectors: Agriculture, forestry, water resources, transport and urban development, public health	
	• Increased floods and droughts can damage agriculture production, especially rice • Damage to infrastructure due to floods • Health impacts on humans due to spread of infectious diseases such as dengue • Floods are projected to affect transportation, communication, housing and utilities • Delayed onset of monsoon can affect rainfed agriculture production • Rainfall variability in June–October can be crucial factor for agriculture production in the country	Lao People's Democratic Republic (2013)

Country	Major impacts in key sectors	Source
Malaysia	Key sectors: Water and coastal resources, agriculture and food, forestry and biodiversity, infrastructure, energy, public health	
	• Increased flooding as average annual mean river flow projected to increase by 36% and maximum mean monthly river flows may increase between 65% and 274% by 2100 • Increase in significant dry spells with return period more than 10 years by 2040 • Increase of projected rainfall by 34% in Peninsular Malaysia by 2100 may lead to reduction of return period of floods from 100 years to 20 years • A sea level rise of 0.36 m by 2100 may increase threat of salt water intrusion and coastal erosion • A 2°C increase in temperature could result in decline of rice yields by 1 tonne per ha. As a result, rice yields in Malaysia are projected to decline in the range of -5.9 to -30.9% by 2050 in various parts of the country, with highest reduction in IADA Barat Laut Selangor region (average of -30.5%) • Dry spells can affect rice quality • Oil palm will be prone to floods, due to increase in area from 68,531 ha to 384,275 ha (+460%) in 2050 • A 10% reduction in rubber production due to dry spells and warming, especially in east coast region • Prolonged dry spells may also affect livestock health, dairy production and livestock fertility • Increase in sea surface temperature (SST) may affect fish habitats, fish catches, as well as due to mangrove degradation • Climate change may affect species composition of forests, habitat loss of mangrove forests, and impact flora and fauna of forests, including orangutans, elephants and marine ecosystems • Flood risk of relief centres is projected to increase by 70% by 2050; increase in flooded areas and flood risk of roads and other infrastructure is projected to occur by 2050. Sea level rise by 2050 may affect ports, jetties by 2050 • Flood risk of electricity transmission towers may increase from 1,666 towers to 2,208 by 2050 • 76% increase in flood risk to public health centres, and 9% due to sea level rise by 2050; increased incidence of dengue and malaria, and other food and water-borne diseases was projected	Ministry of Energy, Science, Technology (2020)
Myanmar	Key sectors: Agriculture, forestry, public health, water resources, coastal zone, biodiversity	
	• Rainfall and temperature changes can affect agriculture production, especially of rice crop • Seasonal and year-round water shortages in reservoirs can affect agriculture and drinking water supplies in many regions in the country, especially the dry zone, facing maximum pressure due to climate change • Climate change could affect the groundwater recharge rate and sustainability of groundwater usage in the country • An increase in water-related diseases and heat stress diseases is expected; increase in malaria outbreak is expected due to climate change • Increasing temperatures affect marine and fresh water ecosystems • Increase in floods and droughts, and increase in temperatures are expected to affect forests and biodiversity, including forest fires • SST changes can affect fishery types, populations and fish catches • A large proportion of biodiversity in Myanmar is endangered and these species will face further stress to extinction due to climate change	Ministry of Environmental Conservation and Forestry (2012)

Country	Major impacts in key sectors	Source
Philippines	Key sectors: Agriculture and food, watersheds covering, forestry, biodiversity, water resources, coastal and marine resources, human health	
	• Increased tropical cyclones, droughts, floods and temperature increase are projected to negatively affect agriculture production in the country • Pest infestation of crops may increase with increasing weather variability associated with climate change • Increasing water shortages, heavy rainfall events and floods may affect forestry, biodiversity and water resources in the country, and affect overall productivity of watersheds • Storm surges can affect coastal populations and coastal infrastructure; coastal erosion can put millions of people at risk due to coastal inundation and loss of infrastructure • Sea level rise can affect freshwater aquifers in coastal areas due to sea water intrusion affecting coastal ecosystems, agriculture production and drinking water supply • Infectious diseases such as malaria and dengue are expected to expand in terms of area	Department of Environment and Natural Resources (2014)
Singapore	Key sectors: Water, transport and urban infrastructure, public health, food supply	
	• Sea level rise – With about 30 per cent of our island less than five metres above the mean sea level, the rise in sea level poses the most immediate threat to Singapore. Rising sea levels coupled with extreme rainfall will lead to an increased risk of flooding, affecting coastal areas and communities residing there. • Water resources – Singapore is a water-scarce country due to limited land to collect and store rainwater. Greater weather variability could affect the resilience of our water resources and infrastructure. Periods of drought can affect the reliability of Singapore's water supply, while sudden episodes of intense rainfall could overwhelm our drainage system and lead to flash floods. • Urban heat island effect – Singapore is a densely built-up and highly urbanised city, hence we are affected by the urban heat island effect where urban areas that are more built-up and densely populated are warmer than rural areas. This happens because of the emitting of waste heat from sources such as cars and factories. Buildings also trap heat during the day, which then dissipates at night. Higher temperatures and humidity can affect public health and quality of life, as well as increase the likelihood of heat-induced health impacts. • Food security – The impacts of climate change, such as intense storms, flooding and prolonged droughts, will affect Singapore's food security, which currently imports more than 90 per cent of our food. • Public health – As Singapore's temperature and humidity increases, the likelihood of certain vector-borne diseases may also increase.	Ministry of Sustainability and the Environment (2021)
Thailand	Key sectors: Water management, agriculture and food security, tourism, health, natural resource management, human settlement and security	
	• Prolonged dry spells, declining rainfall, and increasing extreme rainfall events can affect agriculture production, with specific implications for rainfed crops of rice, sugarcane, cassava, maize and rubber plantations • Manufacturing and service sectors are expected to be affected by floods and droughts, especially large industrial estates in east and factories in northeastern region • Northeastern region is projected to face severe droughts, while the upper Chao Praya river basin is projected to experience floods with implications for human settlements and economic activities in the basin • In terms of urban areas, specific areas were identified to be more vulnerable to floods, including the Bangkok region • Climate change will have serious implications for malaria and dengue in several parts of the country • Tourism is projected to be seriously affected by climate change as country's beaches will be affected due to sea level rise, coral bleaching and coupled with human pressures; southern parts of Thailand were identified as the most vulnerable areas	Ministry of Natural Resources and Environment (2018)

Country	Major impacts in key sectors	Source
Vietnam	Key sectors: Water resources, agriculture, transportation, urban development, tourism, public health	
	• Sea level rise and saline water intrusion are serious problems for the country and climate change can exacerbate saline water intrusion, affecting rice production, narrowing coastal grazing and grasslands, reducing breeding facilities, and degrading the water quality for human and animal consumption • Long coastlines with dense settlements can be affected by sea level rise, saline water intrusion and coastal hazards; sea level rise can affect coastal biodiversity, lead to coastal ecosystem degradation, beach erosion, degrade coastal infrastructure, and affect coastal livelihoods including agriculture, animal husbandry and fisheries in coastal areas • Higher risk of floods and landslides in northern mountain and central areas and central coast, south central coast, Red River delta and highlands may face severe droughts • Extreme heat and dry weather can cause forest fires, threatening forest biodiversity, and affect distribution of dipterocarp, mangrove and semi-deciduous forests • Demand for groundwater extraction may rise, coupled with change in groundwater recharge characteristics of rainfall events overall, with a negative consequence on groundwater availability • Potential yield of spring rice may decline by 717 kg/ha or 2.16 million tonnes under average scenarios; yield reduction of summer–autumn rice could be around 795 kg/ha; extended summer monsoon period can have significant implications for agricultural operations • Crops such as maize and soybean may also face significant reductions in productivity, with impacts on food security, feed supplies to dairies, and livestock production • Climate change threatens fish production, both inland and in the ocean, due to temperature and salinity impacts and disease outbreaks, with projected loss of VND 855 billion by 2050 to fishery sector • The country faces severe health risks with climate change, with threat of spread of infectious diseases, and food related diseases from polluted fisheries affecting the health and food security of millions of people	Ministry of Natural Resources and Environment (2019)

Source: Compiled by authors from various sources

3.4. Climate change adaptation

3.4.1. Current status: National Actions

Key message

The region is already doing a significant amount of work in the field of climate change adaptation and disaster risk reduction. Several countries are setting new frontiers in the area of climate change risk and vulnerability assessments, capacity building, and institutions including laws and policies. With this, the region is poised to enhance its adaptation ambition to even higher levels in the years to come.

3.4.1.1. Key sectors for adaptation interventions

AMS have identified several key sectors on which adaptation interventions can be focused. These sectors were identified in various official communications, including the National Communications, Nationally Determined Contributions, Adaptation Plans and Adaptation Strategies. Although there is no uniform or clearly described method on how these sectors were prioritised, some of the underlying criteria could include their climate change vulnerability to projected impacts, significance to the national economy, significance to societal wellbeing, and to an extent their significance to future development goals, plans and pathways. Most countries presented these key sectors as a set, without allocating any priority.

From Table 10, it is apparent that food and agriculture, water resources, forest(ry) and biodiversity, and health formed the most common key sectors for all 10 AMS. These are followed by urban settlements and energy (6 countries), coastal and marine (5 countries), industry and infrastructure, tourism and fisheries (3 countries), transport (2 countries) and livelihood and poverty (1 country). Even though the theme of livelihood implications of climate change is important for all countries, only Cambodia identified it as a separate priority, while others integrated the livelihood aspects into other sectoral priorities. Similarly, even though countries such as Brunei, Myanmar, Malaysia and the Philippines have not identified urban areas as a key sector, their national communications placed sufficient emphasis on the climate change implications for urban areas and have identified specific interventions to address urban vulnerabilities by mainstreaming urban issues into relevant key sectors they prioritised. While fisheries is an important sector in terms of economic contribution to overall GDP for countries such as Cambodia, Vietnam, Indonesia, the Philippines, Thailand, Lao PDR, Malaysia and Myanmar, only a few countries allocated priority to fisheries in their discussion of priority sectors for climate change impacts. Similarly, while tourism was only identified as a key sector by a few countries, all other countries have mentioned the impacts of climate change on tourism in their national communications.

Table 10. Key sectors identified by ASEAN countries in their National Communications and other official communications

	Food & Agriculture	Water resources	Health	Forest(ry) & biodiversity	Urban	Coastal & Marine	Energy	Industry & infrastructure	Fisheries	Livelihoods & poverty	Tourism	Transport
Brunei	■	■	■	■					■			
Cambodia	■	■	■	■	■	■	■	■		■	■	
Indonesia	■	■	■	■	■		■	■	■			
Lao PDR	■	■	■	■	■		■					■
Malaysia	■	■	■	■		■	■	■				
Myanmar	■	■	■	■		■						
Philippines	■	■	■	■		■						
Singapore	■	■	■	■	■		■	■				■
Thailand	■	■	■	■	■	■			■		■	
Vietnam	■	■	■	■	■	■	■		■		■	■
Total	10	10	10	10	6	6	6	4	4	1	3	3

Source: Compiled from National reports submitted to ASCCR process & National Communications

3.4.1.2. Preparedness for the Enhanced Transparency Framework

The enhanced transparency framework (ETF), established under the Paris Agreement (PA), was designed to facilitate the reporting and review process under the Agreement to ensure transparency of adaptation and mitigation actions by all Parties, as well as the provision of financial, technology transfer and capacity-building support provided by developed countries to developing countries. It is intended to be facilitative, non-intrusive and respectful of national sovereignty. The ETF brings new MRV requirements, especially for developing countries, as the PA calls for the principles of equity and common but differentiated responsibilities and respective capabilities that take into consideration different national circumstances. Since there is a strong linkage between transparency and receipt of various kinds of support under the PA, developing countries in particular are incentivised to fulfill the requirements of the ETF.

In the ETF, nationally determined contributions (NDCs) represent an important vehicle for developing countries to communicate information on adaptation and mitigation. In particular, countries are encouraged to inform about climate change impacts and adaptation interventions. The ETF guidelines (UNFCCC, 2020), prepared for guiding the Parties, state that developing countries are encouraged to report the adaptation co-benefits of mitigation actions and adaptation actions by Parties in their NDCs. Hence, where the ETF is concerned, it is encouraged (i.e. not mandatory) for all countries to report climate change impacts and adaptation actions under Section 13.8 of the Paris Agreement.

The other opportunity for countries to report under the ETF is in the submission of biennial transparency reports (BTRs). In these reports, all parties are to submit mitigation co-benefits of adaptation actions and information on climate change impacts and adaptation interventions. Since the information on climate change impacts and adaptation interventions of BTR can also be used as the adaptation communication, this section is of critical importance for

all countries to report on. It should include information on national circumstances, institutional arrangements, legal frameworks, impacts, risks and vulnerabilities, adaptation priorities and barriers, adaptation strategies, policies, plans, goals and actions, progress on the implementation of adaptation, monitoring and evaluation of adaptation actions, information covering various aspects of loss and damage including actions for averting, minimising and addressing losses and damage, cooperation, good practices experiences learned, and any other adaptation related information that Parties chose to report on.

Considering the additional burden the reporting process can place on countries, sufficient flexibility is built into the process to help countries deliberate on how to report adaptation related matters in the BTR, including on how such reporting can assist in their information needs and synergy with other reporting requirements under the UNFCCC and PA. To support implementation of the PA including the ETF, various mechanisms have been established under the PA, including the Capacity-Building Initiative for Transparency (CBIT), Consultative Group of Experts (CGE), Paris Committee on Capacity Building, Adaptation Committee, and Least Developed Countries Expert Group to provide the necessary support. While CGE provides technical support in the preparation of BTR, the Adaptation Committee provides guidance on adaptation communications. The LDC Expert Group in collaboration with the Adaptation Committee develops an inventory of adaptation needs assessment methodologies, finance, capacity building and relevant technical support for implementing national adaptation plans.

In view of the above background on the reporting requirements for adaptation, both in the NDCs and BTR, the following sections outline the progress made in the key elements required to be reported on in the BTR and NDCs. Figure 19 summarises the current status of institutional mechanisms, policies and planning, financial mechanisms, and risk assessments related to climate change adaptation (CCA), disaster risk reduction (DRR) and their integration. Here, both the CCA and DRR are considered because of their strong mutual synergies and in most countries the CCA mechanisms were based on the experiences from implementing the DRR, which predates the CCA. For these synergies, assessing countries only based on their progress in CCA would provide an incomplete picture on their readiness to address climate change issues.

3.4.1.3. Adaptation strategies and implementation of adaptation

As can be understood from Figure 19, ASEAN countries have made significant progress instigating various institutional mechanisms for addressing CCA and DRR issues as well as integrating the same into various sectoral and national policies and plans. While some commonalities exist in how institutional mechanisms were designed, these mechanisms have been adapted to a country's national circumstances and are not to be compared in terms of their design and implementation. Hence, gauging the effectiveness of these interventions needs to take into consideration national contexts, and comparisons should only be made cautiously.

All countries have made substantial progress in recognising climate change issues in their development planning processes, either by explicitly mentioning climate change issues or identifying means to address them in their development plans. All AMS have put in place disaster risk management (DRM) policies at the national level, which define the principle means of addressing domestic disaster issues, and provide related guidance. To implement these policies, most countries have also enacted DRM laws, which can be leveraged to assist in policy implementation and enforcement. While some countries have yet to enact such laws, they were either at the stage of drafting or governmental debate as of the time of compiling this report.

All AMS identified focal agencies for implementing DRM, known under different names in different countries, and have formed inter-ministerial committees that help them implement DRM, due to the cross-sectoral nature of DRM. Further, all AMS have extended the DRM committee reach from the national to local level, enabling cross-sectoral and vertical coordination between them.

A similar approach and extent of progress can be found in climate change adaptation. Most countries have put in place CCA policies and are at different stages of finalising adaptation plans. In terms of adaptation planning, the National Adaptation Programme of Actions (NAPAs) was introduced under the Kyoto Protocol to support least developed countries (LDCs) in identifying and implementing priority adaptation actions. Cambodia and Lao PDR have submitted their NAPAs as per the provisions under the Protocol. Other ASEAN countries have submitted National Communications (NCs), which serve a similar purpose but also cover mitigation. All AMS have submitted NCs.

Subsequently, a new set of mechanisms were developed under the UNFCCC to strengthen adaptation, which led to the creation of National Adaptation Plans (NAPs). NAPs evolved as part of the Cancun Adaptation Framework (2011) to encourage all countries to develop and implement national adaptation plans, irrespective of their development status. The Paris Agreement (2015) has proposed additional provisions to strengthen adaptation, besides NAPs, which include monitoring and evaluation, adaptation communications, transparency framework to improve the transparency of actions, and a global stocktake exercise. To date, NAPs are being drafted as an improvement over the NAPAs and NCs. None of the ASEAN countries have submitted NAPs. All the countries have established national committees, similar to DRM, to improve coordination and mainstream climate change adaptation into different sectors. Here, the integration of CCA and DRR is of significance as climate change has serious implications for natural hazards and their intensity, duration, onset and cessation characteristics. Much progress has been made by ASEAN countries in integrating DRR and CCA, and some have made significant progress. Some have also produced guidelines to help different stakeholders integrate CCA and DRR into their operations. Under the PA, Parties have agreed to develop Nationally Determined Contributions (NDCs), which outline contributions of each country to global climate change actions. Though not legally binding, all ASEAN countries have submitted NDCs. In the absence of fully developed NAPs, the adaptation priorities of ASEAN countries can be found in their NDCs, NAPAs and NCs.

In terms of risk assessments, disaster risk assessments that do not incorporate climate change have already been undertaken in the ASEAN region. Flood risk, drought risk and landslide risk assessments have been conducted at national and sub-national levels, while some countries are taking risk assessments to the community level to develop community-based disaster management plans. This has provided a good starting point for the countries in terms of experience with climate change risk assessments and adaptation planning. The major bottlenecks identified with such assessments are the quality of data, quality of climate projections, and the technical ability to downscale them to the local level. To conduct reliable climate risk assessments that are also useful for local-level action, it is necessary to obtain reliable downscaled climate change projections, conduct impact assessments at the sectoral level (e.g. water resources, agriculture), and identify suitable adaptation options that can mitigate the projected impacts at the scale where administrative decisions are made. Building on the progress made under DRR and various global technical and financial support measures, several counties in the region have implemented disaster data systems (e.g. DesInventar) and all countries have established meteorological observatories that provide climate data and weather observations. However, downscaling climate change projections has been challenging, thus progress is slow. As discussed in the previous section, most countries lack climate change risk assessments at the sectoral level, including for loss and damage, owing to slow progress made in upstream processes.

Item	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
1. Laws, regulations and policies										
Recognise CC in National Dev. Plans										
DRM policy										
DRM law										
DRM plan										
Focal agency for DRM										
National DRM committee										
Sub-national DRM institutions										
CCA policy										
CCA plan (National Adaptation Plans)										
Focal agency for CCA										
National CC Committee										
DRR and CCA integration in policies										
Guidelines for DRR and CCA integration										
2. Risk assessments										
Disaster data systems										
Meteorological data systems										
Downscaled CC projections										
Risk maps with CC impacts										
3. Financial mechanisms										
Funding for DRM										
Funding for CCA										

Figure 19.
Current status of institutional mechanisms, policies and planning related to climate change adaptation, disaster risk reduction and their integration. Green: actions are fully implemented, grey: not fully implemented and under planning, white: no actions taken yet or not relevant. Source: National reports submitted to ASCCR process

The level of quantitative assessment of climate change risks for each sector at the national level is not yet at a stage that could reliably contribute to policy processes. However, despite such limited progress with sectoral risk assessments, countries have identified priority adaptation sectors through a combination of qualitative and quantitative exercises. In most cases, adaptation prioritisation involved stakeholder consultations that considered the economic importance of sectors and their vulnerability, based on future climate change projections. The priority sectors for adaptation for various countries are listed in Table 10, in which it can be seen that most countries have done this. For Indonesia, the NDC has combined both adaptation and mitigation into 'enabling conditions' for low-carbon and climate resilience. The priority sectors were then listed under three categories of economic, social and livelihood and ecosystem and landscape resilience, which highlight natural resource-based sectors. Several commonalities are apparent among the priority sectors identified by ASEAN countries (Table 10), such as water resources, agriculture and food, and human health. These commonalities exist despite differences in sectoral contribution to overall national GDP, which shows that the GDP contribution itself need not be the crucial factor when prioritising sectors for adaptation—in other words, that vulnerability to climate change takes precedence. These commonalities illustrate the potential for deeper regional cooperation in adaptation actions for such sectors.

ASEAN countries are at an advanced stage of developing adaptation strategies for the priority sectors. As with the commonalities in priority adaptation sectors, the countries have similarities in the adaptation strategies they have adopted—which are to improve adaptive capacity and resilience, thus reducing vulnerability. These strategies are not necessarily developed based on a thorough cost-benefit analysis but rather rely on consultative processes and evidence drawn from various experiences. While specific adaptation measures are identified for each sector, countries have recognised importance of integrating adaptation into various sectoral strategies, including recognising adaptation co-benefits of mitigation actions, and integrating adaptation into disaster risk reduction planning. Most of the countries rely on policy and legislative measures to ensure proper implementation of adaptation measures.

The monitoring and evaluation of adaptation are necessary to keep track of progress and make course corrections if necessary, as well as enabling awareness of whether adaptation actions have resulted in intended outcomes

and avoided maladaptation. Since quantifying adaptation outcomes can be challenging, progress in developing the monitoring and evaluation framework has been slow, which means precise monitoring and evaluation mechanisms are not yet in place in many ASEAN countries. Countries utilise processes such as NDCs, NCs and NDCs to take stock whenever reports are developed for reporting to various processes under UNFCCC. However, some existing ad hoc mechanisms are being used for monitoring and evaluation purposes, which rely on project reporting by implementation agencies to national and local governments, databases, financial tracking mechanisms, etc. Among these, the status of financial tracking could be described as good due to developments and perfections over the years of implementing developmental programmes that are funded domestically and internationally. This indicates ample scope for developing an M&E framework for adaptation in ASEAN countries. The mechanisms and tools developed for monitoring natural resources using remote sensing-based observations, weather and climate records, climate investment tracking measures, climate budget tagging, and natural disaster databases serve as an entry point to developing M&E systems for adaptation in the ASEAN countries.

Loss and damage

The measures related to loss and damage among ASEAN countries are at a nascent stage, and comprise at least three aspects, which the countries are currently pursuing or intend to pursue. The first and foremost measure is setting up a robust disaster impacts database (e.g. DesInventor), which can provide a detailed picture of past disaster impacts, including economic and non-economic losses. Existing records provide highly detailed financial loss data, including for public infrastructure and houses, but relatively little data on the non-economic loss and damage. Among the non-economic losses, loss of human lives and health appears prominently. The second aspect to loss and damage is to project such accounting for climate change, including non-economic loss and damage. Projecting non-economic loss and damage is challenging especially in the areas of loss of social capital and biodiversity, as well as loss of ecosystem services. This is the area in which most ASEAN countries have yet to make significant progress, and only very limited academic studies are available for specific sectors and geographical locations (Table 6). Thus comprehensive, nationwide, all-encompassing loss and damage projections have yet to be developed in ASEAN countries. Third, the countries also need to assess various adaptation options that can address the projected loss and damages. Loss and damage is an area where regional technical cooperation would assist ASEAN countries.

Gender and vulnerable groups

Of the countries' national adaptation strategies, a few have clearly spelt out issues on gender and vulnerable groups. Issues such as gender equality, empowerment of women and child protection were highlighted regarding their implications for disaster risk reduction and climate change adaptation. Greater recognition of gender and vulnerable groups in adaptation has been enabled through advances in DRR planning and policies that have identified women, children, elderly, disabled and ethnic minorities as the most vulnerable. Most national adaptation strategies mention gendered vulnerability assessments, disaggregated disaster impact databases, gender-sensitive knowledge products and gender-sensitive communication strategies.

While key policies and strategies of gender and climate change do exist in a few countries, development of gender-specific action plans has been slow in terms of support for implementation processes, largely due to budget shortfalls and lack of human resources. For example, the M&E framework of Cambodia's current Climate Change Strategic Plan (CCCSP) developed to monitor climate-related gender-specific vulnerabilities is not sufficiently user-friendly for line ministries and subnational agencies, and in Vietnam, integration of gender into policy at the sector-level is being improved as women's participation in sectoral policy-setting and management practices is limited.

Technology development and transfer

Assessments of technology needs for climate change adaptation are at a nascent stage in most ASEAN countries, and countries rely upon a range of technologies in their adaptation strategy development and implementation. Technologies such as climate-smart agriculture, water balance systems, flood and typhoon hazard and early warning systems, integrated water resource development, disease surveillance systems appear prominently among the adaptation strategies listed by the ASEAN countries. However, the related policy and strategy documentation often fails to identify the extent of technological development, how far it has been adopted, and where the new technologies can be sourced from. At the regional level, technological cooperation is taking shape at a rapid pace with establishment of the Committee on Science and Technology, and Plan of Action on Science, Technology and Innovation (PASTI) 2016–2025, which can play vital roles in technological cooperation in the ASEAN region (ASEAN, 2017). PASTI identified climate change as one of the priority areas of action and aims to develop climate prediction models, climate impact assessments, regional climate data sets and climate data processing through the engagement of academia and the private sector. These measures are expected to enhance technological cooperation on climate change adaptation in the near future.

Finance

Financing of climate change adaptation is one of the current challenges faced by countries in the region, owing to the fragmented nature of adaptation financing and the difficulty in obtaining precise finance-related data available for countries. The available funding can be broadly categorised into national and international financing, in which national financing is mainly sourced from government budgets and private sector contributions through corporate social responsibility (CSR) initiatives. CSR initiatives tend to be development-oriented, and the focus of corporations on adaptation is slowly picking up pace. In terms of international financing, important sources are the Adaptation Fund, Green Climate Fund (GCF), Green Technology Fund, Global Environmental Facility (GEF) Trust Fund, LDC Fund, and multi- and bi-lateral finances. A significant part of official development assistance (ODA) also provides for fund adaptation-related projects or development projects that have adaptation co-benefits.

Over the entire period of fourth, fifth and sixth National Communications, ASEAN countries have received a total of USD 3.95 billion in terms of climate financing through bi-lateral financing (Figure 20) (UNFCCC, 2020). Of this, 74%, received from bilateral sources, was allocated to climate change mitigation, while only 15% went to adaptation. The proportion allocated to adaptation was high for Cambodia, Malaysia, Myanmar and the Philippines. This imbalance in adaptation/mitigation funding is a limitation the countries will need to manage going forward. Part of the problem could relate to the supply-driven nature of funding, the donors of which tend to prefer climate change mitigation as developed countries participate in GHG emission trading schemes to offset their domestic emissions. In terms of sectoral allocation of bilateral finances for adaptation, a significant proportion went to vulnerability assessments, followed by capacity building (Figure 21). Although funding for mitigation in agriculture and forestry is much higher than for adaptation, these allocations will likely have significant adaptation co-benefits.

While levels of adaptation financing are on the rise, the speed and scale of funding has yet to catch up with the needs of the countries. The challenge for national governments has been to balance the funding for development with that for adaptation needs. Strategies such as mainstreaming adaptation into development and identifying win-win solutions can help tap into the synergies and reduce overall adaptation costs. Several good management practices such as fiscal discipline, climate budget tagging, and efficient and strategic public spending can improve the efficiency and effectiveness of available finances and hence help procure additional finances for adaptation. However, even after

full implementation of these measures, countries would still need additional finances to fund adaptation programmes and projects (UNEP, 2021). One of the untapped potentials within the region is private sector finance, which could be tapped through various policy and incentive measures that have yet to be fully developed in the region. Further, climate-proofing of building by-laws, food labelling guidelines, and environmental regulations can shift some of the burdens to individuals and reduce the load on national budgets. Countries are also facing the challenge of tapping international finances that are fragmented in nature and involve satisfying multiple conditions, as well as heavy bureaucracy. There is therefore a need to improve capacities of national governments and other stakeholders to develop sound funding proposals that can reduce the time required, increase the flow of finances, and reflect the actual needs of the countries.

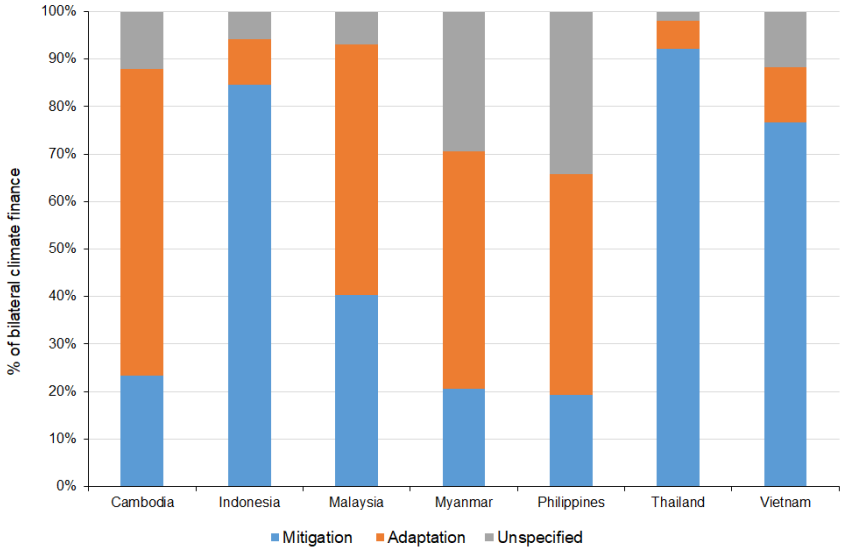

Figure 20.
Allocation of bilateral climate finance between mitigation and adaptation in ASEAN countries (UNFCCC, 2020)

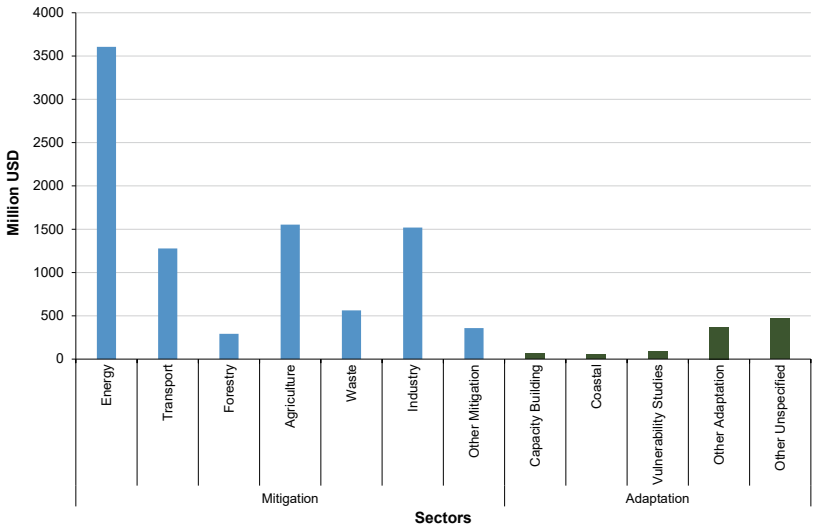

Figure 21.
Sectoral allocation of bilateral finances for mitigation and adaptation

3.4.2. Current Status: Regional Actions

Key message

The progress made in CCA and DRR at the national level in many AMS is very closely linked and promoted by regional cooperation efforts. The ASEAN Socio-Cultural Community is one of the important enabling factors for enhanced regional cooperation on climate change in the region.

The progress achieved by AMS cannot be seen as a separate and unconnected phenomenon, as it could not have been achieved without the vibrant support galvanised at the regional level under the ASEAN. Recognising the vulnerabilities, capacities and needs of AMS, ASEAN has actively promoted various actions to strengthen capacities within AMS in the implementation of adaptation actions at the national and sub-national levels. Some of these regional actions are listed in Table 11. Notable among ASEAN cooperation on climate change is the culmination of all regional climate change ambitions in the form of the ASEAN Socio-Cultural Community (ASCC) Blueprint 2025. Prior to preparing the Blueprint, AMS have expressed the collective will to fight climate change through various declarations/ statements by ASEAN leaders. These declarations and statements provide ample insights into the collective understanding and aspirations of Member States to achieve regional resilience through collective action. The ASCC Blueprint encourages a common understanding on climate change in ASEAN, and development of the ASEAN Climate Change Initiative (ACCI), which provides a consultative platform for strengthening regional cooperation on climate change, encourages the international community to engage with AMS, promotes capacity building and public awareness, engages the private sector and other stakeholders in promoting climate change actions, and encourages synergies between climate change actions and sustainable development. Under this broad umbrella of cooperation, several projects and programmes have been implemented, including capacity building workshops, conferences, information exchange workshops, forums, and implementation of specific projects to address specific issues (e.g., project on 'Rehabilitation and Sustainable Use of Peatland Forests in Southeast Asia'). Cooperation among AMS is heavily supported by cooperation with countries outside the ASEAN. For example, ASEAN cooperates heavily on the environment with countries such as Japan, United States, United Kingdom, Canada, European Union, Australia. Such cooperation spans multiple fields, including the economy and environment, where climate change mitigation, adaptation and resilience aspects are embedded into specific actions. In addition to ASEAN cooperation with other countries, several AMS have bilateral cooperation arrangements with countries outside ASEAN, thus providing an excellent opportunity to enhance adaptation actions. Through these inward and outward forms of cooperation, ASEAN and AMS have been able to mobilise the necessary resources and expertise to bolster climate change resilience in the region. These cooperation efforts are ever-evolving and are expected to continue gaining momentum in the future, as the ASEAN region has become the world's second largest economic block outside the EU.

Table 11. ASEAN regional cooperation on climate change adaptation

Layer of regional cooperation	Vision, plan and others (network, forum, etc.) related to adaptation
Among particular AMS	• Mekong Adaptation Strategy and Action Plan
Among ASEAN countries	• ASEAN Socio-Cultural Community (ASCC) Blueprint 2025 • ASEAN Community Vision 2025 • ASEAN Comprehensive Recovery Framework (ACRF) • Series of ASEAN Joint Statements on Climate Change since 2007 for each Conference of Parties • AWGCC Action Plan (Action Plan on Joint Response to Climate Change) • AADMR Work Programme (related to climate resilience) • ASEAN Tourism Strategic Plan 2016–2025 • Vision and Strategic Plan For ASEAN Cooperation In Food, Agriculture, and Forestry (2016–2025) • ASEAN Guidelines on Promotion of Climate Smart Agriculture Practices • ASEAN Climate Resilience Network (ASEAN-CRN) • ASEAN Climate Outlook Forum • ASEAN Strategic Plan of Action on Water Resources Management • ASEAN Multi-Sectoral Framework on Climate Change (AFCC) and Food Security (AFCC-FS)
ASEAN with outside countries (not exhaustive)	• ASEAN+3 Environment Ministers Meeting • ASEAN-Dialogue Partners (DP) Plans of Action (PoAs) • ASEAN-Japan Dialogue on Environmental Cooperation and ASEAN-Japan Climate Action Agenda • ASEAN-EU High-level Dialogue on Environment and Climate Change • ASEAN-UK Collaboration towards UNFCCC COP26 • ASEAN-UN Action Plan on Environment and Climate Change • ASEAN-DP Projects / Initiatives

3.4.3. Outlook

Key message

The AMS also have a rich set of medium to long-term development plans that acknowledge the region's climate change vulnerability and identify necessary adaptation priorities. These form important signposts for the region to build upon work already done in critical sectors for adaptation.

NDC pledge

AMS through their NDCs have already made substantial pledges to enhance adaptation actions in the ASEAN region (Please refer to Appendix Table 1. ASEAN Climate Adaptation Pledges in NDCs). Countries such as Brunei Darussalam, Myanmar, Singapore and Thailand have made it clear that they intend to safeguard biodiversity resources and invest in conserving them. Forest conservation and enhancing greenery were identified as major ways to safeguard biodiversity resources. Flooding is a major hazard for the region and to this extent clear commitments could be seen in the NDCs of some AMS. For example, Brunei Darussalam, Cambodia, Malaysia and Singapore have prioritised flood protection measures and integrated management of water resources. Agriculture still plays an important role in the region's resilience and noting this, countries have identified developing climate-proof/climate smart agriculture systems especially for adapting to water variability and related uncertainties. Sustainable agriculture and good agricultural practices are some of the other means identified to strengthen the agriculture sector. The region is rapidly urbanising and ensuring systematic urbanisation in the future is of paramount importance. AMS such as Cambodia, Indonesia, Lao PDR and Vietnam have committed to address threats such as sea level rise by strengthening urban infrastructure. Building local capacity, bringing together policy priorities for both adaptation and disaster risk reduction, improving the resilience of public health systems, and understanding climate change vulnerabilities of key sectors can be prominently found in most AMS NDC pledges.

Medium- (up to 2030) to long-term (2030–2050) policy

As Table 12 shows, most PaMs are sector-specific and largely development focused. Further, most PaMs recognise climate change as an essential issue, closely linked with mitigation, and adequately cover adaptation and resilience concerns. Green growth strategies form an essential PaM for some countries (e.g. Vietnam) that combine both mitigation and adaptation. For Malaysia, most PaMs are focused on water, agriculture, public health, and forestry and biodiversity; in the Philippines they are clearly articulated for disaster risk reduction, environment and ecosystems, agriculture, watersheds, forestry, and coastal resources; and in Indonesia they clearly recognise improving environmental quality, disaster and climate resilience, and low-carbon development.

Table 12. Medium- to long-term adaptation vision, strategies and/or plans aside from NDCs outlined by ASEAN Member States. For NDCs, please see Appendix Table 1.

Country	Indicative adaptation strategies/vision	Target year	Adaptation areas	Reference
Brunei	Brunei Darussalam National Climate Change Policy (BNCCP)	2035	Generating awareness on adaptation; promotion of integrated adaptation solutions with mitigation co-benefits; integrated impact assessment tools; national climate risk framework, monitoring and evaluation; research on sea level rise; multi-stakeholder engagement; and consideration of nature-based solutions, coastal protection structures, and community based disaster-prevention as options to increase resilience. Research and mapping of sea level rise, flood risk mitigation, provide nature-based solutions to prevent soil erosion and flooding, community and school-based disaster risk reduction. Enhance climate resilience and increase capacities in adapting to climate change by protecting livelihoods, properties and natural resources	Brunei Climate Change Secretariat (2020)
Cambodia	National Strategic Plan on Green Growth 2013–30	2030	Green jobs; sustainable agriculture (green agriculture); resilient infrastructure; resilient financial systems; public-private partnerships; capacity building for resilience and environmentally sustainable solutions; strengthening the capacity of financial institutions; payment of ecosystem services; enhancing food security	National Council on Green Growth (2013)
Indonesia	Low Carbon Development Initiative (LCDI)	2045	Climate resilient agriculture; resilience to sea level rise; resilient lifestyles for farmers; economic resilience against climatic shocks; resilient infrastructure; promotion of mangroves; flood risk mitigation; developing tolerant crop varieties. Climate risk adaptation in key sectors including agriculture, fisheries and marine resources, forests, water resources, infrastructure	BAPPENAS (2019)
	Roadmap NDC Adaptation	2030	Achievement of climate resilience through increasing economic resilience, social security and livelihoods as well as ecosystem and landscape resilience	National Report
	Long Term Strategy (LTS LCCR)	2050	The LTS document covers the main aspect of climate resilience	Government of Indonesia (2021)
Lao PDR	National Green Growth Strategy (NGGS)	2030	Resilient natural resources; payment of ecosystem services; resilient agriculture; resilient rural economy; development of appropriate crop management techniques; climate resilient forestry; water resource information systems; resilient water infrastructure; strengthening of public health infrastructure	Secretariat for Formulation of National Green Growth Strategy (2018)
	Agriculture and Forestry Research Strategy (AFRS) 2025 and the 'Vision up to 2030'	2030	Programme on agriculture resilient to climate change, including developing climate-smart agricultural practices through testing and scaling up technologies, and improved practices needed to build farmers' capacity to adapt to climate change, policies and institutions for climate-resilience through modeling, and scenario assessment and policy analysis for agriculture and food security under climate change	Ministry of Agriculture and Forestry (2015)
Malaysia	National Renewable Energy Policy and Action Plan 2011	2030	Modern and resilient infrastructure; resilience-based and green jobs	National Report
	Shared Prosperity Vision 2030	2030	A strategy (one of 15 strategies) that targets green economy, including food sovereignty and security, sustainable coastal development, climate adapted technology and organic farming	National Report
	Roadmap for the Water Sector Transformation 2040	2040	A 20-month study over the period 2 May 2020 to 31 December 2021, with a component on climate change impact and adaptation	UTM (2020)

Country	Indicative adaptation strategies/vision	Target year	Adaptation areas	Reference
Myanmar	Myanmar Climate Change Master Plan (2018–2030)	2030	Climate-smart agriculture; livestock and fisheries; Natural resources management; Resilient cities and towns; climate risk management and health; education; science and technology	Ministry of Natural Resources and Environmental Conservation (2019)
	Myanmar Sustainable Development Plan 2018–2030	2030	Disaster risk reduction; adoption of climate-resilient and environmentally sound adaptation technologies and climate-smart management practices in all sectors; increase of adaptive capacity of vulnerable households, communities and sectors	Government of the Republic of the Union of Myanmar (2018)
	Myanmar Climate Change Policy (2019)	2030	A 2030 goal is mentioned in which Myanmar has achieved climate-resilience to support inclusive and sustainable development	National Report
	Myanmar Climate Change Strategy (2018-2030)	2030	A roadmap for Myanmar is mentioned, which aims to materialise the Myanmar Climate Change Policy vision to be a climate-resilient society	Ministry of Natural Resources and Environmental Conservation (2019)
Philippines	Local climate change adaptation plan (LCCAP) Climate Disaster Risk Assessment (CDRA) & National Climate Risk Management Framework (NCRMF)	2030/ 2050	LCCAP, CDRA and NCRMF are being partially implemented.	National Report
Singapore	Singapore's Long-Term Low-Emissions Development Strategy	2050	Protecting coasts and water supplies; alleviating floods; enhancing ecological resilience; resilient public health; enhancing food security; safe buildings and infrastructure	National Climate Change Secretariat (2020)
	Singapore Green Plan 2030	2030	Building up climate resilience by protecting its coastlines, strengthening food security and keeping Singapore cool	Ministry of Sustainability and the Environment (2021)
Thailand	Climate Change Master Plan 2015–2050	2050	Enhancing adaptive capacity; developing adaptation technologies; nature conservation; reducing inequality; developing climate risk maps; ecologically friendly restoration of coastal areas; climate resilience index; developing early warning systems for pests, etc.; enhancing forest coverage; establishing national fund for climate change recovery; integrated regional climate change action plans. Adaptation is focused in the following six sectors: 1) Water resources, flood and drought management, 2) Agriculture and food security, 3) Tourism, 4) Public health, 5) Natural resources, 6) Human settlement and security	ONEP (2015)
	Thailand 4.0	-	Transforming food, agriculture by raising competitiveness of farmers	Royal Thai Embassy (2021)
	National Strategy 2018–2037	2037	Promoting sustainable climate-friendly based growth of society by adapting to prevent and reduce losses and damages caused by natural disasters and impacts of climate change; developing preparedness and response systems for emerging and re-emerging infectious diseases caused by climate change	National Strategy Secretariat Office (2017)
	National Adaptation Plan (NAP) 2018–2037	2037	The plan includes six priority sectors, namely water resource management, agriculture and food security, tourism, public health, natural resource management, and human settlements and security	Thailand updated NDC

Country	Indicative adaptation strategies/vision	Target year	Adaptation areas	Reference
Vietnam	National Climate Change Strategy	2050	Promotion of synergetic adaptation and mitigation actions; ensuring food security; enhancing climate change awareness; strengthening financial mechanisms for resilience and international cooperation on climate change; strengthen hydro meteorological observation systems, regulations in disaster-prone areas; develop resilient crops and livestock; insurance; water resource development; green and modern urban residential areas; conservation of biodiversity; developing information data systems	Government of Vietnam (2011)
	National Green Growth Strategy	2050		Government of Vietnam (2012)
	Strategy for Vietnam's Low-emission Development and Green Growth by 2050	2050		
	Resolution No.55-NQ/TW	2045	Early warning - By 2050, to have a hydro-meteorological observation and forecasting and climate extreme warning system of advanced international level Food and water resource security assurance - To improve integrated management procedures and strengthen facilities for scientific exploitation, and protection and use of water resources in the context of climate change by 2050 Enable suitable proactive response to sea level rise in vulnerable areas - To conserve biodiversity, attach importance to protecting and developing ecosystems, and varieties and species resilient to climate change Building of communities to effectively respond to climate change	National Report
	National Plan on Climate Change Adaptation for 2021–2030, with a vision towards 2050	2030/ 2050	Enhancing resilience of economic sectors, the community and the ecosystem, improving adaptive capacity of people and infrastructure, and ensuring food, energy and water security, gender equality, social welfare, public health	VietnamPlus (2020)

Source: National reports submitted to ASCCR process

Strengthening the ambition of medium-term plan and long-term vision/ strategies:

The information presented above provides a detailed perspective on the current state of climate change adaptation in the ASEAN region. While the overall picture of adaptation is fragmented, i.e. covering numerous official communications, documentations, policies and actions, it should be noted that the region has made extensive efforts in bringing the agenda of climate change to the forefront of the development discourse. However, this progress would not have been achieved without the galvanising and synergising efforts taken at the regional level, together with the willingness of AMS to cooperate in the common interests among the countries.

The progress made to date in climate change adaptation provides a strong foundation for adaptation action of even higher ambition. Several positive factors contribute to a potentially higher level of ambition regarding adaptation, including (i) the significant progress made to date in adaptation and disaster risk reduction, which can provide a firm grounding for future efforts; (ii) increased level of interest within the region to cooperate on adaptation, supported by acceptance of the fact that adaptation is equally a local issue and regional and global issue, given the level of regional economic and socio-cultural integration, including that of trade; (iii) the ever-increasing willingness of countries outside ASEAN to engage with ASEAN countries, as the region has emerged as the single most important block of vibrant economic region outside the EU; and (iv) common understanding and agreement on the fact that ASEAN countries face disproportionate impacts of climate change in terms of GHG emission contributions and underlying vulnerabilities of the countries to climate change. Specifically, progress needs to be made in the fields of science and technology related to climate change projections, impact assessments, and adaptation solution development and implementation. For example, an innovative online platform on long-term climate change and impacts such as the Asia-Pacific Climate Change Adaptation Information Platform (AP-PLAT) (see BOX 3) will surely raise awareness of stakeholders and promote adaptation solution development and implementation.

BOX 3. Asia-Pacific Climate Change Adaptation Information Platform (AP-PLAT), an innovative online platform on the long-term climate change and impacts

Currently, access to climate information—and the technical capacity to use it—is not comprehensive enough to inform planning for integrated adaptation to climate change across sectors over the long term. Hence, AP-PLAT (MOEJ and NIES, 2021) was established by the Ministry of the Environment, Japan in 2019 to share climate risk information for free, online, with research institutes and universities in both developing and developed countries. The platform offers great potential to transform adaptation planning at the regional, national and subnational levels.

3.5. Climate change mitigation

3.5.1. Current status: National Actions

Key message

ASEAN Member States (AMS) have proactively taken measures to strengthen readiness for the enhanced transparency framework (ETF) and there are huge opportunities to share lessons and experiences among AMS. Especially, strengthening capacity to project future GHG emissions and emission reductions is key to connecting the transparency-related capacity building to formulating medium- to long-term mitigation strategies. This is the stepping stone to promote transformation in multiple sectors and areas (e.g. policy, technology, finance, carbon pricing, REDD+ and air pollution prevention) to achieve increased ambition toward net-zero emissions.

3.5.1.1. Key sectors for mitigation intervention

Table 13 illustrates priority mitigation areas for ASEAN countries, including energy, transport, industry, and forestry and land use. These sectors have a large emission share in ASEAN (see Figures 9 and 10).

Table 13. Sectors of mitigation priority in AMS

Country	Energy	Transport	Industry	Agriculture	Forest(ry) & Land Use (FOLU)	Waste
Brunei Darussalam	■	■	■	■	■	■
Cambodia	■	■	■		■	
Indonesia	■	■	■	■	■	■
Lao PDR	■	■			■	
Malaysia	■	■	■	■	■	■
Myanmar	■			■	■	
Philippines	■	■	■	■		■
Singapore	■	■	■			
Thailand	■	■	■			■
Vietnam	■	■	■	■	■	■
Total	10	9	8	6	7	6

Note: The energy sector includes EE and RE areas, while the industry sector focuses on non-energy use (or IPPU) such as cement and fugitive emissions from oil and gas. Source: National reports submitted to ASCCR development process.

Regarding more detailed priority areas, the energy sector actions are divided into energy efficiency improvement and renewable energy diffusion. Regarding energy efficiency for the power sector, advanced coal and gas power plants and power management are the priorities. For renewable energy, diversifying the renewable energy portfolio (solar, wind, large scale hydroelectricity, geothermal, etc.) and accelerating diffusion are seen as of crucial importance. Most AMS prioritise rural electrification, while trans-border energy interconnection between selected AMS is vital in terms of energy security and future renewable power penetration (e.g. through the ASEAN Power Grid). The transport sector in most AMS targets public transportation systems in urban areas and alternative fuels such as biofuel, and some AMS target innovative modes of road transportation, such as diffusion of EVs. The forestry and land use (FOLU) sector focuses on forest cover expansion, including preventing deforestation and degradation of forest and peatland through sustainable forest management with multiple practices. Importantly, REDD+ strategies are considered to be one of the crucial options for reducing emissions from the FOLU sector to achieve NDC targets. The waste sector prioritises diversion of waste from landfills and recycling. Promoting the 3Rs (reduce, reuse, and recycling) serves the circular economy through upgrading material efficiency, thereby reducing material and energy demand. Carbon pricing is also raised as a key cross-sectoral policy area to promote mitigation ambition in several AMS, as described below.

3.5.1.2. Preparedness for the Enhanced Transparency Framework

As Table 1 shows, the level of the reporting requirement in the biennial transparency report (BTR) for each AMS will be higher than that of the biennial update report (BUR) and national communication (NC) owing to the need for robust reporting of mitigation actions, which in turn is needed in order to effectively implement the PaMs and achieve the NDC targets. Indicative items include:

(i) National GHGI MRV (institutional arrangements, methodologies, and uncertainties)

(ii) Design and implementation of mitigation actions and PaMs for achieving NDC targets

(iii) Projection of BAU emissions and those with measures (used for setting and validating NDC targets)

(iv) Estimation of GHG emission reductions (ex-ante and ex-post) to the extent possible

(v) Tracking progress of achieving/implementing NDC targets

One of the salient features of the BTR is the addition of item (iii), which is not required in either the BUR or the NC. This reflects ETF's forward-looking nature. The following shows the current status of preparedness of AMS for future BTR submission, which illustrates both the need for capacity building going forwards, as well as good practices achieved to date.

(i) National monitoring, reporting and verification of the greenhouse gas inventory (GHGI MRV)

The coverage of GHGI has been extended in terms of gases and sectors. For gases, most AMS still do not account for the F-gases (HFCs, PFCs, SF6 and NF3), while all account for CO_2, CH_4 and N_2O. Considering the ongoing industrialisation and future increase of F-gases, it will be necessary to count F-gases as well as CO_2, CH_4 and N_2O. Sector coverage in national GHGI varies by country; countries with advanced procedures count GHG emissions in all sectors, i.e. energy, industry (IPPU), agriculture, FOLU and waste, while some AMS do not segregate AFOLU into agriculture and FOLU. In some cases, emissions of FOLU are estimated, but not removals. In terms of the methodology of GHGI, all AMS follow Tier 1 of the IPCC 2006 Guidelines for National GHG Inventories[20], which

20. Eggleston et al. (2006)

stipulates use of country-specific activity data and default emission/removal factors as well as other parameters provided by IPCC. Some AMS follow Tier 2 and Tier 3 methodology for subsectors where country-specific emission factors are available[21]. In order to follow higher-tier methodologies and/or improve the accuracy of national GHGI systems, it is necessary to have both technical know-how (e.g. remote sensing technology and GIS data application for the AFOLU sector) and integrated MRV systems allowing for smooth data collection and sharing among sectors, provinces, and firms[22]. To manage uncertainty, effective use is made of the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2001) with a view to continually improving the transparency, consistency, comparability, completeness and accuracy of inventories across compilation cycles. Aggregation of GHG emissions and removals is in most AMS conducted based on the global warming potentials (GWPs) obtained from the IPCC Second Assessment Report (SAR); however, novel use of GWP values from the IPCC fifth Assessment Report (AR5) was also found.

In terms of GHGI MRV systems, there are many good examples that can be shared among AMS, including utilisation of the national integrated database and information exchange system, which can provide national, local, and sectoral GHGI data over time[23], sectoral- (e.g. cement sector's MRV for NAMA in Vietnam (MONRE, 2010)) and project-based MRV systems (e.g. clean development mechanism (CDM) projects). Also importantly, some AMS have been preparing and upgrading MRV systems in view of implementation of mitigation measures to achieve NDC targets, and thus novel MRV systems now encompass the requisite information from PaMs and finance as well as GHGI[24]. Such systems improve the efficiency of data management and enable more effective decision-making. In this regard, international support is crucial for upgrading national MRV systems, in order to track progress in NDC achievement. Lastly, challenges also exist in the maintenance and operation of these systems, and as such acquiring financial support is not the only or ultimate solution (Truong, 2020).

(ii) Design and implementation of mitigation actions and PaMs for achieving NDC targets

Before presenting the current status of mitigation efforts in AMS below, an issue concerning transparency is first described. In order to effectively report, assess the progress of, and newly design PaMs, most AMS have introduced a registry system for PaMs for both mitigation and adaptation[25]. This tool greatly assists in identifying the contributions (from ministries to local governments, businesses, and civil society organisations) to climate change mitigation and adaptation efforts, as well as in measuring levels of achievement in mitigation and adaptation—in accordance with the PA stipulation on clarity, transparency and understanding (CTU). This system allows for effective implementation by both Party stakeholders (related ministries) and non-Party stakeholders (local governments, businesses and communities). In some AMS, prioritisation of PaMs is conducted based on the list of NAMAs for all sectors with marginal abatement cost information and the Multi-Criteria Analysis. However, involvement and tracking of

21. In Singapore, Tier 2 methodology was used for CH_4 and N_2O emissions from the combustion of petrol and diesel in land transport in conjunction with vehicle statistics, and CO_2 from waste incineration and HFCs, PFCs and SF6 from integrated circuit and semiconductor production (IPPU). Tier 3 methodology was used for land-use categories such as forest land and settlements for estimating emissions and removals from LULUCF.

22. For Malaysia, in the energy sector, development of country-specific emission factors for fugitive emissions and transport sub-sectors is necessary. In the AFOLU sector, integration of facility level data into GHGI, soil organic carbon mapping is necessary, while in the waste sector improvement in the collection of activity data and capacity building for experts for GHGI is required.

23. For example, the Philippines' National Integrated Climate Change Database Information and Exchange System (NICCDIES) was established in 2018 as an outcome of the United Nations Development Programme's (UNDP) Low Emission Capacity Building (LECB) project. This system is not only aimed at monitoring GHGI but also tracking climate change mitigation measures, national climate change action plans and climate finance, hence such systems can be utilised for MRV to achieve NDC targets.

24. Cambodia's updated NDC submitted in December 2020 highlights this aspect. In Vietnam, an MRV system is being developed under the Supporting Programme in response to climate change (SPRCC), for policy framework development (MONRE, 2017).

25. Indonesia introduces the National Registry System which records mitigation activities.

contributions of local governments and communities in designing PaMs for achieving NDCs are challenges most AMS currently face. Moreover, the enforceability of PaMs is reportedly weak in some AMS, despite the presence of many regulations, legal documents and governmental orders. To avoid overlapping efforts, double counting, and lack of enforceability, it is vital to establish effective and operational MRV systems that are relevant to NDCs by utilising novel data systems on policy information.

(iii) Projections of BAU emission and those with measures

Currently, six AMS (Brunei Darussalam, Cambodia, Indonesia, the Philippines, Thailand and Vietnam) have NDC emission reduction targets relative to BAU emissions, while other AMS have absolute emission reduction targets (Singapore), GHG intensity reduction targets (Malaysia) and policy and action targets (Lao PDR and Myanmar). Brunei Darussalam set a BAU-related target for the first time in its first NDC submitted in December 2020. The basis of the projection was developed from a methodology supported by the Massachusetts Institute of Technology (MIT)[26]. This is a good example of raising capacity as regards ability to project BAU emissions and emissions with measures. Given the ETF requirement of reporting projections of BAU emissions, capacity building in this regard is seen as highly beneficial, especially for countries that pledge policies and action targets without showing GHG emission reduction targets. Building capacity for projecting BAU emission scenarios therefore benefits all AMS in designing and/or verifying their NDC targets, regardless of the type of pledge. Noticeably, Malaysia, which pledges a GHG intensity reduction target in its NDC, also conducted BAU emission estimation for different scenarios in its latest BUR (Ministry of Environment and Water, 2020).

There are several takeaways from this. First, ensuring coverage of gases and sectors in GHGI is a prerequisite for robust estimation of BAU GHG emissions since current NDC targets by AMS do not necessarily cover all GHGs or all sectoral GHG projections. Some AMS report that the presence of a consistent set of methodologies and data sources based on a robust MRV system of GHGI enhanced the quality of projections as well as accuracy of data. Second, selection of an appropriate, robust methodology provides the foundations for clearly describing the methodology and assumptions, and the rationale for utilising the methodology. Capacity building that enables the introduction of robust methodologies therefore enables clearer descriptions on the assumptions, and raises transparency in this regard. Third, multiple mitigation scenarios by sector in a bottom-up fashion are informative as they show GHG emission pathways as well as the assumptions on sector-wise technologies and solutions. This practice is seen for example in Cambodia's latest NDC (The General Secretariat of the National Council for Sustainable Development, 2020), Malaysia's latest BUR (Ministry of Environment and Water, 2020), and Myanmar's ongoing process to update its NDC. Fourth, ideally, projection results of an AMS need to be compared to those of other models to validate the effort levels of the targets, therefore harmonising of methodologies and assumptions can contribute to this purpose.

However, there is still room to improve sectoral bottom-up estimation of GHG emissions, which is also relevant for estimating GHG emission reductions through the sectoral policies. The issue of uncertainty of BAU emission projections is another challenge, especially for the FOLU sector, due to the uncertainty of data and calculation technologies described above. Second, the information base of the data and PaMs used for emission projections needs to be managed and disclosed properly, because in some cases validation of BAU emissions and GHG emission reductions is difficult to accomplish due to the lack of assumptions disclosure (e.g. medium-term economic development scenario, population growth rate, GDP growth rate by sector, GDP structure by sector, energy demand, forest and forest land planning, and the quantity of livestock and arable land). Third, as regards the long-term BAU

26. Valuable knowledge gained from a visiting scholar programme enabled Brunei Climate Change Secretariat (BCCS) to apply these methodologies (Paltsev, Mehling, Winchester, Morris, & Ledvina, 2018) in the context of Brunei Darussalam.

emission projections, the fact that BAU scenarios cannot always adequately capture dramatic societal and behavioural changes could reduce the plausibility of BAU-related emission reduction targets used when preparing long-term strategies (LTS), which is a limitation. This suggests the need for distinguishing methodology to project near-term BAU emissions from that used to project BAU emissions over several decades[27]. Capacity building of appropriate modelling methods would therefore enhance the projection accuracy and verification of policy attribution in emission reductions, leading to more effective policy implementation in all AMS.

(iv) Estimation of GHG emission reductions (Ex-ante and ex-post)

On the one hand, the capacity for estimating ex-ante GHG emission reductions is closely linked with the capacity for projecting BAU emissions with measures. Thus, capacity building for BAU emission projections based on the measures described above would contribute to capacity building for estimation of GHG emission reductions. One novel example in this respect is sectoral and action-based estimation of GHG emission reductions, which is one of the most transparent methods. Several AMS have already estimated action-based emission reductions, while robust estimation in the FOLU sector still presents a challenge for most AMS. This aspect needs to be highlighted to understand ASEAN's NDC mitigation targets. As action-based estimation of emission reductions provides a precise means for showing those with and without financial support, this capacity building is very important for the AMS with high need of financial support. Some AMS have conducted cost estimations based on a least-cost approach and a cost benefit analysis to prioritise mitigation actions. This is a vital step to minimise mitigation costs, but greater efforts are needed to collect the latest data for cost information on an emerging set of low- and zero-carbon technologies, in consideration of the dynamic nature of international markets. In particular, the most recent cost information on power sources such as fossil fuels and renewables (e.g. solar, wind, hydro, and geothermal) provided by international organisations (e.g. IRENA) and private companies for both historical and future values needs to be taken into account in conducting estimation of mitigation costs.

On the other hand, several aspects of ex-post evaluation of GHG emission reductions are also worth considering. First, estimation of ex-post emission reductions requires all AMS to prepare counterfactual BAU emission estimation in the past, since GHG emissions of all AMS have been growing in absolute terms. Second, related to this, selection of the base year needs to be periodically updated and clearly stated. Lastly, as is revealed in Indonesia's ex-post evaluation, estimation of GHG emission reductions in the FOLU sector is subject to the natural variability caused by El Nino Southern Oscillation (ENSO). This lesson needs to be reflected in the ex-ante estimation of future GHG emission reductions, which means that assumption of ENSO for the NDC target year will significantly impact on the NDC GHG emissions for Indonesia and the ASEAN region.

(v) Tracking progress of achieving/implementing NDC targets

In principle, the above items (i.e. GHGI MRV systems, projections of BAU emissions with measures, estimation of GHG emission reductions) provide the premise for tracking progress and outcomes. In particular, tracking progress in achieving NDC emission reduction targets is closely linked with the methodology for the ex-post evaluation of emission reductions. One of the challenges of ex-post evaluation is that all emissions from AMS are on the rise, hence estimation of GHG emission reductions relative to the base year is challenging. Thus, robust methodology for BAU projection as well as its base year selection is the key. One possible method is examination of emission levels of respective years compared to the straight emission pathway toward the emission level in the target year. Sectoral

27. In Singapore, the Government engaged research institutes to utilise a recursive-dynamic numerical model, MARKAL, to simulate possible mitigation pathways, taking into account the long-term national landscape including technological development. This contributed to the development of LTS.

and/or action-based decomposition of the target emission levels would increase the accuracy of this approach. At present, this kind of methodology is not explicitly discussed in AMS. Another method being applied is action-based progress tracking of renewable energy installation and forest cover rates etc. If these actions are more closely linked with NDC targets, this type of tracking can be more effective. However, due attention needs to be paid to the fact that the tracking indicators of this approach need to be comprehensive, through capturing, for example, not only renewable power capacity but also fossil fuel power capacity. Sets of tracking indicators that are not sufficiently comprehensive may generate loopholes, potentially reducing the effectiveness of tracking.

Institutional arrangements for NDC planning and implementation

Table 14 shows the status of institutional arrangements for climate change interventions in AMS, with a focus on the (i) lead council; (ii) responsible ministries for adaptation and mitigation areas; and (iii) stakeholder engagement of citizen groups. First, all AMS have designated a lead council or committee on national climate change policy planning and implementation, involving relevant ministries/departments and subsidiary bodies (e.g. technical working groups for adaptation and mitigation areas). The lead council is chaired by the Prime Minister or Deputy Prime Minister in some AMS, reflecting the high-level nature of national systems for climate change interventions. Second, ministries responsible for adaptation and mitigation are designated in many AMS, while for adaptation, responsible ministries are not necessarily designated. Third, the "whole-nation approach" defined in Table 14 as involving civil society groups such as NGOs, CSOs and youth groups in designing and planning national climate change policy is an innovative decision-making process for combatting long-term climate change issues[28]. Although the definition of "whole-nation approach" is not fixed, involvement of youth groups in national policy planning processes in Brunei Darussalam and Cambodia is a novel example. At present, so-called "citizen assemblies" (OECD, 2020), as seen in France and UK, for example, are not yet established in any AMS, thus there is room to involve a wider group of stakeholders, including citizen groups, in the policymaking processes in AMS or ASEAN.

28. Note that most AMS have involved sectoral agencies, local government and the private sector as part of multi-stakeholder engagement and public participation.

Table 14. Institutional arrangements for adaptation and mitigation in ASEAN countries

Member States	Lead council	Chair (lead agency)	Responsible ministry for adaptation	Responsible ministry for mitigation	"Whole-nation" approach
Brunei Darussalam	Brunei Darussalam National Council on Climate Change (BNCCC)	Minister of Energy, Minister of Development	Deputy Permanent Secretary, Ministry of Home Affairs	Permanent Secretary, Ministry of Energy,	Yes (NGOs, youth group)
Cambodia	National Council for Sustainable Development (NCSD)	Minister of Environment	14 key ministries (each developed a sectoral Climate Change Action Plan (CCAP) 2014–18)	Minister of Environment	Yes (NGOs, youth group)
Indonesia	Directorate General of Climate Change (DGCC)	Ministry of Environment and Forestry	Ministry of Environment and Forestry	Ministry of Environment and Forestry	Yes
Lao PDR	National Steering Committee on Climate Change (NSCCC)	Deputy Prime Minister with Vice Chair (Minister for Agriculture and Forestry, Head of the Water Resources & Environment Administration), and Minister for Planning and Investment	The Ministry of Natural Resources and Environment (MoNRE)	MoNRE	Yes (NGOs)
Malaysia	National Steering Committee on Climate Change (NSCCC), Malaysia Climate Action Council (MyCAC) is being established	Ministry of Energy and Environment (KASA) with members from various ministries and key agencies. MyCAC will be chaired by the Hon. Prime Minister of Malaysia	KASA with various relevant ministries	KASA	-
Myanmar	National Environmental Conservation and Climate Change Central Committee (NECCCCC)	Vice President, Ministry of Natural Resources and Environment Conservation (MONREC)	MONREC	MONREC	Yes (NGOs, CSOs)
Philippines	Climate Change Commission (CCC)	Departments on Energy, Environment and Natural Resources, and Agriculture	No indication of responsible department, but various departments related to adaptation planning and implementation	Departments of Energy, Environment and Natural Resources, and Agriculture	Yes (Dialogues among different stake holders for designing its NDC)
Singapore	Inter-Ministerial Committee on Climate Change (IMCCC)	Senior Minister and Coordinating Minister for National Security	Ministry of National Development, Ministry of Sustainability and the Environment	The Prime Minister's Office (PMO), Ministry of Trade and Industry and Ministry of Sustainability and the Environment	Yes
Thailand	National Committee on Climate Change Policy (NCCC)	Prime Minister and Vice-Chairpersons: Minister of National Resources and Environment (MONRE), Minister of Foreign Affairs	Ministry of Natural Resources and Environment	Ministry of Natural Resources and Environment	-
Vietnam	National Committee on Climate Change (NCCC)	Prime Minister with other Ministers including Ministry of Natural Resources and Environment (MONRE)	No indication of responsible ministry, but various ministries related to adaptation planning and implementation	MONRE	Yes (NGOs)

Note: A "whole-nation approach" here means that civil society groups such as NGOs, CSOs and youth groups are involved in the decision-making processes under certain technical groups or groups for deliberation.
Source: National reports submitted to ASCCR process

3.5.1.3. Mitigation strategies and implementation of mitigation

Here, the current status of national policy for renewable energy, technology, finance, carbon pricing, air pollution prevention and climate change mitigation co-benefits, and REDD+, is provided, aiming to showing key gaps and capacity building opportunities to accelerate transformative mitigation actions. The analysis here is mainly related to the current status of the Integrate-Involve-Motivate category of actions (for AIIM group of actions, see Figures 2 and 3).

Renewable energy policy and other policies

As shown in Figures 13 and 14, all AMS have room to increase RE, including variable renewable energy such as wind and solar, which will be part of the key decarbonising technologies moving to the mid-century. Thus, RE policy is highlighted here. Table 15 shows the national renewable policies currently introduced in AMS. Regarding regulatory policies, the NDCs of all AMS describe renewable energy targets and/or policies and almost all AMS have renewable energy targets. The feed-in tariff policy, which is impactful in deploying RE, is introduced in six AMS. Likewise, net metering, biofuel blend obligation, electric utility quota obligation (Renewable Portfolio Standard: RPS) are introduced in several AMS. Introduction of tradable renewable energy certificates (REC) has only occurred in Vietnam[29], and the renewable heat obligation has not been introduced in any AMS. Of the fiscal incentives and public financing, tax incentives, public investment/loans/grants/subsidies/rebates, reductions in sales/VAT/taxes have been introduced in over half of the AMS. Tendering, investment/production tax credits, and energy production payment have been introduced in some AMS.

Table 15. Regulatory framework to promote renewable energy in AMS

Type of policy		Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Regulatory policies	Renewable energy in INDC or NDC	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Renewable energy targets	✔		✔	✔	✔	✔	✔	✔	✔	✔
	Feed-in tariff/auctions/premium payment		✔	✔		✔		✔		✔	✔
	Net metering/billing/direct consumption-supply			✔		✔		✔	✔		✔
	Biofuel blend obligation/mandate/target			✔		✔		✔		✔	✔
	Electric utility quota obligation/RPS			✔		✔		✔			✔
	Tradable REC										✔
	Renewable heat obligation/mandate										
Fiscal incentives and public financing	Tax incentives		✔	✔	✔	✔	✔	✔		✔	✔
	Public investment/loans/grants/subsidies/rebates			✔	✔	✔		✔	✔	✔	✔
	Reductions in sales, CO2, VAT or taxes			✔		✔	✔	✔		✔	✔
	Tendering			✔		✔		✔	✔		
	Investment or production tax credits			✔				✔			✔
	Energy production payment							✔		✔	

Note: REC stands for the Renewable Energy Certificate and RPS stands for the Renewable Portfolio Standard. Source: (Vakulchuk, et al., 2020)

29. The Philippines, Malaysia, Thailand, Singapore and Vietnam are participating the International Renewable Energy Certificate Standard programmes (International Renewable Energy Certificate Standard, 2021).

Appendix Table 2 summarises sectoral policies currently implemented in each AMS to achieve NDC targets. The sectoral policies span energy policy for increasing EE and RE use in the sectors of transport, building and industry, industry (IPPU) policy, waste policy, AFOLU policy (agricultural management, land use, REDD+, sustainable forest management, trade) and others (e.g. low-carbon cities). These national policies are the basis for achieving NDC targets and ASEAN's collective energy targets stipulated under APAEC 2016–2025. In particular, all AMS need to enhance their RE policies to meet the APAEC 2016–2025 RE target by promoting diffusion of sectoral and cross-sectoral low-carbon technologies.

Technology development and transfer for decarbonisation

Table 16 shows sectoral and cross-sectoral mitigation technologies identified as high priority in AMS up to 2030, together with decarbonising technologies necessary for the transition to net-zero emissions. The high priority technologies toward 2030 for achieving NDCs were identified in the national reports of AMS which were submitted during the process of ASCCR development. Across AMS, a wide range of technology options has been identified, but the basic mitigation actions are to increase the share of renewable energy in the energy mix, enhancing the energy efficiency measures for all energy-related sectors, facilitating sustainable waste management and protecting forest carbon pools.

Regarding the knowledge base for technology development in most AMS, needs for low-carbon technologies contributing to mitigation have been assessed through a technology needs assessment (TNA) with financial support and capacity building by sector (e.g. energy, AFOLU and waste). As a good practice in some AMS, criteria for assessing applicable technologies have been developed; for example, economic benefits, potentials of GHG reduction, applicable capacity, initial cost, suitability for the country's context, impacts on environment and society, and alignment with strategic priorities (Socialist Republic of Viet Nam Ministry of Natural Resources And Environment, 2017).

Table 16. Sectoral priority mitigation technologies toward 2030 and essential technologies to 2050 and beyond

Sector		High priority technologies (Toward 2030)	Decarbonising technologies toward net-zero (Toward 2050 and beyond)
Energy (power)	Centralised	Green coal (upgrading low-rank-coal, equipment with higher thermal efficiency, CCS), fuel switch to gas, co-firing with biomass, nuclear, RE (hydro, biomass, geothermal, etc.), ASEAN Power Grid, reduction of transmission and distribution loss	BECCS, gas with CCS, fuel switch from gas to hydrogen thermal, nuclear, ASEAN Power Grid (larger scale)
	Decentralised	VRE (solar, onshore and offshore wind), advanced energy storage system, demand-side management, smart and mini grid	Scale up of the high priority technologies, plus grid enhancement to accommodate increased VRE
Industry (energy)	Fuels	Higher efficiency of conversion process of fossil fuels	Biofuels, BECCS
	Gas system	Natural gas, biogas	Low-carbon hydrogen (e.g. hydrogen by electrolysis with RE), synthetic methane from low-carbon hydrogen, cleaned biogas (BECCS)
Industry (process)	Iron and steel	Energy efficiency improvement	CCUS, low-carbon hydrogen, biomass, circular economy
	Cement and lime	Substitution of clinker (waste-derived fuels/materials), efficient use of cement for concrete, CO_2 capture	Scale up of the high priority technologies, plus CCUS, RE, waste use, and circular economy
	Chemicals and petrochemicals	Green chemical technology (e.g. production of synthetic plastics based on plant material which easily decompose, production from renewable raw materials, treatment of hazardous waste, producing little or no by-products and waste, production with little consumption of water and chemicals)	CCUS, green chemical technology using biomass, low-carbon hydrogen, DAC (Direct Air Capture) to capture CO_2, circular economy
Transport	Road passenger	Higher efficiency ICE, biofuels, battery charge, modal shift to public transport (railway, bus, Mass Rapid Transit (MRT))	Electrification (EV), low-carbon hydrogen (FCV), Walk-Cycle-Ride (WCR)
	Road freight	Higher efficiency ICE, biofuels, battery charge	Electrification (EV), low-carbon hydrogen (FCV), biofuels
	Aviation	Higher fuel efficiency, higher flight efficiency	Synfuels from green hydrogen (CCU), biofuels, electrification
	Shipping	Higher fuel efficiency, LNG bunker	Synfuels from green hydrogen (CCU), biofuels, electrification, ammonia
Building		Higher efficiency electric appliances, cleaner cookstove (high efficiency wooden stove, LPG stove, biogas stove, electric cookstove), RE (solar PV, solar heating), cogeneration, demand-side management, energy audit	Electrification of appliances, RE (solar PV, solar heating), insulation, ZEH, ZEB
Waste		Biogas recovery, waste treatment technology (waste recycling, In-vessel composting technology, prevention of disposal of hazardous waste), commertial cogeneration (sale of power),	Scale up of the high priority technologies, plus BECCS
AFOLU	Agriculture	New plant varieties, organic fertilizer (e.g. straw), wet and dry irrigation, biochar, reuse of by-products of crop residues, improvement of agro-forestry-fishery processing	Scale up of the high priority technologies
	Forestry	Measuring and monitoring of carbon emission and sequestration, re-map of peatland and vulnerable ecosystems, protection of natural forest and coastal forest, plantation of coastal forest and large timber production forest, eradication of poaching and illegal logging, REDD+	Scale up of the high priority technologies, plus large-scale afforestation & reforestation
Cross-sectoral		Circular economy (enhancing material efficiency, 3R: reduce, reuse and recycling)	Circular economy, Carbon Dioxide Removal (or negative emission technologies) such as large-scale afforestation & reforestation, BECCS, and DACS (Direct Air Capture and Storage)

Source: National reports submitted to ASCCR process and relevant documents for the high priority technologies; IRENA (2020), ETC (2020), Government of Singapore (2020) and National Reports for the decarbonizing technologies toward net-zero.

The current challenges reported by AMS lie in how to ensure adequate financing, consistent regulatory frameworks and cohesive institutional arrangements for scaling up low-carbon technology. First, initial costs of VRE such as solar and wind are still relatively high. Moreover, inadequate finance hampers technological development and transfer, especially for poor countries, and the lack of tax incentives and subsidies in many AMS has resulted in immature markets for renewable energy. Second, a consistent regulatory framework and cohesive institutional arrangements for more targeted technology development and transfer are often requested in several AMS, since irregularities in implementing the rules and regulations have been a disincentive for the market. In actuality, risk perceptions among investors and lingering fossil fuel subsidies have hampered sustained RE market growth in recent years (Overland,

et al., 2021). Specifically, phase-out of fossil fuel subsidies will be unavoidable for expansion of the RE market, and at the same time poor households with limited access to affordable electricity need to be supported in a master plan for diffusing RE in remote areas. To build a consistent regulatory framework in all AMS, clear stipulation of technology development targets specified under TNA processes in strategies and plans is a starting point, since often key science and technology programmes are too inclusive and general without appropriate focal and specific areas. As another example, deregulation to reduce restrictions on geothermal is also important[30]. Third, business plays a vital role. The business mindset that prioritises expansion of typical business activities, rather than pursuing efficiency and decarbonisation technology needs to be innovated through new products, services, technologies and management approaches. Sharing of knowledge among AMS on transferred equipment and its operation and maintenance is necessary.

As part of the challenge of decarbonising the energy system, it is necessary to develop and transfer technologies that are compatible with the technologies required for the final net-zero systems, considering the decades of remaining life of energy infrastructure. Renewable energy-related technology, and electrification, power storage and power transmission technologies are therefore indispensable as they contribute to cross-sector decarbonisation. For example, electrification of the transportation sector contributes to ensuring flexibility in the electric power system and decarbonisation through integration with the electric power sector. Electrification with RE in the future will lead to the production of hydrogen with electrolysis powered by RE (i.e. green hydrogen). Current hydrogen production pilot projects in Brunei Darussalam and Singapore provide an opportunity to advance the production process of hydrogen from fossil fuels to RE in the long run.

For the transition to net-zero energy and land systems, it is important to identify “transient” technologies for decarbonisation and to formulate their strategies, taking into account national circumstances (e.g. availability of alternative clean energy options). As for technological development for utilising fossil fuels such as coal, oil and gas, raising energy and fuel efficiency and deploying CCS technologies can be considered, as stated in ACE (2020). However, these carry the risk of becoming stranded assets when RE becomes less costly than fossil fuel power plants, which will occur in the future. In 2018, LCOEs (Levelised Cost of Electricity; weighted average in the ASEAN region) of biomass, geothermal, hydro, onshore wind and solar photovoltaic were 0.07, 0.07, 0.05, 0.13, and 0.09 USD/kWh respectively, as of 2018 (IRENA, 2020) (p.12)[31], already achieving cost competitiveness with fossil fuel electricity. Nuclear power, which is a decarbonising technology, also requires verification from the comprehensive perspective of social acceptability, safety and cost. In the transport sector, biofuels are important, while it may become vital to limit their use to aviation and shipping fuels and petrochemical raw materials in the long run, considering the pressure on land use (especially deforestation) when expanding it on a large scale[32]. In this sense, a steady expansion of solar and wind power generation is required, considering the abundance of such resources in most AMS, in addition to hydro and geothermal power. Along the transition pathway toward net-zero emissions, it is essential to scrutinise the technology development strategy by capturing global market trends and relative price changes of all energy sources, while retaining a wide range of options listed in Table 16.

30. It is important to reduce the restriction of foreign proprietorship of geothermal projects to 40% because these restrictions are the main hindrances for international companies to invest in geothermal resources in Indonesia.

31. In a consultation meeting with the Energy Transitions Commission (ETC) during the process of developing ASCCR, it was shown that renewable electricity plus battery will be competitive with existing coal plants by 2020-2035 and stranded assets today in the coal industry amount to 42% but will soar to 72% by 2040. Moreover, it was shown that the cost of solar PV modules has dropped to 1/3,000th the original cost over the last 60 years whereas coal power has not gotten any cheaper.

32. In the above-mentioned consultation meeting with the Energy Transitions Commission (ETC) during the process of developing ASCCR, the following points were also noted: (1) concern over biofuel expansion impacting on global deforestation and (2) cost reduction of biofuels will not be as large as that of battery technology.

Finance

Adequate financing to promote energy investments is a requisite for diffusing decarbonising technologies and enhancing carbon sinks from forests. Energy investment estimation in Asia Pacific including all AMS indicates that during 2015–2019, fossil fuels for fuel supply and power generation dominated the share of energy investment on the supply side, which also includes renewables and electricity networks (IEA, 2020). To accelerate decarbonisation of the energy system, there needs to be more investment in RE and electricity networks in the long term as well as in low-carbon fossil fuel technologies, including high efficiency thermal power and CCUS in the near- to medium term. As LCOE for RE continues to decrease in ASEAN (IRENA, 2020, p.12) and globally, this enables more efficient use of financial resources targeted at RE-related investment. Financing schemes targeting this line of energy investment relocation can promote momentum for decarbonisation across the region.

To scale up mitigation financing and make it more effective, it is important to have an accurate grasp of financial flows. According to OECD data, international development climate finance flows to the ASEAN region both for adaptation and mitigation accounts for USD 3.2 billion per annum, rising to USD 6 billion per annum if projects with climate co-benefits (UNFCCC, 2019) are included. As Figure 21 shows, bilateral mitigation finances are distributed to energy, agriculture, industry, transport, waste and forestry sectors in descending order. However, challenges remain in obtaining an accurate, comprehensive picture of financial flows across various scales, from national to local (project level). In some countries, accounting of financial flows is done using a budget tagging tool. The enactment of climate change expenditure tagging (CCET) to provide information on, evaluate and modify the allocation of a country's budget to climate change actions is a good practice. Another system, the Enhanced Climate Budget Tagging System, improved the supervisory nature of public investment aimed at climate change actions as it enabled government corporations and other government organisations to easily determine, prioritise and label climate initiatives. Such budget-tagging tools also have positive implications for raising the capacity of the public-private-partnership (PPP) funding system. Moreover, there is a need to carry out cost estimation by sector (e.g. energy, IPPU, waste and AFOLU) with a focus on lifecycle cost, in accordance with the scenario assumed (e.g. conditional/unconditional scenario in NDCs).

Most AMS receive financial support via multilateral funds such as Green Climate Fund (GCF), Global Environmental Facility (GEF) Trust Fund and People's Survival Fund (PSF). GCF is presently the largest climate change trust fund. However, many AMS face a lack of private financing and international financing, while Brunei Darussalam and Singapore do not state financial support needed. For example, for peat restoration, most financial support still relies on the state budget in Indonesia, thus additional funding from international donors is needed to fill this financial gap, considering the huge impact of peat restoration activity on levels of emission reduction, including its impact on peat fires. Since upfront investment costs for clean technologies are high in general, additional incentives for private actors are necessary other than existing loan subsidies and investment guarantees. There are various instruments for alternative modes of funding available to support a shift in paradigm for future businesses, such as the issuance of Green Bonds. The proceeds from Green Bonds (e.g. Sukuk) are to be used exclusively for funding in the form of budgetary allocations or subsidies for new projects, or refinancing for funding green projects in priority sectors that meet the requirements. As stated above, bilateral mitigation finances are also important.

Last but not least, national financial resources can also play a vital role in energy transition toward net-zero emissions. As an example, Figure 22 shows historical trends in fossil fuel subsidies in five AMS during 2010–2019. In most AMS, a downward trend in subsidies is observed, and further, the national financial resources used for conventional energy systems will need to be directed to RE and low-carbon technology promotion, with due care for low-income households.

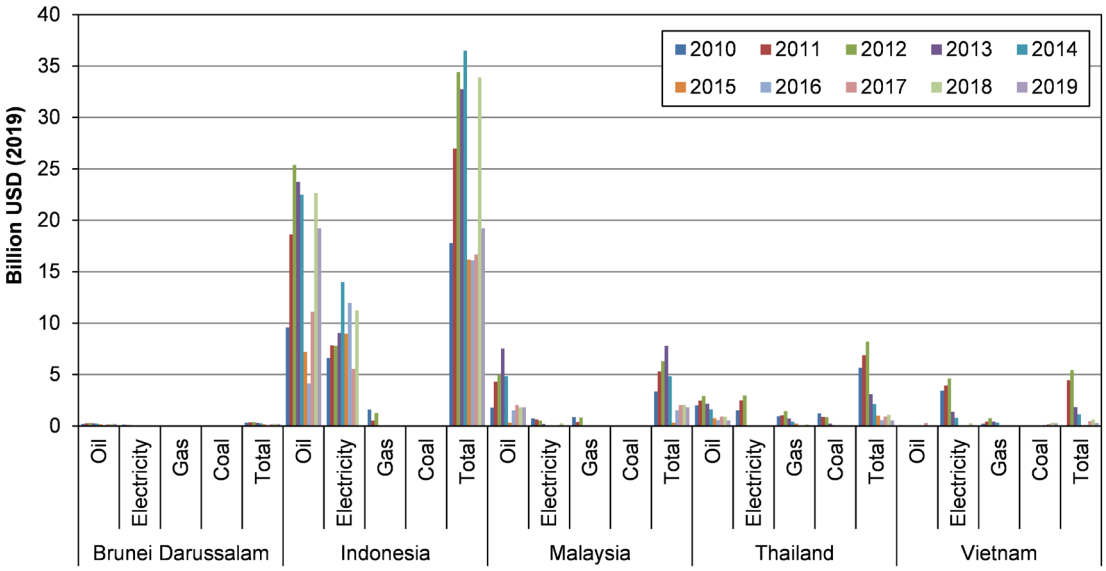

Figure 22.
Fossil fuel subsidies in five AMS. Source: IEA (2020)

Carbon Pricing

Most AMS have extensive experience in CDM projects, as part of the Kyoto Mechanism. Such projects have offered social, economic and environmental benefits including community-based programmes, assistance and green jobs (Mayuga, 2020). Preparation and development of sound MRV systems for all sectors in all AMS will help propel the introduction or expansion of all types of carbon pricing (taxes, subsidies, emission trading, etc.). Coordination across line ministries including finance ministries and alignment of carbon pricing in national plans and NDCs as a cost-effective approach are among the best practices.

There have been calls for the introduction of an ASEAN-wide carbon tax (Nurdianto & Resosudarmo, 2016; Singapore Institute of International Affairs, 2020). Considering the heterogeneity of existing environmental tax systems in AMS, understanding the benefits of creating a regional/sub-regional carbon market (emission trading system) may be a starting point in the harmonisation of carbon pricing policy in the ASEAN region. Furthermore, an MRV system for GHG emissions is vital for linking carbon markets, as shown in Singapore's case (National Environment Agency, 2021). The ASEAN-ROK Carbon Pricing Dialogue (ROK) (Ministry of Foreign Affairs, Republic of Korea, 2020) and the Partnership for Market Readiness (Partnership for Market Readiness, 2019) projects are leading initiatives in the ASEAN region to facilitate actions on carbon pricing in the region.

Table 17 shows the status of carbon pricing schemes in the AMS other than international and bilateral market based mechanisms. Singapore was the first country to implement a mandatory carbon pricing scheme through carbon tax in 2019, and the use of environmental taxes related to energy and fuel is a common mechanism used among the AMS. It is important to ensure the introduction of carbon pricing legislation as part of a holistic approach that considers the impact and cost-effectiveness of other policy instruments that discourage the emission of GHG, as well as taking into account policies which may inadvertently encourage emissions. When designed properly, carbon pricing schemes can assist in sustainable and inclusive growth in each AMS and the whole region. A study has shown that an ASEAN-wide carbon tax may have a positive impact on an economy when revenues generated from the carbon tax scheme are redistributed properly, while there may be some countries seeing economic losses (Nurdianto & Resosudarmo,

2016). In this regard, ensuring progressivity of a tax to promote sustainable and inclusive economic growth is under consideration in a piece of legislation in the Philippines[33]; tax exemptions for advanced technologies is another good example (e.g. incentives or tax exemptions for hybrid cars and EVs). From a holistic perspective, it is also necessary to design a policy framework to reduce RE costs relative to fossil fuels, such as the phase-out of subsidies (Overland, et al., 2021).

In order to advance the carbon pricing scheme, the social cost of carbon (SCC)[34] will gain increasing relevance as an indicator for setting carbon pricing rates. Despite the large uncertainty and inability to capture all climate impacts, such as ecosystem and species loss which is difficult to monetise, SCC can provide supporting information on the negative impacts of climate change resulting from one unit of CO_2 emissions. Thus, setting a minimum carbon price equal to the rate of SCC is a justifiable policy in terms of economic rationality and will appeal to all stakeholders facing climate change impacts. Recent scientific knowledge on the national-level social cost of carbon (RFF, 2020) shows that the national-level SCC (per tCO_2) of selected AMS amounts to non-negligible US dollars (11, 8, 5, 8, 3 USD/tCO_2 for Indonesia, Malaysia, the Philippines, Thailand and Vietnam, respectively.). The level of this SCC is comparable to the level of Singapore's current carbon tax rate (5 Singapore dollars). If the ASEAN region were to consider an SCC (sum of all AMS' SCC) suitable for the whole region, a carbon pricing scheme based on a higher rate would be justifiable. Lastly, it is important to note that any policy intervention incurs implicit costs on society even without explicit use of a carbon pricing scheme, which indicates that overall price systems need to be geared in the direction of low-carbon technology diffusion.

33. The first package of the TRAIN Law (Republic Act 10963), an Act Amending Sections of the National Internal Revenue Code of 1997, was approved by the Philippine Congress on 24 July 2017.

34. Social cost of carbon (SCC) is a monetised climate change impact incurred by one unit of CO_2 emissions (Nordhaus, 2017).

Table 17. Status of Carbon Pricing Schemes in the AMS

Country	Carbon Pricing Mechanism	Reference
Indonesia	- Environmental tax (public service tax on motor vehicle fuel) - Establishing an ETS by 2024 (currently a pilot starting with power sector) - A domestic carbon offset mechanism is under discussion, which utilises emission reduction certificates known as Indonesia Certified Emission Reduction (ICERs)	Budidjaja International Lawyers (2017), Direktorat Jenderal Pengendalian Perubahan Iklim (2019), Nikkei Asia (2021)
Philippines	- Energy related taxes (energy sector)	Bureau of Internal Revenue (2019)
Singapore	- Carbon tax (applied uniformly to all sectors, without exemption)	National Climate Change Secretariat (2020)
Thailand	- Carbon Crediting: Thailand Voluntary Emission Reductions (T-VER) scheme (project based) - Carbon Offset: Thailand Carbon Offsetting Programme (T-COP) (public and private organisations) - Cap and Trade: Thailand Voluntary Emission Trading Scheme (Thailand V-ETS) (currently a pilot for economy-wide use except power sector)	Partnership for Market Readiness (2019), IEA (2020)
Vietnam	- Environmental protection tax (products and goods including gasoline, oil, petroleum and coal) - Carbon Payment for Forest Environmental Services (C-PFES) pilot activity underway (forest sector)	National Assembly (2010), Winlock International (2018)

Source: Compiled by authors from various sources

In May 2021, Climate Impact X (CIX) was launched in Singapore. CIX aims to establish a global marketplace for high-quality carbon credits in the voluntary carbon market, with an initial focus to catalyse the market for nature-based solutions (NbS) and expand its trading volume. Carbon credits generated through NbS such as reducing emissions from deforestation and enhancing carbon sinks through afforestation and restoration of peatlands and mangroves are traded by means of innovative digital technologies to ensure transparency and verifiability of the credits. This marketplace is expected to dramatically increase liquidity and quality of credits traded, and thereby changing the landscape of current fragmented nature of multiple carbon credit markets in the region and outside of the region. In the short term, this market aims to reap the opportunities to gain co-benefits by diffusing NbS on a larger scale, the examples of which include economic development of local communities and conservation of biodiversity. In the long run, this initiative will be advanced to promote carbon capture, utilisation, and storage (CCUS) projects. Singapore is located at the heart of Southeast Asia, and can be a carbon services and trading hub for the region and global community (Government of Singapore, 2021). This initiative can enhance transparency of the carbon market, provide sufficient financial incentives to buyers and sellers, and transform the land-use systems toward greater sustainability conserving natural ecosystems and livelihood of local communities.

REDD+

REDD+ is a vital tool that incentivises actions to prevent deforestation and forest degradation, which are significant in the ASEAN region, and to enhance carbon sinks to reduce airborne CO_2 concentrations. The REDD+ programmes are led by various actors, from national governments to local communities. While a significant number of local voluntary REDD+ programmes have been implemented, it is necessary for national governments to legislate and promote REDD+ programmes in order to scale up programmes in a sustainable manner. The result-based payment for REDD+ activities which is stated in Article 5 of the PA is conducted based on verified reduced emissions. Results-based finance provided to REDD+ countries for the full implementation of REDD+ activities that is new, additional and predictable may come from a variety of sources — public and private, bilateral and multilateral, including alternative sources. There are many different initiatives, organisations and donors that provide funding for REDD+ activities. Most AMS are working on REDD+ and have submitted relevant information to the UNFCCC, as shown in Table 18. Meeting the UNFCCC's requirements is essential to enable access to GCF. As of May 2021, REDD+ proposals from two AMS (Lao PDR and Indonesia) had been approved by GCF, with Indonesia supported through result-based payments for its emission reduction during 2014–2016[35].

Table 18. Status of Carbon Pricing Schemes in the AMS

Country	Involvement in UN-REDD+
Brunei Darussalam	No
Cambodia	Yes
Lao PDR	Yes
Indonesia	Yes
Malaysia	Yes
Myanmar	Yes
Philippines	Yes (Observer)
Singapore	No
Thailand	Yes
Vietnam	Yes

As a starting point, national REDD+ safeguards, frameworks and guidelines for concerned stakeholders are prepared to provide criteria, indicators, principles and actions to lessen possible negative impacts on indigenous peoples, habitats and ecosystems. In some AMS, a Safeguards Information System (SIS), which has a website and offline software with safeguarding data for REDD+ sites has been developed, and is a useful monitoring tool for checking if safeguards are addressed in the REDD+ implementation phase. These advanced frameworks and guidelines have contributed to the institutional arrangements that are necessary to successfully implement REDD+ projects in local communities. The development of registry systems on climate change interventions including those in the AFOLU/LULUCF sector contributes to preventing duplication of efforts, overlaps in reporting, double reporting and double counting, as well as contributing to synchronising climate change mitigation and adaptation.

35. Some potential REDD+ results-based payment mechanisms in Indonesia include the REDD+ Funds within the framework of cooperation between Indonesia and Norway, Forest Carbon Partnership Facilities (FCPF) Carbon Fund and Bio Carbon Fund Initiative for Sustainable Forest Landscapes (BioCF ISFL).

There are various institutional arrangements at the national level. Examples include the MRV system, information system on safeguards, communications among stakeholders, development of the National Forest Reference Level (used to calculate emission reductions), preparation of technical documents on result-based payments, development of national REDD+ strategies and policies, policy implementation, and finance. Vertical mainstreaming of REDD+ mitigation measures into local development plans is a challenging but inevitable process. Furthermore, in AMS that implement REDD+ projects, many major policy changes in the forestry sector, including important international treaties and agreements on trade, are being observed[36]. Equitable REDD+ policies require a contextual, procedural and distributive setting, as well as a more inclusive decision-making process. Currently, it has been observed that participation and information-sharing of all stakeholders, particularly local and ethnic peoples/communities, women, CSOs, NGOs were continuously improving.

In terms of tracking progress, there are still gaps when it comes to verifying policy effectiveness. Forest carbon management in terms of FCO (forest carbon offset) and FCC (forest conservation certification) is a vital action to better capture and quantify the impacts of different actions. Support to access the information of REDD+ and financial support for REDD+ are also key areas of action.

Regarding some key challenges, the root causes (e.g. increasing population pressure and expansion of agricultural areas) of deforestation need to be assessed and reflected in national forestry policies, not only in REDD+ projects. Local communities often rely on artificial forests such as rubber and oil palm plantations, or on reforestation. Conflicts over protected areas and land and resource use are another major cause. Currently, governments face a critical challenge of completing the zoning processes. Also, granting of economic land concessions inside protected areas adds further complexity to zoning processes and land conflicts (Scheidel & Work, 2016; Work, Rong, Song, & Scheidel, 2018). Resolving all these tensions in the short-term would pose a challenge, and these numerous factors in turn cause implementation gaps. Hence, the use of a holistic policy design for resource use and management is important, as are provisions for incentives for early engagement in REDD+ in pilot areas, integration of immigration and population growth with forest management, and securing of carbon tenure and improvement of carbon stocks. Many drivers, actors and partners related to REDD+ are often outside the forestry sector and have strong links to national economic development goals. Thus, national governments of AMS need to incorporate REDD+ programmes into their national development and mitigation strategies and plans. A new wave of stakeholder engagement is necessary, since REDD+ is a highly cross-sectoral issue.

Finally, R&D is a vital step for designing and implementing REDD+ mechanisms to advise REDD+ governance and policy reforms, provide baselines, conduct MRV techniques, and enhance research capacity. Below are the key strategies identified in the Philippines, indicating essential actions to promote REDD+ programmes.

Recommended key strategies for REDD+ (mostly from DENR-FMB (2017); p 39):

1) Developing of comprehensive R&D programme on REDD+

2) Analysing drivers of deforestation and forest degradation

3) Identifying conservation interventions

4) Enabling resource valuation

5) Review policy to inform alignment and reforms

36. In Vietnam's case, international treaties and agreements on trade are jointly signed by the Vietnamese government. Examples include the Voluntary Partnership Agreements (VPAs) through the European Union's (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan and the Free Trade Agreement (Thuy, et al., 2019).

6) Establishing pilot national and sub-national projects on REDD+

7) Determining realistic and appropriate benefit sharing schemes

8) Identifying strategies to harmonize REDD+ and community practices

9) Developing and communicating REDD+ baselines

10) Information dissemination and knowledge management of R&D

BOX 4. Real-time monitoring system of global forests

Global Forest Watch (GFW) is an online platform for monitoring forests[37], and realises near real-time information provision about where and how forests are changing around the world, including the ASEAN region. Based on data related to forests available for free, GFW is tangibly raising transparency on the state of forests, thus supporting smarter decisions on how to manage and protect forests at the local, national and regional level. This is a further example of how greater transparency can help change the course of actions in a transformative way that could have not been possible otherwise.

Air pollution prevention and climate change mitigation co-benefit:

Air pollution imposes steep costs on the health and wellbeing of millions of people in AMS. This is evident from research suggesting that “air pollution is the second-leading global cause of non-communicable diseases [in AMS]” (Overland, et al., 2021). It is also apparent from data that many countries in the ASEAN region suffer a greater number of disability adjusted life years (DALYs)[38] on a per capita basis than countries such as China (see Figure 23).

37. Global Forest Watch (2021)

38. A DALY is the sum of years of potential life lost due to premature death and mortality and years of productive life lost due to disability.

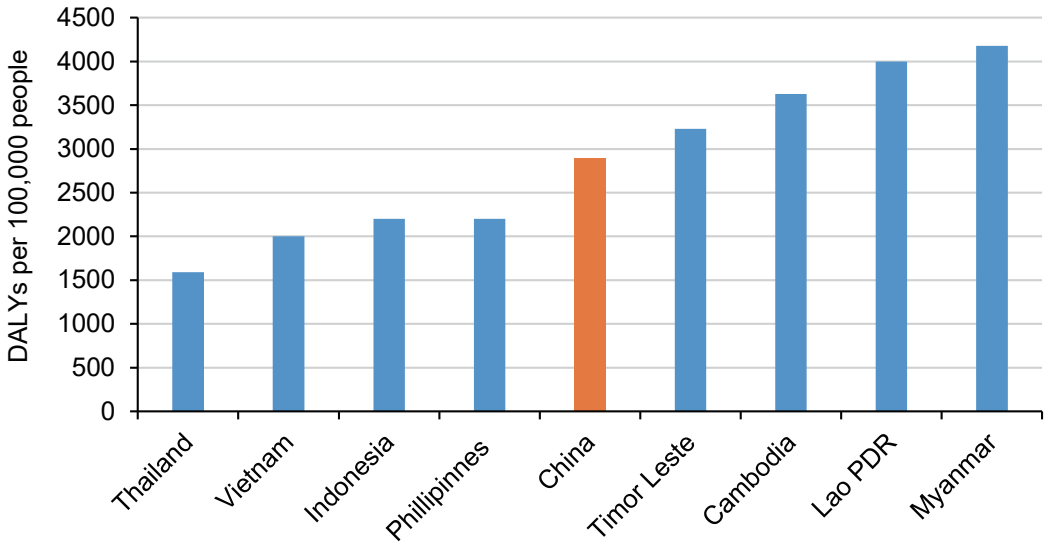

Figure 23.
Impacts of $PM_{2.5}$ on Health in ASEAN and China in 2019 (Source: Data is extracted from Global Burden of Disease, Institute for Health Metrics and Evaluation, https://vizhub.healthdata.org/gbd-compare/).

A related branch of research suggests that AMS have ample opportunities to control air pollution while mitigating climate change. A recent UNEP Climate Change and Clean Air Coalition (CCAC) and Asia Pacific Clean Air Partnership (APCAP) report identified three groups of solutions for health-damaging $PM_{2.5}$ that simultaneously affect climate (UNEP, CCAC, APCAP, 2019). The first category, conventional controls, involves chiefly end-of- pipe technologies such as desulfurisation and denitrification technologies that actually increase—not decrease—energy use and GHGs. A second category of next generation solutions does not have these climate trade-offs, and entails changes in technologies and behaviours that reduce emissions from smaller, dispersed sources such as cook stoves or brick kilns. These sources emit short-lived climate pollutants (SLCPs) such as black carbon, which have high climate warming potential over the short term. The third set of solutions, known as development priority solutions, concentrate on shifting to cleaner sources of energy such as wind or solar power that can also offset increases in long-lived GHGs as opposed to SLCPs. As suggested above, cleaner air and a stable climate will require combinations of these three types of solutions to improve air quality and health while mitigating near and long-term climate change in AMS.

Fortunately, several AMS have introduced some of the above solutions. In Malaysia, for instance, advanced power plants generate cleaner, more efficient power, thereby mitigating climate change while reducing other harmful emissions[39]. Other countries in the region are also becoming more aware of the co-benefits from different air pollution and climate solutions. BAPPENAS (2019), for example, completed a recent study that shows the overall cost, including externalities and subsidies, of new coal projects, is higher than RE generated from wind, solar, geothermal and hydropower. Conversely, increasing RE will result in lower costs and have beneficial implications for public health (Figure 24). The solutions in AMS are also not limited to the energy sector. In the transport sector, many countries are adopting EURO 4 emission standards (and some are considering higher standards) and/or greening of buildings, infrastructure and city centres that could yield benefits for air quality, health and climate change. Improved waste and wastewater treatment technologies in some parts of the region can also deliver significant co-benefits from reductions

39. In Malaysia, the National Biofuel Policy also implemented the use of B10 and B7 biodiesel for the transport and industrial sector. Malaysia aims to deploy 100,000 electric vehicles and attain 40% of modal share of public transport by 2030 (Table 3.1, NC3) (Ministry of Energy, Science, Technology, Environment and Climate Change, 2018).

in methane and ozone[40,41]. Further, both rural and urban areas of AMS are capturing multiple benefits from transitioning from charcoal and peat stoves to cleaner fuels (such as liquefied petroleum gas, compressed natural gas or electricity) and other technologies.

For many areas of AMS, the key to capturing these co-benefits is not simply finding the solutions but actually embedding them in appropriate enabling policies and reforms (including Nationally Determined Contributions). For example, eliminating fossil fuel subsidies that inhibit the deployment of RE will help bring down costs and facilitate the much-needed spread of clean technologies. If the cost of renewable energy projects falls to international levels, then renewable energy will become more cost-competitive with other forms of power generation. To illustrate using another regionally important example, it is increasingly clear that reductions in the open burning of crop residues will not come simply from government-enforced bans on the practice; rather, there needs to be a well-crafted set of awareness-raising activities as well as financial support for high-yield alternative crops, or baling and fertilizing machines that offer farmers a compelling reason to halt burning.

In addition to the solution-specific barriers, there are also a range of broader policy and institutional challenges that make realising co-benefits difficult. In many countries, for example, in urban planning and national policy-making, science- and evidence-based policy is still more of an ideal than a reality. This is partially attributable to the need for better data and greater capacities. It also reflects the constraints of working across different agencies and stakeholders. Almost by definition, the integrated strategies needed to capture co-benefits necessitate coordination between divisions working on air pollution, climate change and a host of sectoral concerns. This coordination is often weak or lacking in several relevant policy areas. For example, road safety standards in the transport sector are not yet integrated with air pollution and/or climate policy. Even within specific policy areas, greater integration could be desirable, such as enhancement of public transport and the demand management of private vehicle traffic combined with efforts to improve vehicle technologies and electrify vehicle fleets. Lastly, an understanding of co-benefits should extend to some of the socioeconomic issues featured under the SDGs. To illustrate, the rapid elimination of obsolete and polluting vehicles could affect owners of old vehicles since they tend to be from lower-income households, which might widen equity gaps. The energy poverty issue is among the most serious concerns, thus appropriate policy design is necessary. In order to properly deal with this issue, national long-term strategies (LTS) and regional long-term visions need to clearly integrate strategies for an inclusive and just transition which duly cares about unemployed people and disadvantaged communities with appropriate financial support for reskilling of labourers and reemployment (for further information, please see Section 4.2.4).

40. Some other good practices include: enforcement of standards concerning air pollutants emission for motor vehicles; maintenance and inspection programmes; roadside anti-smoking campaigns; four-stroke tricycle and electric vehicle promotion; more lines of LRT and MRT investment; bikeway establishment; truck bans; and LPG, CNG, and biofuel introduction. Also there are campaigns such as car-free days and eco-safe driving to raise awareness of the negative consequences of pollution.

41. As one of the signatory countries to the Montreal Protocol, in 2019, Vietnam approved the Kigali Amendment for reducing production and use of HFCs, and halting use of HFCs by 2028.

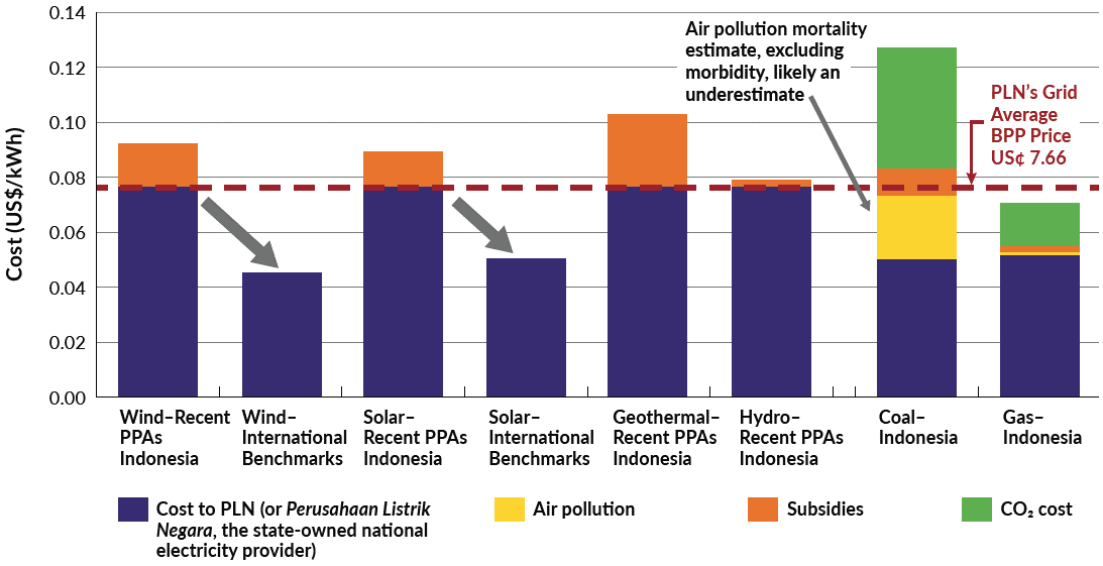

Figure 24.
Relative cost of coal and renewable sources of energy (BAPPENAS, 2019)

3.5.2. Current Status: Regional Actions

Key message

In the energy sector, the ASEAN Plan of Action for Energy Cooperation (APAEC) includes a renewable energy (RE) target of 23% in total primary energy supply by 2025, and this poses a critical challenge for AMS to enhance or reshape national RE policies. In the AFOLU/LULUCF sector, the Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry (SP-FAF) 2016–2025 includes action programmes to facilitate climate smart/friendly agriculture, land use and fisheries based on nature-based solutions (NbS). It is vital in the AFOLU sector to develop policy indicators to track progress and to enhance policy target and implementation to generate tangible impact on the GHG emissions in this sector.

Aside from the national targets of each AMS, the ASEAN region has a quantitative target in the energy sector, which is strongly related to climate change mitigation. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025, consisting of phase I (2016–2020) (ACE, 2015) and phase II (2021–2025) (ACE, 2020), sets a target of 32% reduction in energy intensity by 2025 relative to 2005 levels, and a 23% share for renewable energy (RE) share in the total primary energy supply (TPES) by 2025. ASEAN is well on track to reach the APAEC 2016–2025 energy intensity target, and achieved a 24.4% reduction in energy intensity in 2019. However, stronger efforts will be required to reach the RE target, with a 14.3% share of RE in 2017 (ACE, 2019). It has been pointed out that in terms of the aggregate installed capacity excluding hydropower, ASEAN has not tapped potential opportunities for RE diffusion (Overland, et al., 2021). This is also shown in Figures 13 and 14.

In the AFOLU sector, the Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry (SP-FAF) 2016–2025 was adopted in 2015, which includes action programmes to facilitate climate smart/friendly agriculture, land use and fishery in cooperation with R&D programmes and networks (ASEAN, 2015). Specific examples of action programmes to reduce GHG emissions involve agroforestry, protecting mangrove forests, establishment of regional agreements on timber trade, strengthening forest management by involving local communities and certification, and REDD+. SP-FAF does not have policy indicators to track progress, but most countries emit net positive GHG emissions from LULUCF, as shown in Figure 9, implying a vital need for progressing actions in the AFOLU sector. The Regional Action Plan for the ASEAN Heritage Parks (AHP) 2016–2020 is an important nature conservation plan which stipulates seven goals, strategic actions, and specific activities to implement the actions (ACB, 2015). There is a new plan under development, and this, as well as many other conservation programmes, contribute significantly to GHG emission reductions in the LULUCF sector.

To date, all AMS have been committed to enhance regional and international cooperation to address the issue of climate change and its impacts on socio-economic development, health and the environment in accordance with the ASEAN Socio-Cultural Community (ASCC) Blueprint 2025 (ASEAN Secretariat, 2016). ASCC's actions for mitigation include (i) strengthening human and institutional capacity; (ii) facilitating multi-stakeholder and multi-sectoral approaches; (iii) leveraging the private sector and communities for access to new and innovative financing mechanisms; (iv) strengthening the capacity of sectoral institutions and local governments in conducting GHGI; (v) strengthening efforts by government, private sector and communities to reduce GHG emissions; (vi) mainstreaming GHG emission reduction on sectoral planning; and (vii) strengthening global partnerships such as the UNFCCC.

In line with the above strategic action areas (i) to (vii), projects among particular AMS, as the entire ASEAN region, and among ASEAN and various development partners have been implemented as shown in Table 19. ASEAN regional action plans such as the ASEAN Action Plan on Joint Response to Climate Change (AAP-JRCC) and the AWGCC Action Plan stipulate cross-sectoral and sectoral actions, and AWGCC has taken on the role of actively implementing these actions. However, due to the cross-sectoral nature of climate change mitigation intervention, AWGCC has proactively sought opportunities to coordinate action plans with other relevant working groups and bodies beyond the environment sector, such as energy, transport, agriculture, forestry, and science and technology. Specifically, the regional initiatives in Table 19, cross-sectoral or sectoral, have been and are being implemented for this purpose through active partnerships and collaboration among ASEAN's development partners, AWGCC National Focal Points, relevant ministries of AMS, and ASEAN sectoral divisions other than the environmental division.

Table 19. ASEAN regional cooperation on climate change mitigation

Layer of regional cooperation	Visions, plans and others (guidelines, networks, forums, etc)
Among particular AMS	• Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP)
ASEAN	• ASEAN Socio-Cultural Community (ASCC) Blueprint 2025 • ASEAN Community Vision 2025 • ASEAN Joint Statements on Climate Change to United Nations Climate Action Summit and COP25 • ASEAN Action Plan on Joint Response to Climate Change (AAP-JRCC) • AWGCC Action Plan • ASEAN Tourism Strategic Plan 2016–2025 • Vision and Strategic Plan for ASEAN Cooperation In Food, Agriculture, and Forestry (2016–2025) • ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 • Sub-Sector Networks in the energy sector comprising Energy Efficiency and Conservation, Renewable Energy, Regional Energy Policy and Planning, and Nuclear Energy Cooperation • ASEAN Collaborative Network on MRV ("South East Asia MRV Hub") • ASEAN Guidelines on Promotion of Climate Smart Agriculture Practices • ASEAN Climate Outlook Forum • ASEAN Initiative on clean air, health and climate change • ASEAN Agreement on Transboundary Haze Pollution (AATHP)[42] • Southeast Asia (ASEAN) MRV Network
ASEAN and Dialogue / Development Partners	• ASEAN+3 Environment Ministers Meeting • ASEAN-Dialogue Partners (DP) Plans of Action (PoAs) • ASEAN-Japan Dialogue on Environmental Cooperation and ASEAN-Japan Climate Action Agenda • ASEAN-EU High-level Dialogue on Environment and Climate Change • ASEAN-ROK Carbon Dialogue • ASEAN-UK Collaboration towards UNFCCC COP26 • ASEAN-UN Action Plan on Environment and Climate Change • ASEAN-DP Projects / Initiatives, e.g. ASEAN Climate Change and Energy Project (ACCEPT)[43], PaSTI JAIF project (Phase 1 & 2) for developing facility level MRV guideline and Information Platform on transparency actions for the ASEAN region, ASEAN COP26 Climate Dialogue on Nationally Determined Contributions (NDCs) and Long-Term Strategies (LTS)

The ASEAN Joint Statement on Climate Change in 2014 stipulated actions ahead of COP21 in Paris in December 2015, including preparation of the Intended Nationally Determined Contribution (INDC) (ASEAN Secretariat, 2021). The statement called on developed countries to show leadership and increase commitments to assist developing countries including AMS in mitigation, technology development and transfer, REDD+, finance, transparency of action and support (including MRV). The statement reiterated commitments for AMS to enhance cooperation to improve ASEAN's collective capacity to address climate change. As precisely stated in Section 1.1, the ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties (COP) to the UNFCCC (ASEAN, 2019) strengthened the above commitments with more detailed action targets. Furthermore, the ASEAN Joint Statement to the United Nations Climate Action Summit 2019 (ASEAN, 2019) declared key ASEAN targets with regard to: i) energy transition of reducing energy intensity by 32% by 2025 and increasing the component of renewable energy mix by 23% by 2025; and ii) land transport aiming to reduce the average fuel consumption per 100 km of new light-duty vehicles sold in ASEAN by 26% between 2015 and 2025, to strengthen fiscal policy measures on fuel economy or on CO_2 emissions, and to adopt national/regional fuel consumption standards for light-duty vehicles.

42. ASEAN Secretariat (2016)

43. ACE (ASEAN Centre for Energy) (2021)

Currently, various projects ranging from transparency such as capacity building on MRV to carbon pricing dialogue are being implemented to help better integrate ASEAN climate change actions across various scales and actors. Among others, the ASEAN COP26 Climate Dialogue on Nationally Determined Contributions (NDCs) and Long-Term Strategies (LTS) was held in September 2020 under a new ASEAN-UK Cooperation Framework on COP26, reaffirming the significance of effective cross-government coordination and ASEAN collaboration on carbon pricing, nature-based solutions, capacity building and the energy transition[44].

Regarding the energy-climate nexus, findings of the ASEAN Climate Change and Energy Project (ACCEPT) (2018–2020) underscore the importance of (i) establishing effective coordination frameworks to facilitate more interaction between energy and climate policy makers; (ii) setting ambitious NDC targets considering PA goals and the global stocktake (GST); (iii) realising the APAEC targets which are recorded in the ASEAN Joint Statement to the United Nations Climate Action Summit 2019 (ASEAN, 2019); and (iv) the movement of AMS towards sustainable and decarbonised energy systems (Chan, Overland, & Suryadi, 2020). The APAEC 2016–2025 Phase II (2021–2025) (ACE, 2020) (Phase I was 2016–2020) envisages regional actions up to 2025 in the energy sector, with seven indicative programme areas, as shown in Table 20. The additional sub-theme unique to Phase II is with regard to (i) accelerating energy transition; and (ii) strengthening energy resilience through greater innovation and cooperation. Under the APAEC 2016-2025 Phase II (2021-2025), a new Outcome-Based Strategy to Promote Information Sharing on the Energy-Climate Nexus was included under the Regional Energy Policy and Planning programme area.

Table 20. APAEC 2016–2025 Phase II (2021-2025) Key Strategies

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

Source: ACE (2020)

In the context of energy transition, the ASEAN Power Grid is intended to contribute to accommodating higher shares of renewable energy through expanded multilateral electricity trading to provide affordable and resilient electricity. ASEAN is to optimise the role of Clean Coal Technology and Carbon Capture Utilization and Storage (CCUS) towards a low-carbon economy. On energy efficiency and conservation and renewable energy, market transformation initiatives in favour of these technologies in building, transport and industry sectors are carried out. Moreover, new and emerging energy technologies such as hydrogen and fuel cells are also being explored. As for Regional Energy Policy and Planning, ASEAN aims to monitor global energy trends and strengthen partnerships with Dialogue Partners and International Organisations (IOs) to accelerate the region's energy transition and strengthen energy resilience. Lastly,

44. UK Mission to ASEAN (2020)

the civilian nuclear energy sector will aim to promote regional initiatives to enhance human resource capabilities on nuclear science and technology for power generation.

Preparation of APAEC 2026–2035 Phase I will be initiated in 2023 (ACE, 2020). Since the GST will be carried out in 2023, APAEC 2026–2035 Phase I is expected to take into account more stringent climate change mitigation measures. As ACE (2020) (p. 68) projects toward 2040, meeting EE and RE targets of AMS as well as NDC targets can reduce the risks associated with fossil fuel imports, thereby enhancing energy security of AMS and the ASEAN region. While clean coal technology combining CCUS is a vital near- to medium-term option, long-term transition toward decarbonising systems based on RE will be the key to advancing energy security to accommodate growing energy demand in the region.

3.5.3. Outlook

Key message

An increasing number of AMS have updated their NDCs and two AMS (Singapore and Indonesia) have submitted long-term strategies (LTS) to the UNFCCC as of August 2021. Efforts to track progress in terms of the targets and implementation of NDCs/LTS at the regional level will strengthen coordinated and harmonised action for raising NDCs' ambition in line with the PA goals. Setting an ASEAN long-term mitigation vision comprising goals and actions will send clear signals to all sectors across all AMS, thereby paving the way for multiple transformations to achieve net-zero GHG emissions.

As mentioned in Sections 3.5.1 and 3.5.2, ASEAN currently has regional strategies in place for the energy and land sectors up to 2025. Considering a long-term path toward the PA goals, ASEAN needs to have a long-term vision and strategy. In Section 3.5.3, national NDC targets for 2030 and medium- and long-term visions/strategies are summarised. These policy frameworks will be the basis of the ASEAN long-term climate vision to be presented in Section 4.

NDC targets

Most AMS have converted their INDCs into NDCs, and Brunei Darussalam, Cambodia, Singapore, Thailand and Vietnam updated their NDCs in 2020 and Myanmar in 2021. This indicates the momentum for AMS to step up on their pledges. However, ASEAN's aggregated GHG emissions considering updated NDCs are likely to grow until 2030 over the range of 3,294–4,506 $MtCO_2eq$, depending on assumptions of international financial support to be used in the energy and AFOLU/LULUCF sectors (Figure 15). While the contribution of the AFOLU/LULUCF sector to total GHG emission reductions varies across countries, its relative contribution is especially large in Cambodia, Lao PDR and Myanmar. Thus, key roles are played not only by the energy sector but also by the AFOLU/LULUCF sector in achieving lower GHG emissions by 2030. This will largely be dependent on the success of avoiding deforestation and increasing forest cover and carbon sinks, and will require sufficient financial support and enforcement of policies and measures.

Currently, only Singapore sets an absolute target for emissions, peaking around 2030 (Government of Singapore, 2020). Moreover, a study on ASEAN's energy and climate policy indicates that CO_2 emissions per capita will increase by 140% between 2015 and 2040 in the region, and that emissions must fall by 11% relative to the present trajectory to meet the targets of the NDCs (Overland, et al., 2021). Therefore, current policies need to be enhanced for achieving the NDC targets of the AMS. The commitments under the NDCs will provide ASEAN a better perspective of the need for a more ambitious course of actions on mitigation in the future.

In the rapidly growing ASEAN region, two aspects of NDC targets deserve special attention: (i) timing of peaking emissions; and (ii) emission reduction amounts. The absolute emission target is important as this determines emission reductions that must take place, which can be tracked with clear timelines. Emission targets relative to BAU emissions are subject to the uncertainty of the methodology used to estimate GHG emissions reductions, and items (i) and (ii) are not necessarily certain. The emission intensity target is also affected by the uncertainty of GDP growth and thus items (i) and (ii) are not fixed. Policies and action targets work well for tracking the progress of specific areas, such as RE introduction and forest cover, but RE introduction targets alone cannot capture the CO_2 emissions from fossil fuels. Further, national overall emission levels may not be sufficiently curbed. Forest cover targets have room for improvement, with more robust techniques for estimating carbon stocks and carbon emissions from the forest sector.

Medium-term (up to 2030) and long-term (beyond 2030) strategies

Table 21 provides a summary of policy frameworks in AMS beyond the target year of NDCs[45], ranging from 2030 to 2070. Some strategies/plans stipulate concrete measures as legal frameworks to achieve NDC targets for 2030. Others stipulate actions to be taken beyond 2030, thereby indicating the course of action each AMS will take after achieving their NDCs. First, it should be noted that variations exist across countries in the preparation of mitigation-related strategies, plans, and policies beyond 2030. These strategies are classified with a focus on climate change, energy and green growth. Planned policies include those aiming to promote EVs, hydrogen, CCUS, and ASEAN Power Grid utilisation to share RE. Second, some strategies present specific numerical targets aside from those mentioned in NDCs, with implications on the directions and magnitude of mitigation actions for 2050 and beyond. Third, medium-term plans are in many AMS linked with SDGs, and progress toward achieving the targets is monitored periodically. Thus it is expected that synergies between climate change mitigation and SDGs will be enhanced. Lastly, in some AMS, medium-term strategies integrate mitigation and adaptation areas as shown in Table 12 and Table 21, partly because these master plans are established at higher political levels. The enhancement and upgrading of these strategies will form the basis for enhancing the ambition of NDC targets and strategies even further.

Long-term strategies (LTS) are vital to enhancing NDC targets to meet the PA long-term temperature goals, and thus are also critical for global stocktaking. Establishment of LTS is also the key to informing a country's ambition toward net-zero emissions. As of August 2021, Singapore (Government of Singapore, 2020) and Indonesia (Government of Indonesia, 2021) have communicated long-term strategies to the UNFCCC, while Cambodia, Lao PDR and Myanmar have participated in the campaign by UNFCCC on the long-term vision for net-zero emissions by 2050[46]. Importantly, some countries such as Lao PDR and Vietnam are currently preparing their own LTS. Upon completion of national LTS of AMS, there could be worth opportunities to synthesise systematically at the ASEAN level on how LTS targets are in line with the global PA goals and regional goals stated in Section 4.1.1.4 and how collective LTS ambition could be furthered through regional collaboration such as exchange of information, best practices and expertise and practical

45. As Appendix Table 2 indicates, Lao PDR's previous NDC targets the year 2020 and 2025.

46. Cambodia, Lao PDR, Myanmar are participants of Climate Ambition Alliance pursuing a Net Zero 2050.

mechanisms to mobilise finance and promote technological development and transfer. It is also expected that these efforts to track progress of LTS development at the regional level will strengthen coordinated and harmonised action for raising NDCs' ambition.

Lastly, no regional long-term strategy for mitigation toward mid-century currently exists. Regarding the outlook on energy systems, the ASEAN Centre for Energy (ACE) has published scenarios on energy demand and supply toward 2040, as shown in Figure 16 (ACE, 2017) (ACE, 2020). To date, the 6th ASEAN Energy Outlook (ACE, 2020), which analyses energy demand and related CO_2 emission projections toward 2040, is the only official document to present long-term mitigation strategy scenarios. In order to prepare for a regional long-term climate vision on transition toward net-zero GHG emissions, revisiting the model methods and assumptions of energy technologies such as CCUS and other decarbonising technologies will no doubt be vital steps. In parallel, a long-term regional land system transition strategy needs to be prepared by utilising a novel methodology to assess land system transition.

Table 21. Medium- to long-term mitigation vision, strategies and/or plans aside from NDCs outlined by AMS. For NDCs including those enhanced, please see Appendix Table 2.

Country	Indicative mitigation strategies/plans	Target year	Mitigation areas	Reference
Brunei	Brunei Darussalam National Climate Change Policy (BNCCP)	2035	Nine mitigation strategies: industry, forest, EV, RE, power management, carbon pricing, waste management, carbon inventory, awareness & education	Brunei Climate Change Secretariat (2020)
Cambodia	National Strategic Plan on Green Growth 2013–30	2030	Focus areas for mitigation are: 1) Green Investment and Green Jobs Creation (RE), 2) Green Economy Management in balance with Environment (low carbon emission, green finance procurement), 3) Green Environment and Natural Resources Management (energy efficiency improvement of fossil fuel use, RE in rural areas, green public transport infrastructure), 4) Effective Green Technology Management (trade, transfer, R&D)	National Council on Green Growth (2013)
	National Policy and Action Plan on Energy Efficiency (NPAPEE) 2018–2035	2035	This plan aims to decrease energy consumption and to increase energy efficiency. Specific targets include: By 2035 and relative to BAU, cutting energy consumption by 20% (1 million tonnes of oil equivalent (toe)) and reducing emissions by 3 $MtCO_2$	RGC (2019)
Indonesia	Government Regulation No. 79/2014 on National Energy Policy	2050	Primary energy supply mix share is as follows: 1) new and renewable energy to be at least 23% in 2025 and at least 31% in 2050 2) oil to be less than 25% in 2025 and less than 20% in 2050 3) coal should at minimum be 30% in 2025 and minimum of 25% in 2050 4) gas should at minimum be 22% in 2025 and minimum of 24% in 2050	Government of Indonesia (2016)
	Indonesia Long-term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050	2050	Indonesia set up its long-term strategy to reach net-zero emission by 2060 or sooner	Government of Indonesia (2021)
Lao PDR	National Green Growth Strategy (NGGS)	2030	The NGGS is the main long-term national vision and strategy that translates the Resolution of the 10th Party Congress, Vision 2030, 10-Year Strategy (2016–2025) and the 8th and 9th Five-Year NSEDPs (2016–2020; 2021–2026) into details. The main themes in the NGGS are: i) green cities, ii) sustainable landscape, iii) sustainable energy, iv) cross-cutting issues. There are several targets in 2030 among which are CO_2 emissions per capita (no more than eight-fold that in 2014), proportion of use of clean energy (hydroelectricity, solar energy and wind energy) (40%), and rate of forest cover (70%)	Secretariat for Formulation of National Green Growth Strategy (2018)
	Long-term strategy being prepared	2050	Lao PDR is currently updating its INDC and the long-term target in the NDC update is to be net-zero carbon in 2050	National Report

Country	Indicative mitigation strategies/plans	Target year	Mitigation areas	Reference
Malaysia	National Renewable Energy Policy and Action Plan 2011	2030	Renewable energy capacity target of 3,484 MW realised via large-scale solar, hydro power, biomass, geothermal, and biogas, and FiT scheme	National Report
	Land Public Transport Master Plan	2030	Public transport modal share to reach 40% by 2030, expanding rail transport to greater area	National Report
	National Automotive Policy 2014 and National Electric Mobility Blueprint	2030	Improvement of fuel efficiency vehicles manufactured, use of alternative fuels, 1,683 electric cars and 322,532 hybrid cars by 2030	National Report
	Malaysia Roadmap Towards Zero Single-Use Plastics 2018–2030	2030	The roadmap specifies reduction of plastic pollution and provides guidelines for local industries to adopt eco-friendly alternative production processes. Some measures included uptake of biogas nationwide and federal pollution levy on plastic manufacturers and pollution charge by 2022	National Report
	National Forestry Policy 1978, National Biological Diversity Policy, REDD Plus Strategy	2030	At least 50% of Malaysia's land mass remains forested by 2030 through forest certification scheme, sustainable forest management, and conservation activities	National Report
	Various national plans being prepared	2040	Malaysia has plans to revise its National Energy Policy 2040, Green Technology Masterplan (revision), establishing Low Carbon Mobility Blueprint, National Mitigation Plan, etc.	National Report
Myanmar	Myanmar Climate Change Policy (2019)	2030	It stipulates a 2030 goal in which Myanmar has achieved climate-resilience and pursued a low-carbon growth pathway to support inclusive and sustainable development	National Report
	Myanmar Climate Change Master Plan (2018–2030)	2030	Identified sectoral areas include climate-smart responses in the agriculture, fisheries and livestock sectors to support food security and livelihood strategies through promoting resource-efficient and low-carbon practices; natural resource management to deliver carbon sequestration; low-carbon energy, transport and industrial systems that support inclusive and sustainable development and economic growth; low-carbon development solutions for city dwellers, communities, and economic sectors; and strengthened education, awareness and technological systems to promote low-carbon solutions	Ministry of Natural Resources and Environmental Conservation (2019)
	Myanmar Climate Change Strategy (2018-2030)	2030	It aims to provide a roadmap for Myanmar to materialise the Myanmar Climate Change Policy vision to be a climate-resilient and low-carbon society	Ministry of Natural Resources and Environmental Conservation (2019)
Philippines	Philippine Energy Plan (2018–2040)	2040	The plan consists of sectoral energy roadmaps (upstream oil and gas, coal, downstream oil industry, downstream natural gas, electric power industry, RE, alternative fuels and energy technologies, and energy efficiency and conservation) that set out specific actions and directions to support increasing clean and indigenous sources of energy, improving energy efficiency, and ensuring a balance among affordable energy, economic growth and protecting environment	Department of Energy (2020)
	National Energy Efficiency and Conservation Programme (NEECP) (second version)	2040	The overall objective of the programme (that came into force in April 2019) is to reduce energy intensity and total energy consumption (by 24%) relative to BAU by 2040. The programme targets different stakeholders especially in the transport, industrial, and commercial sectors	Department of Energy (2021)

Country	Indicative mitigation strategies/plans	Target year	Mitigation areas	Reference
Singapore	Singapore's Long-Term Low-Emissions Development Strategy	2050	Singapore aims to halve emissions from its peak to 33 $MtCO_2eq$ by 2050, with a view to achieving net-zero emissions as soon as viable in the second half of the century	National Climate Change Secretariat (2020)
	Singapore Green Plan 2030	2030	This plan is a national sustainability movement which seeks to rally bold and collective action to tackle climate change	Ministry of Sustainability and the Environment (2021)
	Phase out Internal Combustion Engine (ICE) Vehicles & Switching from ICE buses to electric buses	2040	This policy calls for improvement of EVs, electric busses, and related infrastructure and phase out of ICE vehicles in 2040. This policy was announced during Budget 2020 to come into effect in 2040	National Report
	Energy Self-Sufficiency and Sludge Reduction in Used Water Treatment	2060	Part of government plans under the Research, Innovation and Enterprise 2025 (RIE2025) Plan. The RIE2025 Plan has a section on "Understanding, mitigating and adapting to climate change", which states that Singapore will invest in research and development of renewables, low-carbon technologies, novel CCUS technologies, nature-based solutions, multifunctional greenery etc.	National Report
	Singapore's Energy Story	-	This plan outlines the Four Switches which Singapore will harness to work towards a future where energy is reliable, produced and consumed efficiently	Energy Market Authority (2019)
Thailand	Climate Change Master Plan 2015–2050	2050	On the mitigation side, the plan aims to reduce national GHG emissions and develop sustainable low carbon growth modalities, and to raise awareness and capacity to implement climate change related policies and plans at all levels	ONEP (2015)
Vietnam	National Climate Change Strategy	2050	The strategy focuses on improving energy efficiency, changing the fuel structure in industry and transportation, increasing the proportion of new and renewable energy sources and the development of organic agriculture (Michal Nachmany, et al.)	Government of Vietnam (2011)
	National Green Growth Strategy	2050	The orientation to 2050 is in reducing greenhouse gas emissions each year by 1.5–2%	Government of Vietnam (2012)
	Strategy for Vietnam's Low-emission Development and Green Growth by 2050	2050	Targets on RE share in TPES are 15–20% in 2030 and 25–30% in 2045. Targets on energy saving by 7% by 2030 and 20% by 2045. Targets on GHG reductions from energy use are 15% by 2030 and 20% by 2045 relative to BAU	

Source: National reports submitted to ASCCR process and other documents listed above

Strengthening ambition of medium-term plan and long-term vision/ strategies:

Table 22 summarises key gaps, good practices and capacity building opportunities to strengthen the ambition of NDCs and to develop LTS toward net-zero emissions. In order to strengthen the ambition of NDCs, it is vital to continuously encourage administrative, legal, technical and institutional capacity building and collaboration between national government, local government and the private sectors. Access to international funding, policy design and readiness support for the implementation of NDCs were also identified as essential elements. Moreover, coherence of policy is identified as crucial, which implies that fossil fuels are still in an advantageous position in many countries and sectors despite a set of good policy menus for RE policies (e.g. Table 15). Thus, holistic policy design that accurately accounts for relative prices of energy sources, is essential to boost uptake of low-carbon technologies by the private sector.

Meanwhile, to design the LTS, each AMS needs to prioritise specific key sectors and be equipped with the modelling technologies needed to project future energy and land system changes beyond 2050. Furthermore, long-term mitigation strategies require research and development for mitigation technology and redesign of policy to reduce the relative price of RE so that economic sectors can expand RE and other decarbonising technologies.

Section 4 identifies in a more structured manner prioritised actions for how to promote more transparent and transformative actions, which contributes to the progression of ambition of NDCs and development of LTS, as well as enhancement of collective ambition of ASEAN climate actions.

Table 22. Summaries of key gaps, good practices, and capacity building opportunities for strengthening ambition of NDCs and preparing LTS

NDCs/LTS	Gaps	Good practices	Capacity building opportunities
Raising ambition of NDCs	Energy - Lack of budget/funding (main barrier), human resources, and technology due to lack of sound system - Difficulties in replicating and upscaling the programme due to lack of capacities - Lack of policy/regulations regarding RE financing, EE targets for industry and commercial buildings, and emission cap for industry IPPU - Lack of attractive investment scheme for mitigation actions AFOLU - Development of REDD+ strategy - Low implementation rate due to lengthy administration process before obtaining permit and low incentive for the private sector - Constraints on funds and technical capacities	Energy - Green building certification - Social and environmental criteria for public infrastructure investment projects AFOLU - Sustainable management of forest production and forest coverage - Good agricultural practices aiming to increase the productivity and optimised use of fertilizers Overarching - NDC linkages with SDGs with numerical targets to track progress - Enhancement of multiple benefits from developing low carbon pathway - Prioritisation of synergising adaptation and mitigation	Overarching - Continuous administrative, legal, technical and institutional capacity building - Collaboration between national government, local government, and private sectors - Access to international funding - Policy design and readiness support for implementation of NDCs (e.g. MRV, data collection, processing and management for GHGI, modelling of climate, climate change and mitigation, carbon pricing, enhanced mainstreaming of climate change into national and sub-national policies, including through climate action planning tools such as climate risk screening and climate budgeting) - Developing coherent policy
Developing LTS toward net-zero emissions	Energy - Technological change and massive infrastructure development - Cost of decarbonising technologies (e.g., solar, onshore and offshore wind, hydro, bioenergy, and geothermal) AFOLU - Land tenurial/conflict which results in high social/transaction cost and less participation of private sectors in land-based mitigation scheme - Limited research funding from the government due to passive participation from private sectors	Energy - Roadmap of decarbonising technologies deployment that considers already-occurring and expected cost reductions AFOLU - Research spending on crop productivity improvement - Increased land productivity and cropping intensity which leads to lower land demand for crop production, low reliance on natural forest for wood production - Implementation of peatland moratorium policy and peatland restoration to lower pressure on peatland - Implementation of mitigation measures in agriculture (e.g., improvement of manure management and feed supplement, and improved water management in rice field and peatland)	Overarching - Modelling capacity development for long-term projections on mitigation measures which spans 2050 and beyond - Promoting research and development for mitigation technology - Promoting redesign of policy to reduce cost of RE and spur industrial shift to expand RE

Toward the ASEAN climate vision 2050

4

ASEAN
State of
Climate Change
Report

Section 4 sheds light on the ASEAN vision for climate action through 2030 and on to 2050, which is expected to guide the region and each AMS to achieve the long-term PA goals, by identifying key opportunities for coordination and enhancement of climate change interventions in the region. The vision shown in Section 4 comprises a goal for the ASEAN region, and actions (i.e. a transition pathway) to achieve the goals. A diverse set of actions is grouped using the AIIM categorisation, which shows how ASEAN and AMS will periodically raise their ambitions to pursue the PA goals. Priorities among the regional actions for adaptation and mitigation over the next 10 years, together with essential actions for the period 2030-2050, were identified by AMS through a questionnaire survey and consultations. It should be noted that some of these actions have already been implemented by some AMS, but that many actions need to be newly incorporated into regional action plans and national legal frameworks to scale up and accelerate the transition toward the goal. In this way, this section shows how ASEAN can change its course of action to continue enhancing transparency and raising ambitions, and ensure the implementation of actions.

4.1. ASEAN's goal for tackling climate change

4.1.1. Climate change interventions (adaptation and mitigation)

4.1.1.1. Overall goal

Development goals should be incorporated into achievement of any climate change interventions, and thus each AMS has varying official strategies and plans for mitigation and adaptation for the period after 2030, as shown in Section 3 and especially NDCs (Appendix A). Furthermore, other official climate change strategies for adaptation (Table 12) and mitigation (Table 21) can be seen as the baseline, and will inform ASEAN's goals for tackling climate change from the bottom up. At the same time, scientific knowledge on temperature rise and future climate change impacts calls for continuous modification and raising of ambition to fill the gap between the baseline and the PA goal. Accordingly, ASEAN aims to operationalise the collective adaptation and mitigation potential of AMS for climate-friendly and resilient economic transformation. The following components are shared across AMS.

4.1.1.2. Development goal

ASEAN aims to realise the AMS developmental goals shown in Table 4, based on an understanding of the extent of multi-dimensional trade-offs and synergies among the sustainable development goals (SDGs) related to energy security, resources, food, water, safety and climate.

4.1.1.3. Adaptation goal

In contrast to mitigation, there is not a uniform outcome-based goal for adaptation for the ASEAN region and AMS, since adaptation is site-specific, adaptive and process-oriented in nature. However, sectors that are commonly impacted by climate change impacts across AMS aim to set process-oriented and/or outcome-based goals,[47] with reference to the PA goal on adaptation (PA, Article 7.1; see ASCCR, p.24). The adaptation transition will require synergy with the mitigation transition toward net-zero emissions, meaning that adaptation measures should aim to incorporate mitigation measures whenever appropriate, or to take advantage of the potential for mitigation to varying degrees according to the type of adaptation technology.

4.1.1.4. Mitigation goal

Mitigation actions have a clear goal of realising net-zero GHG emissions as early as possible in the latter half of the 21st century, in order to keep the rise in temperature below 1.5–2°C relative to pre-industrial levels. Thus, GHG emissions need to be capped at peak levels as soon as possible after 2030 to ensure the net-zero GHG emission goal is met on schedule. Mitigation actions should aim to incorporate adaptation measures whenever appropriate, which will help to moderate the pressure on adaptation interventions.

4.1.1.5. Goal for synergising adaptation and mitigation

Wherever possible, adaptation interventions should aim for synergy with mitigation synergies in order to drive the ASEAN transformative pathway toward net-zero emissions. For this purpose, climate change adaptation and mitigation need to be integrated using cost-effective solutions that maximise well-being.

4.1.2. AIIM pathway to raise ambition toward the goal

The analysis in Section 3 showed that there are gaps in NDCs' stated adaptation and mitigation ambitions compared to the PA goals, even though several long-term strategies for adaptation and mitigation have already been adopted by the AMS. Recognising the aspirational nature of the PA goals, further action is needed to enhance or upgrade currently implemented policies to support NDCs and relevant strategies and plans (See Appendix Tables 1 and 2). Through national reports, questionnaires submitted during the ASCCR development process and consultations, 41 actions for adaptation and mitigation were identified and prioritised. These actions are categorised into the AIIM groups.

As shown in Figure 2, the "Acquaint" group of actions contributes to enhancing transparency, while the "Integrate", "Involve" and "Motivate" groups would help ASEAN induce transformations in the multiple dimensions of technology, market (scale merit and cost reduction) supply chains and finance. The Acquaint group of actions are especially important for regional cooperation and partnership development to accelerate climate action in the region and meet the NDCs targets, in addition to the Involve group of actions. Importantly, the AIIM groups of actions are meant to contribute to upgrading current national policy and/or establishment of new policy, whether sectoral or cross-sectoral, since the proposed multidimensional transformation is largely led by the enhancement and redesign of national

47. Examples include coastal protection against sea-level rise and urban planning to reduce urban heat island effects, which compound surface warming due to GHGs.

policy. Regional-level AIIM actions explore key opportunities to make the sectoral transitions more impactful for both adaptation and mitigation. Figures 25 and 26 show the specific actions of the AIIM frameworks for adaptation and mitigation, respectively (Specific actions are described in Section 4.2).

Figure 25 shows that climate change adaptation in the ASEAN region can be enhanced by implementing the AIIM groups of actions. The Acquaint group of actions includes promoting risk and vulnerability assessments, and strengthening scientific information base, and thus this group provides an important base for science-based decision making in the region. Similarly, the Motivate group of actions, including setting adaptation goals, finance, and reskilling the workforce, provides impetus to stakeholders to engage in the Involve group of actions. Further, the Integrate group of actions such as formulating adaptation plans enables to integrate all synergistic activities and achieve a harmonious adaptation progression in the region.

Figure 26 shows an overall strategy on climate change mitigation in the ASEAN region toward net-zero GHG emissions. This is achieved by implementing the AIIM groups of actions. The Acquaint group of actions, such as strengthening the information base, tracking regional progress towards the PA long-term goal, and strengthening modelling capacity for long-term projections, provides a basis for science-based decision-making in the region. The Involve group of actions will connect science with policymaking by facilitating science-policy integration and multistakeholder involvement. The Integrate group of actions such as integration of mitigation with air pollution prevention, RE promotion through ASEAN Power Grid, and green recovery, expand opportunities to reap co-benefits across various strategies in an interdisciplinary and transdisciplinary manner. The Motivate group of actions include long-term mitigation goals, business innovation, finance and carbon pricing, afforestation programmes, technology development and diffusion, and reskilling of the workforce (just transition) and as such, this group accelerates transformative actions at the regional and national levels toward achieving net-zero GHG emissions.

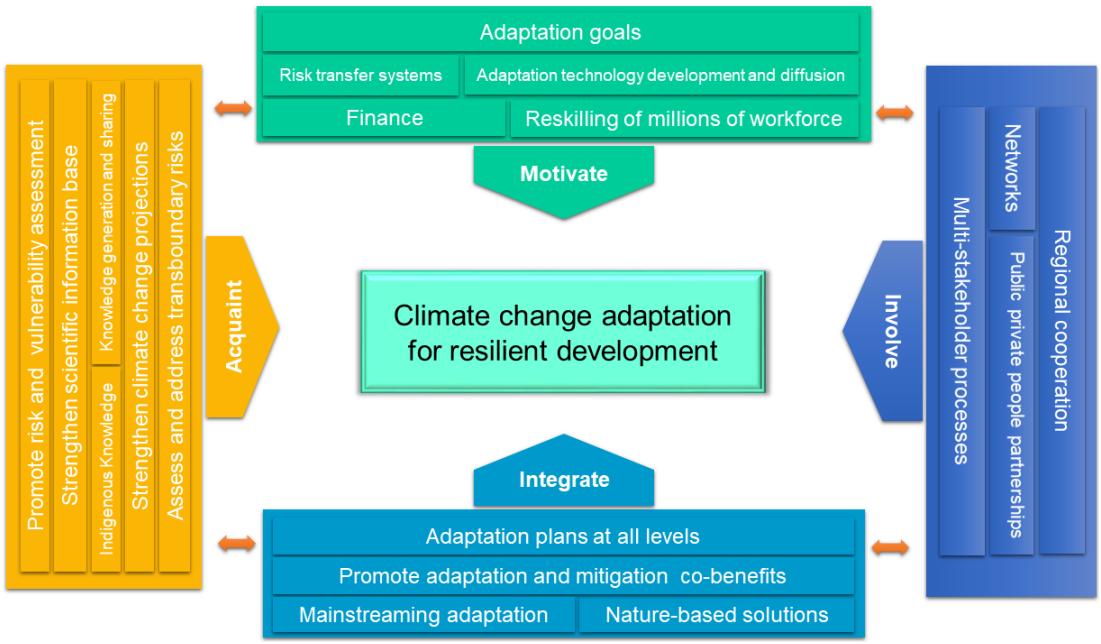

Figure 25.
AIIM (Acquaint–Integrate–Involve–Motivate) framework for achieving the required speed and scale of climate change adaptation in the ASEAN region (Source: Authors)

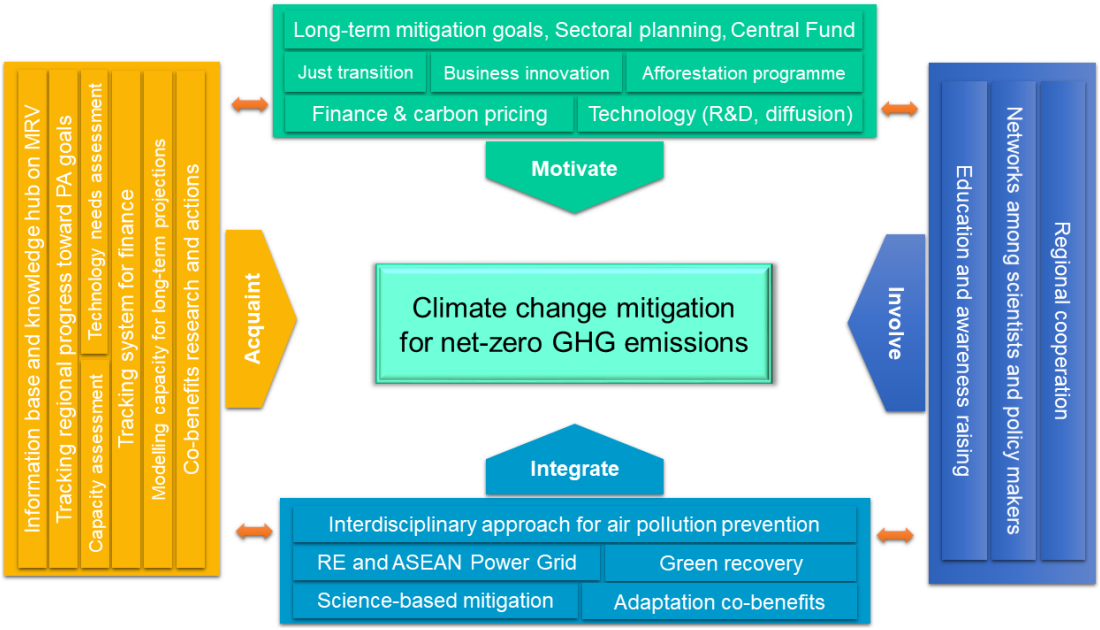

Figure 26.
AIIM (Acquaint–Integrate–Involve–Motivate) framework for achieving the required speed and scale of climate change mitigation in the ASEAN region (Source: Authors)

4.2. ASEAN actions by 2030 and up to 2050

Section 4.2 provides summarised results of the prioritised actions for adaptation and mitigation by 2030 and up to 2050. The prioritisation was done by the AWGCC NFPs in consideration of the AWGCC action plan to the present time. Prioritised actions presented here for the next 10 years, as well as essential actions after 2030 and up to 2050, are based on discussions with AMS through the process to develop the ASCCR. This section envisions what areas of action need to be enhanced at the regional level by 2030, and how ASEAN will need to change its course of action to continuously raise ambition toward the PA goals by realising transformation across regional, national and local scales. These are the areas where there is immense potential for cooperation toward regional action.

4.2.1. Enhancing adaptation: Prioritised actions by 2030

Adaptation needs to take place at all levels, including international, regional, national, subnational/provincial and village levels, as well as in all sectors and across sectors. Hence, adaptation is collective action by all stakeholders, governmental and nongovernmental (UNFCCC, 2016). For adaptation to occur at a rapid pace, it must be made everyone's business. Taking these truths about adaptation into consideration, this section presents priority actions for enhancing transparency and transformation in adaptation under the AIIM framework, which will help to enhance the speed and scale of climate change adaptation in the ASEAN region (Figure 27). The essential qualifications of a transformative adaptation action include its ability to achieve the objective of adaptation within a short time period and to affect a vast geographical area and population, leading to significant changes

Both transparency and transformative actions are necessary for enhancing ambition toward adaptation in the ASEAN region. Accordingly, AMS have identified several transparency and transformative actions for 2030 up to 2050. The process of selecting these actions is described in the methodology section of this report (Section 2.2).

The list of adaptation actions, categorised into transformative and transparency actions, is presented in Figure 27. The actions were prioritised together, and hence the scores for ranking are combined for both groups of actions in the figure. Overall, AMS have chosen to prioritise more transformation actions (18) than transparency actions (11). Multiple actions that received the same scores were also considered to make the list inclusive.

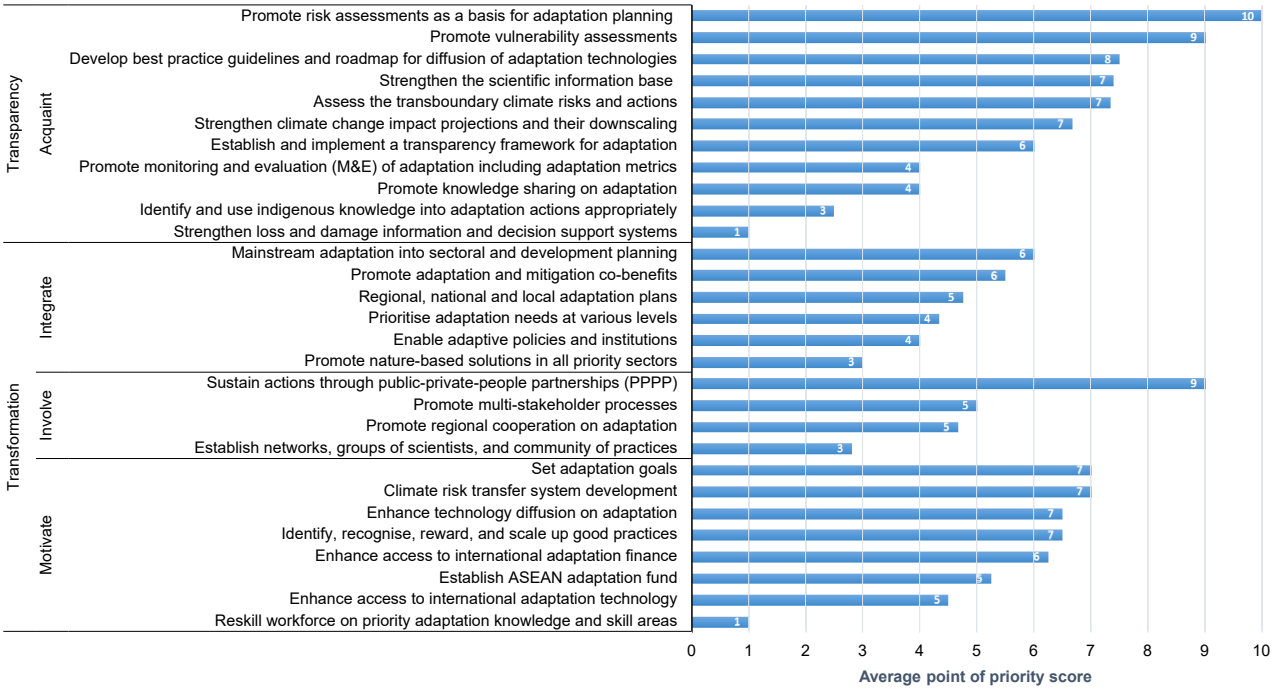

Figure 27.
Prioritised adaptation actions for enhancing transparency and transformation in the ASEAN region by 2030. Source: Authors with the information from a survey for prioritisation made by the AWGCC NFPs of each AMS. Prioritisation was made by scores on a scale from 1 to 10, where a higher score means higher priority.

Table 23 shows the categorisation of these actions according to the AIIM framework. In the rest of this section, these actions are described in detail in terms of what they mean for the region.

Table 23. AIIM framework of actions for promoting transparency and transformation of adaptation in the ASEAN region.

Acquaint	Integrate
1. Assess transboundary climate risks and actions 2. Conduct vulnerability assessments 3. Develop best-practice guidelines and roadmap for diffusion of adaptation technologies 4. Establish and implement a transparency framework for adaptation 5. Identify and use indigenous knowledge in adaptation actions appropriately 6. Promote knowledge-sharing on adaptation 7. Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics 8. Promote risk assessments as a basis for adaptation planning 9. Strengthen climate change impact projections and their downscaling 10. Strengthen loss and damage information and decision support systems 11. Strengthen the scientific information base	1. Enable adaptive policies and institutions 2. Mainstream adaptation into sectoral and development planning 3. Prioritise adaptation needs at various levels 4. Promote adaptation and mitigation co-benefits 5. Promote nature-based solutions in all priority sectors 6. Develop regional, national and local adaptation plans
Involve	**Motivate**
1. Establish networks, groups of scientists, and communities of practice 2. Promote multi-stakeholder processes 3. Promote regional cooperation on adaptation 4. Sustain actions through public-private-people partnerships (PPPP)	1. Climate risk transfer system development 2. Enhance access to international adaptation finance 3. Enhance access to international adaptation technology 4. Enhance technology diffusion on adaptation 5. Establish an ASEAN adaptation fund 6. Identify, recognise, reward and scale up good practices 7. Reskill workforce on priority adaptation knowledge and skill areas 8. Set adaptation goals

Acquaint

The Acquaint group of actions consists of providing the necessary information base for understanding adaptation needs and promoting the efficacy of adaptation actions to be implemented. These actions also provide guidance for decision-making by stakeholders, so that their decisions are based on scientific evidence with minimal room for failure, taking into account the uncertainties involved in climate change decision-making. To this extent, making data and information publicly available and accessible is an essential element of this group of actions.

1. **Promote risk assessments as a basis for adaptation planning:** Risk assessments are the basis for adaptation planning that spans decades into the future. Risk assessments, depending on the methodology employed, take into consideration various climatic, biophysical and socio-economic conditions to project future climate conditions, and estimate the probability of losses for a given level of hazard. Since risk assessments are constructed based on available information at a given point in time, these assessments need to be revised at regular intervals to take into consideration the latest developments in the science and understanding of risk assessments. Such regular revisions help minimise uncertainties over the period and strengthen decision-making. Climate change adaptation planning is multi-sectoral and cross-sectoral, so risk assessments need to be carried out accordingly. At present, climate change risk assessments are well developed for water resources and partly for the agriculture sector, but further advancement is needed for other sectors such as infrastructure, health, and social development. Risk assessments are also well developed for disaster risk reduction (DRR), where historical data often form the basis for risk assessments. However, these risk assessments also need to be integrated with future climate change to provide understanding of the nature and extent of climate

change impacts on risk and associated disaster impacts. Such risk assessments will enable strategic planning by departments responsible for DRR in strengthening preparedness and response planning. Disaster risk assessments have been the basis for disaster risk management plans for several years.

2. **Conduct vulnerability assessments:** While risk assessments already take into consideration underlying vulnerabilities, they are often not comprehensive in that they tend to focus on quantitative assessments, and quantitative risk assessments are not well developed in many fields, especially where qualitative aspects play a major role such as in social and biodiversity impacts of climate change. In places where risk assessments cannot be conducted due to data limitations, vulnerability assessments, especially focusing on qualitative aspects, still provide a more robust and detailed understanding of the underlying factors behind exacerbated climate change impacts in the future. To this extent, adaptation planning can be based on a mix of risk and vulnerability assessments covering a much wider area than risk assessments themselves can cover. In addition, emphasis on understanding vulnerabilities is much more important than risk assessments, as addressing underlying vulnerabilities provides a much more robust approach to adaptation planning than risk assessment-based adaptation planning. Hence, depending on the circumstances, stakeholders in the region should focus on conducting detailed vulnerability assessments, either qualitative or quantitative, and integrate this information into adaptation planning.

   Similar to environmental impact assessments (EIAs), the introduction of vulnerability impact assessments into projects and programmes can ensure that development projects do not exacerbate the vulnerabilities of current and future generations. These vulnerability impact assessments could be integrated into EIAs or implemented separately, depending on the needs of the local context (e.g. when there are no EIAs implemented). Such vulnerability impact assessments need to be introduced at the level of projects and programmes implemented by governments, non-governmental agencies and the private sector. As such, development projects should be able to be implemented only upon satisfactorily meeting the adaptation standards set for the project. Introducing a set of guidelines will ensure that such vulnerability impact assessments and adaptation standards are effectively implemented.

3. **Strengthen the information base:** The information base for adaptation may consist of two broad groups: an information base for decision-making; and any data that is necessary to support scientific research and decision-making. AMS are making steady progress in establishing databases for monitoring of weather, climate data and natural resources including water, land and forests. However, improvements are not yet satisfactory in some ASEAN countries, and there is ample room for regional cooperation to enhance action in these areas especially in the fields of projection of loss and damages, downscaling climate change projections for decision-making at the local level, and strengthening weather observatories across the region. The information base for decision-making could include evaluation of adaptation options for location-specific conditions based on risk and vulnerability assessments, including cost-benefit and other multi-criteria analysis techniques.

4. **Assess transboundary climate risks and actions:** The ASEAN region is rapidly integrating, and such regional integration provides both economic opportunities and risks. In terms of risks, growing economic dependency across borders can worsen transboundary climate risks. Considering the examples of the 2008 world food price crisis and the more recent Bangkok floods of 2011, it is evident that risks are no longer limited by national boundaries. This is increasingly apparent for the ASEAN region. Taking into consideration the future regional integration prospects of the ASEAN region, it is recommended that the region conducts thorough transboundary climate risk assessments in areas of transboundary biophysical resources, human mobility, food trade, energy and biodiversity, as these tend to act as conduits of risk transfer from one location to another. In addition to such

risks, adaptation actions by some countries can have severe negative impacts on other countries, as in the case of transboundary rivers. Hence, adaptation in the region needs to be much more regionally coordinated. The understanding generated from transboundary risk assessments can inform the region in its development of a regional adaptation plan that bridges the gaps not covered by national adaptation plans (NAPs) and addresses climate risks holistically.

5. **Strengthening climate change and impact projections:** Climate change projections are necessary for understanding future climate change impacts at the national and sub-national levels, and at individual sector levels. Countries are making progress in upgrading their skills for climate change projections, but there is a need to bring this knowledge from international and regional sources to national institutions. Areas such as dynamic downscaling of projections to the local level, deepening understanding of uncertainties involved in climate change projections, and using this information for effective communication with the end-users still need greater attention in the region. Climate change impact assessments are relatively well developed in the areas of water resources, and food and agriculture. Other areas still need to be strengthened, such as loss and damage projections due to extreme events, health risks and projection of impacts on infrastructure.

6. **Transparency framework for adaptation:** As a multi-stakeholder and multi-sectoral intervention, adaptation needs to establish sufficient safeguards to ensure transparency of action by all stakeholders in order to ensure that all activities contribute to nationally-determined adaptation goals. The transparency framework provides regular reporting of actions based on a set of agreed indicators to a central authority and makes this information widely available to inform and encourage further action. Essentially, the transparency framework encompasses, but is not limited to, elements such as monitoring and evaluation, adaptation goals and adaptation performance standards.

7. **Knowledge generation and sharing:** Adaptation is a technical issue that relates to implementing solutions that work in a wide range of timeframes from today and into the future. Many adaptation solutions may have to be implemented in contexts where prior knowledge and experience is limited, and in areas where it is difficult to implement adaptation due to limited climate change signals. This makes adaptation planning a challenging task, especially when there is no evidence that adaptation solutions are effective. There needs to be more research to identify adaptation solutions that are demonstrated through robust scientific evidence and take note of other considerations such as indigenous knowledge. Adaptation is a rapidly evolving area, and there is a need to incorporate this knowledge into education and capacity building processes so that it will be accessible and usable to support decision-making by various stakeholders. A centralised knowledge repository for adaptation may not be within the practical limitations for the ASEAN region, although such a knowledge repository could be facilitated by the ASEAN Secretariat. Countries, however, need to put in place a reliable process to constantly screen, synthesise and share new knowledge with necessary stakeholders and decision-making processes. At the international level, these processes are undertaken by bodies such as the Intergovernmental Panel on Climate Change (IPCC). Institutions at the regional and national level should be better enabled to carry out this work. The region must find better ways to incorporate new knowledge into education curricula, use new knowledge to update risk assessment and adaptation planning processes, and further apply this updated knowledge to research and solution creation.

8. **Monitoring and evaluation:** The Adaptation M&E is necessary to keep track of progress, to make course corrections if necessary, and to help understand whether adaptation actions have resulted in intended outcomes

and avoided maladaptation. Since quantifying adaptation outcomes can be challenging, progress in developing an M&E framework has been slow. As a result, no precise M&E mechanisms are in place in many ASEAN countries. Countries use processes such as NDCs, NCs and NDCs to take stock of progress each time they develop these reports for reporting to various processes under UNFCCC. However, some existing ad hoc mechanisms are being used for M&E purposes. These measures rely on project reporting by implementation agencies to national and local governments, databases, financial tracking mechanisms etc. Among these, financial tracking can be said to be well developed as it has been perfected over many years of implementing developmental programmes funded domestically and internationally. This indicates that there is ample scope for developing an M&E framework for adaptation in ASEAN countries. The mechanisms and tools developed for monitoring natural resources make use of observations based on remote sensing, weather and climate records, climate investment tracking measures, climate budget tagging and natural disaster databases, and serve as an entry point to develop an M&E system for adaptation in ASEAN countries. M&E has to accompany a strong information disclosure regime to promote transparency.

9. **Loss and damage assessments:** Most countries in the ASEAN region have national databases of disaster losses. These databases often cover economic, infrastructure and human losses and should be strengthened for non-economic losses and damage. Further, loss and damage projections in various future climate change scenarios have not yet been formulated, and there is ample scope for cooperation with international and regional knowledge institutions so that assessments are developed for the individual priority sectors.

10. **Best practice guidelines for scaling up good practices:** Good practices are essential to provide evidence of effectiveness, showing that such practices can be implemented and similar benefits can be obtained elsewhere, as well as provide confidence to implement effective adaptation and avoid maladaptation. The ASEAN region has several good practices often implemented in small pockets, and these good practices need to be recognised, systematically documented, and shared widely within the region and beyond. The ASEAN Secretariat can initiate programmes to create an in situ clearinghouse that can perform such functions.

11. **Indigenous knowledge:** Indigenous knowledge has been historically developed through an understanding of how humans and nature interact with the climate. The climate in years to come may not be the same as it was in the past, and so past experiences may not always hold in the future. An understanding of the evolution of indigenous knowledge can help us to grasp the contexts in which certain practices evolved, how and why they are effective, and how they have been sustained. This can provide important insights into designing sustainable and location-specific new interventions that benefit from appropriate local knowledge.

Integrate

The Integrate group of actions aims to achieve holistic adaptation by recognising that adaptation is an inter- and multi-disciplinary action, requiring seamless integration and efforts by faculties, ministries and stakeholders.

1. **Adaptive policies and institutions:** Adaptation deals with ever-changing baselines and uncertainty about how climate change may manifest in the distant future, as well as the constant evolution of understanding climate change, human responses and how effective these responses are over time. However, adaptation is expected to be implemented by institutions and policies that are rigid and not designed to accommodate new knowledge and experiences. For this reason, it must be guaranteed that institutions and policies are adaptive in

nature, i.e. that they have built-in mechanisms to absorb new knowledge and evidence to change the course of action if necessary. It may, however, be difficult to expect institutions and policies to be adaptive since they are embedded within their own sociocultural contexts.

2. **Mainstreaming climate adaptation into development planning:** The scale and depth of climate change impacts are considerable and call for integrating climate change adaptation into a range of development sectors at the national and sub-national levels. Such mainstreaming entails an iterative process of integrating climate change adaptation considerations into national policies, budgeting, implementation and monitoring (UNDP and UNEP, 2015). Mainstreaming has several advantages, one of which is to maximise synergies and reduce the overall cost of adaptation. While adaptation planning provides overall guidance to adaptation at the national level, integration of adaptation considerations at sub-national and sectoral levels requires clear guidelines and operational procedures. One example of integration of climate change into development planning is in the area of poverty reduction strategies, where it is included in national and sectoral development plans etc. Mainstreaming adaptation will enable adaptation to be a multi-sectoral and multi-stakeholder process, as all stakeholders engaged in development are obligated to pursue adaptation as called upon by specific development plans and policies. Mainstreaming also requires considerable cross-sectoral coordination. Several AMS have developed sound institutional mechanisms for both climate change adaptation (CCA) and DRR. Some have put in place robust guidelines on how to coordinate these mechanisms, while many others are yet to make progress in this area. There is a need to strengthen cooperation and coordination between CCA and DRR to harness benefits such as learning from the extensive experience gained in the field of DRR.

3. **Prioritisation of adaptation needs at all levels:** Adaptation planning processes currently identify adaptation needs at the national and, to some extent, at the sub-national level. However, these adaptation needs should be identified at village, city and provincial levels. All adaptation needs identified at the local level should be well linked and recognised at higher levels, ensuring that sufficient resources are allocated through planning processes. Since adaptation planning at the local level is still in its nascent stages, and the idea of prioritising adaptation needs at the local level will hasten the adaptation planning process eventually, establishing adaptation plans at various levels will ensure that such adaptation needs are identified, recognised and addressed.

4. **Promotion of adaptation and mitigation co-benefits:** Adaptation and mitigation are intricately related at the level of implementation of practices on the ground. There are several economic sectors that are vulnerable to the impacts of climate change but at the same time are contributing to climate change through high GHG emissions. For example, the agriculture sector is a significant GHG emitter and is also highly vulnerable to climate change impacts. The energy sector is primarily seen as a GHG emitter, but it can be highly vulnerable to climate change impacts depending on the location and condition of its infrastructure. Hence, to varying degrees, adaptation to climate change is relevant to almost all of the economic sectors that have been traditionally focused on mitigation. A co-benefits approach could be further applied to synergistic benefits between adaptation and sustainable development as well. The co-benefits approach has been developed as a synergistic approach to maximise both the adaptation benefits of mitigation actions and the mitigation benefits of adaptation actions. This framework also enables identification and implementation of practices that provide advantages to varying degrees depending on the need. For example, climate-smart agriculture addresses climate change impacts while mitigating GHG emissions. Emissions reduction in households and a shift to renewable energy-based transportation can provide health benefits in terms of indoor and outdoor air pollution with resilience implications. It will be prudent for the ASEAN region to identify appropriate technologies that provide both

adaptation and mitigation co-benefits in priority sectors, so that the region can achieve adaptation and mitigation at minimal cost.

5. **Nature-based solutions (NbS):** Historically, human beings have been reliant on nature for various products and services. Nature provides an important source of resilience for communities and countries to absorb shocks from future climate change. Hence, well-functioning nature is in the interest of human well-being. Unlike hard infrastructure, NbS, including ecosystems-based adaptation (EbA), can provide multiple benefits and are more sustainable. They can combine GHG mitigation and adaptation benefits and provide various ecosystem services including livelihood and health benefits among others. In fact, safeguarding nature is not exclusive to human development; rather it is at the centre of human welfare, and it is essential to recognise the importance of nature in the fight against climate change. Examples of NbS include urban forests, protecting forests and wetlands, sustainable grassland management, sustainable agriculture, and changes in food habits toward environmentally-friendly diets, ecological restoration. NbS could inspire a radical change in our approach to prioritising solutions in agriculture, infrastructure development, urban planning, energy, and transportation fields. There is a need to assess the potential of NbS in all sectors, develop guidelines to assist countries in implementing them, and build the capacity of stakeholders engaged in implementing solutions.

6. **Regional, national and local adaptation plans:** Adaptation plans can incentivise organisations and individuals to implement a set of activities in a concerted manner, contributing to adaptation goals. ASEAN countries are still drawing up their NAPs, and these need to be strengthened with new evidence suggesting the transboundary impacts of climate change. There is also a need to encourage sub-national adaptation planning and links with sectoral and organisational adaptation plans, including the private sector. Such multi-level adaptation governance will ensure engagement of multiple players at appropriate levels, bring new knowledge to adaptation, and ensure that bottom-up and top-down approaches work in tandem. Community-based adaptation planning is a powerful tool that can put adaptation in the hands of local communities and empower them to take action at the individual level, as well as build their capacity to respond robustly to climate emergencies. Countries in the ASEAN region are making progress with community-based disaster risk management (CBDRM) plans, and there is a need to transition to community-based adaptation planning. This requires capacity building and the sharing of good cases and experiences that can be emulated across the region.

Involve

The Involve group consists of actions that recognise the importance of multi-stakeholder processes to realise adaptation in its full scale and depth.

1. **Multi-stakeholder processes:** Adaptation requires cooperation from various stakeholders, as adaptation objectives cannot be met by governments alone. This requires the constant engagement of different stakeholders at every step of adaptation planning and implementation at regional, national and sub-national levels. Identifying appropriate actors, allocating responsibilities, capacity building, and ensuring that these responsibilities are regularly monitored and that progress is shared can ensure that adaptation becomes a collective objective. Public-private partnerships are essential mechanisms that need to be tapped to enhance adaptation actions. Since adaptation has to take place in various contexts and involves multiple stakeholders, the sustainability of solutions is dependent on capturing the location-specific conditions within which solutions have to work, and understanding the capacities and vulnerabilities of local stakeholders who would benefit from these solutions. Collective action should be promoted, including co-design and co-production, emphasising

the importance of participatory approaches in designing and implementation of solutions for them to be highly effective and long-lasting. Such collective actions will enable effective vertical and horizontal integration and coordination of adaptation.

Promotion of community-based adaptation planning is to be especially prioritised, as it will bring knowledge of and responsibility for adaptation to the grassroots level. For this to happen, adaptation must be brought down to the local government level instead of being driven in a top-down fashion from the national to sub-national level. This requires empowering local institutions and providing them with appropriate mandates. Adaptation in most countries is a matter for the environmental ministry which often has the least power to influence other ministries. Inter-ministerial groups are set up for climate change matters and are usually hosted by environmental ministries and departments. However, the decisions made by these groups do not necessarily have sufficient power to influence individual ministries and departments. Countries are overcoming such power issues by establishing empowered groups of ministers or by putting such inter-ministerial groups under the direct purview of their prime ministers. Such actions will empower the agenda of adaptation itself at the national level. However, at the sub-national level, the picture is entirely different, where national resources often take precedence and allocation of resources for adaptation from sub-national resources is usually negligible.

2. **Networks, groups of scientists and practitioners:** Networks of professionals and groups of scientists and practitioners can play a role in knowledge generation and sharing and creation of solutions, which can in turn help with infusion of knowledge at the regional level and the development of knowledge and technology innovation. Regional networks such as the Asia Pacific Adaptation Network (APAN) are working on this across Asia as a whole, but there also needs to be a strong network of professionals focused on the ASEAN region specifically. Novel examples of stronger networks include the ASEAN Specialised Meteorological Centre, which can be a platform for climate scientists to network with practitioners on climate adaptation activities.

3. **Regional cooperation:** Regional cooperation is essential in a highly integrated region like ASEAN for two reasons. First, adaptation interventions by one country can have a negative impact on other countries in the region. Second, climate change vulnerabilities in one part of the region can expose other countries to climate change risks as a result of cascading impacts that spill across borders through supply chains and biophysical resource flows. Climate change impacts cross boundaries, and adaptation actions by an individual country can have a significant effect on others. Hence, there is a need for coordinated responses at the regional level so that isolated responses to climate change by one country do not have negative impacts on others. Further, since regional integration is progressing at a rapid pace across ASEAN, cooperation is essential to ensure that climate change vulnerabilities in one location do not affect the rest of the region.

4. **Public-private partnerships:** The public sector is largely comprised of governments, and is responsible for the single largest investment in adaptation. However, public sector resources alone cannot provide sufficient adaptation funding and technology for the region. This is where ASEAN needs the private sector to participate in adaptation. Private sector engagement in areas such as risk insurance, innovative financial instruments, weather and climate data services, resilience infrastructure, energy and transportation has high potential in the region. The private sector is well placed to work between communities and governments, where projects can be operationalised that are not financially possible otherwise, through finance-build-operate-transfer schemes and others, in areas such as infrastructure, drinking water supply plants etc. Further, the private sector in the region also needs to work on its own climate readiness by assessing how investments are affected by climate risks. These could include supply chain risks, production risks and market risks which are all exacerbated by climate change.

Motivate

The Motivate group of actions is aimed at providing necessary incentives to individuals, groups and industries to take necessary action on adaptation. The debate on incentivising adaptation is split between those in its favour and those against it. However, the region has to take a balanced approach so that incentivising does not stop at providing financial support, but rather leads to more harmonised and synergistic outcomes.

1. **Climate insurance policy and risk transfer system development in the ASEAN region:** With climate change impacts projected to increase by orders of magnitude in the future, there is immense economic pressure on governments. Governments in the region spend millions of dollars in loss compensation, relief, resettlement and reconstruction in the aftermath of natural calamities, and a major proportion of this burden can be reduced if risk insurance schemes can be designed targeting specific vulnerable groups and regions. Risk insurance can help to enhance the potential of public-private partnership in addressing some of the chronic issues associated with poorly-realised development and, if designed appropriately, can incentivise individuals and corporations to take risk-aware decisions as opposed to risk-averse or risk-seeking behaviour. Two kinds of risk insurance systems need to be developed in the region: (i) regional insurance facility that can cover the catastrophic losses of countries; and (ii) strengthened risk insurance in specific vulnerable sectors such as agriculture, home and infrastructure insurance. To this end, the ASEAN+3 countries, including China, Japan and the Republic of Korea, came to an agreement to set up a Southeast Asia Disaster Risk Insurance Facility (SEADRIF) at a Finance and Central Bank Deputies Meeting in December 2018 in Busan, Republic of Korea. This sets a very good precedent for the region to develop a regional risk insurance facility that can further strengthen risk insurance development within each AMS. In terms of agriculture insurance, countries such as the Philippines, Indonesia and Thailand provide good experiences that other countries can emulate. With the emergence of weather index insurance products, there is now an opportunity to develop reliable insurance products that can trigger at an appropriate time and provide adequate financial support to the affected areas with minimal cost of implementation. Based on ample experience in the region, governments in the region can scale this up based on existing good practices.

2. **Adaptation goals:** Currently there are no clearly-stated adaptation goals by any AMS. However, some AMS, including Indonesia, have indicated they have ongoing discussions on setting adaptation goals. Two kinds of adaptation goals are being pursued by AMS currently: outcome-oriented adaptation goals, and process-oriented adaptation goals. Examples of the former include reduction of loss and damage by certain percentages, or reduction of societal vulnerability by a certain number of units. The latter could include establishing regional cooperation mechanisms or putting in place adaptation plans, conducting risk assessments etc. There appears to be a general support for process-oriented adaptation goals over outcome-oriented adaptation goals among AMS. Adaptation goals should be supported by monitoring and evaluation as discussed earlier. Countries do have clear mitigation goals, but adaptation goals are not as clearly articulated as mitigation goals either nationally or internationally. Adaptation goals are locally and nationally relevant, but can be regionally coordinated for M&E purposes so that the region as a whole can move together in achieving them. ASEAN countries can benefit from establishing measurable and verifiable adaptation goals. Goals can incentivise adaptation actions and can facilitate innovations in behaviour at the individual and organisation levels, and thus guide and sustain progress. Goals can also help allocate appropriate burdens and responsibilities to relevant stakeholders, sectors and geographical regions. Adaptation goal setting and adaptation metrics are closely linked, as countries need to be able to measure their progress.

3. **Reward and recognise good practices:** Adaptation to climate change is a new paradigm for many stakeholders, and the available experiences at the local level may not be sufficient to manage future climate change impacts that may be new to them. Hence, identification of practices that have worked elsewhere can provide a good resource, cut down the time needed for innovation, and provide evidence that practices are widely feasible. For these multiple benefits, the systematic identification of best practices is necessary to scale up adaptation to the next level. Such systematic identification of best practices comprises documenting the socioeconomic, geographical, climatic, institutional and technological environment within which the practices succeeded, and potential areas where they can be implemented based on their past success. In this way, the region can develop a technology landscape that is not only based on past experience but also superimposes future climatic conditions. Recognition of good practices is already taking place in many ASEAN countries, e.g. through the Climate and Disaster Resiliency Recognition Award and Gawad Kalasag awards in the Philippines. Such awards will advance best practices and motivate institutions and individuals to take initiative in areas of importance. Such practices may be promoted across the region.

4. **Enhance access to international technology and its diffusion for adaptation:** Access to adaptation technology is an important issue for the ASEAN region, as many countries in the region are highly vulnerable to climate change impacts and technological development is still in its nascent stages. Access to new and emerging technologies in areas of climate change risk assessments, impact projections, downscaling climate change projections, developing drought- and flood-tolerant crop varieties, developing climate-smart infrastructure including urban dwellings that are energy efficient yet resilient to climate vagaries, coastal infrastructure development, extreme event mitigation and management, early warning systems and disease surveillance are all essential for the region. In addition, soft technologies for policy-level decision-making are yet to be developed. Decision support systems that can work in complex environments need to be tailored to location-specific conditions in the region. Multi-criteria decision support systems including cost benefit analysis for adaptation solutions, loss and damage mitigation and overcoming data gaps are some of the cross-cutting areas the region can benefit from.

5. **Enhance access to international adaptation finance:** Adaptation finance at the global level is highly fragmented, requiring national entities to prepare proposals targeting different donors and fund streams each with different guidelines and procedures, often involving considerable bureaucracy. This means that there is a need to build the capacity of national stakeholders to prepare effective proposals while lobbying to streamline multilateral and bilateral adaptation fund proposal formalities. A considerable amount of ODA funds are diverted to climate change adaptation, and this could mean a reduction in funds available for development, although there is still a significant shortage of adaptation finance. This problem could be addressed with effective mainstreaming practices that can maximise synergies and minimise costs. On the domestic front, good practices are essential. These include as fiscal management, improving the efficiency of national budgeting, private sector engagement, and mainstreaming climate change considerations into various laws and guidelines related to infrastructure, food production and consumption, and manufacturing of goods. This will pass part of the burden to a section of the public who may be capable and willing to pay for adaptation costs without undue burden on the poor and vulnerable. Insurance is one such instrument that can spread the risk while minimising the burden on individuals, although, despite these stated benefits, insurance is yet to reach its potential in terms of coverage in Asia. National policies need to be drawn to incentivise insurance in the areas of agriculture and urban infrastructure.

6. **Establish an ASEAN adaptation fund:** The ASEAN region is made up of a diverse group of countries that are at different levels of economic and social development. The countries also have a diverse profile in terms of disaster and climate risks. An extreme event in some of the vulnerable countries of the region could easily overpower their resistance capacities, significantly crippling their ability to recover quickly and adequately. In addition, due to economic integration in the region, these impacts can severely affect other nearby countries through trade and other linkages. Hence, it is in the best interest of ASEAN countries to work together by taking into consideration the economic, technological and DRR capacity diversity in the region. Establishment of an ASEAN regional adaptation fund could make adaptation a regional agenda, help build solidarity, help address transboundary climate risks that individual country adaptation planning may not be able to address, and make easily available new resources that countries need. The desired operational modality for such a fund can be mutually determined, although there are some precedents, including the Adaptation Fund under the Conference of Parties (COP). This regional adaptation fund could be financed through proceeds generated from a future regional carbon-trading mechanism and support from multilateral and international financial sources.

7. **Reskilling millions for a workforce engaged in climate-sensitive sectors:** Since adaptation is a technical problem and new technologies and solutions are constantly being developed, adoption of these technologies calls for skill enhancement in millions of workers engaged in agriculture, urban planning, water resource management, disaster risk reduction, governance and others. There is no systematic and comprehensive capacity needs assessment for the current workforce in the government and private sector. The first step for the governments in the region is to understand the existing skill-sets and the skills needs, and then to design capacity-building interventions that reach out to the applicable workforce. Similarly, there is also a need to upgrade the curriculum of the professional and non-professional courses so that educational institutions produce a capable future workforce. One of the important aspects of capacity building is to train workers to make decisions despite the uncertainty that climate change brings to their work domains.

4.2.2. Enhancing adaptation: How ASEAN needs to change its course of action toward 2050

Prioritised adaptation actions by AMS for the periods up to 2030 and 2050 are summarised in Table 24, which shows the course of ASEAN's actions. Necessary actions by 2050 were selected through consultation with NFPs at the 3rd regional meeting, based on scientific knowledge on future temperature rise and possible impacts upon the region. The difference between the 2030 and 2050 actions is in terms of raising ambitions. Through 2030, AMS are expected to focus on implementation of these activities in priority geographical areas and sectors (refer to Table 10 for the priority sectors). However, for 2050, AMS may consider expansion of these actions to cover the rest of the country and the entire ASEAN region. With this approach, the AMS will be able to gradually build their capacity to scale up actions to all of ASEAN by 2050.

Table 24. ASEAN's prioritised adaptation actions to enhance transparency and progress ambition through achieving multi-fold transformation through 2030 and on to 2050

Adaptation actions	By 2030	By 2050
Transparency		
Promote risk assessments	Develop necessary capacity, strengthen data and capacity to use information. Cover all priority geographical areas and sectors for risk assessments	Complete all geographical areas and sectors covered under risk assessments. Continue to conduct risk assessments and promote decisions based on risk assessments
Promote vulnerability assessments	Focus on all priority geographical areas and sectors. Develop necessary capacity at all levels.	Complete all geographical areas and sectors including capacity building.
Strengthen the scientific information base	Strengthen databases, establish seamless information sharing systems and protocols	Continue to strengthen the information base updating with the new developments
Assess the transboundary climate risks and actions	Build the awareness of stakeholders, identify priority sectors and areas for transboundary risk assessments, develop case studies of TBRs and adaptation planning	Mainstream transboundary climate risk information into regional, national and sub-national adaptation planning
Strengthen climate change impact projections and their downscaling	Focus on capacity building of all relevant staff, develop cases for priority departments and sectors, integrate into curriculum, develop guidelines for local level implementation. Underlying uncertainties are documented and understood	All departments and ministries are able to conduct and use climate change impact projections, uncertainties are well understood and addressed
Establish and implement a transparency framework for adaptation	Stakeholders are fully aware of the importance of transparency, transparency framework is established, basic tenets of transparency are implemented	Transparency framework is fully implemented with full support from all stakeholders.
Promote knowledge sharing on adaptation	Establish knowledge sharing platforms accessible to all relevant stakeholders for all priority areas, with a clearing house at appropriate level	All stakeholders have properly vetted information sources on adaptation for decision making at all levels
Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics	Develop M&E methodologies for priority areas and use case scenarios of adaptation, develop best cases, use M&E for strengthening adaptation	Continue to implement M&E, synergise with the adaptation goals at the national and global levels
Strengthen loss and damage information and decision support systems	Strengthen L&D databases, develop L&D methodologies especially for the non-economic L&D, build capacity of stakeholders to use L&D information to strengthen adaptation	Continue to strengthen L&D and related decision support systems, evaluate adaptation efficacy for the projected L&D
Identify and use indigenous knowledge in adaptation actions appropriately	IK is understood, their relevance to the new climate regime is appreciated, and IK-based adaptation solutions are identified and implemented	IK continues to provide necessary solutions to adaptation issues
Develop best practice guidelines	Establish a database of best practices, analyse best practices and provide synthesis of lessons, develop tools for stakeholders to choose best practices for a given location	Continue to promote best practices and continue to update the guidelines based on the experiences. All stakeholders are now able to implement adaptation with full understanding on their efficacy

Adaptation actions	By 2030	By 2050
Transformation		
Sustain actions through public-private-people partnerships (PPPP)	Establish enabling environment for sustaining PPPP, identify and develop best cases for PPPP, document best cases	Continue promoting PPPP with an aim to strengthen the government systems
Climate insurance policy and risk transfer system development	Promote private sector involvement in insurance, incentivise insurance programs for the poor and vulnerable, focus on priority areas such as agriculture, flood and drought prone areas etc. Build capacity of stakeholders to understand insurance	Insurance products are highly specialised and diversified with all stakeholders fully aware of advantages of insurance
Set adaptation goals	Establish dialogue among stakeholders on the nature of adaptation goals, identify quantifiable and verifiable adaptation goals for priority sectors and regions, build capacity of stakeholders on measuring and verifying the status of adaptation goals	Adaptation goals are well integrated into development planning, adaptation goals at the national level are percolated to the sub-national level and are in harmony with the global goals of adaptation
Identify, recognise, reward, and scale up good practices	Establish mechanisms to identify, recognise and reward good practices, identify factors for scaling up good practices, stakeholders appreciate and participate in promoting good practices with initial reward regime	Move away from financial reward regime for scaling up, recognition of adaptation best practices is well developed among stakeholders
Enhance technology diffusion on adaptation	Develop an adaptation technology landscape for priority areas showing technology needs, availability, and gaps, sources and opportunities, provide incentive schemes for technology development and diffusion. Develop best cases for technology adoption.	Technology development is at its peak with seamless dissemination and no hurdles in technology adoption
Enhance access to international adaptation finance	Develop an adaptation finance facility at the national and regional level to facilitate easy access to international finances, improve the quality of public finance management, build the capacity of countries to access international finances	Reduce dependency on international finances with greater reliance on national finances and increased adaptive capacity
Mainstream adaptation into sectoral and development planning	Develop guidelines for mainstreaming adaptation into priority sectors, develop case studies focusing on mainstreaming, build the capacity of stakeholders in mainstreaming	All sectors and ministries are mainstreamed with adaptation solutions, stakeholders are fully capable of integrating climate change adaptation into sectoral and development planning
Promote adaptation and mitigation co-benefits	Develop methodologies to evaluate adaptation co-benefits of mitigation actions and vice versa, build capacity of stakeholders, identify appropriate solutions for maximising synergies	Adaptation and mitigation synergies of solutions are fully understood and utilised in the policy and implementation spaces
Establish ASEAN adaptation fund	ASEAN Adaptation Fund modalities are framed, implementation mechanism agreed and fund is operational	Adaptation fund is fully operational and become a significant funder of adaptation in the region
Promote multi-stakeholder processes	Multi-stakeholder platforms and processes are well established in priority areas of adaptation, CBDRM and CBA plans are created at the local level, PPP partnerships are strengthened	Multi-stakeholder processes are well established
Formulate ASEAN regional adaptation plan	Dialogue on regional adaptation planning initiated, modalities and resources for implementation of regional adaptation plan identified, regional adaptation planning initiated	Regional adaptation planning operational with a good synergy with the national adaptation plans
Promote regional cooperation on adaptation	Regional cooperation on adaptation is strengthened through various mechanisms under the ASEAN including those discussed above	Regional cooperation on adaptation is well developed with sharing of financial, technological and human resources for the benefit of the region

Enhance access to international adaptation technology	Adaptation technology needs are assessed, sources are identified and necessary mechanisms to channel new technologies are implemented	Adaptation technologies are tried and tested within the region, the region develops good capacity to develop its technologies
Prioritise adaptation needs at various levels	Adaptation priorities are identified at all levels, synergies across levels and regions identified and resources are allocated for priority areas and needs	Adaptation needs are well recognised at all levels, adaptation needs are well supported at all levels
Enable adaptive policies and institutions	Capacity building of institutions in the region for their adaptiveness, adaptive policies are understood and formulated	Institutions and policies are increasingly adaptive with ability to absorb new experiences
Promote nature-based solutions (NbS) in all priority sectors	Nature-based solutions are evaluated for their efficacy, NbS are integrated, where feasible, into various adaptation interventions, stakeholders capacity is improved in NbS	NbS form an important part of adaptation strategy in the region
Establish networks, groups of scientists, and community of practices	Networks such as AP-PLAT, APAN strengthen their relevance and reach within the ASEAN region, stakeholders are well connected through various networks	Networks contribute to adaptation solution development and their relevance to local needs continue to be strong
Reskill workforce on priority adaptation knowledge and skill areas	National roster of trainers, training of trainers are created, training needs assessments are completed at national and sub-national level, centers of excellence at the regional and national level contribute to the capacity development	Capacity building frameworks are well established, countries have strengthened their skill and knowledge resources, there is a reduced dependency on external resources

4.2.3. Enabling environment to enhance transparency and transformation in adaptation actions

The necessary enabling environment for enhancing adaptation ambition in the region can be divided into three broad categories of support, i.e. technology, finance and human resources. The AMS believe that the region in general requires marginally more emphasis on finance and human resources and less support on technology (Figure 28; see Appendix B for method). This is a general observation across all types of adaptation actions prioritised by the AMS as presented in the previous section.

As Figure 28 shows, among the AIIM groups of actions, AMS have the most capacity for the Involve group of actions, as these require the least technology, finance and human-resource capacities to promote. This is followed by the Integrate group, where the AMS have relatively high capacity. However, the Motivate and Acquaint groups of actions require the highest technology, finance and human-resource support. Among these groups of actions, the share of support sought between technology, finance and human resources remained more or less equally distributed, while relatively higher finance support was sought for the Motivate group (31%).

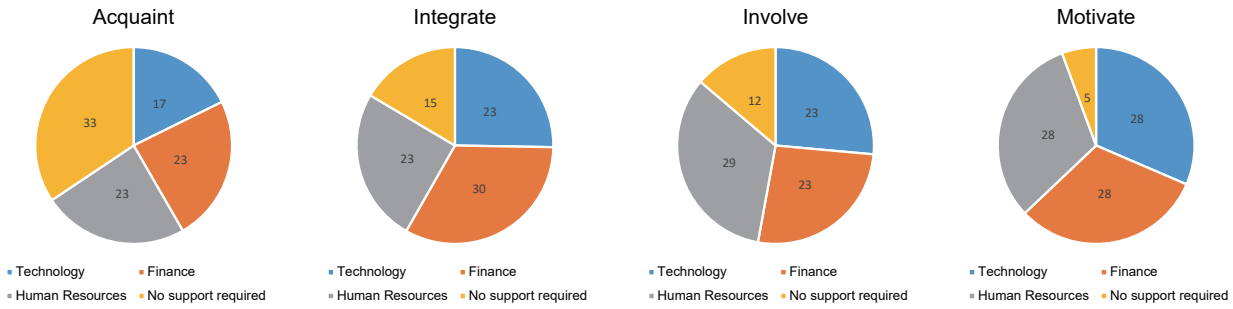

Figure 28.
Technology, finance and human-resource support sought for the AIIM groups of actions for adaptation by AMS. Note: Numbers in the pie chart indicate the percentage of all AMS and AIIM group of actions requiring TFH (Technology, Finance and Human resources) support to enhance adaptation ambition in the ASEAN region. AMS were asked to express their needs for technology, finance, and human resources for each action under the AIIM groups, and needs were numerically aggregated across 10 AMS and actions (N=11, 6, 4 and 8 for "Acquaint", "Integrate", "Involve" and "Motivate", respectively).

In terms of specific adaptation actions, actions such as climate change projections, creation of a regional adaptation fund, enhanced access to international financing, enhanced access to internationally available adaptation technologies, and establishment of networks and groups of scientists and communities of practitioners required higher financial investment than other actions. Similarly, more technological support was sought in the areas of strengthening the scientific information base, enhanced access to internationally available technologies and establishing networks and communities of practice. Relatively higher human resources were required to promote adaptation actions such as strengthening the scientific information base, enhanced access to internationally available financing and technologies, formulation of an ASEAN regional adaptation plan and establishing networks and communities of practice. For country-specific information, see Appendix B.

4.2.4. Enhancing mitigation: Prioritised actions by 2030

As shown in Section 3, the ASEAN region, like the world as a whole, needs to enhance mitigation actions to aim for net-zero emissions as soon as possible in the latter half of the 21st century and to meet the global PA goal of 1.5–2°C. Mitigation of climate change is largely a technical and financial issue, but also an issue of economic and social development through more efficient and decarbonised materials, energy and land-use. Thus, it also involves lifestyle changes for citizens in ASEAN and other regions alike, since production and consumption patterns of goods and services are the root cause of GHG emissions from all sectors. Technology development and transfer within and across sectors (Section 3.5.1, Table 16) are at the core of energy and land-use transitions, and so it is essential that policies in this area are strengthened. UNEP (2020, p. 34) points out that inadequate climate action by 2030 would lead to:

- Higher committed global warming and associated climate impacts and risks
- A lock-in into carbon-intensive infrastructure and higher risk of stranded fossil fuel assets
- Missed opportunities to achieve benefits for sustainable development
- Higher reliance on CO_2 and higher requirement for global net negative emissions

These risks show why the next 10 years are critical for mitigation. As the snapshot of the ASEAN climate vision toward 2050 shows in Figure 1, the challenge for ASEAN is how to enhance transparency and realise multi-fold transformation with different capacities and resources across AMS and with limited time. In order to make progress on a pathway toward the PA goal, cooperation among AMS and with countries outside ASEAN is essential. ETC (2019) points out that successful international coordination produces impactful changes in sectoral decarbonisation by classifying the depth of coordination, for example exchange of information and best practices, coordinated voluntary commitments, and coordinated policy action. Likewise, sector-based cooperation across AMS through sharing of various roles, comprising research and development of decarbonising technologies and market expansion by accelerating their diffusion with economic growth, will accelerate the ASEAN region's energy and land transitions more effectively. Coherent actions of various depths as mentioned above will form a decarbonising model for how regional collective actions are spurred by and can promote national actions, thereby reshaping national legal frameworks.

Both transparency and transformation are necessary for enhancing mitigation ambition in the ASEAN region. Accordingly, AMS have identified essential transparency and transformation actions for the region under the AIIM group of actions. These actions are identified for through 2030 and on to 2050. It is expected that these will lead to strengthening, redesigning or formulating new policies that support NDCs and LTS, and will serve as a stepping stone for long-term transformation toward a net-zero ASEAN region.

As in the case of adaptation, AMS have chosen more transformative actions (22) than transparency actions (8). One difference between mitigation and adaptation is the number in the Motivate group of actions (13 actions for mitigation and 8 actions for adaptation). The list of mitigation actions, categorised into transparency and transformative actions, is presented in Figure 29. Table 25 shows the categorisation of these actions according to the AIIM framework. The rest of this section describes these actions in detail in terms of what they mean for the region.

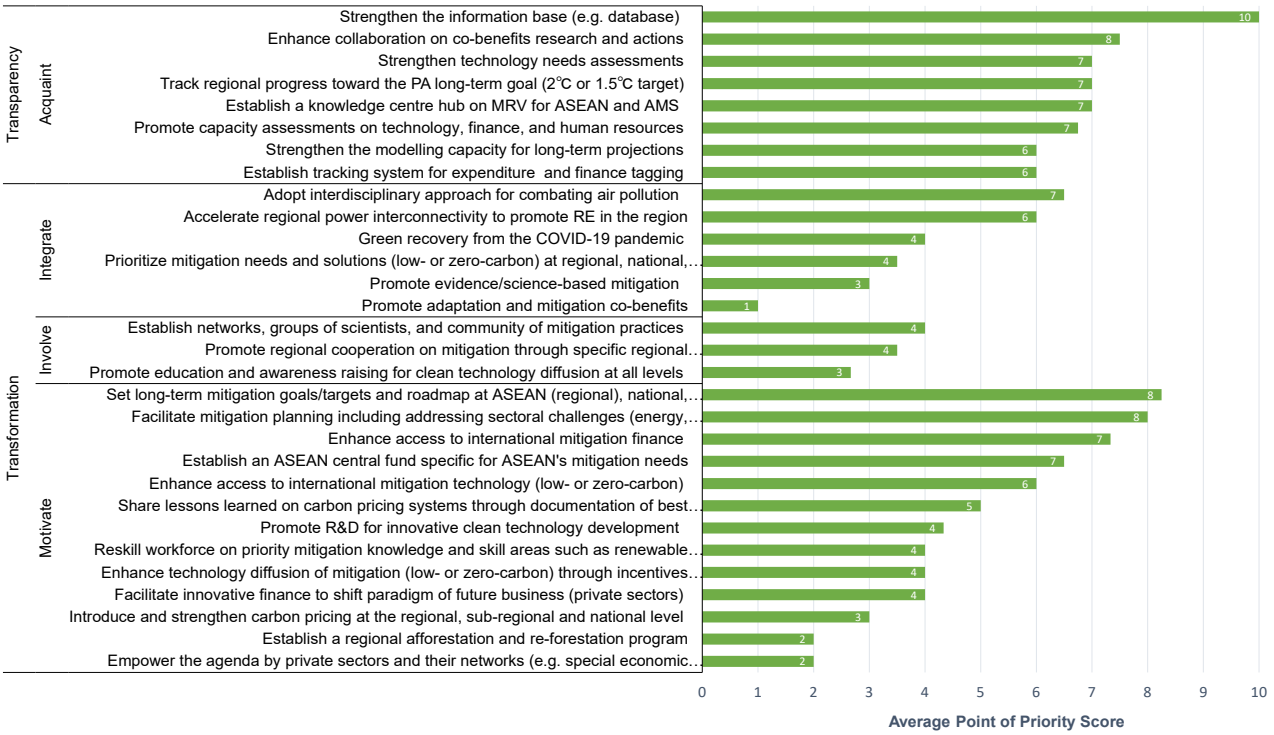

Figure 29.
Prioritised mitigation actions for enhancing transparency and transformation in the ASEAN region by 2030. Source: Authors with the information from a survey for prioritisation made by the AWGCC NFPs of each AMS. Prioritisation was made by scores on a scale from 1 to 10, where a higher score means higher priority.

Table 25. AIIM framework of actions for promoting transparency and transformation of mitigation in the ASEAN region

Acquaint	Integrate
1. Strengthen the information base (e.g. database) 2. Enhance collaboration on co-benefits research and actions 3. Establish a knowledge centre hub on MRV for ASEAN and AMS 4. Track regional progress toward the PA long-term goal (2°C or 1.5°C target) 5. Strengthen technology needs assessments 6. Promote capacity assessments on technology, finance, and human resources 7. Strengthen the modelling capacity for long-term projections 8. Establish tracking system for expenditure and finance tagging	1. Adopt interdisciplinary approach for combating air pollution 2. Accelerate regional power interconnectivity to promote RE in the region (Transf) 3. Green recovery from the COVID-19 pandemic 4. Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level 5. Promote evidence/science-based mitigation 6. Promote adaptation and mitigation co-benefits
Involve	**Motivate**
1. Establish networks, groups of scientists, and community of mitigation practices 2. Promote regional cooperation on mitigation through specific regional activities/frameworks 3. Promote education and awareness raising for clean technology diffusion at all levels	1. Set long-term mitigation goals/targets and roadmap at ASEAN (regional), national, and local level 2. Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste) 3. Enhance access to international mitigation finance 4. Establish an ASEAN central fund specific for ASEAN's mitigation needs 5. Enhance access to international mitigation technology (low- or zero-carbon) 6. Share lessons learned on carbon pricing systems through documentation of best practices, gaps, challenges etc. 7. Promote R&D for innovative clean technology development 8. Facilitate innovative finance to shift paradigm of future business (private sectors) 9. Enhance technology diffusion of mitigation (low- or zero-carbon) through incentives and innovative policy framework 10. Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition) 11. Introduce and strengthen carbon pricing at the regional, sub-regional and national level 12. Empower the agenda by private sectors and their networks (e.g. special economic zone, RE100) 13. Establish a regional afforestation and re-forestation programme

Acquaint

The Acquaint group of actions consists of providing the necessary information base for understanding mitigation needs and promoting the efficacy of mitigation actions to be implemented. Making data and information publicly available and accessible is an essential element of this group of actions. These actions also provide guidance for decision-making by stakeholders so that their decisions are scientifically informed based on the evidence, and with minimal room for failure, to take into account global trends toward net-zero emissions in the long term. Thus, this set of actions can be a driver of transformative actions to raise ambition in NDCs and prepare LTS. Furthermore, this group of actions will help AMS prepare their BTR by 2023, contributing to the ETF and GST.

1. **Strengthen the information base**: For AMS, it is vital to establish a database of sectoral data on GHGI (including non-CO_2 GHG) and short-lived climate pollutants (SLCPs), a database of socio-economic data such as GDP, population and sectoral information, and a database of natural resource information such as RE potential and GIS information on land-uses (upland, forest etc.). Not only developing the database, but also how it is operated and maintained for policymaking is key.

2. **Enhance collaboration in co-benefits research and actions**: Climate change mitigation through switching to renewable/low-carbon energy produces multi-fold benefits including improved access to electricity, enhanced energy security, local green jobs, improved indoor and outdoor air pollution, and improved development potential (Climate Analytics, 2019). To maximise near-term co-benefits, research, learning and information-sharing through global and regional platforms can enhance national and local actions. Examples include the Asian Co-benefits Partnership (ACP)[48], the Climate and Clean Air Coalition (CCAC)[49], and the Asia Pacific Clean Air Partnership (APCAP)[50].

3. **Establish a knowledge centre hub on MRV for ASEAN and AMS**: An MRV system for GHGI, and more broadly for NDC development, is vital for continuously tracking progress and raising enforceability of mitigation actions. A knowledge centre hub in this regard could promote activities such as developing guidelines on best practices and training modules, and improving access to regional experts.

4. **Track regional progress toward the PA long-term goals (2°C or 1.5°C)**: Periodical examination of regional NDC ambitions is important, in terms of the ASCCR aggregated GHG emissions for 2030 pledged under AMS' NDCs (Figure 15). Similarly, stocktaking of LTS ambitions and relevant long-term sectoral or cross-sectoral policies and measures provide AMS with an opportunity to re-examine the ambitions of NDCs from long-term energy and land transitions toward net-zero emissions.

5. **Strengthen technology needs assessments**: Technology needs assessment must be strengthened so that it can include the perspective of how to promote energy and land transition through 2030 and on to 2050. Trends in cost reduction of decarbonising technologies such as RE in the region need to be taken into account.

6. **Promote capacity assessments on technology, finance and human resources**: As Appendix C shows, capacity assessments on technology, finance and human resources are vital to make progress toward decarbonisation in the ASEAN region. This will lead to promoting targeted cooperation among AMS and greater support by international development partners.

7. **Strengthen the modelling capacity for long-term projections**: ASEAN needs to project pathways for energy and land system transition toward net-zero emissions in order to develop long-term mitigation goals and targets and a roadmap for the region. Thus, modelling techniques for the region need to be explored, starting from initiating dialogue with relevant research institutes and universities, and compiling best practices for assessing scenarios for GHG emissions, technology diffusion and land-use change.

48. Asian Co-benefits Partnership (2021)

49. UNEP (2021)

50. UNEP (2021)

8. **Establish a tracking system for expenditure and finance tagging**: Although some AMS have introduced an innovative expenditure tagging system, ASEAN's collective expenditure and financial flow are not systematically tracked. Expenditure in the public and private sectors and financial flows, including from international donors and the private sector, need to be managed by means of a tagging system. Cost information on decarbonising infrastructure will also help ASEAN assess future financial needs more accurately. This action will be the key to promoting green recovery toward net-zero emissions.

Integrate

The Integrate group of actions aims to achieve mitigation holistically by recognising that mitigation is an interdisciplinary and multidisciplinary process, and that it requires seamless integration and working of faculties, ministries and stakeholders. Integration becomes especially crucial when immediate and urgent social and economic interests conflict with the direction of decarbonisation investments, for example, under COVID-19.

1. **Adopt an interdisciplinary approach to combat air pollution**: Simultaneously pursuing air pollution prevention and climate change mitigation is essential for cost-effectiveness with limited time and resources to stabilise the climate, since end-of-pipe technologies such as stack gas desulfurisation facilities and CCS can only reduce either air pollutants or CO_2. Switching from current fuels to RE is one of the key solutions, and urban planning needs to be aligned with energy transition in multiple dimensions. Research on public health is at the centre for integration of air pollution prevention and mitigation and adaptation goals, including research into health benefits of reducing GHGs and SLCPs, as well as the wider mitigation benefits provided by preventing climate-sensitive infectious diseases.

2. **Accelerate regional power interconnectivity to promote RE in the region**: This is one of the key strategies in APAEC 2016-2025. Preparing roadmaps for the next APAEC 2026-2035 and a vision until 2050 will be beneficial for AMS with limited RE potential in their national territory in order to facilitate future electricity trade among AMS and promote RE. Pursuing this solution goes together with promoting local micro-grid and off-grid solutions, which will enhance resilience of electricity networks and enable steady growth in urban and rural areas.

3. **Green recovery from the COVID-19 pandemic**: Currently, fiscal expenditures directed to clean energy infrastructure such as RE (solar, wind, hydro, geothermal etc.) and EE improvement are not being tracked systematically in the region. IISD's tracker (IISD, 2021) of public money for energy in recovery packages indicates that there is plenty of room to increase public spending for RE and EE investments in selected AMS and reshape energy infrastructure toward decarbonisation as well as securing jobs and economic recovery. Promoting green recovery toward net-zero emissions is critical over the next 10 years, since decision-making during this period is very likely to affect the GHG emission pathways until 2050 and beyond. Huge near-term opportunities for EE improvement need to be fully seized.

4. **Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national and local levels**: Prioritisation of mitigation needs and solutions is vital to accelerate the transition to net-zero energy and land systems in the ASEAN region in a cost-effective and welfare-maximising manner. To this extent, it is important to distinguish "transient" technologies that will be diminished and phased out in the end and technologies that will keep playing a central role for achieving net-zero emissions. A range of sectoral technology options

for decarbonisation such as fossil fuels (gas) together with CCUS, BECCS, DACS, RE (hydro, wind, solar, geothermal etc.) with battery and enhanced grid systems, sustainable forest-management measures, and afforestation and reforestation need to be assessed with proper methods including modelling frameworks to enable better prioritisation.

5. **Promote evidence-based and science-based mitigation**: To overcome a system lock-in and transform the energy and land-use system, redesigning policy to reshape the socioeconomic system becomes essential. An evidence- and science-based mitigation strategy is important to persuade wider and more diverse relevant stakeholders to take mitigation actions in all AMS. Examples include cost-benefit analysis, multi-criteria analysis, nexus approaches, and long-term projections of GHG emission pathways in line with the PA goals (i.e. 2°C or 1.5°C) with detailed sectoral technological options for energy and land systems.

6. **Promote adaptation and mitigation co-benefits**: Action to promote adaptation and mitigation co-benefits was also prioritised in Section 4.2.1, indicating the serious need expressed by policymakers and research communities working on adaptation and mitigation. Specifically, national registry systems applied in some AMS can capture information on policy implementation and fiscal expenditures for adaptation and mitigation. Public awareness-raising also can promote adaptation and mitigation interventions. Areas of synergy between both types of interventions include forest-based actions and hydropower reservoir management. These not only increase GHG sinks but also provide adaptation co-benefits, contributing to prevention of flooding, soil erosion and landslides, improvement of crop productivity, and protection of biodiversity and ecosystem services, thereby enhancing water, energy and food security in different AMS.

Involve

The Involve group of actions aims at multi-stakeholder processes to realise mitigation in its full scale and depth. The process of involving a wide variety of stakeholders is critical for developing medium- to long-term strategies, as discussed in the ASEAN-COP26 Climate Dialogue on Nationally Determined Contributions (NDCs) and Long-Term Strategies (LTS) (UK Mission to ASEAN, 2020).

1. **Establish networks, groups of scientists and communities of mitigation practice**: In the face of unprecedented mitigation challenges until the end of century, regional consultations are vital to explore the science-policy interface for updating NDCs and developing LTS in line with the long-term PA goal. Examples include the Low Carbon Asia Research Network (LoCARNet), which several AMS (Malaysia, Thailand, Cambodia, Lao PDR, the Philippines etc.) have already joined, and the Climate Change International Technical and Training Center (CITC) established in Bangkok and supported by JICA. It is important to note that ASEAN can initiate such research partnerships for long-term mitigation assessments, based on the past rich experiences of capacity-building programmes. These kinds of interventions need to be promoted to provide sound evidence to make progress toward the ambitions of NDCs and LTS.

2. **Promote regional cooperation on mitigation through specific regional activities and frameworks**: There are many regional plans and programmes in the ASEAN region, led by the ASEAN Community Vision 2025 as shown in Table 19. These are expected to be further enhanced, since successful regional cooperation on energy and land-use measures is expected to transform all sectors through expansion of technology transfer across AMS.

3. **Promote education and awareness-raising for clean technology diffusion at all levels**: Lack of awareness at individual, village/city, provincial and national levels is one of the reasons for low diffusion of RE in ASEAN. All stakeholders need to be well informed and educated through environmental education and awareness-raising programmes targeted at climate change issues, so that they can prioritise the selection of clean technology, taking into account climate benefits and other multiple co-benefits. Understanding of international and regional RE cost-reduction trends is also a vital process for many economic sectors and individuals.

Motivate

The Motivate group of actions aims to provide necessary incentives to individuals, groups and industries to take necessary action on mitigation, including through policy, finance and technology. If these three components are driven toward a shared goal, they can have a sufficiently large impact on the region. Policy can determine the direction of mitigation through subsidies, taxes, procurement, investment and standards, while financing driven by public spending can mobilise and reallocate private investment toward decarbonising technologies, and technology supported by domestic and international finance can then penetrate across AMS. Sufficient diffusion of decarbonising technologies and services will help to shape a new market and relevant industries in the region. ASEAN, which will become the fourth-largest economy in the world by 2030, will be a destination for global investment in decarbonising technologies and solutions. The region needs to take a balanced approach to develop more inclusive long-term policy, to mobilise financial support more harmoniously and synergistically, and to diffuse technologies in line with long-term transition toward net-zero emissions.

1. **Set long-term mitigation goals/targets and roadmaps at the ASEAN (regional), national and local levels**: Setting long-term mitigation goals and targets is a critical step for any regional actions. Considering Singapore's LTS and a few AMS' preparation processes, it will be beneficial for ASEAN to develop long-term mitigation goals, targets and roadmaps to achieve net-zero GHG emissions of energy and land systems to meet the PA temperature goal. GHG emissions are required to peak out by around 2030 in order to enable the transition toward net-zero emissions as soon as possible after 2050.

2. **Facilitate mitigation planning, including sectoral challenges (energy, AFOLU, transport, industry and waste)**: Regional cooperation in addressing sectoral challenges is an impactful means to transform sectoral mitigation actions, since AMS are diverse in terms of economic capacity, technology and existing RE resources. In particular, sharing knowledge across AMS on sector-specific decarbonising technologies will facilitate mitigation planning in each AMS, by providing leapfrogging opportunities for AMS to lower emissions at minimal cost with the best available technologies.

3. **Enhance access to international mitigation finance**: Enhancing access to international mitigation finance such as through GCF and GEF is of critical importance to test and diffuse low- and zero-carbon technologies and solutions in all sectors. Under GCF, two AMS have been supported for REDD+ programmes[51,52] while ASEAN as a region will be supported for 20 high-impact, low-emission sub-projects for the sake of green recovery (GCF 2021).[53]

51. FP130: Indonesia REDD-plus RBP for results period 2014-2016 (GCF, 2021)

52. FP117: Implementation of the Lao PDR Emission Reductions Programme through improved governance and sustainable forest landscape management (GCF, 2021)

53. FP156: ASEAN Catalytic Green Finance Facility (ACGF): Green Recovery Program (GCF, 2021)

4. **Establish an ASEAN central fund specific to ASEAN's mitigation needs**: With the increasing role of finance in diffusion of decarbonising technologies and solutions, an ASEAN central fund specific to ASEAN's mitigation needs should be considered. Such a regional funding mechanism could be designed under a long-term mitigation strategy and roadmap, and this type of new and innovative funding scheme in particular may be created through a roadmap of transition management or "just transition", as described below under action 10.
5. **Enhance access to international mitigation (low- or zero-carbon) technology**: All AMS are members of the Climate Technology Centre and Network (CTCN), and are in a position to receive technical assistance and capacity-building support on a voluntary basis. This kind of mechanism should be enhanced in pursuit of net-zero energy and land transition.
6. **Share lessons learned on carbon-pricing systems through documentation of best practices, gaps, challenges etc.**: Currently, several AMS have introduced carbon taxes, and two have emissions-trading systems. At the regional level, the ASEAN-ROK Carbon Pricing Dialogue has initiated sharing of information and lessons learned on carbon-pricing systems. In the pursuit of establishing a regional mechanism relevant to carbon pricing, documentation of best practices for carbon pricing in the region is beneficial.
7. **Promote R&D for innovative clean technology development**: Technological development for a sustainable transition toward net-zero energy and land systems is a global challenge, and thus R&D for innovative decarbonising technologies may benefit from appropriate collaboration with industrialised countries outside of ASEAN with high potential for innovation. In particular, VRE using batteries and enhanced grid systems, high energy efficiency appliances, bioenergy (waste and primary resources), decarbonising technologies for industry (steel, cement, petrochemical etc.), electric or hydrogen-related mobility (land, aviation and shipping), materials with lower lifecycle GHG emissions, and CCUS are promising candidates for this kind of collaboration.
8. **Facilitate innovative finance to shift the paradigm of future business (private sector)**: Innovative finance comes with a clear vision to shift the paradigm of the environmental-services business. Domestic sources of funding can range from conventional national tax revenue to other innovative sources such as carbon pricing, energy and carbon taxes, auction revenue from emission-trading systems, green bonds and other private funds to facilitate local and project-based finance for energy- and land-related GHG emissions reductions. Targeted distribution of funds to priority areas will accelerate decarbonisation of the region through business transformation.
9. **Enhance diffusion of mitigation (low- or zero-carbon) technologies through incentives and innovative policy frameworks**: Diffusion is key to successful decarbonisation of the region, since decarbonisation is largely a matter of the scale of diffusion of relevant technologies and solutions. Thus, reduction of costs for RE and end-use technologies that work with electrification and DX, essential enablers of a decarbonised energy system, will be essential. To this extent, governmental policy can play a vital role in incentivising the uptake of RE solutions and energy-efficient technologies. A recent survey in ASEAN revealed that RE investment is the top priority of AMS' governments (ISEAS-Yusof Ishak Institute, 2020). Furthermore, reductions in energy demand and emissions can be motivated by policies pursuing a circular economy, such as recycling standards, and by various policies to drive lifestyle changes such as modal shifts and remote working. Rapidly growing AMS can play these kinds of roles and transform the region through knowledge- and practice-sharing across AMS.

10. **Reskill the workforce for priority mitigation knowledge and skill areas such as renewable industries (i.e. "just transition")**: A long-term transition to a decentralised VRE-based society will generate multi-fold benefits at all levels from local to regional, including improving access to electricity, enhancing energy security, providing local green jobs, improving indoor and outdoor air pollution, and improving development potential by supporting education and industrial activities even in remote areas. It is time for ASEAN to develop a transition management vision for how fossil fuel-related industries involved in mining, processing, power generation and material use can smoothly and inclusively transition to a new mode powered by RE, making full use of services related to electrification and DX.[54] Distribution of financing in this rearrangement needs to be considered so as not to harm existing industries and a skilled workforce, but rather to recreate new markets and industries and to reskill both the young and old into a visionary and productive workforce for the long-term sustainable development and prosperity of the ASEAN region. ASEAN's people-centred approach needs to perform at its full potential in this regard.

11. **Introduce and strengthen carbon pricing at regional, sub-regional and national levels**: Sharing lessons learned in the ongoing carbon pricing systems that exist in several AMS and outside of ASEAN is also prioritised as mentioned above under action 6. The next vital step is more related to implementation of a carbon-pricing system. It may take different forms, such as tax exemptions for clean technologies, abolishment of fossil fuel subsidies,[55] regional emission trading schemes and regionally harmonised carbon taxes, with varying degrees of depth of coordination among AMS. The last two options may require more learning and greater coherence among AMS. Regional cooperation on the ASEAN Power Grid and such preceding initiatives with a deeper level of coordination provides good examples of how to promote cooperation for carbon-pricing schemes in the region for the shared purpose of transition toward a net-zero ASEAN region.

12. **Empower the agenda through the private sector and its networks (e.g. special economic zones or RE100)**: The potential roles and impacts of Non-state and Subnational Actors (NSA) need to be highlighted in the unprecedented pursuit of net-zero emissions, as UNEP (2018) quantitatively estimated. NSA activities can sufficiently complement the mitigation efforts pledged in NDCs and contribute powerfully to filling emissions gaps up to 2030 and beyond. The special economic zone is among the good practices to invite industries to work for decarbonisation. Voluntary initiatives such as RE100, setting internal emissions targets,[56] and disclosure of climate-related data as part of the Task Force on Climate-related Financial Disclosures (TCFD) will also play more vital roles in transforming businesses in the region.

54. It was announced that PT Perusahaan Listrik Negara, an Indonesian national power company, will exit from all coal-fired power plants by 2056 and turn to renewable energy (Listiyorini & Jiao, 2021). This type of long-term management strategies is a novel example in ASEAN. Importantly, for a good transition management, national policy in line with PA goals needs to well inform and support private sectors.

55. More than 65% of respondents (N=502) of a survey in AMS agreed with abolishment of fossil fuel subsidies, while 12% disagreed and 23% neither agreed nor disagreed (ISEAS-Yusof Ishak Institute, 2020, p. 24). The survey, conducted by ISEAS-Yusof Ishak Institute from 3 August 2020 to 18 September 2020, analysed the attitudes and concerns of Southeast Asian citizens towards climate change, governmental actions and the role of different stakeholders in climate action.

56. The survey conducted by ISEAS-Yusof Ishak Institute mentioned in the previous footnote also revealed that businesses' actions are among the highest priorities, such as setting internal emissions targets and disclosure of climate-related data (ISEAS-Yusof Ishak Institute, 2020, p. 39).

13. **Establish a regional afforestation and reforestation programme**: In the pursuit of net-zero emissions, large-scale afforestation and reforestation will be essential in addition to reversing the trend of deforestation that is currently leading to positive CO_2 emissions. The root causes of deforestation are multifaceted, and it is difficult to sufficiently control deforestation by working only within ASEAN, since it is related to global supply chains of food, energy and commodities. Regional afforestation and reforestation programmes[57] can be devised in concert with a range of current practices and solutions to protect forest and peatland in the region. Innovative methods involving citizens and private companies utilising digital devices to plant trees is one of the good examples of how to raise awareness, transform behaviour and scale up actions from local to regional levels.

4.2.5. Enhancing mitigation: How ASEAN needs to change its course of action toward 2050

In 2030, the landscape of technology, costs, markets, supply chains and social norms will have dramatically changed, given rapid growth and technological change driven by DX, and, more broadly, the fourth industrial revolution ("Industry 4.0"). Moreover, life standards, quality of life, social welfare and people's capabilities will have improved in multiple dimensions thanks to progressive implementation of the SDGs by 2030. Hence, it is important to scrutinise changes in the global and regional landscape up to 2030, and to upgrade or redesign policy frameworks to incentivise the adoption of essential technologies toward 2050, considering the technological solutions potentially compatible with net-zero GHG emissions listed in Table 16. Some of the actions for 2030 prioritised in the AIIM groups described in Section 4.2.4 will be kept and scaled up toward 2050, and other actions may need to be substantially redesigned considering the degree of changes that net-zero transitions may require for the ASEAN region. Table 26 summarises how ASEAN may need to change its course of action up to 2050. Very importantly, actions that have been identified as critical for the period 2030–2050 will need to be seriously taken into account in policy planning during the period 2021–2030, which will enable much smoother and more sustainable transitions to achieve the PA goals.

57. The survey mentioned in the previous notes also found that this action is the third priority among the action lists (ISEAS-Yusof Ishak Institute, 2020, p. 39).

Table 26. ASEAN's prioritised mitigation actions to enhance transparency and raise ambition through achieving multi-fold transformation through 2030 and on to 2050

Mitigation actions	By 2030	By 2050
Transparency		
Strengthen the information base (e.g. database)	Establish and operate database regarding sectoral GHGI (including non-CO_2 GHG), SLCPs, socioeconomic status, natural resource such as RE potential, GIS information on land use	Enhance accuracy of GHGI and SLCPs to improve emission estimation of the region, and efficiently operate and utilise the information base for policy-making. Conduct R&D for emission reduction options especially for IPPU (CO_2 from material use in heavy industry) and agriculture (N_2O and CH_4)
Enhance collaboration on co-benefits research and actions	Conduct research, learning and information sharing through global and regional platform on co-benefits research and actions and promote fuel switch to RE rather than end-of-pipe technology such as desulfurisation facility and CCS	Scale up fuel switch from fossil fuels to RE to the maximum, based on further understanding on multifaceted co-benefits to increase the social welfare and quality of life in the ASEAN community
Establish a knowledge centre hub on MRV for ASEAN and AMS	Establish and operate MRV system for GHGI and NDCs, and promote activities such as developing guideline on best practices and training modules, and improving access to regional experts	Complete MRV system for GHGI and NDCs and operate the system in a time and resource efficient manner with innovative information sharing interface and online platform
Track regional progress toward the PA long-term goals (2°C or 1.5°C target)	Periodically examine on a voluntary basis the regional NDC and LTS ambitions and track progress toward the long-term PA goals. Sectoral and cross-sectoral policy targets and progress are also tracked	Complete the approach of tracking regional progress toward the long-term PA goals. Enhance database to minimise the uncertainty about emission estimations to track progress
Strengthen technology needs assessments	Conduct technology needs assessment with a particular focus on seizing all low-cost decarbonising technology options, among others, RE and EE improvement	Examine cost effectiveness of RE options, while examining whether CCS will have been introduced as planned in the 2020's. Change strategies for fossil fuels + CCS technology option if this option is not socially acceptable or not already economically competitive by 2030
Promote capacity assessments on technology, finance, and human resources	Upgrade regional capacity assessments on technology, finance, and human resource for the issue on transparency and transformation shown in ASCCR	Complete basic capacity assessments on finance and human resources and target the assessment on decarbonising technology development and diffusion
Establish tracking system for expenditure and finance tagging	Establish ASEAN's collective tracking system for expenditure, financial flow, and costs for decarbonising technologies. Utilise the system for distributing funding in clean energy infrastructure (such as RE and EE) for promoting green recovery	Complete the tracking system and mobilise financial resources to targeted areas vital for the transition toward net-zero emissions
Strengthen the modelling capacity for long-term projections	Strengthen the modelling capacity for long-term projections of ASEAN energy and land system transition toward net-zero emissions. Start dialogues with relevant research institutes and universities and compile best practices	Upgrade the modelling capacity with updated assumptions on demographic and socioeconomic changes, sector-wise decarbonising technology options, and costs, considering social acceptability of negative emission technologies

Mitigation actions	By 2030	By 2050
Transformation		
Adopt interdisciplinary approach for combating air pollution	Simultaneously pursue air pollution prevention and climate change mitigation, among others, fuel-switch to RE and urban planning. Conduct research on health benefits of GHG and SLCP reduction	Enhance implementation of urban planning facilitating diffusion of RE, electrification and DX in all sectors to enable decarbonisation of the supply and demand side
Accelerate regional power interconnectivity to promote RE in the region	Facilitate future electricity trade among AMS to promote RE	Expand the regional power interconnectivity to promote RE while scaling up decentralised VRE and battery systems in remote areas
Green recovery from COVID-19 pandemic	Increase public spending for RE and EE investments to reshape energy infrastructures by mobilising domestic and international funding, considering huge near-term opportunities of EE improvement in AMS	Substantially scale up investment in long-life energy infrastructures such as VRE (wind and solar), battery technology, power grid enhancement including micro grid, charging infrastructure for EVs and FCVs, smart public transportation system, ZEH, and ZEB
Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level	Identify "transient" technologies that will be diminished and phased out in the end and prioritise technologies that keep playing a central role for achieving net-zero emissions	Prioritise technologies compatible with net-zero emissions, while considering the global and regional market trends and cost reductions in the 2020's. Especially, VRE with battery and enhanced grid connection and fossil fuel power with CCS will need to be evaluated by cost reduction trends and multi-criteria including social and environmental impacts and co-benefits
Promote evidence/science-based mitigation	To inform climate policy, promote cost benefit analysis, multi-criteria analysis, nexus approach, and long-term projections of GHG emission pathways in line with PA goals with detailed sectoral technological options for energy and land systems	Upgrade or redesign policy to promote decarbonising technologies based on an examination of their market share and cost trends until 2030
Promote adaptation and mitigation co-benefits	Prepare national registry system to grasp policy implementation and fiscal expenditures for adaptation and mitigation. Other examples include public awareness raising, forest-based actions and hydropower reservoirs management	Scale up nature-based solution for enhancing carbon sinks in coastal and inland forest and soils toward achieving net-zero emissions and resilience against 1.5°C or higher temperature
Establish networks, groups of scientists, and community of mitigation practices	Take advantage of existing opportunities and/or initiate new opportunities including research partnership on long-term mitigation assessments and other technical training	Initiate and scale up ASEAN's initiatives for self-enforcing and self-sustaining progression of NDC and LTS ambitions
Promote regional cooperation on mitigation through specific regional activities/frameworks	Take advantage of and upgrade existing regional plans and programs and/or establish new initiatives to complement existing cooperative frameworks	Enhance the depth of regional cooperation mechanisms to drive the ASEAN community toward net-zero emissions, including RE expansion through APG and carbon market
Promote education and awareness raising for clean technology diffusion at all levels	Promote environmental education and raise awareness on the issue of climate change, vulnerability and impacts, GHG emissions, effective climate change interventions especially RE, EE improvement and other demand-side responses, and multiple co-benefits	Enhance scientific knowledge on climate change and impacts, international and the ASEAN's regional market trends decarbonising technologies such as RE and fossil fuels with CCS, including information on cost reductions and co-benefits
Set long-term mitigation goals/targets and roadmap at ASEAN (regional), national, and local level	Set ASEAN's long-term mitigation goals/targets and roadmap, drawing lessons from AMS' experiences of developing LTS and other long-term visions strategies	Take stock of mitigation interventions until 2030 and reshape LTS of each AMS and ASEAN's long-term mitigation goals/targets and roadmap, by fully taking account of global and regional market trend on decarbonising technologies mentioned above
Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste)	Share knowledge across AMS on sector-specific decarbonising technologies to facilitate mitigation planning in each AMS, by giving leapfrogging opportunities for AMS to lower emissions at least cost with best available technologies	Scale up RE deployment and end-use electrification in all sectors to the maximum based on the substantially reduced costs thanks to a market expansion in Asia and abroad. Scale up carbon sinks from forest

Mitigation actions	By 2030	By 2050
Enhance access to international mitigation finance	Enhance access to international mitigation finance by jointly seeking funding opportunities	Seek further international and regional funding opportunities with a clear vision and roadmap of transition management toward achieving net-zero GHG emissions soonest possible after 2050
Establish an ASEAN central fund specific for ASEAN's mitigation needs	Establish a central fund for mitigation along the long-term mitigation strategy and roadmap to accelerate transition. The fund can also compensate costs incurred by transition process	Enhance the role of the ASEAN central fund, considering economic growth that ASEAN will have achieved by 2030 and the market of RE and decarbonising technologies
Enhance access to international mitigation technology (low- or zero-carbon)	Make the best use of intentional networks and channels for technology development and transfer while seeking leapfrogging opportunity to foster industry for decarbonising technologies in the region	Foster industry dealing with decarbonising technologies/solutions within ASEAN and accelerate trade of these goods and services while enhancing partnership with international networks
Share lessons learned on carbon pricing systems through documentation of best practices, gaps, challenges etc.	Enhance ongoing dialogue on carbon pricing systems and share lessons and knowledge though documentation of best practices of carbon pricing	Upgrade and expand carbon pricing systems in AMS and ASEAN
Promote R&D for innovative clean technology development	Promote R&D in partnership with industrialised countries with high potential of innovation within and outside of ASEAN	Prioritise R&D area for more targeted and sustainable transition toward a net-zero ASEAN region, by fully taking account of global and regional market for decarbonising technologies and solutions
Facilitate innovative finance to shift paradigm of future business (private sectors)	Distribute financial resources to RE promotion by fully mobilising domestic public and private funding through a range of options including change of the current policy on subsidy and taxation, carbon pricing mechanism, and green bond scheme	Accelerate distribution of financial resources to RE promotion and other decarbonising technologies and solutions, with a recognition that energy transition is a business opportunity
Enhance technology diffusion of mitigation (low- or zero-carbon) through incentives and innovative policy framework	Fully diffuse energy efficient and low-emission solutions while shifting conventional energy and climate policy to accelerate RE diffusion, especially VRE with battery and enhanced grid networks	Dramatically scale up diffusion of decarbonising technologies with the growth of related industry, market, reduction of cost, and lifestyle change in the region, while reaping multi-fold benefits from such transition
Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition)	Develop a transition management vision as to how fossil fuel-related industry involved in mining, processing, power generation, and material use can be smoothly and inclusively transitioned to a new mode of industry powered by RE	Scale up implementation of the vision as a plan or strategy, with a focus on smooth, inclusive and sustainable transition with a detailed compensation scheme and industry reformation
Introduce and strengthen carbon pricing at the regional, sub-regional and national level	Introduce and verify various forms of carbon pricing systems in AMS and share lessons across AMS or in the entire region	Deepen the level of integration and coordination by linking or harmonising carbon pricing systems in the region with a shared goal toward the net-zero ASEAN region
Empower the agenda by private sectors and their networks (e.g. special economic zone, RE100)	Foster the agenda for transformation of mitigation actions by Non-State and Subnational Actors (NSAs), recognising the potential role and impact of various schemes for finance, industrial development, and forest management to fill mitigation ambition gaps with those in PA	Scale up initiatives led by NSAs through reshaping national policy frameworks (e.g. RE policy and forest policy) for the shared goal of net-zero emission in energy and land systems
Establish a regional afforestation and re-forestation program	Establish and promote mechanism for afforestation and re-forestation by involving citizens and private companies, while promoting sustainable forest management and deforestation preventions	Secure enough land for large-scale afforestation and sufficient food production by land productivity increase. Phase out illegal logging and prevent forest fire by innovative monitoring and surveillance system

4.2.6. Enabling environment to enhance transparency and transformation in mitigation actions

As in the case of adaptation, the necessary enabling environment for enhancing mitigation ambitions in the region are divided into three broad categories of support, namely technology, finance and human resources. The aforementioned survey of the AMS revealed features of support sought for each AIIM group of actions.

Overall, AMS have relatively better capacity in the Acquaint, Involve and Integrate groups of actions as they require relatively less technology, finance and human resource capacity to implement than the Motivate group. In terms of sharing between capacity-development needs, the Acquaint group requires slightly higher support for human resources, the Integrate group requires relatively higher support for finance and technology, the Involve group requires more technology, and the Motivate group requires slightly higher support for finance and human resources (Figure 30).

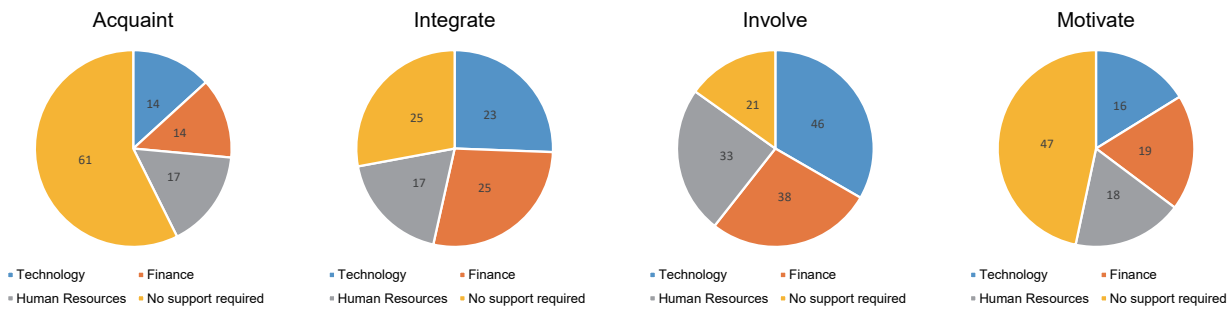

Figure 30.
Technology, finance and human resource support sought among the AIIM groups of actions for mitigation by AMS. Note: Numbers in the pie chart indicate the percentage of all AMS and AIIM group of actions requiring TFH (Technology, Finance and Human resources) support to enhance adaptation ambition in the ASEAN region. AMS were asked to express their needs for technology, finance, and human resources for each action under the AIIM groups, and needs were numerically aggregated across 10 AMS and actions (N=8, 6, 3 and 13 for "Acquaint", "Integrate", "Involve" and "Motivate", respectively).

In terms of specific mitigation actions, actions such as setting long-term mitigation goals, targets and roadmaps, access to international mitigation finance, prioritising mitigation needs and solutions across regional, national and local scales, accelerating regional power interconnectivity to promote RE, establishing networks among scientists and policymakers, promoting education and awareness-raising for clean technology diffusion, and promoting regional cooperation of any sort require higher financial investments than other actions. Similarly, more technological support was sought in the areas of establishing networks among scientists and policymakers, setting long-term mitigation goals, targets and roadmaps, strengthening modelling capacity for long-term projections, enhancing access to international mitigation finance, regional power interconnectivity, and promoting education and awareness-raising. Relatively higher human resources were said to be required to promote mitigation actions such as setting long-term mitigation goals, establishing networks among scientists and policymakers, strengthening modelling capacity for long-term projections, and regional power interconnectivity. For country-specific information, see Appendix B.

Conclusion

5 ASEAN State of Climate Change Report

The ASEAN Member States (AMS) have done significant work in both adaptation and mitigation thus far, despite their developmental obligations, and various financial, human resource and technological constraints. Although much of the progress made in climate change adaptation and mitigation stems from bottom-up efforts by the AMS, it has been the rapidly evolving integration and cooperation across the region that has fueled progress in recent years. While progress has been made, as presented in this report, AMS have come to realise that there is greater scope to raise ambition for adaptation and mitigation in the region. The pathway for ASEAN set out in this report can help achieve enhanced transparency and ambition through 2030 and on to 2050, guiding AMS and the entire region in the direction of the PA goals, while securing multifaceted sustainable development. On this transformative pathway, adaptation and mitigation will continue to advance in parallel and in synergy with each other. Highlights of adaptation and mitigation are summarised as follows.

5.1. Overarching issues

1. Adaptation and mitigation actions should be synergised wherever possible, especially at the level of implementation of practices on the ground. This will help to ensure that solutions are cost-effective, as well as enhance societal well-being. Examples include climate-smart agriculture and nature-based solutions (NbS), including ecosystems-based adaptation (EbA), such as agroforestry, protecting mangrove forests, and strengthening forest management through certification and “reducing emissions from deforestation and forest degradation” (REDD+) that contributes to enhancing forest carbon stocks. Appropriate hydropower reservoir management will also protect local communities from riverine floods and other extreme events, while contributing to climate change mitigation. Furthermore, “climate-proofed” energy infrastructure, such as electricity generators, power grids and associated buildings that have incorporated adequate adaptation and mitigation measures needs to be located or relocated in places which are less exposed to climate change to sustain its mitigation and adaptation synergy.

2. In response to the COVID-19 pandemic and climate crisis, financial flows need to support a green and resilient recovery as well as just transition. Fiscal spending can also help to leverage private finance while utilisation of regional/international funds is also essential. Finance will be the key to achieving a recovery compatible with the pathway to the PA goals for adaptation and mitigation, by providing enough funding for technology development and diffusion as well as human capacity building for development and climate change intervention. In order to secure and mobilise public and private funding, ASEAN programmes for sustainable and resilient recovery from COVID-19 (e.g. the ASEAN Comprehensive Recovery Framework) need to integrate strategies for green recovery and just transition which involve specific programmes to reskill the workforce and assist in smooth reemployment in industries related to clean energy, climate smart agriculture and sustainable forest management.

5.2. Adaptation

1. AMS are highly vulnerable to climate change impacts, regardless of mitigation progress. The ASEAN region is already experiencing significant climate change impacts with the growing intensity and magnitude of extreme weather events and increasing economic, environmental and social damage. Future climate change impacts will undermine decades of development progress, so the region needs to prioritise resiliency as well as adaptation interventions.

2. The region has been making steady progress in several areas relevant to climate change adaptation and disaster risk reduction (DRR). Importantly, the region's policies and institutional environment in relation to climate change adaptation (CCA) and DRR are at the forefront of this improvement, setting up a good enabling environment for robust implementation of CCA and DRR. While progress at the national policy and institutional level is commendable, this progress needs to percolate down to the grassroots level. Community-based DRR plans are being implemented, but CCA needs to be implemented at this level as well. Devolving power to local institutions needs to take place at a rapid pace to provide them with the needed autonomy in undertaking locally appropriate adaptation actions, matched by accelerated capacity strengthening at the local government level.

3. On the scientific and technological fronts, some AMS have made good progress in strengthening climate science in terms of climate change projections, downscaling projections, climate change risk assessments and vulnerability assessments, particularly in priority sectors such as water resources and agriculture. However, these are yet to be scaled up beyond specific river basins and sectors and to the rest of the region. Countries that have made significant progress in climate change risk assessments, adaptation planning, climate-smart agriculture etc. are well placed to share this expertise with the rest of the AMS. This report identifies areas for regional cooperation as well as what kind of enabling environment is needed for the cooperation to succeed. These suggestions can provide a good basis for the ASEAN Working Group on Climate Change (AWGCC) to develop a climate change cooperation plan for the region.

4. As specific matters related to the AFOLU/LULUCF sector in the region, i) nature-based solutions (NbS) and investing in natural capital provide important entry points to resilient livelihoods and sustainable adaptation; ii) there is a need to acknowledge and promote local and indigenous knowledge of climate adaptation across the region, and iii) there is a need for early consideration and integration of adaptation in different sectors at various stages such as during planning, decision-making and management.

5. The diversity of advances made in adaptation in the region means that there is an immense potential for ASEAN regional cooperation in adaptation. Countries that have made significant progress in climate change risk assessments, adaptation planning, climate smart agriculture etc. are well placed to share these expertise with the rest of the AMS. The report has identified various areas for regional cooperation and the necessary enabling environment for the cooperation to succeed. This can provide necessary guidance to the AWGCC to chalk out a cooperation plan in the region.

5.3. Mitigation

1. AMS have proactively taken measures in the areas of GHG inventory, monitoring, reporting and verification (MRV) for GHG inventories, and sector policy planning in the course of developing their nationally determined contributions (NDC). A key challenge is how to raise the level of ambition of the NDCs and related long-term national strategies and policies. To do so, it is vital to strengthen the science and information base with novel technologies related to, but not limited to, digital transformation (DX), which directly contributes to enhancing transparency of climate change interventions at local, national and regional levels. Capacity building in preparation for the national reporting requirements under the Enhanced Transparency Framework (ETF) and regional-level tracking exercises/systems on GHG emissions and near- to long-term climate change interventions are expected to promote science-policy integration and thus drive transformation of the socioeconomic systems. This is dependent on appropriate management, along with efforts for multi-stakeholder engagement and substantial incentives and assistance with regard to finance and technology. Modelling capacity development for long-term projections on mitigation measures all the way through to 2050 and beyond is a vital requirement for developing regional/national long-term strategies toward net-zero GHG emissions.

2. Developing a long-term mitigation strategy for ASEAN will be the key to informing and guiding sectoral and cross-sectoral policy planning in AMS in line with the pathway towards the long-term PA goals. Stepping stones to frame the future ASEAN community include not only clean energy transition involving the sectors of power, industry, transport and buildings, but also the transition of the land-use system in the AFOLU/LULUCF sector based on NbS. In the energy sector, there is an ASEAN near-term energy target for renewable energy (RE) expansion and energy intensity reduction up to 2025, but after that, the future course of actions to be taken by AMS is not necessarily informed by the PA goals but is more based on current policy trends. An ASEAN-wide collective long-term vision and/or target may encourage AMS to explore more ambitious emission reduction measures in a cost-effective manner by sharing knowledge and experience on best practices and emerging mechanisms such as effective carbon pricing and RE trading via the ASEAN regional power grid. In the AFOLU/LULUCF sector, national development and mitigation strategies and plans need to prioritise REDD+ programmes, or more broadly sustainable forest management, thus enabling interventions to resolve the root causes of deforestation such as population pressure and expansion of agricultural areas affected by global supply chain of agricultural/forestry products.

3. Climate change mitigation through switching to renewable/low-carbon energy produces multiple co-benefits including improving access to electricity, enhancing energy security, providing local green jobs, reducing indoor and outdoor air pollution, and improving development potential. Actions to pursue co-benefits such as combatting local air pollution will expand the possibilities for substantial climate actions in the short and long run.

4. For the transition to net-zero energy and land systems, it is important to distinguish “transient” technologies that will be diminished or ultimately phased out and technologies that will keep playing a central role in achieving net-zero emissions, such as RE, taking into account national circumstances. Various sectoral technology options for decarbonisation need to be assessed with proper methodologies, including modelling frameworks that can show the pathway beyond 2050. Such technologies include, but are not limited to, RE (solar, wind, hydropower, geothermal, etc.) with battery and enhanced grid systems, high energy efficiency appliances, bioenergy (waste and primary resources), decarbonising technologies for industry, electric or hydrogen-related mobility (land,

aviation, and shipping), materials with lower lifecycle GHG emissions, carbon capture, utilisation and storage (CCUS), hydrogen, sustainable forest management options, and afforestation and reforestation. In formulating a regional vision or strategy, it will be important to take into account trends in the global and regional markets of low- and zero-carbon technologies, cost reduction trends, and multiple co-benefits that will contribute to the long-term sustainable development of the ASEAN region.

5. Regarding energy transition, trade-offs between energy intensity reduction and emission intensity reduction need to be recognised and reflected in ASEAN's energy and climate strategies. The level of ambition of the energy mix, which is related to emission intensity reduction, is farther from the PA target trajectory than the demand-side ambition as measured by energy intensity reduction. In addition, energy supply and demand and GHG emissions need to be tracked (e.g. on a per-capita basis) to steadily plan and implement mitigation actions in the context of the different levels of economic development among the AMS. Enhancement or reshaping of national RE policies and implementation is needed, and the ASEAN Plan of Action for Energy Cooperation (APAEC)'s RE target of 23% in total primary energy supply by 2025 is critical for the transition through 2030 and on to 2050.

Lastly, ASCCR illustrated prioritised measures through 2030 and on to 2050, and if these are combined with sufficiently enhanced capacities, they would increase the feasibility to meet the PA goals for adaptation and mitigation. Table 27 shows prioritised actions at the regional level over the next 10 years, which are expected to be incorporated into and linked with the regional climate change actions plans and national/local policy frameworks in each AMS. It should be noted that the table only shows the top three actions for each group of AIIM (Acquaint−Integrate−Involve−Motivate) actions. The other prioritised actions for each group are shown in Table 23 and Table 25 of the main text. The Acquaint group of actions mostly aims to enhance transparency of climate actions in line with ETF under the PA. Especially, active public engagement/participation is essential to promote transparency of climate action, besides making data and information available and accessible to the public, especially in relation to planning, decision, and investment concerning climate change as highlighted by the Involve group of actions prioritised in this report. The other three groups of actions (i.e. Integrate, Involve and Motivate) basically contribute to promoting transformation and achieving the increased level of climate ambitions. Importantly, enhanced transparency of climate actions can be a driver/enabler for the transformative actions, making a self-sustaining loop for raising climate ambitions toward achieving the PA goals.

The AIIM group of actions at the regional level explores key opportunities to accelerate the sectoral transitions for both adaptation and mitigation. Regional-level AIIM actions also aim to contribute to upgrading current national policies and/or establishing new policies, whether sectoral or cross-sectoral, since the proposed multidimensional transformation is largely led by the enhancement and redesign of national policies. In 2030, ASEAN will need to change/strengthen the intensity of the AIIM group of actions to stay on track toward the PA goals for adaptation and mitigation (See Table 24 and Table 26).

The prioritised regional actions for adaptation and mitigation will contribute to upgrading and redesigning AMS' national policy frameworks, effectively changing the flow of finance, diffusing relevant technologies, reshaping the market, and transforming society toward the direction of the PA goals. Going forward, while meeting a variety of development needs unique to each AMS, ASEAN aims to operationalise the collective adaptation and mitigation potential of the region for climate-friendly and resilient economic transformation toward 2050 and beyond.

Table 27. Highlights of the prioritised actions at the regional level for the next decade

Actions to promote transparency or transformation	AIIM groups of actions	Adaptation	Mitigation
Transparency of climate actions	Acquaint	1. Promote risk and vulnerability assessment as a basis for adaptation planning 2. Develop best practice guidelines and roadmap for diffusion of adaptation technologies 3. Strengthen the scientific information base	1. Strengthen the scientific information base 2. Enhance collaboration on co-benefits research and actions 3. Establish a knowledge centre hub on MRV for ASEAN and AMS
Transformation to achieve increased climate ambition	Integrate	1. Mainstream adaptation into sectoral and development planning 2. Promote adaptation and mitigation co-benefits 3. Develop regional, national and local adaptation plans	1. Adopt an interdisciplinary approach for combating air pollution 2. Accelerate regional power interconnectivity to promote RE in the region 3. Promote green recovery from the COVID-19 pandemic
	Involve	1. Sustain actions through public-private-people partnerships (PPPP) 2. Promote multi-stakeholder processes 3. Promote regional cooperation on adaptation	1. Establish networks, groups of scientists, and communities of practice for mitigation 2. Promote regional cooperation on mitigation through specific regional activities/frameworks 3. Promote education and awareness raising for clean technology diffusion at all levels
	Motivate	1. Set adaptation goals 2. Develop climate risk transfer system 3. Enhance technology diffusion on adaptation	1. Set long-term mitigation goals/targets and roadmaps at regional, national and local levels 2. Facilitate mitigation planning including addressing sectoral challenges 3. Enhance access to international mitigation finance

Note: This table only shows the top three actions for each group of AIIM (Acquaint−Integrate−Involve−Motivate) actions. The other prioritised actions for each group are shown in Table 23 and Table 25 of the main text.

Appendix

Appendix A. NDC targets and national policy

1. Adaptation

Appendix Table 1. ASEAN Climate Adaptation Pledges in NDCs

Country	Detailed Adaptation Pledge	Major Policy
Brunei Darussalam	• Promote the development of a local biotechnology industry based on the country's forest biodiversity resource • Legislation and regulations (Forest Act (Chapter 46) Forest Rules, National Forestry Policy of Brunei Darussalam. These are not mentioned in the NDC) in the land use sector, such as restrictions and reduced-scale on logging activities • Integrated approach combining flood protection, river quality improvement and coastal protection	1) Brunei Darussalam National Climate Change Policy (BNCCP) 2) National Forestry Policy of Brunei Darussalam 3) Forest Act (Chapter 46) Forest Rules
Cambodia	• Promote and improve the adaptive capacity of communities, especially through community based adaptation actions, and restoring the natural ecology system to respond to climate change • Strengthen early warning systems and climate information dissemination • Develop and rehabilitate the flood protection dykes for agricultural and urban development • Increase the use of mobile pumping stations and permanent stations in responding to mini-droughts, and promoting groundwater research in response to drought and climate risk • Develop climate-proof agriculture systems for adapting to changes in water variability	1) Cambodia Climate Change Strategic Plan 2014-2023 2) Climate Change Priorities Action Plan for Agriculture, Forestry and Fisheries Sector 2016-2020 3) Strategic National Action Plan for Disaster Risk Reduction in Cambodia 2008-2013 4) National Action Plan for Disaster Risk Reduction 2019-2023 5) 2015 Law on Disaster Management 6) National Adaptation Plan 2017
Indonesia	• Study and map regional vulnerabilities as the basis of adaptation information system • Strengthen institutional capacity and promulgation of climate change sensitive policies and regulations by 2020 • Reduce risks on all development sectors (agriculture, water, energy security, forestry, maritime and fisheries, health, public service, infrastructure, and urban system) by 2030 through local capacity strengthening, improved knowledge management, convergent policy on climate change adaptation and disaster risks reduction, and application of adaptive technology • Award and encourage adaptation and mitigation actions at the site level (Climate Village Programs), with a target of 20,000 locations by 2024	1) National Action Plan on Climate Change Adaptation (RAN-AIP) 2) Climate Change Adaptation Programme (ICCAP) 3) Proklim (Climate Village Programs)
Lao People's Democratic Republic	• Climate Resilience in Farming Systems and Agriculture Infrastructure; • Climate Resilience in Forestry Production and Forest Ecosystems; • Water Resource Information Systems; Managing Watersheds and Wetlands; Increasing Water Resource Infrastructure Resilience; • Increase the Resilience of Urban Development and Infrastructure to Climate Change; • Increase the Resilience of Public Health Infrastructure and Water Supply System	1) National Strategy on Climate Change (NSCC) (2010) 2) Forestry Strategy to the Year 2020 of the Lao PDR (2005) 3) Climate Change Action Plan of Lao PDR for 2013-2020 (2013) 4) National Adaptation Plan for Action (NAPA) 5) Strategic Plan on Disaster Risk Management (2020)

Country	Detailed Adaptation Pledge	Major Policy
Malaysia	• Flood mitigation programmes and strengthening of disaster risk management and resilience of infrastructure would be further enhanced in the Eleventh Malaysia Plan (Malaysia's five-year development plan towards 2020) and beyond. • Strengthen the regulatory framework (Environmental Quality Act 1974 which has 38 subsidiary environmental regulations and provides legislative framework to control water pollution) of the water services industry, expand the water supply network and treatment capacity infrastructure and increase the efficiency of water supply services. • Expand implementation of good agricultural practices and intensifying research and development for improving agriculture production. New granary areas and adequate and efficient irrigation and drainage infrastructure will be developed to increase the production of rice. • A National Coastal Vulnerability Index to sea level rise is being developed.	1) Eleventh Malaysia Plan 2) National Water Resources Policy (2012) 3) Water Services Industry Act 2006(WSIA Act 655) and National Water Services Commission Act (SPAN Act 654) 4) Environmental Quality Act 1974 5) National Agro-food Policy (2011-2020)
Myanmar	• Resilience in the agriculture sector, developing early warning systems and forest preservation measures • Public health protection and water resource management • Coastal zone protection • Energy and industry sectors, and biodiversity preservation	1) National Environment Policy (2019), 2) Myanmar Climate Change Policy (2019), 3) Myanmar Climate Change Strategy (2018-2030) 4) Myanmar Climate Change Master Plan (2018-2030), 5) National Waste Management Strategy and Master Action Plans (2020), 6) National Environmental Quality Emission Guidelines (2015), 7) Myanmar National Water Policy (2014) 8) Myanmar Action Plan for Disaster Risk Reduction (2017) 9) The National Forestry Master Plan (2001-31) 10) Community Forestry Instructions (2019) 11) National Adaptation Programme of Action 12) Climate Smart Agriculture Strategy (2015)
Philippines	• System strengthening for downscaling climate change models, climate scenario-building, climate monitoring and observation; • Science-based climate/disaster risk and vulnerability assessment process • Enhancement of climate and disaster-resilience of key sectors – agriculture, water and health; • Systematic transition to a climate and disaster-resilient social and economic growth	1) National Disaster Risk Reduction and Management Law of 2010 2) National Climate Change Action Plan (NCCAP) of 2011
Singapore	- Invest in Research - Protect from Sea Level Rise - Manage water, minimise floods - Keep essential services running well - Keep buildings and infrastructure safe - Strengthen resilience in public health and enhance greenery and biodiversity - Ensure resilient food supply	1) National Climate Change Strategy (2012) 2) Singapore's Climate Action Plan: A Climate-Resilient Singapore, For a Sustainable Future (2016) 3) Singapore's Long-Term Low-Emissions Development Strategy (2020) 4) Singapore Green Plan 2030 (2021)
Thailand	• Promote and strengthen Integrated Water Resources Management (IWRM) practices • Safeguard food security through the guidance of Sufficiency Economy Philosophy; • Promote sustainable agriculture and Good Agricultural Practice (GAP); • Increase capacity to manage climate-related health impacts • Increase national forest cover to 40% through local community participation • Safeguard biodiversity and restore ecological integrity in protected areas and important landscapes from the adverse impacts of climate change.	1) National Adaptation Plan (NAP) 2) 2019 Community Forestry Law 3) Climate Change Master Plan 2015-2050

Country	Detailed Adaptation Pledge	Major Policy
Vietnam	• Respond pro-actively to disasters and improve climate monitoring: Modernise the hydro-meteorological observatory and forecasting system; Produce Socio-Economic Development Plans;'Implement disaster prevention plans and measures... • Ensure social security: Review, adjust and develop livelihoods and production processes; Develop mechanisms, policies, and strengthen the insurance system; Improve regulations and technical standards for infrastructure; Implement community-based adaptation... • Responding to sea level rise and urban inundation: Implement integrated coastal zone management; Use sea level rise scenarios in urban and land use planning for infrastructure, industrial parks, coastal and island resettlement areas;Implement anti-inundation measures for large coastal cities...	1) Law on Natural Disaster Prevention and Control (2013) 2) National Climate Change Strategy (2011) 3) National Target Programme to Respond to Climate Change (2008, 2012)

Source: IGES NDC Database (Hattori and Takahashi, 2021), NDCs submitted to the UNFCCC, REDD+ Web Platform (UNFCCC, 2021), Open Development Initiative (Open Development Mekong, 2021), Brunei Darussalam's Ministry of Primary Resources and Tourism- Forestry Department[58], Water Environment Partnership in Asia[59]

2. Mitigation

Appendix Table 2. ASEAN Climate Mitigation Pledges in NDCs

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Brunei Darussalam	Relative emission reduction	20%	BAU	2030
Detailed Mitigation Pledge				
• Energy sector: at least 30% RE share of power generation mix by 2035; at least 10% GHG emissions in the power sector through energy efficiency and conservation on both the supply and demand sides • Transport sector: 60% EV share of total annual vehicle sales by 2035 • Forestry sector: increase forest reserves from 41% to 55% by increasing the carbon sink through reforestation with a target of planting 500,000 trees by 2035				
Major Policy				
Energy and industry 1) Increasing the use of solar power 2) Utilising the 10-15 MW1 potential of waste-to-energy resources 3) Energy intensity target: 45% reduction in tonnes of oil equivalent per unit of gross domestic product, using 2005 as a base year 4) Policies and regulatory frameworks for energy efficiency and conservation 5) Land Transport White Paper **AFOLU** 1) National Forestry Policy of Brunei Darussalam 2) Forest Act (Chapter 46) Forest Rules				

58. Ministry of Primary Resources and Tourism, Brunei Darussalam (2021)

59. Water Environment Partnership in Asia (2021)

A. NDC targets and national policy

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Cambodia	Relative emission reduction	41.7% with FOLU	BAU	2030
Detailed Mitigation Pledge				
• The emissions reduction of 64.6 million tCO_2e/year is expected by 2030, a 41.7 % reduction compared with the BAU case • The FOLU is expected to provide the major share of 59.1% emission reduction by 2030. Other sectors like energy (21.3%), agriculture (9.6%), industry (IPPU) (9.1%), and waste (0.9%) are also expected to contribute significantly				
Major Policy				
Energy and industry 1) Climate Change Action Plans (2014-2018) for Manufacturing Industry and Energy, and Transport Sectors 2) Renewable energy in power grid and off-grid electricity 3) Promote end-use energy efficiency 4) Promote renewable energy and energy efficiency in manufacturing industries 5) Mass public transport 6) Improve vehicles' energy efficiency through eco-driving and use of hybrid cars, electric vehicles and bicycles. 7) Promote energy efficiency in buildings and cookstoves 8) Use of biodigesters and water filters to reduce waste emissions 9) Use of renewable energy for irrigation and solar 10) Industrial Development Policy 2015-2025 11) The National Policy, Strategy and Action Plan on Energy Efficiency in Cambodia (MIME 2013) 12) Basic Energy Plan (2019) 13) The national strategy on 3R for waste management in Cambodia 14) Cambodia Climate Change Strategic Plan 2014-2023 **AFOLU** 1) National REDD+ Strategy (NRS) 2017-2026 2) National REDD+ Action and Investment Plan (2019) 3) National Forest Program 2010-2029 4) National Action Program to combat land degradation 2018-2027 5) Climate Change Priorities Action Plan for Agriculture, Forestry and Fisheries Sector 2016-2020				

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Indonesia	Relative emission reduction	29% unconditional, 41% conditional	BAU	2030

Detailed Mitigation Pledge

- Indonesia has committed to reduce unconditionally 26% of its greenhouse gases against the business as usual scenario by the year 2020
- Indonesia is committed to reducing emissions by 29% compared to the business as usual (BAU) scenario by 2030
- Indonesia's target should encourage support from international cooperation, which is expected to help Indonesia to increase its contribution up to 41% reduction in emissions by 2030

Major Policy

Energy and industry

1) Shares of new and renewable energy in the primary energy supply: at least 23% by 2025, and at least 31% by 2030
2) Mitigation actions and emissions reduction compared to BAU (unconditional; conditional)
   i) Implementation of clean coal technology in power plants (75%; 100%)
   ii) Renewable energy in electricity production (7.4GW; 132TWh)
   iii) Implementation of biofuels in transportation (Mandatory B30) (90%; 100%)
   iv) Additional gas distribution lines (100%; 100%)
   v) Additional compressed-natural gas fuel stations (SPBG) (100%; 100%)
3) National Energy Policy (KEN) 2014
4) Electricity Supply Business Plan (RUPTL)2016-2025
5) National Energy Plan (RUEN)2016
6) Act No.18 year 2008 regarding Solid Waste Management,
7) Government Regulation No. 81 year 2012 regarding Management of Domestic Solid Waste

AFOLU

1) RKTN (Rencana Kehutanan Tingkat Nasional2011-2030/National Forestry Plan 2011-2030)
2) Industri Minyak Sawit Indonesia Menuju 100 Tahun NKRI/Indonesian Oil Palm Industry toward 100year (GAPKI),
3) The Roadmap of Indonesia's Forest Business Association (APHI) 2050
4) Strategic Plan for Plantation/estate crops (including scenario for livestock)
5) Indonesia National REDD+ Strategy

A. NDC targets and national policy

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Lao People's Democratic Republic	Relative emission reduction	40% unconditional and 50% conditional (50% is based on the NDC's information on BAU emission in 2020 and 2030 and reduced emissions during 2020-2030)	BAU	2030

Detailed Mitigation Pledge

- Forest cover increase to 70% of land area (i.e. to 16.58 million hectares) by 2030
- Increase in the share of renewable energy (13GW total hydropower capacity, 1GW for solar and wind, and 300MW for biomass) by 2030
- 10% reduction of final energy consumption relative to BAU scenario, and introduction of 50,000 energy efficient cook stoves
- 30% EV in national vehicles mix, biofuels to meet 10% of transport fuels, new Bus Rapid Transit system in Vientiane and Lao-China Railway
- 50,000 hectares adjusted water management practices in lowland rice cultivation
- Implementation of 500 tons/day sustainable municipal solid waste management project

Major Policy

Energy and industry

1) Increase the share of renewable energy (<15MW) to 30% of energy consumption by 2025
2) Increase the share of biofuels to meet 10% of the demand for transport fuels by 2025
3) Make grid-based electricity available to 90% of households in rural areas by the year 2020, thus reducing the consumption of off-grid fossil fuels
4) Implement the findings of the Nationally Appropriate Mitigation Actions (NAMA) feasibility study in transportation
5) Build large scale (>15 MW) hydropower plants to provide clean electricity to neighbouring countries: approximately 5,500 MW by 2020; 20,000 MW after 2020
6) The Renewable Energy Strategy (2011)
7) National Strategy on Climate Change (NSCC) (2010)
8) Sustainable Transport Development Strategy (2010)
9) Climate Change Action Plan of Lao PDR for 2013-2020 (2013)

AFOLU

1) Forestry Strategy to the Year 2020 of the Lao PDR (2005)
2) Forest Law Enforcement, Governance and Trade (FLEGT)

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Malaysia	Carbon intensity reduction	35% unconditional plus 10% conditional	2005	2030

Detailed Mitigation Pledge

- Malaysia intends to reduce its greenhouse gas (GHG) emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. This consist of 35% on an unconditional basis and a further 10% is condition upon receipt of climate finance, technology transfer and capacity building from developed countries

Major Policy

Energy and industry

1) National Petroleum Policy (1975)
2) National Energy Policy (1979)
3) National Depletion Policy (1980)
4) Four-Fuel Diversification Policy (1981)
5) Five-Fuel Policy (2001)
6) National Policy on the Environment (2002)
7) National Strategic Plan for Solid Waste Management (2005)
8) National Biofuel Policy (2006)
9) National Energy Policy (2008)
10) National Green Technology Policy (2009)
11) National Policy on Climate Change (2009)
12) New Economic Model, Government Transformation Programme and Economic Transformation Programme (2010)
13) Renewable Energy Policy and Action Plan (2010)
14) Low Carbon Cities Framework (2011)
15) National Automotive Policy (2014)

AFOLU

1) National Forestry Policy (1978, Revised 1992)
2) National Policy on Biological Diversity (1998)
3) National REDD Plus Strategy

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Myanmar	Relative emission reduction	To be updated	BAU	2030
Detailed Mitigation Pledge				
• Indicative goal - hydroelectric generation of 9.4 GW by 2030				
• Indicative goal: Rural electrification through the use of at least 30% renewable sources as to generate electricity supplies				
• Indicative goal: To realise a 20% electricity saving potential by 2030 of the total forecast electricity consumption				
• Indicative goal: To distribute approximately 260,000 cook stoves between 2016 and 2031				
Major Policy				
Energy and industry				
1) National Energy Policy				
2) Draft of the Long-term Energy Master Plan				
3) Draft of the National Electrification Master Plan				
4) Draft of the Rural Electrification Plan				
5) Draft of the National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar				
6) Myanmar Climate Change Strategy (2018-2030)				
7) Myanmar Climate Change Master Plan (2018-2030)				
8) Myanmar Climate Change Policy (2019)				
9) National Transport Master Plan				
10) National Waste Management Strategy and Master Action Plans (2020)				
AFOLU				
1) National Forest Policy (1995)				
2) National Forest Law (2018)				
3) National Land Use Policy (2016)				
4) The National Forestry Master Plan (2001-31)				
5) Drafted REDD+ Strategy, Myanmar Reforestration and Rehabilitation Programme (2017-2026)				
6) REDD+ Safeguard Roadmap				

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Philippines	Relative emission reduction	2.71% unconditional, 75% conditional	BAU (during 2020-2030)	2020-2030
Detailed Mitigation Pledge				
• The Philippines intends to undertake GHG (CO_2e) emissions reduction of 2.71-75% during 2030-2030 relative to its BAU scenario for the same period				
• Reduction of CO_2e emissions will come from energy, transport, waste, forestry and industry sectors. Most mitigation contribution is conditioned on the extent of financial resources, including technology development & transfer, and capacity building, that will be made available to the Philippines				
Major Policy				
Energy and industry				
1) National Climate Change Action Plan (NCCAP) of 2011				
2) Philippine Energy Plan (2016-2030, 2018-2040)				
3) National Energy Efficiency and Conservation Programme (NEECP)				
4) Ecological Solid Waste Management Act of 2000				
5) Biofuels Act of 2006				
6) Renewable Energy Act of 2008				
AFOLU				
1) Philippine National REDD-Plus Strategy (PNRPS)				

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Singapore	Absolute emission peaking	Peak emissions at no higher than 65 $MtCO_2eq$ around 2030	-	2030
Detailed Mitigation Pledge				
• Singapore has set a goal of emissions peaking at 65$MtCO_2eq$ around 2030				
Major Policy				
Energy and industry 1) The Singapore Green Plan 2030 2) Singapore's Long-Term Low-Emissions Development Strategy (2020) 3) Carbon Tax under Carbon Pricing Act (2018) 4) Promote solar PV deployment which: i) facilitates system integration of intermittent sources to ensure grid stability and security ii) addresses non-market barriers to entry without subsidising the consumption of any form of energy iii) supports continued investment in research, development, and demonstration to reduce the cost of solar PV modules and improve their efficiency 5) By 2030, it is estimated that renewable energy could potentially contribute up to 8% of Singapore's peak electricity demand 6) Singapore Energy Story **AFOLU** N/A				

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Thailand	Relative emission reduction	20% unconditional, 25% conditional	BAU	2030
Detailed Mitigation Pledge				
• Thailand intends to reduce its greenhouse gas emissions by 20 percent from the projected business-as-usual (BAU) level by 2030 • The level of contribution could increase up to 25 percent, subject to adequate and enhanced access to technology development and transfer, financial resources and capacity building support through a balanced and ambitious global agreement under the United Nations Framework Convention on Climate Change (UNFCCC)				
Major Policy				
Energy and industry 1) Power Development Plan B.E. 2558–2579 (2015-2036) 2) Thailand Smart Grid Development Master Plan B.E. 2558-2579 (2015-2036) 3) Alternative Energy Development Plan B.E. 2558–2579 (2015-2036) 4) Energy Efficiency Plan B.E. 2558–2579 (2015-2036) 5) Environmentally Sustainable Transport System Plan B.E. 2556–2573 (2013-2030) 6) Climate Change Master Plan B.E. 2558–2593 (2015-2050) 7) National Industrial Development Master Plan B.E. 2555–2574 (2012-2031) 8) Waste Management Roadmap 9) National energy targets: i) Achieve a 20% share of power generation from renewable sources in 2036 ii) Achieve a 30% share of renewable energy in total final energy consumption in 2036 iii) Reduce the country's energy intensity by 30% below the 2010 level in 2036 **AFOLU** 1) Agricultural Development Plan (2017–2021) 2) Forest Law (1941) 3) 1992 Forest Plantation Law and its revisions 4) 2019 Community Forestry Law				

Country	Mitigation Type	Mitigation Target	Reference Point	Target Year
Vietnam	Relative emission reduction	9% unconditional, 27% conditional	BAU	2030
• With domestic resources, by 2030, VietNam will have reduced total GHG emissions by about 9% compared to the BAU scenario, equivalent to 83.9 million tonnesCO_2eq • The above-mentioned 9%contribution can be increased by up to 27% compared to the BAU scenario (equivalent to 250.8 million tonnes of CO_2eq) with international support • GHG reduction in energy sector (5.5% or 51.5 million tCO_2e), agriculture sector (0.7% or 6.8 million tCO_2e), LULUCF sector (1% or 9.3 million tCO_2e), waste sector (1% or 9.1 million tCO_2e), and industrial process (0.8% or 7.2 million tCO_2e)				
Major Policy				
Energy and industry 1) Law on Economical and Efficient use of Energy (6/2010) 2) National Climate Change Strategy (12/2011) 3) National Green Growth Strategy (9/2012) 4) Decision 1775/QD-TTg on “Management of GHG emissions; management of carbon credit trading activities to the world market” (11/2012) 5) Promote effective exploitation and increase the proportion of new and renewable energy sources in energy production and consumption 6) Improve effectiveness and efficiency of energy use, thereby reducing energy consumption 7) Change the fuel structure in industry and transportation **AFOLU** 1) Cirvular No. 34/2009 / TT-BNNPTNT on the criteria for determining and classifying forests (2009) 2) Decree No. 117/2010/ND-CP on Organization and Management of the Special-use Forest System (2010) 3) Land Law 2013 4) Law on forestry (2017)				

Source: IGES NDC Database[60], National reports submitted to ASCCR process, NDCs submitted to the UNFCCC[61], REDD+ Platform[62], Open Development Initiative[63]
Note: Policy was drawn from Chan et al. (2020).

60. Hattori and Takahashi (2021)

61. NDC Registry (UNFCCC, 2021)

62. REDD+ Web Platform (UNFCCC, 2021)

63. Open Development Initiative (Open Development Mekong, 2021)

Appendix B. Capacity needs of each AMS

Appendix Tables 3-20 show 10 prioritised national actions for adaptation and mitigation by AMS, which include capacity development needs in terms of human resource capacity (knowledge and skills), technology and finance in the short (now to next 3 years), medium (4-6 years), and long (7-10 years) term. These are the results of the survey to each AMS.

Note:	
Transp	Refers to Transparency, i.e. information, knowledge, monitoring & evaluation system
Transf	Refers to transformation, i.e. institution, policy planning, stakeholder engagement, systematic change, innovative solution, resources (technology, finance, human)
H	Human resource capacity (knowledge and skill)
T	Technology
F	Finance
-	Means the region/country will have achieved full THF in an action at a given scale
NR	Not relevant
Short-term	Now to next 3 years
Medium-term	4-6 years
Long-term	7-10 years

Brunei Darussalam

Appendix Table 3. Brunei's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs		
			National		
			Short-term	Medium-term	Long-term
1	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	H	HT	HTF
2	Integrate	Enable adaptive policies and institutions (Transf)	HT	HT	HTF
3	Involve	Promote collective approaches (Transf)	H	HT	HTF
4	Acquaint	Conduct vulnerability assessments (Transp)	HT	HTF	HTF
5	Integrate	Prioritise adaptation needs at various levels (Transf)	HT	HT	HTF
6	Integrate	Identify and recognise climate change coupling points (Transf)	H	HTF	HTF
7	Integrate	Promote adaptation and mitigation co-benefits (Transf)	H	HTF	HTF
8	Integrate	Identify and use indigenous knowledge into adaptation actions appropriately (Transf)	H	HT	HTF
9	Involve	Promote multi-stakeholder processes (Transf)	HF	HTF	HTF
10	Integrate	Promote nature-based solutions in all priority sectors (Transf)	HT	HTF	HTF

Appendix Table 4. Brunei's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs		
			National		
			Short-term	Medium-term	Long-term
1	Acquaint	Strengthen the information base (e.g. database) (Transp)	HTF	HTF	HT
2	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HT	HTF	HTF
3	Motivate	Set long-term mitigation goals/targets and roadmap at ASEAN (regional), national, and local level (Transf)	HTF	HTF	HTF
4	Acquaint	Establish a knowledge centre hub on MRV for ASEAN and AMS (Transp)	HT	HTF	HTF
5	Involve	Establish networks, groups of scientists, and community of mitigation practices (Transf)	HF	HTF	HTF
6	Motivate	Share lessons learned on carbon pricing systems through documentation of best practices, gaps, challenges etc. (Transf)	HF	H	HF
7	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	HF	H	H
8	Motivate	Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition) (Transf)	HTF	HTF	HTF
9	Integrate	Mainstream mitigation into development and socio-economic policies and strategies (Transf)	HTF	HTF	HTF
10	Motivate	Promote R&D for innovative clean technology development (Transf)	HTF	HTF	HTF

Cambodia

Appendix Table 5. Cambodia's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	H	HTF	HTF	NR	HTF	FHT	NR	HTF	HTF
2	Motivate	Enhance access to international adaptation finance (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
3	Acquaint	Conduct vulnerability assessments (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
4	Acquaint	Promote evidence-based adaptation (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
5	Integrate	Promote nature-based solutions in all priority sectors (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
6	Integrate	Mainstream adaptation into sectoral and development planning (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	HTF	HTF	HTF	NR	NR	HTF	NR	NR	HTF
8	Integrate	Promote adaptation and mitigation co-benefits (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
9	Motivate	Identify, recognise, reward, and scale up good practices (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
10	Involve	Sustain actions through public-private-people partnerships (PPPP) (Tranf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

Appendix Table 6. Cambodia's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Motivate	Enhance access to international mitigation finance (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Motivate	Enhance access to international mitigation technology (low- or zero-carbon) (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
3	Integrate	Mainstream mitigation into development and socio-economic policies and strategies (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
4	Integrate	Promote evidence/science-based mitigation (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
5	Involve	Facilitate multi-stakeholder engagement especially in REDD+ and alignment with ASEAN Initiative (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
6	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Motivate	Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste) (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
8	Motivate	Develop decarbonisation infrastructure in urban area (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
9	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
10	Acquaint	Strengthen technology needs assessments (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

Indonesia

Appendix Table 7. Indonesia's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Strengthen the scientific information base (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Integrate	Mainstream adaptation into sectoral and development planning (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
3	Involve	Sustain actions through public-private-people partnerships (PPPP) (Tranf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
4	Motivate	Enhance access to international adaptation finance (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
5	Acquaint	Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
6	Motivate	Identify, recognise, reward, and scale up good practices (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
7	Motivate	Enhance access to international adaptation technology (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
8	Integrate	Promote adaptation and mitigation co-benefits (Transf)	HT	HT	HT	HT	HT	HT	HT	HT	HT

9	Involve	Establish networks, groups of scientists, and community of practices (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
10	Motivate	Reskill workforce on priority adaptation knowledge and skill areas (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

Appendix Table 8. Indonesia's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Motivate	Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste) (Transf)	HT	-	-	-	-	-	-	-	-
2	Motivate	Set long-term mitigation goals/ targets and roadmap at ASEAN (regional), national, and local level (Transf)	HTF	-	-	HTF	HTF	-	HTF	HTF	-
3	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HT	HT	-	-	-	-	-	-	-
4	Acquaint	Track regional progress toward the PA long-term goal (2°C or 1.5°C target) (Transp)	HTF	HTF	-	-	-	-	-	-	-
5	Acquaint	Establish tracking system for expenditure and finance tagging (Transp)	HT	-	-	HTF	HTF	-	HTF	HTF	HTF
6	Acquaint	Strengthen technology needs assessments (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Motivate	Enhance access to international mitigation technology (low- or zero-carbon) (Transf)	HT	HT	-	-	-	-	-	-	-
8	Acquaint	Promote capacity assessments on technology, finance, and human resources (Transp)	HTF	-	-	HTF	HTF	HTF	HTF	HTF	HTF
9	Motivate	Empower the agenda by private sectors and their networks (e.g. special economic zone, RE100) (Transf)	H	H	H	H	H	H	H	H	H
10	Motivate	Facilitate innovative finance to shift paradigm of future business (private sectors) (Transf)	F	F	F	F	F	F	F	F	F

Malaysia

Appendix Table 9. Malaysia's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Conduct vulnerability assessments (Transp)	HF	HF	H	HF	HF	H	HF	HF	H
2	Acquaint	Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Transp)	HTF	HF	H	HTF	HF	H	HTF	HF	H
3	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	HTF	HTF	HF	HTF	HTF	HF	HTF	HTF	HF
4	Acquaint	Strengthen the scientific information base (Transp)	HTF	HF	HF	HTF	HF	HF	HTF	HF	HF
5	Motivate	Enhance allocation of national finances to adaptation (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
6	Motivate	Empower the adaptation agenda at sub-national level (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
7	Integrate	Prioritise adaptation needs at various levels (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
8	Involve	Sustain actions through public-private-people partnerships (PPPP) (Tranf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
9	Motivate	Enhance access to international adaptation technology (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
10	Motivate	Develop best practice guidelines and roadmap for diffusion of adaptation technologies (Transf)	HF	H	H	HF	H	H	HF	H	H

Appendix Table 10. Malaysia's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Strengthen the information base (e.g. database) (Transp)	HTF	HT	-	HTF	HT	-	HTF	HT	-
2	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HTF	HT	-	HTF	HT	-	HTF	HT	-
3	Motivate	Set long-term mitigation goals/ targets and roadmap at ASEAN (regional), national, and local level (Transf)	HTF	HT	-	HTF	HT	-	HTF	HT	-
4	Motivate	Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste) (Transf)	HTF	HT	-	HTF	HT	-	HTF	HT	-
5	Acquaint	Monitor and track regional actions targeted at REDD+ and carbon trading (Transp)	HTF	HT	-	HTF	HT	-	HTF	HT	-
6	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	HTF	HT	HT	HTF	HT	HT	HTF	HT	HT
7	Integrate	Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level (Transf)	-	-	-	HTF	HT	HT	-	-	-

8	Involve	Establish networks, groups of scientists, and community of mitigation practices (Transf)	HT	HT	HT	HT	HT	HT	HT	HT	HT
9	Involve	Promote regional cooperation on mitigation through specific regional activities/frameworks (Transf)	HT	HT	HT	HT	HT	HT	HT	HT	HT
10	Integrate	Green recovery from the COVID-19 pandemic (Transf)	TFH	TFH	TH	HTF	HTF	HT	TFH	TFH	TH

Myanmar

Appendix Table 11. Myanmar's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Acquaint	Socio-economic scenario development in the context of adaptive capacity enhancement (Transp)	HTF	HTF	T	HTF	HTF	HT	HTF	THF	HT
3	Acquaint	Conduct vulnerability assessments (Transp)	HTF	HTF	HF	HTF	HTF	FH	HTF	HTF	FH
4	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	HTF	HF	HF	HTF	HF	HF	HTF	HF	FH
5	Motivate	Promote evidence-based adaptation (Transf)	HTF	HTF	HF	HTF	HTF	FH	HTF	HTF	FH
6	Integrate	Prioritise adaptation needs at various levels (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Integrate	Mainstream adaptation into sectoral and development planning (Transf)	HTF	HT	HT	HTF	HT	HT	HTF	HT	HT
8	Motivate	Enhance allocation of national finances to adaptation (Transf)	HTF	HTF	HTF	HTF	TF	HTF	HTF	TF	HTF
9	Motivate	Enhance access to international adaptation finance (Transf)	HTF	HTF	HTF	HT	HTF	HTF	HT	HTF	HTF
10	Motivate	Enhance access to international adaptation technology (Transf)	HTF	HTF	HTF	HT	HT	HTF	HT	HT	HTF

Appendix Table 12. Myanmar's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Track regional progress toward the PA long-term goal (2°C or 1.5°C target) (Transp)	HTF	HTF	HTF	HF	HF	HF	F	F	F
2	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HTF	HTF	HTF	HF	HF	HF	F	F	F
3	Acquaint	Monitor and track regional actions targeted at REDD+ and carbon trading (Transp)	HTF	HTF	F	HF	HF	HF	F	F	F
4	Acquaint	Strengthen technology needs assessments (Transp)	HTF	HTF	F	HF	HF	HF	-	-	-

5	Motivate	Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste) (Transf)	HTF	HTF	F	HF	HF	HF	F	F	F
6	Motivate	Enhance allocation of national finances to mitigation (Transf)	HTF	HTF	HTF	HF	HF	HF	F	F	F
7	Motivate	Enhance access to international mitigation finance (Transf)	HTF	HTF	F	HF	HF	HF	F	F	F
8	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	HTF	HTF	HTF	HF	HF	HF	F	F	F
9	Integrate	Mainstream mitigation into development and socio-economic policies and strategies (Transf)	HTF	TF	T	HF	HF	HF	F	F	F
10	Integrate	Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level (Transf)	HTF	TF	T	HF	HF	HF	F	F	F

Philippines

Appendix Table 13. Philippine's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Motivate	Enhance technology diffusion on adaptation (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	H	H	H	H	H	H	H	H	H
3	Acquaint	Strengthen the scientific information base (Transp)	H	H	H	H	H	H	H	H	H
4	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	H	H	H	H	H	H	H	H	H
5	Motivate	Establish an ASEAN adaptation fund (Transf)	F	F	F	F	F	F	F	F	F
6	Motivate	Enhance access to international adaptation technology (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Motivate	Formulate ASEAN regional adaptation plan (Transf)	H	H	H	H	H	H	H	H	H
8	Integrate	Prioritise adaptation needs at various levels (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
9	Involve	Establish networks, groups of scientists, and community of practices (Transf)	H	H	H	H	H	H	H	H	H

Appendix Table 14. Philippine's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Promote capacity assessments on technology, finance, and human resources (Transp)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
2	Acquaint	Establish a collaboration on co-benefits research (e.g. Asian Co-Benefits Partnership and others) (Transp)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
3	Motivate	Enhance access to international mitigation finance (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
4	Motivate	Establish an ASEAN central fund specific for ASEAN's mitigation needs (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
5	Motivate	Promote R&D for innovative clean technology development (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
6	Motivate	Enhance access to international mitigation technology (low- or zero-carbon) (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
7	Motivate	Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition) (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
8	Integrate	Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
9	Involve	Establish networks, groups of scientists, and community of mitigation practices (Transf)	HTF	HTF	TF	HTF	HTF	TF	HTF	HTF	HTF
10	Involve	Promote regional cooperation on mitigation through specific regional activities/frameworks (Transf)	HTF	HTF	TF	HTF	HT	TF	HT	HTF	HTF

Singapore

Appendix Table 15. Singapore's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs		
			National		
			Short-term	Medium-term	Long-term
1	Acquaint	Strengthen climate change impact projections and their downscaling (Transp)	HTF	HTF	TF
2	Acquaint	Strengthen the scientific information base (Transp)	HTF	HTF	HTF
3	Integrate	Mainstream adaptation into sectoral and development planning (Transf)	H	H	H
4	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	HTF	H	H
5	Motivate	Promote evidence-based adaptation (Transf)	HT	HT	HT
6	Involve	Promote collective approaches (Transf)	H	H	H
7	Integrate	Promote nature-based solutions in all priority sectors (Transf)	HT	HT	H
8	Integrate	Enable adaptive policies and institutions (Transf)	H	H	H
9	Involve	Establish networks, groups of scientists, and community of practices (Transf)	HT	HT	HT
10	Motivate	Enhance allocation of national finances to adaptation (Transf)	F	F	F

Appendix Table 16. Singapore's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs		
			National		
			Short-term	Medium-term	Long-term
1	Integrate	Green recovery from the COVID-19 pandemic (Transf)	HTF	HTF	HTF
2	Integrate	Prioritise mitigation needs and solutions (low- or zero-carbon) at regional, national, and local level (Transf)	TF	TF	TF
3	Involve	Promote regional cooperation on mitigation through specific regional activities/ frameworks (Transf)	HTF	HTF	HTF
4	Integrate	Accelerate regional power interconnectivity to promote RE in the region (Transf)	HTF	HTF	HTF
5	Motivate	Set long-term mitigation goals/targets and roadmap at ASEAN (regional), national, and local level (Transf)	HTF	HTF	HTF
6	Motivate	Enhance access to international mitigation technology (low- or zero-carbon) (Transf)	TF	TF	TF
7	Acquaint	Monitor and track regional actions targeted at REDD+ and carbon trading (Transp)	HTF	HF	HF
8	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	HTF	H	H
9	Motivate	Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition) (Transf)	HF	HF	HF
10	Acquaint	Track regional progress toward the PA long-term goal (2°C or 1.5°C target) (Transp)	HT	H	H

Thailand

Appendix Table 17. Thailand's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Conduct vulnerability assessments (Transp)	HTF	-	-	T	HF	-	-	T	HF
2	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	HTF	-	-	T	HF	-	-	T	HF
3	Acquaint	Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Transp)	HTF	HTF	-	T	HF	-	-	T	HF
4	Motivate	Enhance access to international adaptation finance (Transf)	HTF	HTF	HTF	-	-	-	-	-	-
5	Motivate	Enhance allocation of national finances to adaptation (Transf)	HTF	HTF	HTF	T	HF	-	-	T	HF
6	Acquaint	Strengthen loss and damage information and decision support systems (Transp)	HTF	-	-	T	HF	-	-	T	HF
7	Integrate	Promote nature-based solutions in all priority sectors (Transf)	HTF	HTF	HTF	T	HF	-	-	T	HF
8	Involve	Establish networks, groups of scientists, and community of practices (Transf)	HTF	HTF	HTF	-	-	-	-	-	-
9	Motivate	Promote evidence-based adaptation (Transf)	HTF	THF	-	T	HF	-	-	T	HF
10	Involve	Promote multi-stakeholder processes (Transf)	HTF	HTF	HTF	-	-	-	-	-	-

Appendix Table 18. Thailand's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Motivate	Enhance access to international mitigation finance (Transf)	HTF	HTF	HTF	-	-	-	-	-	-
2	Acquaint	Strengthen technology needs assessments (Transp)	-	HTF	-	-	-	-	-	-	-
3	Acquaint	Promote capacity assessments on technology, finance, and human resources (Transp)	-	HTF	-	-	-	-	-	-	-
4	Motivate	Promote R&D for innovative clean technology development (Transf)	-	HTF	-	-	-	-	-	-	-
5	Motivate	Enhance access to international mitigation technology (low- or zero-carbon) (Transf)	-	HTF	-	-	-	-	-	-	-
6	Integrate	Accelerate regional power interconnectivity to promote RE in the region (Transf)	-	-	HTF	-	-	-	-	-	-
7	Integrate	Green recovery from the COVID-19 pandemic (Transf)	F	F	F	F	F	F	F	F	F
8	Involve	Establish networks, groups of scientists, and community of mitigation practices (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
9	Involve	Promote education and awareness raising for clean technology diffusion at all levels (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
10	Integrate	Promote adaptation and mitigation co-benefits (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

Vietnam

Appendix Table 19. Vietnam's Adaptation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Promote risk assessments as a basis for adaptation planning (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Involve	Sustain actions through public-private-people partnerships (PPPP) (Tranf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
3	Motivate	Enhance access to international adaptation finance (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
4	Acquaint	Strengthen the scientific information base (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
5	Acquaint	Promote knowledge sharing on adaptation (Transp)	HTF	HTF	H	HTF	HTF	HTF	HTF	HTF	HTF
6	Acquaint	Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Motivate	Enhance technology diffusion on adaptation (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
8	Involve	Promote multi-stakeholder processes (Transf)	HT	HT	-	HT	HT	-	HT	HT	-
9	Intergrate	Identify and use indigenous knowledge into adaptation actions appropriately (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
10	Motivate	Empower the adaptation agenda at sub-national level (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

Appendix Table 20. Vietnam's Mitigation Capacity Needs

Ranking	AIIM	Action (Transp & Transf)	Capacity Needs								
			National			Provincial			City/Village		
			Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
1	Acquaint	Strengthen the information base (e.g. database) (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
2	Intergrate	Green recovery from the COVID-19 pandemic (Transf)	HTF	HTF	-	HTF	HTF	-	HTF	HTF	-
3	Motivate	Set long-term mitigation goals/ targets and roadmap at ASEAN (regional), national, and local level (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
4	Motivate	Enhance access to international mitigation finance (Transf)	HTF	HTF	-	HTF	HTF	-	HTF	HTF	-
5	Motivate	Reskill workforce on priority mitigation knowledge and skill areas such as renewable industry (i.e. just transition) (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
6	Motivate	Share lessons learned on carbon pricing systems through documentation of best practices, gaps, challenges etc. (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
7	Involve	Promote education and awareness raising for clean technology diffusion at all levels (Transf)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF
8	Motivate	Introduce and strengthen carbon pricing at the regional, sub-regional and national level (Transf)	TF	TF	TF	TF	TF	TF	TF	TF	TF
9	Motivate	Enhance technology diffusion of mitigation (low- or zero-carbon) through incentives and innovative policy framework (Transf)	HF	HF	HF	HF	HF	HF	HF	HF	HF
10	Acquaint	Strengthen the modelling capacity for long-term projections (Transp)	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF	HTF

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