

# Southeast Asia's Green Economy

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Cracking the Code

# 2023 Report

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## Reference

The information included in this report should be sourced as “Bain & Company, Temasek, GenZero, and Amazon Web Services, Southeast Asia’s Green Economy 2023 Report: Cracking the Code.”

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The “Southeast Asia’s (SEA) Green Economy 2023 Report: Cracking the Code” is jointly produced by a collaboration between Bain & Company, Temasek, GenZero, and Amazon Web Services. Contributing authors are as follows:

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# Acknowledgments

We would like to thank the team who has worked tirelessly to develop this report:

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The insights and content of this report also benefited from the wisdom of more than 50 leading industry experts across SEA and beyond. The richness and clarity of thought in this report would not have been possible without the input from these individuals. To all who answered our call or wrote a thoughtful email—we owe you our deepest thanks.

# Foreword by Bain & Company



**Satish Shankar**

Regional Managing Partner,  
Asia-Pacific,  
Bain & Company

The past 12 months have reinforced the need for concerted global action on climate change, and specifically for greater urgency and commitment from governments across the world. This has been equally true across Southeast Asia where, encouragingly, there has been a steady uptick in commitments from all stakeholders. Four governments have raised climate commitments, and seven are now considering carbon pricing measures to promote action. There has been a four-fold increase in corporate commitments to set science-based targets, and many leaders have outlined ambitious multi-billion-dollar investment programs to decarbonize their businesses.

Yet in climate action, as in business and life, the real test of a strategy is not the targets we set, but the concrete steps we take to accelerate progress and deliver the impact we have committed to. The green transition in SEA is at a tricky period where the bold ambition is meeting the realities of the day. Southeast Asia governments are grappling with the challenges of rising energy demand (that will grow by nearly 42% over the decade to 2030), a burgeoning middle class, strong pressure not to increase already low energy and electricity prices, and the need to deliver just and equitable growth—before even considering ambitious plans to decarbonize and build the industries of tomorrow.

Corporates and investors are keen to play their part. Yet uncertainties about the transition path and supporting regulation and policies (central to any translation of climate commitments to reality) make it difficult to take decisive action at scale and invest the billions of dollars that are needed to ensure a speedy and effective transition. To break this logjam, the largest corporates and investors, including the multilateral financial institutions, need to act with urgency and conviction to lead the way.

Despite the uncertainties, there is much that can be done in the “here and now.” There are several actions that are “no regrets” moves and tap proven levers for decarbonization across various industries. Similarly, there are policies that governments can implement to address nature loss and protect carbon sinks that don’t require difficult trade-offs.

This year’s Green Economy report speaks to both the challenges on the road to “Net Zero” and the immediate actions we can take today to accelerate the transition. While the challenges are considerable, there is much room for optimism, as at least the first wave of available levers can meet much of the region’s decarbonization commitments to 2030 if executed with collective commitment and collaboration. In parallel, a focus on defining longer-term solutions that government, corporations, and investors align on will deliver just and sustainable growth in this dynamic region.

We invite all stakeholders to work together to reaffirm their commitment to the green transition and take action today.

# Foreword by Temasek



**Steve Howard**

Vice Chairman,  
Sustainability,  
Temasek

The cost of the climate emergency is rising at an alarming pace, with radical environmental consequences that threaten our collective future. More frequent and extreme weather events, exacerbated by climate change, are disrupting supply chains, displacing people from their homes, and causing disaster response and recovery costs to skyrocket.

Southeast Asia is disproportionately affected by climate change, with its long coastlines and abundant low-lying areas. Yet, it is uniquely positioned to drive progress in the world's journey to Net Zero. Home to 620 million people today with more than half under 30 years of age, the region's vibrant economies, boosted by the accelerated digitization of businesses and services, makes it one with immense potential to become an engine of global decarbonization.

But no country, community, or company can do it alone. Getting to Net Zero by 2050 requires a holistic approach on decarbonization and a concerted effort across all stakeholders including, governments, businesses, academia, and individuals—there is no one silver bullet in this journey. This is true especially for Southeast Asia, where we need a diversified and calibrated approach across different solution pathways—nature, technology, and carbon markets. Our efforts must be scaled practically across communities that may be reliant on traditional ways of life, so that we can embark on the green transition in a just and inclusive manner.

As a long-term investor, Temasek has a fiduciary duty to invest responsibly for sustainable returns and create a better future for generations to come. We believe there are also tremendous opportunities to be seized as we collectively tackle and adapt to the climate crisis. These include opportunities to catalyze growth and innovation through the transition to Net Zero, and opportunities to foster resilience in our economies, communities, and businesses.

To this end, scaling nature-based solutions is one of the most holistic and cost-effective approaches to climate mitigation. Southeast Asia holds some of the most biodiverse ecosystems in the world and is home to an estimated 15% of the world's tropical forests. It is therefore well positioned to drive this shift and develop replicable models in working with nature to address the global climate crisis.

Achieving our Net Zero goals will also require an acceleration of the energy transition, and technological developments will be key to unlocking scalable climate impact. This is especially true in Southeast Asia, where dramatic improvements in access and affordability for renewable energy sources like solar and wind have enabled them to grow at an unprecedented rate. We are seeing countries like Vietnam and the Philippines lead the way in deploying renewable energy and transforming their power generation systems in parallel.

To further accelerate the development of sustainable infrastructure here in Southeast Asia, we have partnered with HSBC to establish Pentagreen Capital, a debt financing platform that aims to close the funding gap for marginally bankable clean infrastructure projects. Our carbon solutions platform GenZero is also working closely with Climate Impact X, a global marketplace and exchange we set up with DBS, the Singapore Exchange, and Standard Chartered, to scale the voluntary carbon market with trusted, high-quality carbon credits.

Southeast Asia is well-placed to create a lasting, meaningful impact in the global climate transition. We hope this report will provide useful insights into the transformational opportunities that the region's green economy is ushering in, and join us in accelerating bold, collaborative action toward our shared future.

# Foreword by GenZero



**Frederick Teo**

CEO,  
GenZero

GenZero was founded by Temasek as an investment platform company focused on accelerating decarbonization globally. We are proud to contribute to this report, which provides an overview of the green economy landscape in Southeast Asia, including the region's potential, decarbonization challenges, and opportunities for green investments. The takeaway is clear: For Net Zero to become a reality, countries, corporates, and communities need to take a collective and constructive approach to decarbonization.

As a region, Southeast Asia is brimming with potential. It is home to some of the world's fastest growing cities, with a large and youthful population that is growing alongside its rapidly growing middle class. Southeast Asia has an important role to play in global climate action and decarbonization. While countries in the region have stepped up their commitments (with 8 out of 10 countries having Net Zero pledges), key obstacles remain. In a region that remains heavily dependent on fossil fuels, growing energy demands will drive emissions increase. Southeast Asia will have to strike a delicate balance between economic growth and a just transition, while stepping up decarbonization efforts to make meaningful climate action.

Energy and nature sectors are the most critical levers for Southeast Asia, given their potential to contribute ~85% of emissions reduction needed. Proven solutions such as increasing renewable deployment, grid enhancement, and accelerating nature-based solutions development, as well as building and scaling the carbon market, can help close the emissions gap of 2.4Gt toward the region's unconditional 2030 targets.

The opportunities for green investments, initiatives, and innovative technologies in Southeast Asia are immense. The region's growing green energy capacity, coupled with its abundant natural resources, presents an opportunity to create sustainable industries and jobs, while also helping to advance the global transition to a Net Zero economy. Regional collaboration

can catalyze transition and unlock further renewable energy and nature-based solutions potential, for instance through cross-border regional grid, carbon trading, and harmonization of technical standards.

At GenZero, we are committed to driving climate action through our investments and partnerships. Through our investments in nature-based solutions, technology-based solutions, and carbon ecosystem enablers, we seek to accelerate decarbonization, while creating positive impact for local communities, businesses, and the environment. We seek to deliver positive climate impact alongside long-term sustainable financial returns by investing in opportunities that can be nurtured into impactful and scalable solutions.

Since our launch in June 2022, we have deployed capital across a diverse range of solutions in the region with the objective of accelerating impact. Through a joint investment in C-Quest Capital, we funded the deployment of clean, energy efficient cookstoves to 650,000 rural households across Thailand, Vietnam, Cambodia, and Laos to reduce carbon emissions. We have also invested in New Forests Tropical Asia Forest Fund 2, which aims to develop a diversified portfolio of sustainable forest plantation assets in Southeast Asia and support the region's transition toward responsible forestry management. To broaden and deepen the voluntary carbon market, we are also invested in Climate Impact X, a global marketplace, auctions house, and exchange for trusted high-quality carbon credits. Our investments and partnerships globally also provide us with learnings and potential solutions that can be helpful for Southeast Asia.

There is no panacea to the climate change conundrum—to achieve Net Zero, our approach must be dynamic and diversified across all solution pathways. We hope that this report will be a useful resource and encouragement for investors, corporates, policymakers, and other stakeholders looking to support, catalyze and grow the region's green economy opportunities.

# Foreword by Amazon Web Services



**Ken Haig**

Head of Energy and Sustainability Policy,  
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Amazon Web Services

The “Green Economy” is becoming a major focus for countries in Southeast Asia (SEA), as they strive to set and meet ambitious decarbonization goals while collaborating with the private sector to accelerate these goals. This year’s report highlights the untapped opportunities across clean power and nature in particular, as well as rising regional ambitions to do more. At Amazon, we are committed to achieving Net Zero carbon across our business worldwide by 2040, a decade ahead of the Paris Agreement, and we co-founded The Climate Pledge to encourage others to work together and solve decarbonization challenges.

Amazon has been the world’s largest corporate purchaser of renewable energy since 2020. We now have over 400 renewable energy projects around the world, across 22 countries, representing more than 20 GW of renewable capacity to date. Once every project is fully operational, the energy generated by these projects is expected to help avoid more than 21 million metric tons of carbon emissions annually. Amazon is already powered with 85% renewable energy across our global operations, and we are on a path to 100% renewable energy by 2025.

Southeast Asia faces challenges in scaling renewable energy due to limited availability, undue regulatory complexity, and high costs. Enabling corporate renewable energy investments is one area where SEA can do much more by increasing market availability. Corporate consumer demand can help the renewable energy sector grow—helping governments meet national climate targets without additional fiscal burden, and bringing with it associated capital, green jobs, and the proliferation of green technologies. Amazon supports regulatory frameworks that incentivize varied, affordable, and additional renewable power purchasing options, beyond what is available on the grid today.

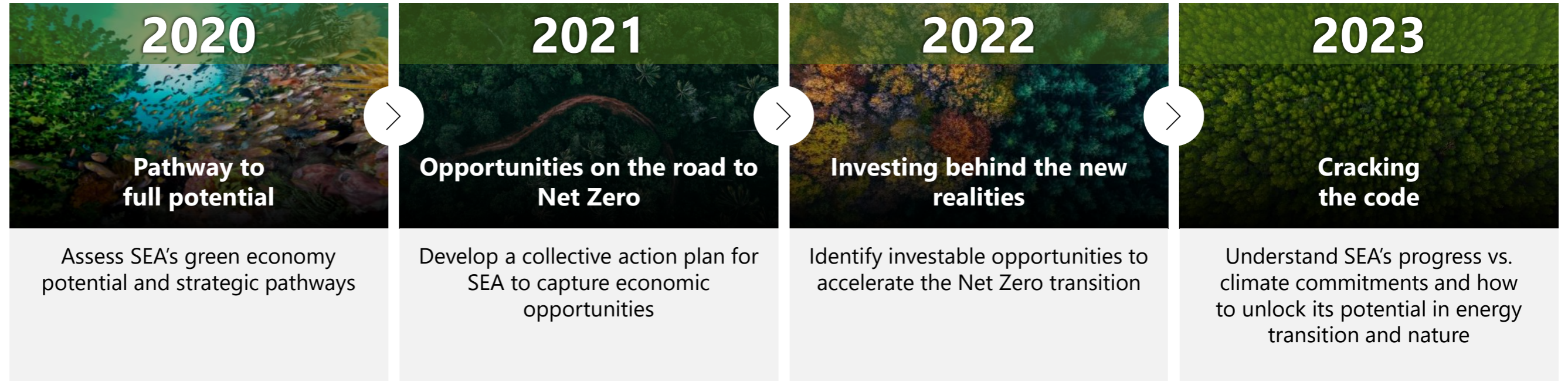
Amazon also recognizes the important role of nature, and especially the potential for blue carbon in SEA’s decarbonization. While SEA holds over one-third of the world’s mangrove forests, the greatest loss of mangrove forests has also occurred in the region. Amazon is proud to partner with Conservation International to support the establishment of the International Blue Carbon Institute to work with governments across SEA to support the restoration and protection of regional coastal blue carbon ecosystems.

Cloud computing can also help regional governments as well as the public and private sectors leverage digital technologies to drive deeper decarbonization and sustainability across their operations. For example, moving on-premises workloads to Amazon Web Services (AWS) can lower the workload carbon footprint by nearly 80%, and up to 96% once AWS is powered with 100% renewable energy, by 2025.

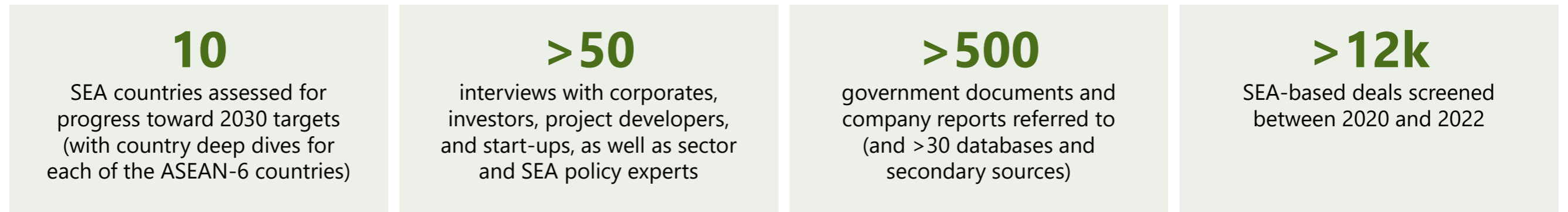
Furthermore, cloud-enabled technologies such as artificial intelligence, machine learning, big data analytics, and Internet of Things, enable acceleration of the sustainability innovation process itself. There are a number of use cases from among customers in the power and nature sectors already that you will see in the report. To further democratize access to climate research and spark innovation, we provide open access to climate-related data sets through the Amazon Sustainability Data Initiative.

We hope this year’s report can raise awareness of opportunity to accelerate our path to sustainability in SEA, prompt new and innovative ways of thinking to solve climate change challenges in region, and catalyze meaningful near-term actions by governments and organizations across the region.

# Context | About the Southeast Asia Green Economy Report



## Extensive foundation for the 4<sup>th</sup> edition of the report





# The 2023 report in numbers

## 2022

 **Rising Commitments**

**>33%**  
target emission reduction to 2030

**4x**  
SEA companies committing to science-based targets

**\$5.2B**  
green investment in SEA in 2022<sup>1</sup>

 **Reality on the Ground**

**3 out of 4**  
top emitting countries may be at risk of not achieving targets<sup>2</sup>

**2x**  
increase in intraregional green investment vs. 2021

**42%**  
increase in energy needs to 2030

## 2030

Meeting NDC commitments is possible with action, collaboration, and proven solutions.

SEA has committed to:

**~2.4 GtCO<sub>2</sub>e** unconditional reduction in emissions from forecasted level in 2030

Proven solutions in nature and energy could deliver up to

**85%**

of needed action to close the emissions gap

Significant, consistent investment is needed up to 2030

**\$1.5T**

Estimated cumulative investment needed to meet 2030 targets<sup>4</sup>

**\$1.1T**

Estimated investment need in clean, efficient energy

**\$400B**

Estimated investment need in nature<sup>3</sup>

Note: (1) Includes transactions involving corporates, PE/VC, infrastructure funds, climate-focused "green" funds, and sovereign wealth funds and government-affiliated companies; (2) By targets, we refer to Nationally Determined Contributions; of SEA's top 4 emitters (Indonesia, Vietnam, Thailand, Malaysia), all except Malaysia are unlikely to be on track; (3) Based on a starting carbon price of \$5.8/tCO<sub>2</sub>; (4) Investments in energy and nature sectors needed in order to meet SEA NDCs by 2030 – a proportion of an estimated ~\$2T investment needed for the economy overall  
Source: Country NDCs; SBTi; Preqin; S&P Capital IQ; Pitchbook; AVCJ; Climate Watch; Industry participant interviews; Peer-reviewed journals; Lit. search; Bain analysis

# SEA has a critical role to play in global climate action and decarbonization

SEA is a key contributor to global GHG emissions ...

4<sup>th</sup>

largest energy consumer in the world<sup>1</sup>

80%

of energy derived from fossil fuel

70%

contribution to global emissions from land use change and forestry

... and has potential to accelerate the energy transition

8 out of 10

SEA countries have sufficient RE technical potential to meet electricity demand<sup>3,4</sup>

4 out of 10

SEA countries export or plan to export electricity generated from renewable sources

15%

of world's forestland come from SEA






“

*“Actions of ASEAN will be critical to meeting global environmental targets. The decisions leaders make now about decarbonization will determine our collective future.”*

World Economic Forum, 2023

Notes: (1) Compare Southeast Asia region with other individual countries in the world; (2) Land-Use Change and Forestry; (3) Except for Brunei and Singapore; (4) Based on renewable energy technical potential, which factors in geographical information, generation patterns and hourly profiles, and system and topographic constraints, but does not include economic (e.g., cost competitiveness, grid connectivity) and market factors (e.g., investor interest); solar & wind potential excludes settlements and urban areas to consider wind parks and utility-scale PV systems (does not assess rooftop solar potential) Sources: IEA; ADB; S&P Global; World Economics Forum; IRENA

# Yet the region is not on track to deliver its 2030 climate targets

 <p>Work underway but <b>uncertainty about delivery of national plans</b></p>	<p><b>4/10</b></p>	<p>countries have published long-term policy strategy documents, but most still <b>lack actionable implementation details</b></p>	<p><b>3/4</b></p>	<p>of SEA's top emitters are unlikely to be on track to deliver on Nationally Determined Contributions (NDCs)</p>
 <p>Pace of development <b>faster</b> than decarbonization</p>	<p><b>~4%</b></p>	<p><b>annual SEA nominal GDP growth</b> over the past decade (vs. world average 2.5%)</p>	<p><b>~42%</b></p>	<p><b>increase in energy consumption</b> expected from 2020 to 2030 under current policies</p>
 <p>Recent <b>slowdown</b> in green capital deployment</p>	<p><b>~\$1.5T</b></p>	<p><b>cumulative investment</b> needed for <b>energy and nature sectors</b> to reach NDC targets by 2030</p>	<p><b>~\$5.2B</b></p>	<p><b>green investment</b> in SEA in 2022 (~7% decrease from ~5.6B in 2021)</p>

## What Can We Do?

- 

**1** Develop holistic plans at **industry and national levels**
- 

**2** Scale **proven solutions** while building for the future
- 

**3** Ensure capital use is optimized for **high-impact solutions**
- 

**4** Recognize that **SEA can deliver solutions together**

# Four priority actions can deliver commitments and impact

1

## Develop holistic plans at industry and national levels

Develop clear roadmap to 2030, with economically viable initiatives in key sectors

Investors and corporates don't need perfect plans—but they do need a clear direction

2

## Scale proven solutions while building for the future

Known, near-term and high-potential levers that can deliver 2030 Nationally Determined Contributions (NDCs) should be prioritized

Collective action needed now to enhance grids, value nature, promote EVs, etc. for the future

3

## Ensure capital use is optimized for high-impact solutions

Connect capital to most important levers, ensuring funding meets impact

Pilot innovation and market solutions to phase out coal, value nature, and tax carbon

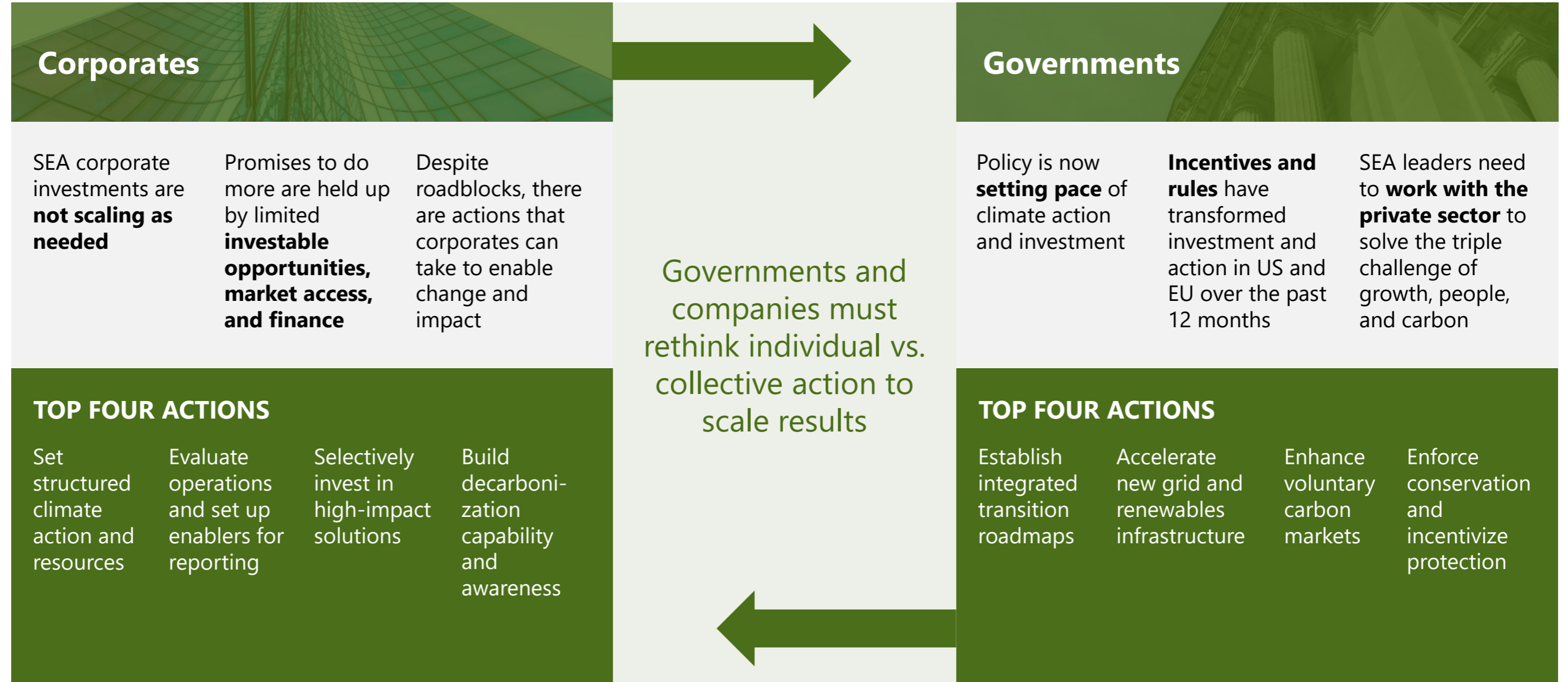
4

## Recognize that SEA can deliver solutions together

SEA has the resources needed to decarbonize and thrive—not just at a country level, but also regional level

Bilateral and regional collaboration need to be accelerated to maximize impact

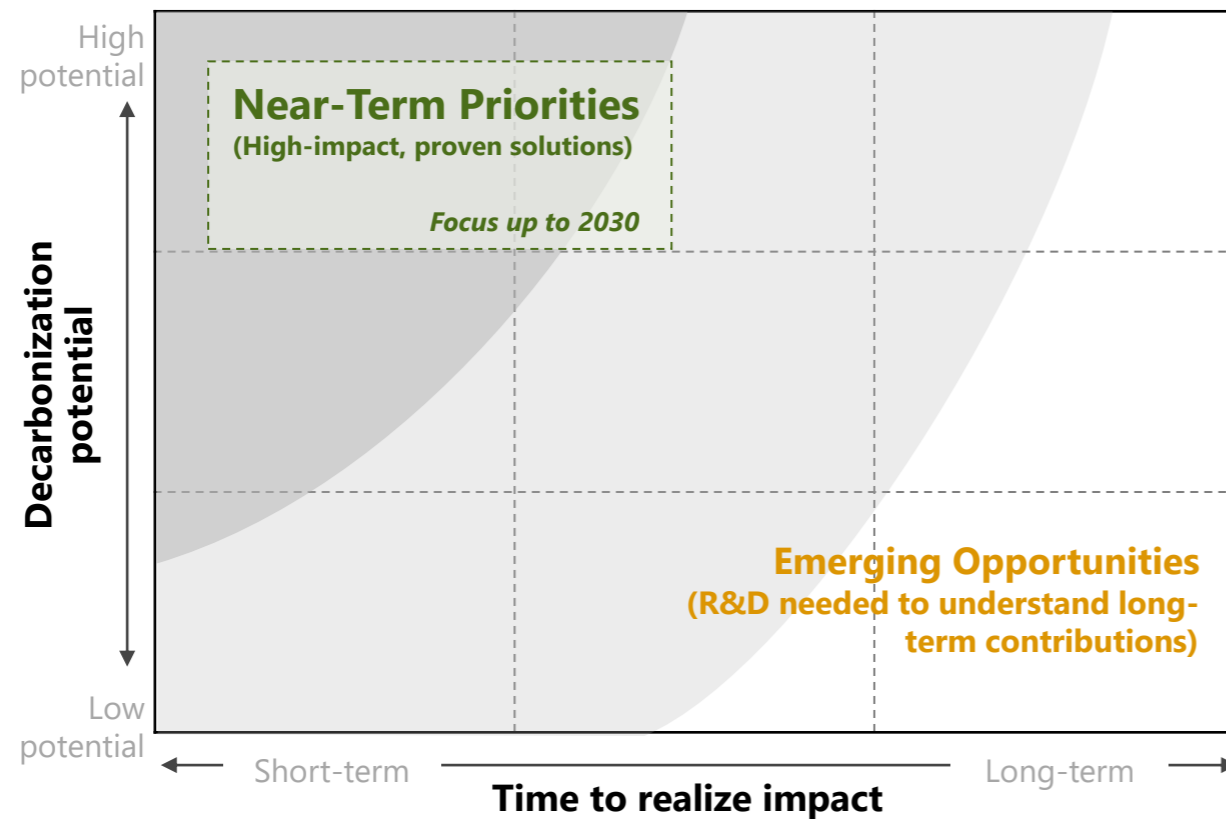
# Improved collaboration between corporates and governments will unlock action



# Time matters: Prioritize solutions that can deliver results today

## Actions prioritized based on time value of carbon

This report has assessed solutions with a bias toward proven solutions that can deliver significant decarbonization in the near term.



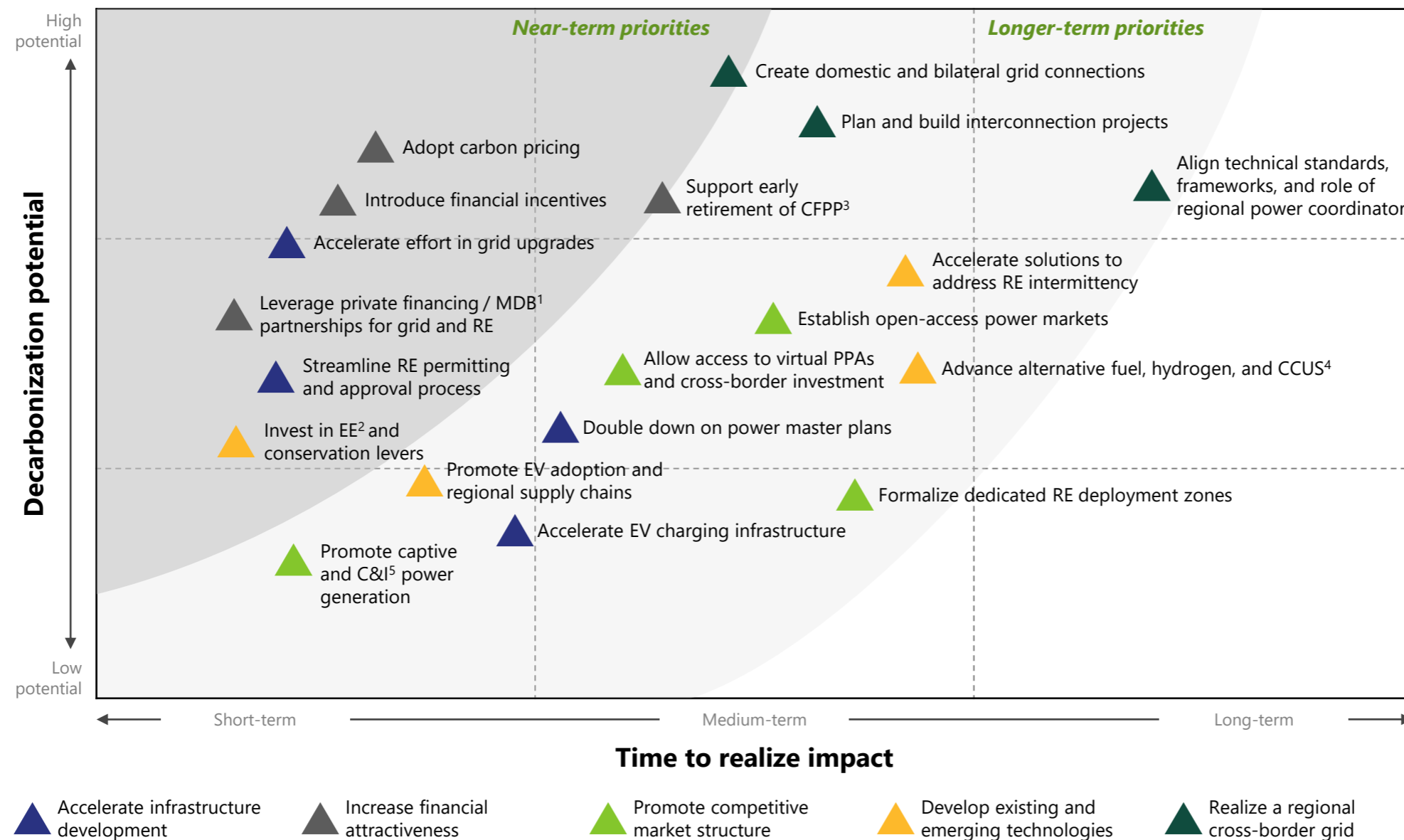
### Near-Term Priorities

No scientific breakthroughs are required to realize their potential today; challenges are addressable through intentional coordination

 <p>Create domestic and bilateral grid connections</p>	 <p>Scale blended financing to fund grid and RE infra</p>	 <p>Early retirement of coal power plants</p>
 <p>Enforcement of existing conservation policies</p>	 <p>Incentivize forestland restoration/protection</p>	 <p>Adopt carbon pricing</p>

Driven by ■ Governments ■ Investors ■ Corporates

# Energy solutions | Near-term priorities like grid infrastructure, renewables, and financing require partnership to accelerate

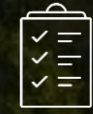
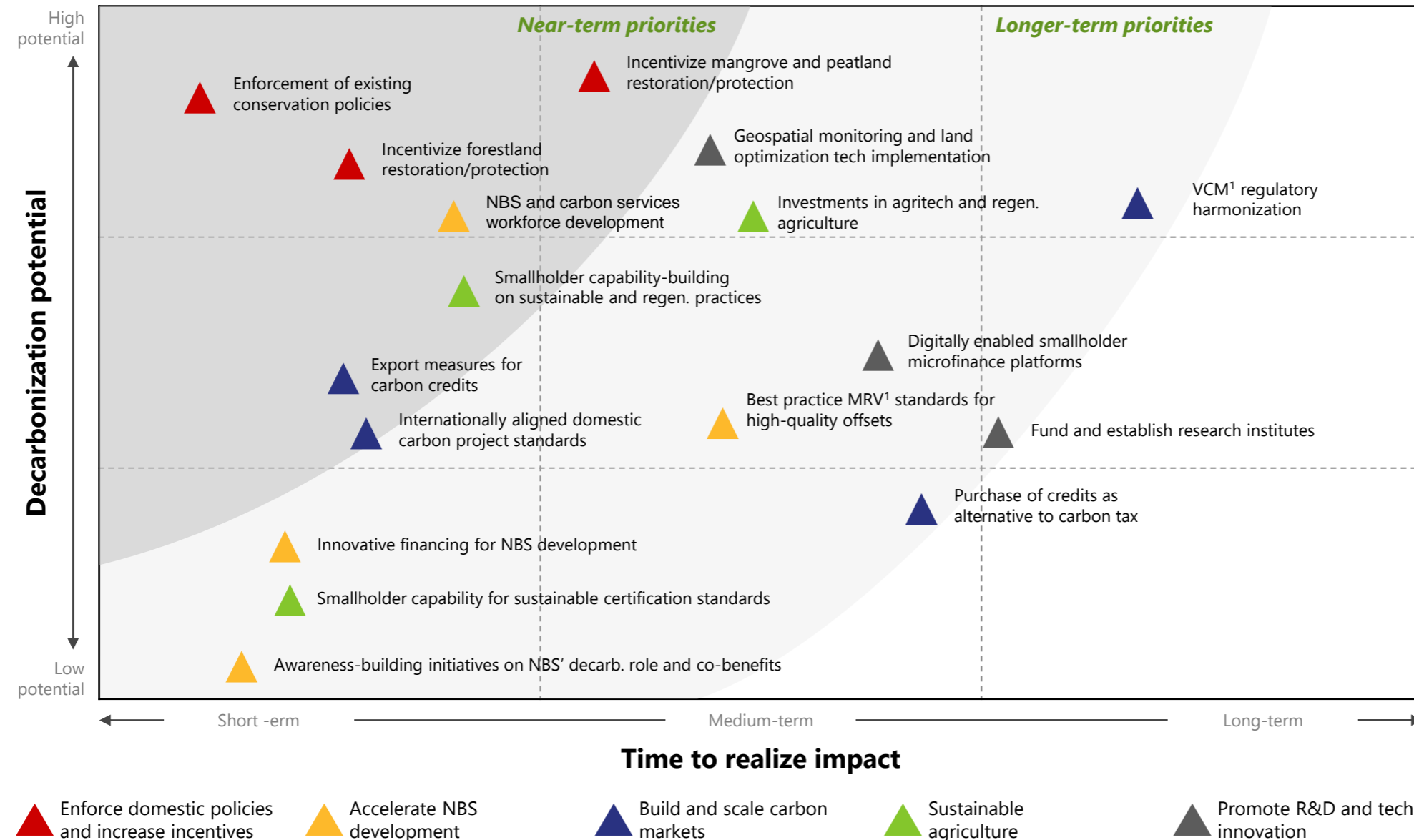


## Key takeaways

- **Policy and partnership-oriented levers** are both highly impactful and relatively actionable in the near term to accelerate decarbonization
  - **Government actions** to introduce **carbon taxes, financial incentives, development funding, and grid investments** are most critical in the immediate term
  - **Private sector** to participate more in RE deployment through **financing and partnership agreements**
- Highly impactful levers within **emerging technologies** and **regional grid networks** are longer-term solutions requiring high R&D and financial investment. However, **interim steps can be taken today** to accelerate these levers, e.g.,
  - **Strategic opportunities for battery storage investments** to complement RE infrastructure deployment
  - **Cross-border RE trade deals** e.g., Singapore's arrangements with Laos, Cambodia, and Indonesia

Notes: (1) Multilateral development bank; (2) Energy efficiency; (3) Coal-fired power plant; (4) Carbon capture utilization and storage; (5) Commercial and Industrial

# Nature solutions | Near-term solutions include incentives for protection/restoration, enforcing conservation, and promoting carbon markets



## Key takeaways

- **Policy incentives and enforcement are critical** to meet 2030 commitments
  - **Protecting/restoring** ecosystems must be economically competitive with commodity production
  - Both **tech and active forest management** can improve enforcement
- Beyond policy, an **ecosystem of players can act** to tackle gaps to accelerate NBS momentum
  - Build **NBS talent pipeline** with training programs/accelerators
  - **Train smallholders in sustainable agriculture practices**; leverage certifications
  - **Support development and use of NBS tech** for project lifecycle and market development (MRV, etc.)
  - **Bilateral/regional agreements on project standards and credit trading** aligned with international agreements (Article 6)

Notes: (1) Measurement, reporting, and verification



# Taking action will alter SEA's trajectory and allow it to meet economic and climate goals

By harnessing collective will to **challenge the status quo** and **lead the carbon transition**, SEA in 2030 can achieve:

- ✓ Collaboration across stakeholder groups
- ✓ Significant green investment unlocked
- ✓ Clear plan and results-driven prioritization



**33%**

reduction in GHG emissions<sup>1</sup> vs. BAU



**Up to \$2T**

in new investment to transition across SEA's economies<sup>2</sup>



**>25%**

regional power generation fulfilled by renewables



**5–6M**

new jobs created through SEA green economy



**100%**

electricity access across all SEA countries



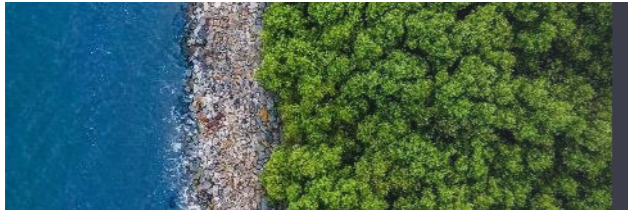
**~1.7Gt**

CO<sub>2</sub>e/year in full abatement potential from nature-based solutions

Notes: (1) Reduction from forecast emissions in 2030 estimated to meet unconditional emissions targets (2) Investment needed to meet current stated policies and commitments (unconditional NDCs, adjusted down from 1.5°C pathway established in 2022 Green Economy Report.

Sources: Country NDCs, IRENA, ASEAN Centre for Energy; peer-reviewed journals; Bain analysis

# Contents



**Introduction: Context and challenges**



**Progress towards decarbonization**



**Accelerating the energy transition**



**Valuing nature for impact**



**Recommendations and call for action**

An aerial photograph showing a rocky coastline. The left side of the image is dominated by deep blue water with some white foam from waves crashing against the shore. The middle section is a narrow strip of grey and brown rocks. To the right of the rocks is a dense, lush green forest. The text is overlaid on the right side of the image, partially overlapping the forest and the white background.

Introduction  
**Context and  
challenges**

# SE Asia is a unique region with a young population & strong economic prospects



SEA has favorable demographics and a rapidly growing middle class

**380M**

residents (~60% of total population) are under the age of 35

**3<sup>rd</sup>**

largest labor force supplier in the world (only behind China and India)

**~50%**

of population will join the middle class by 2030<sup>1</sup>, doubling in size vs. 2020



SEA will continue to see significant, above-average growth

**4%**

annual nominal GDP growth over the past decade (vs. world average 2.5%)

**4<sup>th</sup>**


largest economy by 2050<sup>2</sup>, overtaking EU and Japan, behind US, China, and India


*"ASEAN has stood up well to the global economic slowdown, partly due to appropriate monetary and macroeconomic policy responses, sound export performance, and robust domestic demand in some countries."*


OECD




Each country has unique advantages and roles to play in the global economy

 Global top 11 in GDP per capita and political stability ranking<sup>3</sup>

 World's top 3 largest reserves for nickel, tin, and rare earth (key elements for batteries and electronics)<sup>4</sup>

 World's top 3 largest solar PV module manufacturers<sup>4</sup>

 World's 11<sup>th</sup> largest car manufacturer, potential to become EV hub<sup>4</sup>

*"Given the increasing volatility and uncertainty in the global economy, turning this diversity into a strength will be essential for ASEAN to sustain robust economic growth and development."*

Asian Development Bank

Notes: (1) ADB projection; (2) Measured by total GDP, projected by US-ASEAN Business Council, based on ASEAN annual growth rate of 5.5%; (3) As of 2021, stability ranking refers to global political stability index; (4) As of 2022, IEA research  
Sources: IEA; ADB; S&P Global; World Economics Forum; World Bank

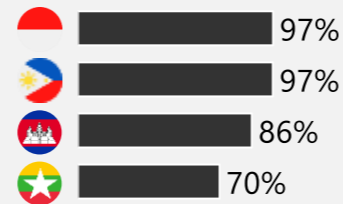
# SEA needs to manage competing priorities on the road to 2030



**5%**

of SEA households still don't have access to electricity (vs. 1% in India)

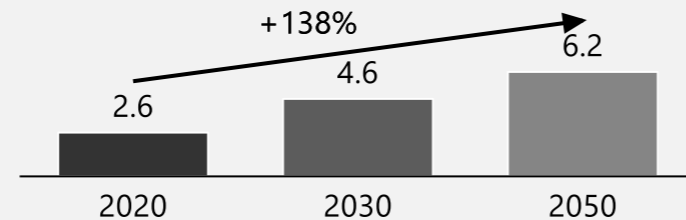
**% Electricity access by household<sup>1</sup>**  
(showing only SEA countries with <100% access to electricity)



**~40%**

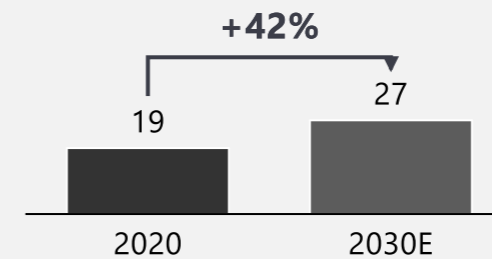
of SEA energy consumption from fossil fuels relies on imports by 2030 under current policies<sup>2</sup>

**SEA oil import projection (mb/d<sup>3</sup>)**

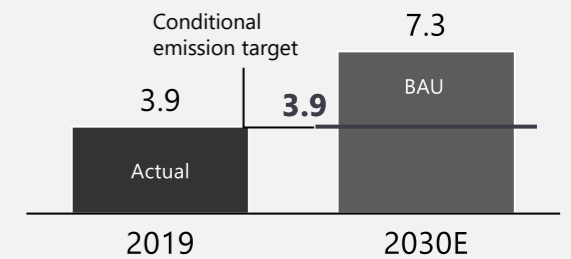


**Energy demand** projected to increase, yet **emissions** must be kept under control

SEA final energy consumption (EJ)<sup>2</sup>



SEA GHG emissions<sup>4</sup> (GtCO<sub>2</sub>e)



*“SEA’s reliance on fossil fuels to meet rising demand for energy is proving to be a significant vulnerability. Meeting energy security and emissions goals will require countries in the region to make major efforts to improve energy efficiency, accelerate renewable power generation, and switch to low emissions fuels..”*

International Energy Agency, 2022

Notes: (1) As of 2021, based on World Bank database; (2) Modeled based on Stated Policies Scenario (STEPS) where policies that have been implemented and announced by each country and sector are considered for their impact on emissions reduction; (3) Million barrels per day, IEA projection; (4) Unconditional emissions target of ~5 GtCO<sub>2</sub>e by 2030 committed by SEA countries, whereas business as usual (BAU) emissions represents regional emissions in absence of climate intervention  
Sources: IEA; ADB; S&P Global; World Economics Forum; World Bank

# SEA is raising targets but has yet to define how promises will translate to results



## Governments

**8 out of 10**

SEA countries have Net Zero or carbon neutrality commitments

**7 out of 10**

SEA countries are now considering or have implemented carbon pricing/taxes



## Corporates

**4x**

growth of SBTi<sup>1</sup> commitments from SEA companies (2021–2022)

**69%**

of green investments in the region in 2022 are funded by corporates



## Investors

**\$5.2B**

total green transaction value<sup>2</sup> in SEA in 2022 (vs. \$5.6B in 2021)

**>55%**

green investments come from foreign investors (esp. investors outside SEA)



## Emissions

**+10%**

increase in SEA greenhouse gas emissions (2018–2019)<sup>3</sup>

**+23%**

increase in emissions from environmental degradation<sup>3</sup>

More details in the following pages ...

Notes: (1) Science Based Targets initiatives; (2) Includes transactions involving corporates, PE / VC, infrastructure funds, climate-focused "green" funds, and sovereign wealth funds and government-affiliated companies; (3) Comparing 2018 with 2019, the latest available year from Climate Watch  
Sources: SBTi; UNFCCC; Climate Watch; Preqin; S&P Capital IQ; Pitchbook; AVCJ; ISEAS; World Bank; Bain analysis

# Four SEA countries strengthened commitments; others moving to price carbon

## SEA decarbonization scorecard

Positive developments<sup>1</sup> Negative developments<sup>1</sup> No changes<sup>1</sup> Does not exist

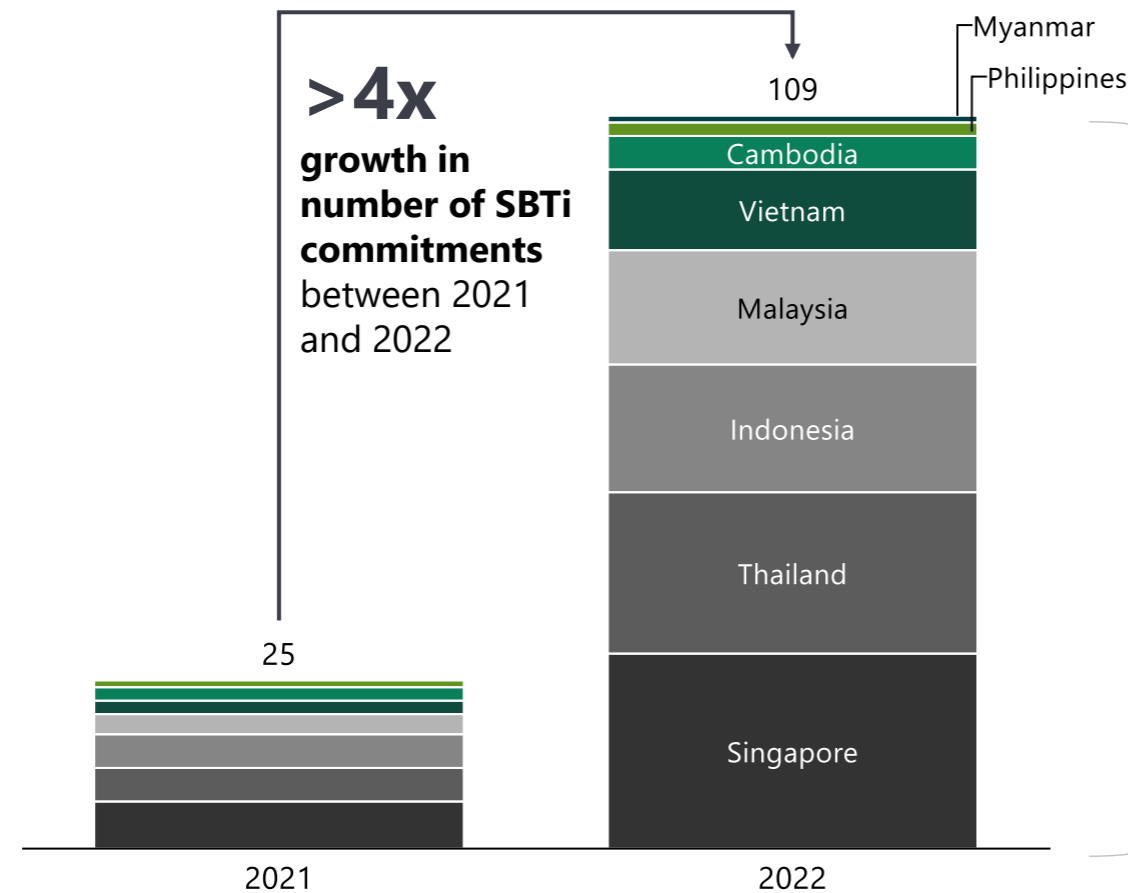
	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
<b>Net Zero</b>	2050	(2050+) <sup>2</sup>	2060	2050	(2050+) <sup>3</sup>	NA	NA	2050	2065	2050
<b>Emissions<sup>4</sup></b>										
NDC date of submission	Dec 2020	Dec 2020	Sep 2022	May 2021	Jul 2021	Aug 2021	Apr 2021	Nov 2022	Nov 2022	Sep 2020
Unconditional	~20%		~32%	~60%	~45% <sup>4</sup>	~245 MtCO <sub>2</sub> e	~3%	60MtCO <sub>2</sub> e <sup>6</sup>	~30%	~16%
Conditional		~42%	~43%	~67%		~415 MtCO <sub>2</sub> e	~75%		~40%	~44%
<b>Carbon pricing (in USD)</b>	Carbon pricing to be implemented by 2025	NA	Carbon tax for coal power delayed, ETS for coal launched in Q1 2023	NA	Carbon tax or ETS under consideration	NA	Carbon tax and ETS under consideration	Carbon tax (~\$4/tCO <sub>2</sub> e) implemented, to increase to \$40-\$60 by 2030	ETS exchange launched, carbon tax under consideration	ETS legalized – Pilot Carbon Exchange from 2025
<b>Renewable energy mix targets</b>	30% generation by 2035	25% generation by 2030	34% generation by 2030	30% consumption by 2025 <sup>7</sup>	~40% capacity by 2035	>39% generation by 2030	~35% generation by 2030	2GWp solar by 2030, 4GW low-carbon imports by 2035	30% consumption by 2037	~47% generation by 2030 <sup>9</sup>
← Regional target of 35% by 2025 (from ~24% in 2018) →										
<b>Nature targets</b>	Forest reserves increased from 41% to 55% by 2035	Forest increase cover to 60% of total area by 2030	2M ha of peatlands and 12M ha of degraded land restored by 2030	Forest cover increased to 70% of total area (conditional) by 2030	>20% of terrestrial and 10% of coastal areas protected by 2025	Forest under public protection increased to 30% of total area by 2030	Net loss in natural forests, mangroves and seagrass cover eliminated by 2028	1M more trees planted by 2030 and add 130ha of new parks by 2026	Forest cover increased to 55% of total area by 2037	Forest cover increased to 42% of total area by 2030

(1) Relative to 2022 Green Economy report; (2) Committed to carbon neutrality by 2050, no direct commitments on Net Zero (expecting 2050+); (3) 2050 at earliest; (4) Emissions reduction targets by 2030 from BAU. Unconditional reduction targets are non-dependent on external support. Conditional targets dependent on sufficient support from international community; (5) Reflects emissions intensity of GDP relative to BAU; (6) Absolute target emission level by 2030; (7) Target has not been revised since 2011; (8) Laos is in discussion with JICA (Japan International Cooperation Agency) to set out a plan to restore forest coverage to 70% by 2035 (9) If G7 pledges are met under the JETP; otherwise, 31%.

Sources: UNFCCC NDC Registry; UNFCCC; Climate Watch; New Straits Times; Climate Action Tracker; Government of Philippines; Business Inquirer; IEA; Bloomberg; Government of Thailand; Singapore National Climate Change Secretariat; Singapore Energy Market Authority; EU; the Edge Markets; ASEAN Briefing; Carbon Pulse; ASEAN Centre for Energy; Vietnam Plus; Industry participant interviews

# Corporate commitments to science-based targets have materially accelerated

## Number of SEA firms with SBTi commitments



## Factors linked to rise in SBTi<sup>1</sup> commitments include:



**Increased awareness** of SBTi leading to surpassing of **critical mass<sup>2</sup>** target for rapid adoption of SBTi in 2021



**Simplified commitment submission mechanism** for SMEs



**Increased climate change awareness and expectations** from end customers and shareholders

## Several large firms across SEA set new SBTi commitments or targets in 2022



Notes: (1) Science-Based Target initiatives are emission reduction targets that are aligned from a climate science perspective to Paris Agreement goals (efforts to limit warming to 1.5°C by 2050); The Science-Based Targets Initiative (SBTi) works to collect and validate targets set by private sector companies; (2) Based on SBTi's adoption of the diffusion of innovations theory; SBTi set a critical mass target of 20% high-impact companies having SBTi commitments, after which rapid adoption would be achieved; Target passed in 2021 (27%)  
Source: SBTi



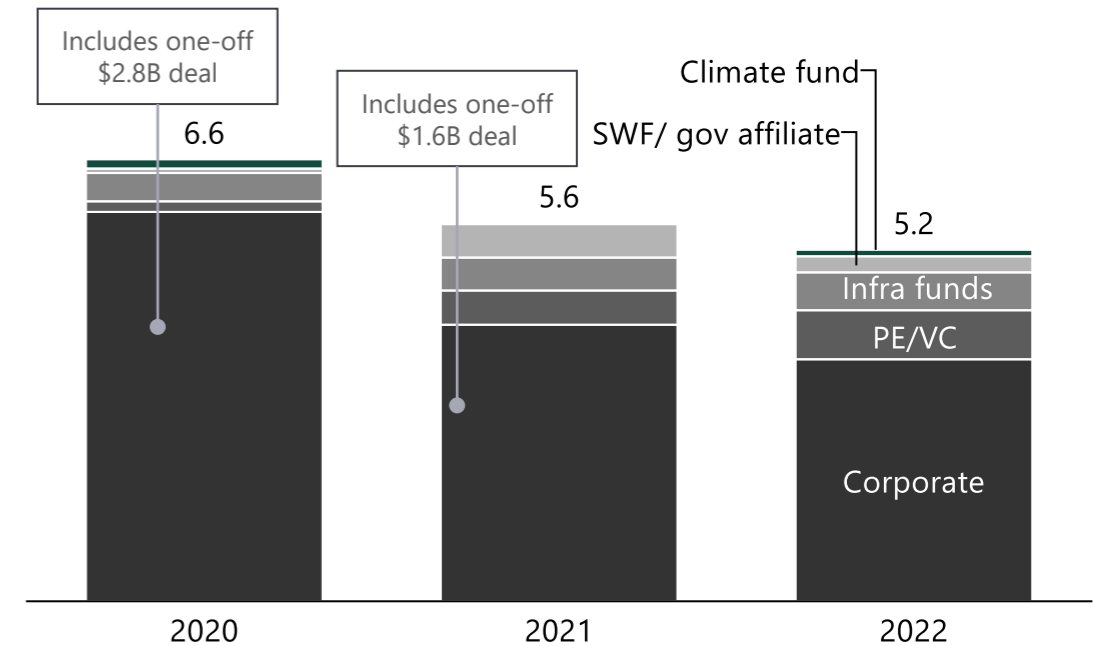
# Green investment commitments increased in 2022 but less capital deployed

Commitments of new capital from governments and corporates is rising, but has not yet translated into more transactions and spending at scale

However, momentum has not yet translated into capital spend or an upward trajectory as expected

<b>Governments</b> 	<b>&gt; \$35B</b> committed by EU, US, Japan, and other international partners over next 3–5 years to <b>help Indonesia and Vietnam phase out fossil fuels</b>
	<b>&gt; \$17B</b> committed by Singapore to <b>combat climate change under 2030 Green Plan</b>
<b>Corporates</b> 	 announced <b>\$7B</b> to fund green hydrogen projects, including construction of Thai hydrogen plant
	 committed to investing <b>\$6B</b> in Indonesia over the next 3 years for 6 EV battery projects
	 expected to commit at least <b>\$2B</b> for clean energy projects in 2023

SEA "green" deal transaction value by investor type (USD B)<sup>1</sup>



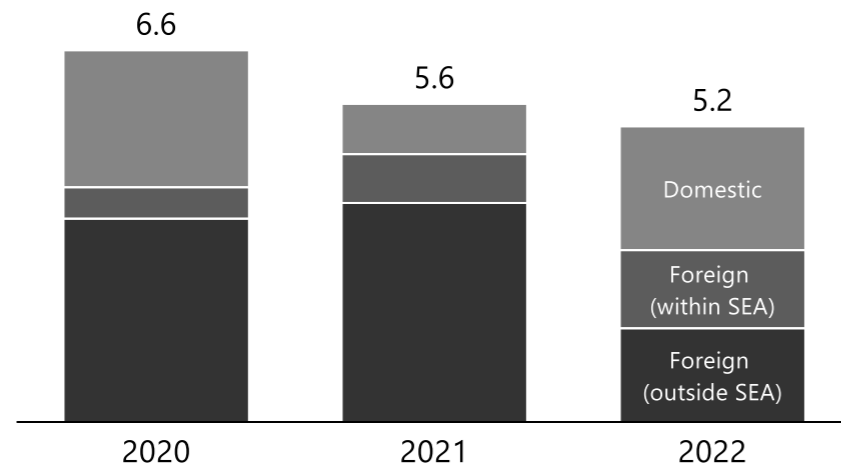
*"In markets like SEA ... there are a range of competing priorities that can make ESG challenging to drive forward. There are still gaps and much work to be done, but ESG has come a long way in the region over last 20 years, and there is an awareness of the value of ESG"*  
 Senior Partner, Global Private Equity Firm

Notes: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; Capex spend on renewable energy infrastructure estimated at \$45B across past 3 years  
 Sources: AVCJ; Preqin; S&P Capital IQ; Pitchbook; Industry participant interviews; Lit. search

# SEA continues to rely heavily on foreign investments; significant capital moving into Singapore, Indonesia, and renewables, but at a slower pace than projected

## >55% of 2022 green investments in SEA come from foreign investors

Private green investments in SEA by investor origin<sup>1</sup> (USD B)



**Singapore** is the most active investor in the region, involved in **30% of deals** in past 3 years

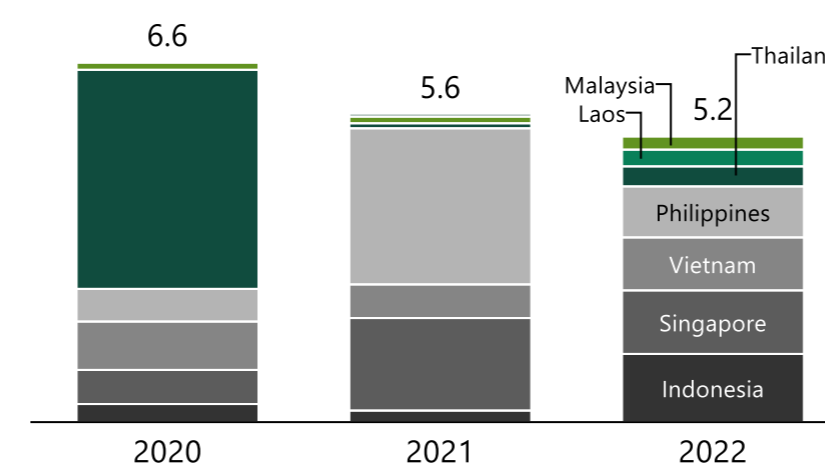
- e.g., GIC acquired ~18% of AC Energy Philippines for ~\$0.4B in 2021

**US** was involved in **20% of deals** in past 3 years, trailing only Singapore in deal involvement

- e.g., KKR raised its stakes in First Gen, Philippines' power producer, from ~12% to ~20% for ~\$0.2B

## >50% of 2022 green investments are in Singapore and Indonesia

Private green investments by SEA countries<sup>1</sup> (USD B)

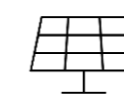
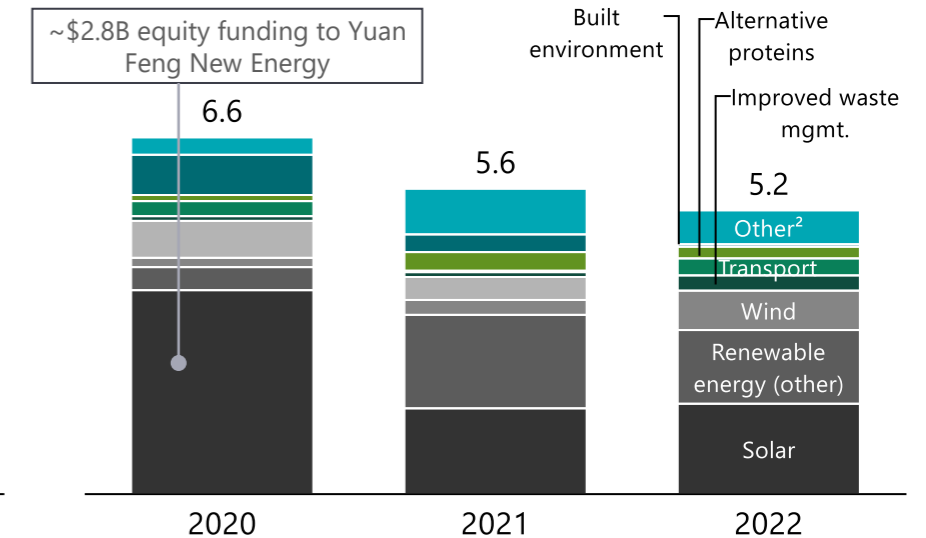


**Indonesia** and **Singapore** steadily growing in investments whereas rest of the region experiencing **fluctuations** driven by large, one-off deals in Philippines and Thailand

- e.g., JERA has acquired ~27% of Aboitiz Power for ~\$1.6B, accounting for ~55% of the total transaction amount in Philippines during 2021

## >70% of 2022 green investments in SEA are in renewable energy

Private green investments in SEA by theme<sup>1</sup> (USD B)



Share of **investments in renewables remains stable** (70%–75%), though larger push for wind in recent years

Note: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Others include transport, agricultural productivity, fuel substitution, sustainable biomass/ biogas/ biofuel, alternative materials, minimal food loss and waste, and others

Sources: AVCJ; Preqin; S&P Capital IQ; Pitchbook

# What will it take to attract more investments? SEA faces distinct challenges

## High cost of capital mixed with insufficient returns



*"The **hurdle rate** is the main challenge, especially with investments in RE projects. Financial investors may **expect returns higher than 20%**, and in today's environment it's difficult for RE to generate that level of return."*

Chief Investment Officer,  
Climate Impact Fund

## Irregularity and uncertainty of policies



*"One of the challenges in RE deployment is that there are **many changes in offtaking processes**. Thailand moved from FiT to Quasi-bid offtaking mechanism; Vietnam from FiT to bidding and auction pricing."*

Head of Wind Development, Renewable Solutions Company

## Immature innovation ecosystem for novel technologies



*"The **US and EU** definitely rank much **higher than SEA** in terms of how unique the tech is. The whole ecosystem around **R&D, talent, and venture capital** is just **not as strong in SEA**, focusing more on implementation of existing tech."*

Director, Late-stage Venture / Growth Equity  
Capital Investor

## Limited green growth policies lower investor confidence



*"**EU frames decarbonization as engine of growth**, but the framing is different in SEA. As you decouple energy from GDP, the more service-based your economy is. **SEA countries haven't reached this stage of development yet**"*

Former Manager, Sustainability Strategy Group

## Diversity in economic development stage of SEA countries



*"Countries like Indonesia, Vietnam, Philippines, and Thailand all have **high energy demand** and **acceptable offtaker quality** compared to less-developed SEA countries where **local offtaker risk is high** due to poor credit history."*

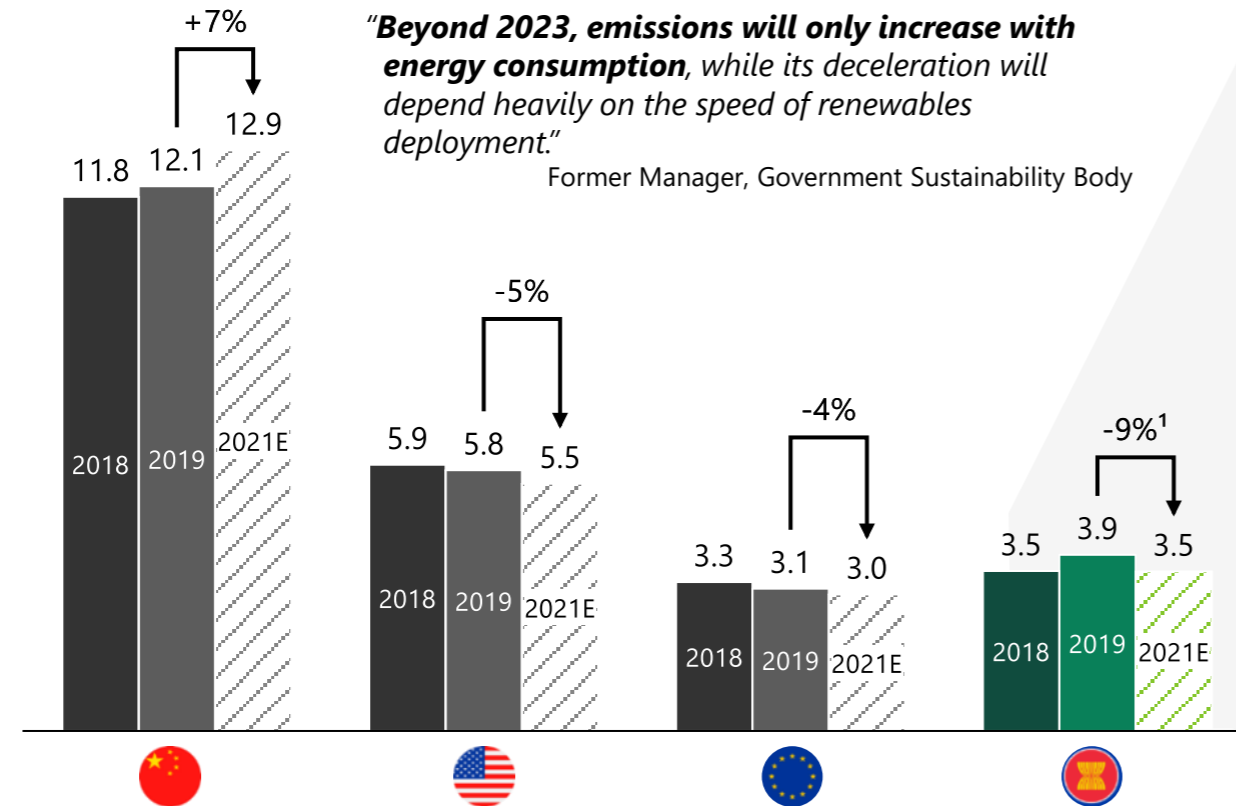
Senior Portfolio Management Officer, Regional Multilateral Development Bank

# SEA emissions dipped during the pandemic after steadily increasing ...

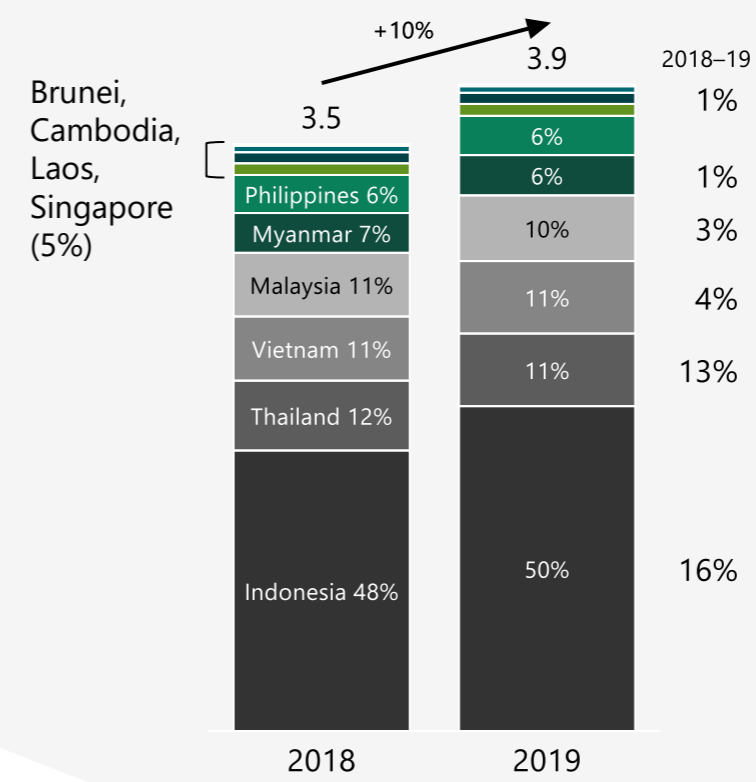
SEA emissions reduced more than global peers in 2021; trend not expected to last as economy recovers post-pandemic

Indonesia remains the biggest SEA emitter, whereas energy and nature contribute ~75% of emissions in the region

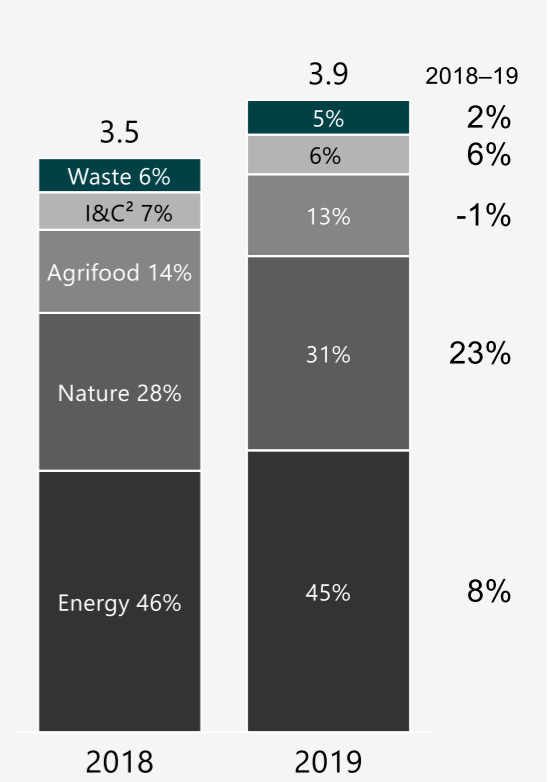
GHG emissions of various economies (GtCO<sub>2</sub>e)



SEA GHG emissions by country (GtCO<sub>2</sub>e)



SEA GHG emissions by sector (GtCO<sub>2</sub>e)

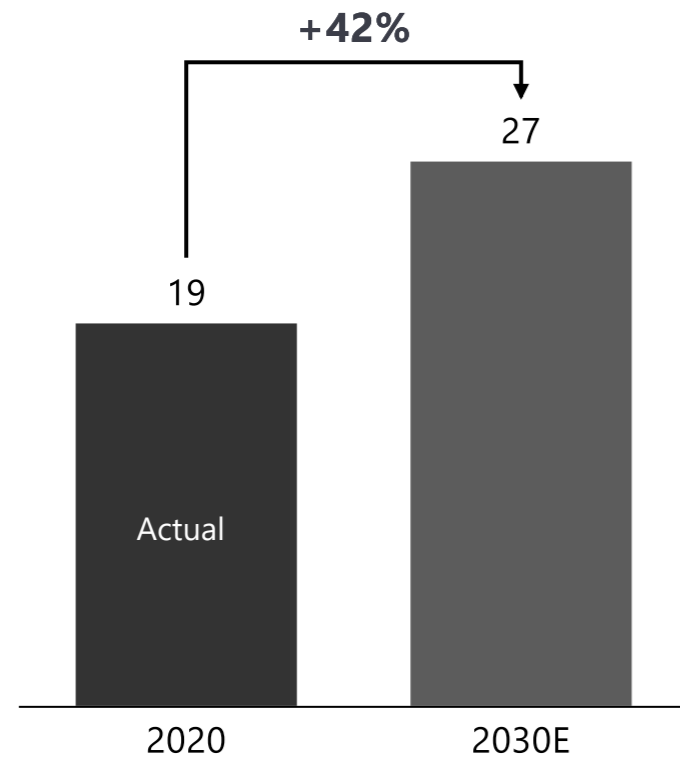


Notes: 2021 emissions are estimated from average SEA emissions growth rate from 2019 to 2021 from data sources such as Euromonitor and Our World in Data applied to 2019 Climate Watch emissions figures; (1) Due to decreased pandemic economic activities, stronger climate related policies, acceleration of tech; (2) Industrial and construction Sources: Climate Watch, January 2023; Euromonitor; Our World in Data; Industry participant interviews; Bain analysis

# ... but the coming decade will see rising energy demand and emissions; SEA needs to intensify its decarbonization efforts to meet a 33% reduction by 2030

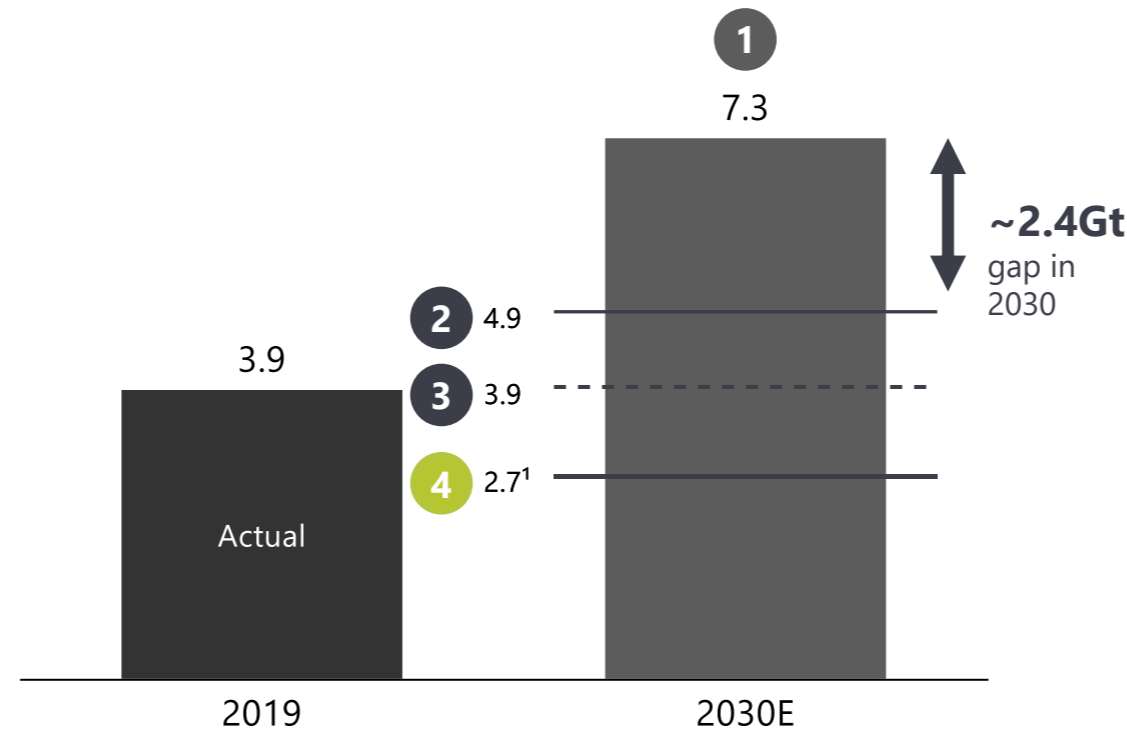
Energy demand is rising to fuel regional economic growth ...

SEA total final energy consumption (EJ)<sup>1</sup>



... yet SEA must take actions to keep GHG emissions under control

SEA GHG emissions by country (GtCO<sub>2</sub>e)



**1 Business-as-Usual (BAU):** Projected emissions level should there be no significant change in technology, economics, or policies such that historical trends continue

**2 NDC unconditional target:** Emissions level<sup>2</sup> committed by SEA countries that can be reached with own resources and capabilities and without international support

**3 NDC conditional target:** Emissions level<sup>2</sup> committed by SEA countries that can be reached subject to international support and/or other conditions

**4 Country policies:** Projected emissions level based on current and planned policies of each SEA country

Notes: (1) Modeled based on Stated Policies Scenario (STEPS) in which policies which have been implemented and announced by each country and for each sector are considered for their impact on emissions reduction; (2) BAU minus emissions reductions commitments elaborated in Nationally Determined Contribution – a country's official commitment to greenhouse gas emission reduction as submitted to the UNFCCC

Sources: UNFCCC Country NDCs; IEA; Bain analysis

# Given this point of departure, this report seeks to answer three main questions



Where do **SEA countries stand** on translating **climate commitments into action** and are the countries on track to deliver heading into COP28?

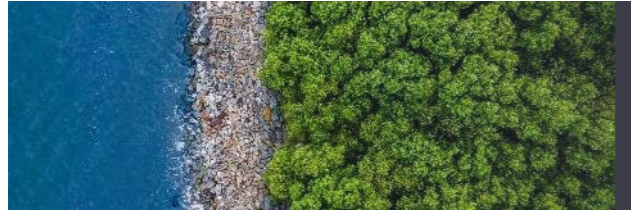


How can the region **accelerate decarbonization and investment** in the two highest-emitting sectors in SEA: **Energy and Nature**?



What can SEA do today to **accelerate action and punch above its weight** as a region vs a collection of individual countries?

# Contents



**Introduction: Context and challenges**



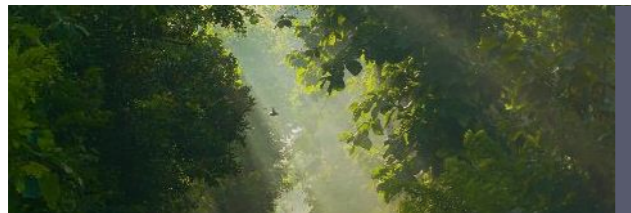
**Progress towards decarbonization**



**Accelerating the energy transition**



**Valuing nature for impact**



**Recommendations and call for action**

An aerial photograph of a solar farm. The solar panels are arranged in neat, parallel rows on a cleared area, surrounded by dense green trees. The lighting suggests it might be early morning or late afternoon, with long shadows cast across the panels. The overall scene is a blend of nature and renewable energy technology.

**Progress towards  
decarbonization**



# SEA faces a unique set of challenges, making decarbonization challenging

## Dependence on fossil fuels for baseline load



### Region remains heavily dependent on fossil fuels for electricity generation

- Indonesia, Brunei, Malaysia, and Philippines still subsidize some fossil fuel use<sup>1</sup>

## Complex grid connectivity



### Archipelagic nations have complicated interconnection challenges

- Increased grid connection among Indonesia's main islands achieved by 2028 at the earliest
- ~3% of Philippines' and Indonesia's population still without access to electricity<sup>3</sup>

## Stage of economic development



### SEA's large economies are emerging markets and require foreign investment to transition

- ~\$1.1T is needed to finance SEA's energy transition over the next decade
- Vietnam and Indonesia to receive \$15.5B and \$20B respectively for the managed phase-out of coal

## Workforce transition



### Huge workforce in fossil fuel sectors requires just transition plans to switch to green jobs

- Phasing out of coal will affect ~250K workers in Indonesia
- 35K+ people work in petroleum and natural gas in Malaysia<sup>4</sup>

## Balancing decarbonization and growth



### Tension between decarbonizing and achieving quick economic growth

*"In Southeast Asia, there is a [decarbonization] cost to economic growth, whereas in Europe, decarbonization is actually perceived as an engine of growth."*

Former Manager in Sustainability Strategy Group

## Uneven distribution of renewable resources



### SEA's RE technical potential sufficient for region's energy needs, but the region suffers from a demand/supply mismatch

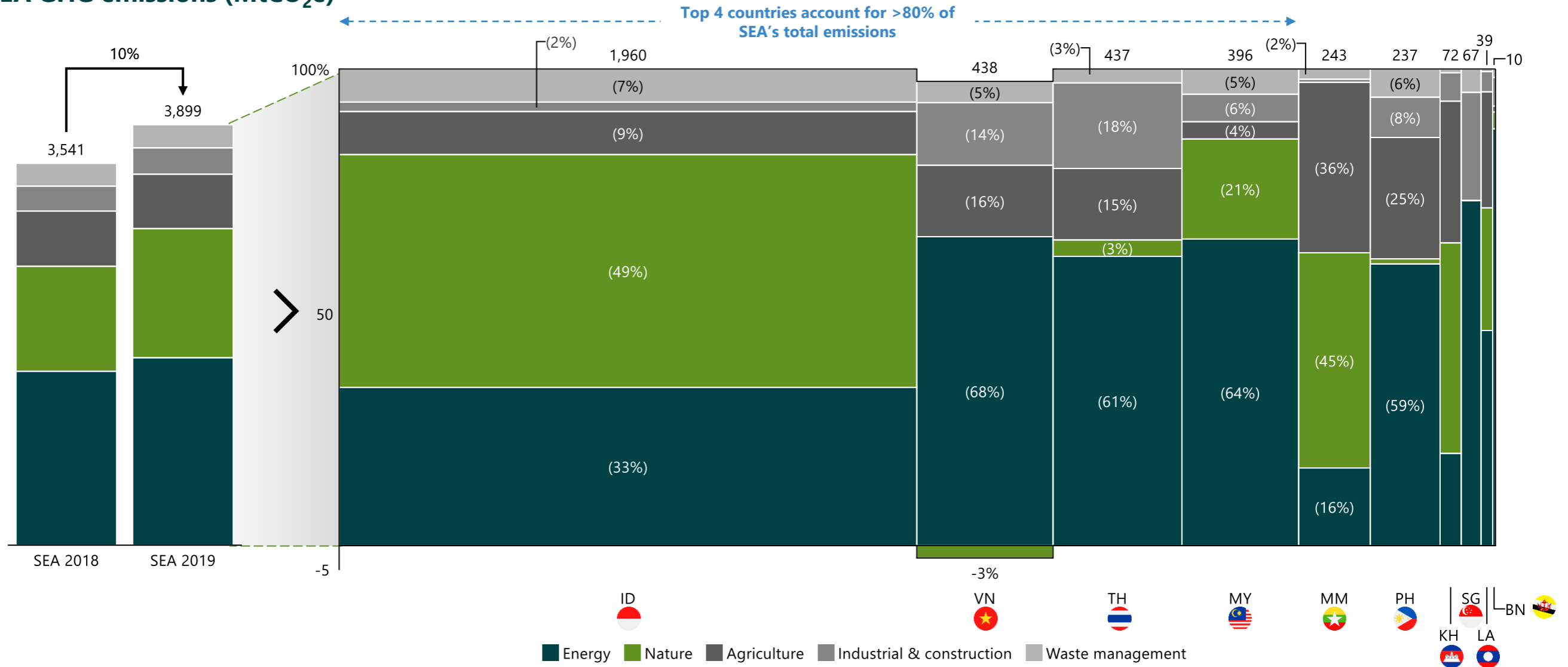
- For Singapore and Brunei, RE technical potential is insufficient; both will need to import from neighbors

Notes: (1) Refers to explicit fossil fuel subsidy in 2021; (2) ASEAN 2022 figures as of Jan 2023; (3) As of 2020; (4) As of 2017

Sources: IEA; Asian Development Bank; Institute for Energy Economics and Financial Analysis; Bloomberg; Equal Times; Malaysia Department of Statistics; IRENA; World Bank; Our World in Data; IESR; Euromonitor; IMF; Lit. search; Industry participant interviews

# Different emissions profiles across countries; energy and nature largest sources

## SEA GHG emissions (MtCO<sub>2</sub>e)



Note: Bunker fuels are not included in accordance with IPCC guidelines  
Source: Climate Watch

# Detailed assessments vs. National Development Contributions (NDCs) at a country level are important, given little consensus and historically track record



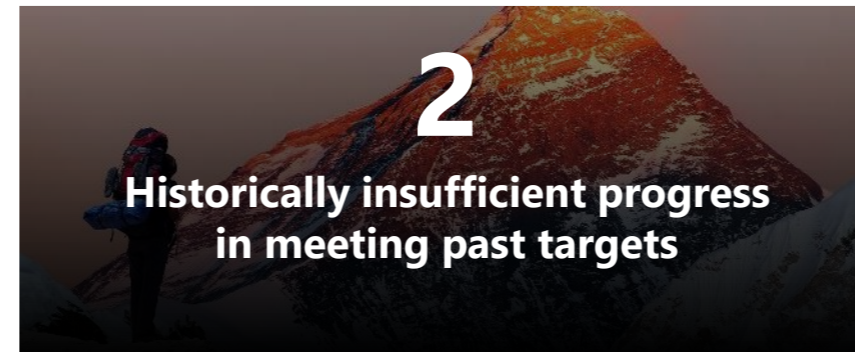
**1**  
**Lack of consensus view on SEA's decarbonization progress**

*"Ministers ... responded resolutely by underlining the urgency of boosting clean energy investment and financial flows."*

Indonesia's Minister of Energy & Mineral Resources, Nov 2022

*"Southeast Asia is still a long way off the pathway consistent with its clean energy ambitions."*

IEA Southeast Asia Energy Outlook 2022



**2**  
**Historically insufficient progress in meeting past targets**

**~14%**

of TPES<sup>1</sup> in 2020 supplied by renewables vs. **target of ~23%** in 2025



**3**  
**Identification of concrete actions to close gaps required across stakeholders**

**4**

updated country NDCs and new Net Zero targets within the past year



*"... Reaching the NDC commitment cannot be done by the government alone<sup>2</sup>. We also need corporations ... and the whole ecosystem to pitch in"*

Indonesia's Minister of Finance, Sept 2021

**Understanding SEA's status today is critical to identify where interventions are needed**

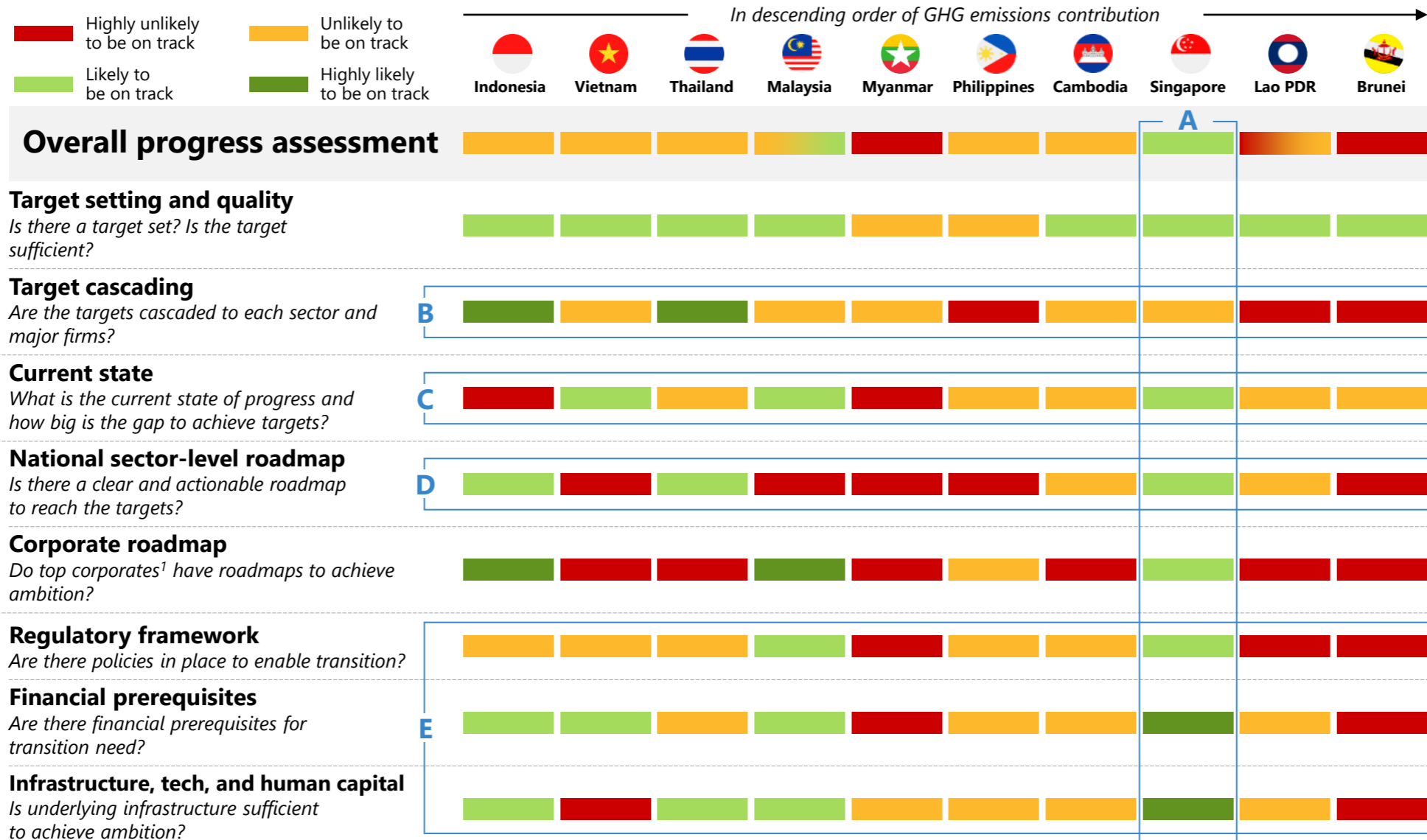
# To understand state of play for SEA countries, this report has assessed a wide range of characteristics that are essential for effective delivery of climate targets

## Decarbonization progress assessment framework

Topic	Assessment criteria				
 <b>Ambition</b> (20% of overall assessment weighting)	<b>Target setting</b> Is there a target set?	<b>Sector-specific targets</b> Are the targets cascaded to each sector?	<b>Target quality</b> Is the target sufficient to achieve Net Zero?	<b>Corporate-specific targets</b> Are the targets cascaded to leading corporates?	<b>Sector-agnostic assessment</b>
 <b>State of progress</b> (35% of overall assessment weighting)	<b>State of progress based on quantitative metrics</b> What is the current state of progress and how big is the gap to achieve targets?				<b>Sector-specific assessment on energy and nature</b>
 <b>Roadmap</b> (20% of overall assessment weighting)	<b>National sector-level roadmap</b> Is there a clear and actionable roadmap to reach the targets?	<b>Corporate roadmap</b> Do top corporates <sup>1</sup> have roadmaps to achieve their ambitions?			
 <b>Enablers</b> (25% of overall assessment weighting)	<b>Regulatory framework</b> Are there policies in place to enable transition?	<b>Financial prerequisite</b> Are the financial prerequisites for transition met?	<b>Infra, tech, and human capital</b> Is underlying infrastructure sufficient to achieve ambition?		

Notes: Stage of progress, Roadmap, and Enablers are assessed based on relevant indicators at both country and sector-level; Focus on energy and nature sector due to large contribution of ~75% to SEA's 2019 GHG emissions; (1) Top 5 local companies considering level of emission and size of the business

# There are significant differences in performance across countries; Singapore leads while 3 of the top 4 emitters appear unlikely to deliver 2030 targets



**Ambition**  
→ → →  
**Progress**

**Roadmap**

**Enablers**

### Key takeaways

- A. Singapore leads** across criteria; compelling key enablers support energy sector
- B. Indonesia and Thailand** have sector targets; top corporates have also set targets
- C. Indonesia** has been slow to progress, but has the right enablers in place
- D. Sector-specific roadmaps** are the critical next step for many countries
- E. Broadly, key enablers** are needed to accelerate progress:
  - Clear regulatory frameworks and streamlined permitting processes
  - Carbon taxes and/or financial incentives
  - Grid connectivity
  - Active NBS developers

Notes: Stage of progress, Roadmap, Enablers are assessed based on relevant indicators at both country and sector-level; Assessment considers equal weightage for energy and nature sector, except for Singapore; NBS = Nature-based solutions; (1) Top 5 local companies considering level of emission and size of the business  
Sources: Bain analysis; Lit. search; Industry participant interviews

# Leading countries have translated climate commitments into tangible policies that are catalyzing investments and actions in private sector

## 1 Inflation Reduction Act

*Extends and enhances existing energy-related tax credits and incentives spanning renewable energy, carbon capture, EVs, GHG reductions, etc.*

**~\$369B**

of investments in **energy security** and **climate change** over the next 10 years

**~\$200B**

of **large-scale investments in manufacturing projects** and **clean tech** from corporations such as **LG, LONGI**

*"The IRA is the **most meaningful climate bill ever passed in the US**. It has the potential to significantly curb the country's greenhouse gas emissions (GHG) over the next few years."*

World Economic Forum

## 2 Green Deal Industrial Plan

*Covers 4 pillars: predictable and simplified regulatory environment, faster access to funding, enhancing skills, and open trade for resilient supply chains*

**~\$272B**

for the greening of industry, including **tax breaks** for businesses **investing in Net Zero technologies**

**~\$17B**

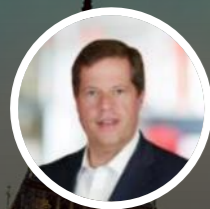
committed by **European Investment Bank Group** in **new financing for sustainable energy projects** including renewables and efficiency

*"We have a **once in a generation opportunity** to show the way with speed, ambition, and a sense of purpose to **secure the EU's industrial lead** in the **fast-growing net-zero technology sector**."*

President of the European Commission

**Achieving 2030 targets is highly dependent on integrated action by SEA's policymakers and private sector**

# Why is it so hard to translate targets into an actionable national plan? Lessons learned from the Former UK Climate Advisor at COP26



**Julian Critchlow**  
Advisory partner  
London

**Director General** for Department for Business Energy & Industrial Strategy (BEIS) in UK (2018–2021)

Experiences in decarbonization :

- Supported national legislation for **Net Zero by 2050**
- Coordinated effort to **bid, win, and prepare for COP26** in Glasgow
- Developed **Net Zero strategy** for both major carbon emission sectors and key enablers
- Set up the **6th Carbon Budget (2033–37)**, leading 78% reduction from 1990
- Set up **cross-Whitehall governance** and **Cabinet Climate Committee**

During your tenure at UK civil service, what surprised you most in **leading policy setting** and translating effort ahead of COP26?



There was **broad consensus** on the need to take actions on climate change, but **navigating the politics of this transition is hard**—on one hand, we need **long-term commitment** such as £1.5 trillion investment in infrastructure by 2050, and on the other hand, there are short-term turbulences such as Brexit, global pandemic, Ukraine war, etc.



**Recommendations for SEA leaders**

- ✓ **Integrate efforts from both national and corporate leaders** and follow the same playbook to enable a successful transition
- ✓ **Recognize the impact to existing businesses** that are highly exposed to traditional energy sources and help them navigate
- ✓ **Strategize and prioritize opportunities**—not every business or country can win in every sector

The UK has been a leader in driving the **alignment of national targets to industry commitments**. What was hardest thing about bringing that **top-down and bottom-up integration**? What **lessons can other countries draw** from the UK's experience?



Before we legislated for Net Zero, the UK's target was an 80% reduction in carbon emissions by 2050—and everyone assumed that they, uniquely, were in the 20% that did not have to decarbonize as fast! **When the target changed to a 100% reduction, every part of government and business realized their role.** This had an enormously mobilizing effect with an **"everyone is in"** mantra, which enabled a **fully integrated plan for the energy transition.**

Clarity of the overall direction is a prerequisite, but the **real action is on the ground.** This will **require bold pragmatic Net Zero strategies and then organizing to deliver.** Ignoring the energy transition will not make it go away.

Why is it **particularly hard** to do this in fast-developing countries like those in **Southeast Asia**?



The strain will particularly fall on the **power generation infrastructure**, the capacity of which has been largely flat, or declining because of equipment deteriorating over the years. In a fast-growing developing country like those in Southeast Asia, the challenge will be even larger as the **infrastructure may need to increase by 5–6 times.**


- ✓ **Manage the transition carefully and justly** for shareholders, employees, customers, regulators, and other stakeholders
- ✓ **Build infrastructures right the first time**, which is significantly cheaper than retrofitting clean energy solutions subsequently—this is a **unique advantage for forward-looking developing economies such as SEA**

# To date, SEA's overall policy effectiveness has been mixed; some countries are making decarbonization progress, but most lack clear and results-driven policy

## 1 Most SEA countries lack clear policy roadmaps for decarbonization


**6/10** countries lack **LT-LEDS<sup>1</sup>** to lay out **detailed policy plans and sector specific roadmaps.**

**For Example**

 **No published LT-LEDS** and has delayed the release of the 8<sup>th</sup> PDP<sup>2</sup> for over 2 years

**4/10** countries have published long-term policy strategy documents, but **most still lack actionable implementation details ...**

**For Example**

 2021 Green Plan document sets out specific targets and milestones but **lacks sufficient policy details on how to achieve stated targets**

## 2 Slow renewables integration due to grid capabilities and lack of effective policies

**Grid sufficiency and connectivity** continues to be a roadblock to SEA's renewable energy deployment.

**2/6**

ASEAN-6 countries<sup>3</sup> have insufficient grid capacity to accommodate RE deployment, slowing all investments

... with the progress further impeded by **regulatory uncertainty and lack of continuity of policies ...**

**Up to 8 years**

needed to clear necessary permits for RE deployment<sup>4</sup>


**1/10**


countries with streamlined permitting for RE

## 3 Inconsistent forest conservation and VCM<sup>5</sup> policies with uneven enforcement

Forest conservation policies have suffered from **unforeseen revisions, contradictions across documents, and misalignments** across national and state policies.

**For Example**

 End to 2018 moratorium on new oil palm concessions caused **heightened uncertainty and illegal activity**

 **Indefinite suspension of carbon credit validation** and issuance for some NBS projects in Apr 2022 **before subsequent reversal in Dec 2022**

... that have historically exacerbated less-than-adequate **law enforcement efforts.**

**~20%** of Indonesia's palm oil plantations **illegally operating inside designated forest areas in 2019**

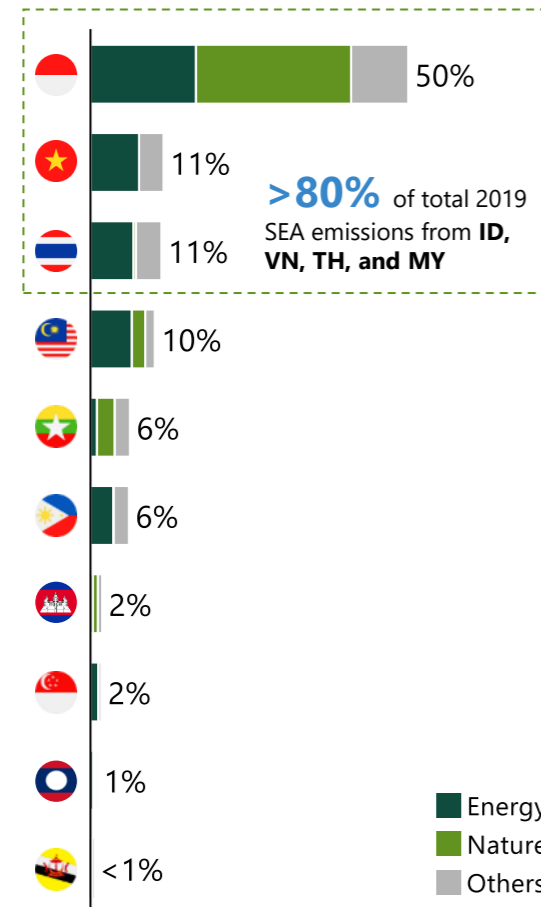
Notes: (1) Long-term low emissions development strategy; (2) Power development plan; (3) Excluding Singapore; (4) Time needed varies by type, scale, and country of respective projects; (5) Voluntary carbon markets  
Sources: Government websites; UNFCCC; Lit. search; Global Energy Monitor; IRENA



# SEA countries face unique challenges within energy and nature sectors

SEA's top 4 emitters make up >80% of total SEA emissions ...

2019 emissions by country (% of total SEA emissions)



... but challenges exist across these countries in decarbonizing energy and nature sectors

## Energy

- **Congested grid** and inadequate **intra-island connectivity** to create reliable power supply
  - Despite coal MPO<sup>1</sup> commitment, **new CFPP<sup>2</sup> is still allowed under certain criteria** (e.g., ~24GW of coal plants still in development stage)
  - **Surplus coal capacity** has driven down coal power costs
  - **>250k jobs in the current coal industry** need to be transitioned
- **Congested grid** to accommodate RE ambitions (RE plants are curtailed due to grid insufficiency to move power from south to north)
  - **Lack of policy transparency** (e.g., two-year delay in release of 8<sup>th</sup> Power Development Plan, lack of corporate PPA regime)
  - **High cost of project financing** (up to 10%–12%)
- **Climate Change Act** still under drafting process
  - **Long lead time for RE permitting** (up to 8 years)
  - **Lack of policy continuity** (e.g., moved from FIT<sup>3</sup> to Quasi-bid offtaking mechanism)
- **High dependence on fossil fuel** for energy generation (~95% of total energy supply in 2019) and economic growth (~20% of national GDP)
  - **Lack of national level sector roadmap** to cascade climate target to actions (LT-LEDS<sup>4</sup> under development)

## Nature

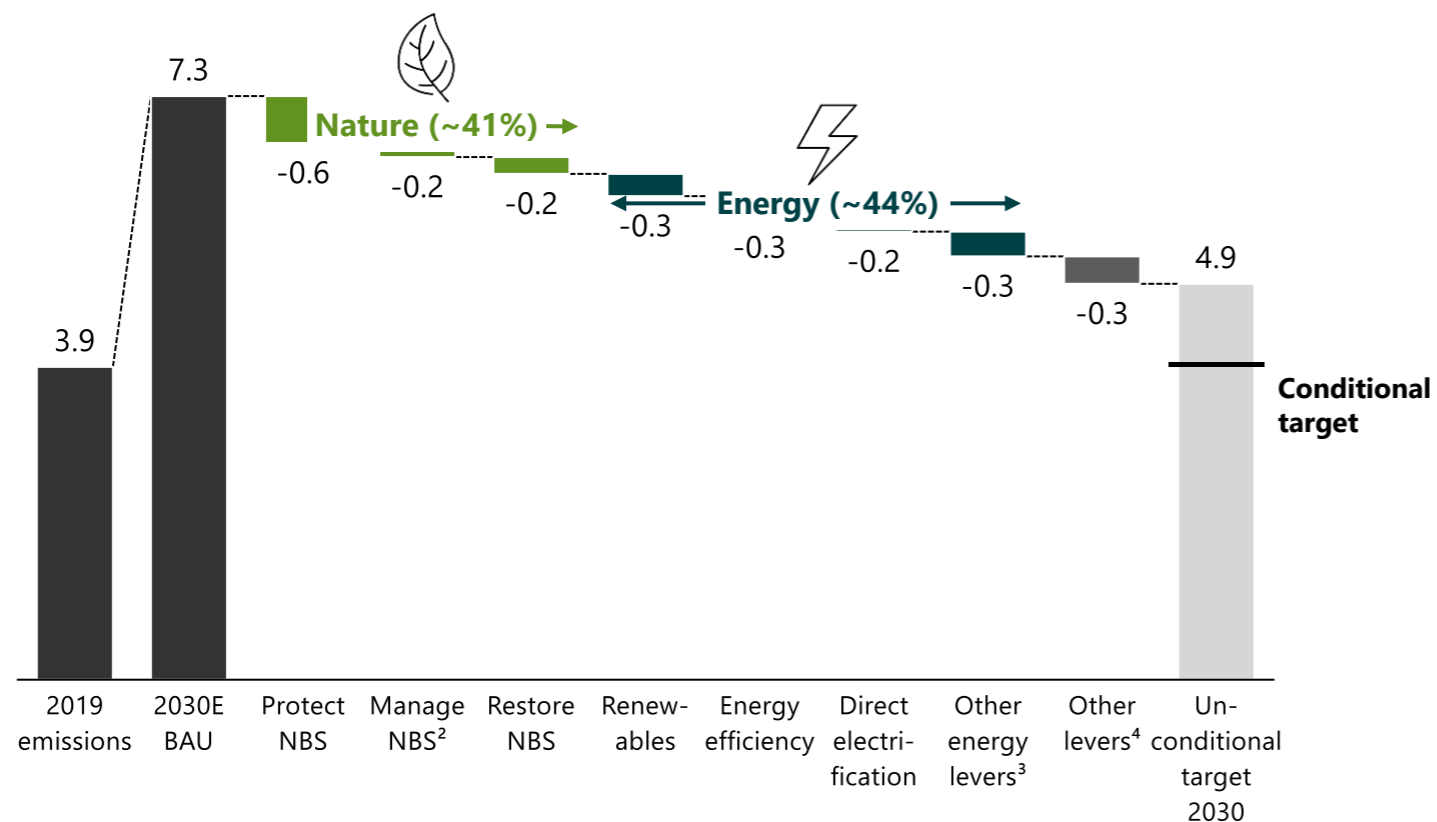
- **Inconsistent policy** (e.g., no net forestland reduction target to replace 2030 zero deforestation pledged in 2021; 2020 Omnibus Bill weakened legal protections for natural forests, contradicting the 2019 moratorium)
  - **Lack of policy enforcement** (e.g., ~20% of palm oil plantations are illegally operating inside designated forest areas)
  - **Regulatory uncertainty on NBS project jurisdiction** (sold to VCM vs. count for NDC) and **carbon credit validation** (lack of clear regime)
- **Lacks existing NBS development ecosystem** despite its abundant forestry natural resources
  - **Broad carbon pricing regulation exists, but no detailed framework** on VCMs and international carbon trading
  - **Illegal logging activities** remain due to strong demand for timber
- Lack of **compliance carbon market regulation** and nationwide **PES<sup>5</sup> policy**
  - **No demonstrated expertise in NBS projects** (through Verra) and early traction of projects (e.g., Kuan Kreng Peat Swamp Forest)
- **National targets not cascaded**, resulting in misaligned policies and strategy at national and state levels
  - Lack of **compliance carbon market regulation**
  - **Limited PES<sup>5</sup> schemes** available
  - The only country **not yet involved in Article 6 Pilot Project** from SEA

Notes: (1) Managed phase-out; (2) Coal-fired power plants; (3) Feed-in Tariff; (4) Long-term low emission development strategy; (5) Payments for ecosystem services  
Sources: Berkeley Voluntary Registry Offsets Database; Climate Watch; Government websites; FAO; IRENA; Lit. search

# Nature and energy sectors ~85% of cumulative emissions reduction needed

## Nature (41%) and Energy (44%) are critical sectors to meet SEA's 2030 targets

Contribution to SEA's 2030 emission reduction targets<sup>1</sup> (GtCO<sub>2</sub>e)



Notes: (1) Contribution of key decarbonization levers across energy and nature sectors towards 2030 NDC unconditional targets, estimated through triangulation of country's commitments and industry expertise; (2) Due to the overlapping nature between agriculture and nature sectors, it can be difficult to draw the distinction between the two sectors – Manage NBS excludes improving rice cultivation and considers improving natural forest management, reduce woodfuel harvest, trees in agricultural land, etc.; (3) Includes building-related emission reduction upgrades, alternative fuels and minimal contributions from carbon offsets; (4) Includes other agrifood, industry and construction, and waste-related emission reduction levers; (5) Since signing the pledge, Indonesia has reversed their commitment for zero deforestation but instead focuses on offsetting potential deforestation with forest restoration programs. Sources: Climate Watch; Country NDCs; Industry participant interviews; Nature4Climate

## Nature and energy are where decarbonization efforts should focus in the next 5–7 years

- **Protecting existing ecosystems accounts for 25% of total emissions reduction**
- Most SEA countries<sup>5</sup> (excl. Laos and Myanmar) have signed the COP26 **pledge to halt and reverse forest loss and land degradation by 2030**
- **Renewables (10%–15%), energy efficiency (10%–15%), and direct electrification (5%–10%) account for between 25% and 40% of total emissions reductions**
- SEA aims to achieve **35% renewables in its installed capacity mix and 23% in its total primary energy supply by 2025**, whilst managing a cumulative **~42% increase in energy demand by 2030 (vs. 2020)**

**2030 targets can be reached with proven technologies, but not without collaboration across stakeholders and countries**

# Key takeaways

1

SEA needs to strike a **delicate balance between achieving primary developmental objectives** (e.g., economic growth, universal electricity access) **and its decarbonization goals** (e.g., NDC targets)

2

Overall **climate action policy effectiveness has been mixed to date** (e.g., 6/10 countries lacking LT-LEDS, insufficient grid infrastructure, inconsistent forest conservation policy)

3

**3 of SEA's top 4 emitters—Indonesia, Vietnam, and Thailand—are unlikely to be on track to 2030 goal** given slow progress, the lack of specific plans and enablers (e.g., Vietnam's and Indonesia's grid, connections)

4

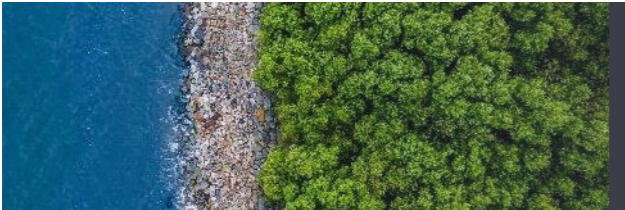
Prioritizing immediate efforts on the **energy and nature sectors will "make or break" the region's ability to meet 2030 targets** given their ~85% contribution to SEA's total emissions reduction targets

5

**Specific and actionable plans, enhanced public-private sector and regional collaboration, and interventions to fix key enablers** (e.g., regulation, grid connectivity, carbon taxes) need to be done now



# Contents



**Introduction: Context and challenges**



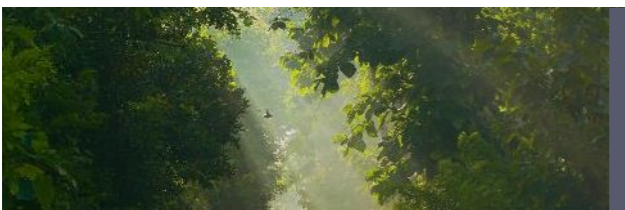
**Progress towards decarbonization**



**Accelerating the energy transition**



**Valuing nature for impact**



**Recommendations and call for action**

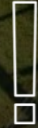
A photograph of a wind farm situated on a lush, green forested hillside. Several white wind turbines are visible, with their blades extending into the sky. The background shows a hazy, mountainous landscape under a soft, overcast sky. The image is split vertically, with the left side showing the natural landscape and the right side being a solid black background with white text.

# Accelerating the energy transition

# Accelerating the energy transition

## Key takeaways

1



### Energy plays a crucial role in economy and climate action

35% of SEA GDP is driven by energy-intensive sectors today, and energy consumption may increase by >40% by 2030 (vs. 2018); countries must balance economics with emissions

2



### Abundant resources but fundamental challenges holding back progress

Surplus of renewable energy technical potential, but only <200 GW are in the pipeline, with 90% still pre-permitting; slow progress of infrastructure, insufficient financial attractiveness, and regulatory uncertainty are key barriers

3



### Infra deployment, financial attractiveness, and competitive market structure are key levers

Investments to strengthen infrastructure and market fundamentals are needed in addition to deployment of renewables and other green tech

4



### Bold moves and collaboration will signal commitment and foster confidence

Bold moves, especially collaborative ones, signal commitment to investors; opportunities include mega interconnection projects and early investments in emerging technologies, in addition to bolstering carbon pricing mechanisms

# Key questions in this chapter

## A

### Role of the sector

- Why is the energy sector **important for SEA countries**, and why is it critical to accelerate the energy transition?
- Why is there **inherent tension between energy transition and economic growth**, and how can the two work **synergistically**?

## B

### Context & Progress

- How do power, transport, and industry sub-sectors **contribute to emissions**?
- **Where do SEA countries stand today**, and how far are they from achieving 2030 targets?
- How do **carbon abatement potential and cost-effectiveness** vary across technological initiatives—**which levers are critical** in the near term?

## C

### Challenges

- What are the **most significant barriers** that have **impeded further progress** toward decarbonization in the region?

## D





### Recommendations

- What are the **critical levers to overcome barriers** and accelerate decarbonization?
- What are the **immediate priorities** that will make material impacts and help the region achieve 2030 targets?

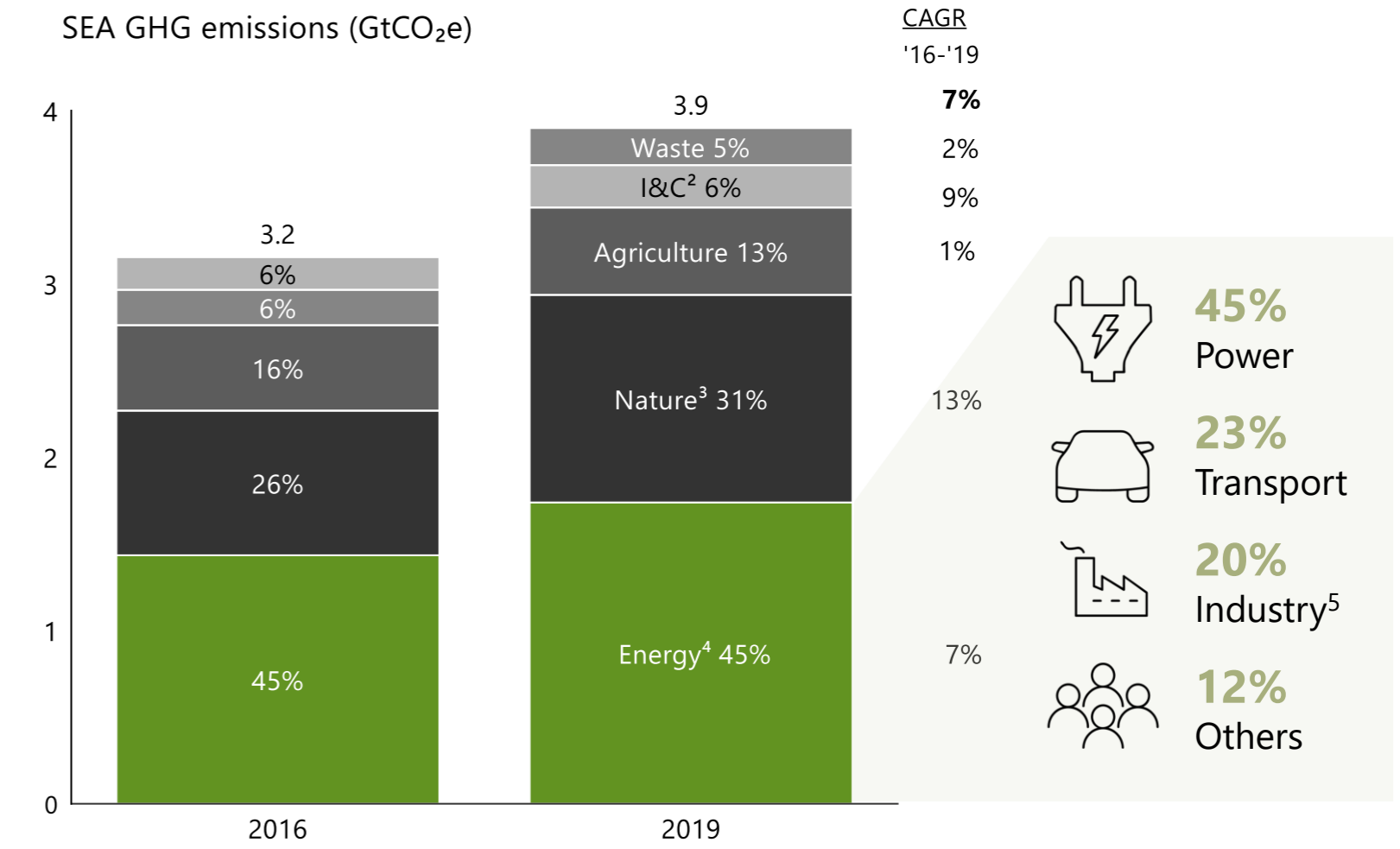
*3 separate sections for Power, Transport, and Industry*

# A Energy's crucial role in economy and decarbonization: 45% of SEA emissions

Energy is a key growth driver in SEA ...

 <p><b>Energy-intensive economy</b></p>	<p>~<b>35%</b> of SEA GDP driven by energy-intensive sectors<sup>1</sup></p>
 <p><b>Increasing energy demand</b></p>	<p>SEA energy consumption expected to increase by <b>&gt;40%</b> by 2030</p>
 <p><b>Continued reliance on fossil fuels for growth</b></p>	<p>SEA contributes to <b>1/3</b> of global coal exports today</p>
 <p><b>High employment in energy-intensive sector</b></p>	<p><b>&gt;60M</b> employments in energy-intensive industries<sup>1</sup> today</p>

... but also the largest contributor of emissions in line with economic growth



Notes: (1) Includes manufacturing, construction, mining and quarrying, electricity, gas and water supply; (2) Industrial and construction; (3) 70% degree of uncertainty in Nature CO<sub>2</sub> emissions vs. ~8% within fossil fuels from IPCC estimates; (4) Includes emissions from electricity and heat from plants and industries, manufacturing and construction, transport, building, combustion of agriculture and fishing, and fugitive emissions; (5) Energy-related emissions from mining and quarrying, construction, and manufacturing  
 Sources: International Labour Organization; The World Bank; Our World in Data; Climate Watch



# A Renewable energy is a critical near-term decarbonization lever; however, other new technologies are also required to reach Net Zero in the longer term

## Renewables are most critical but alone are not enough for SEA to reach decarbonization goals

### Limitation of renewables

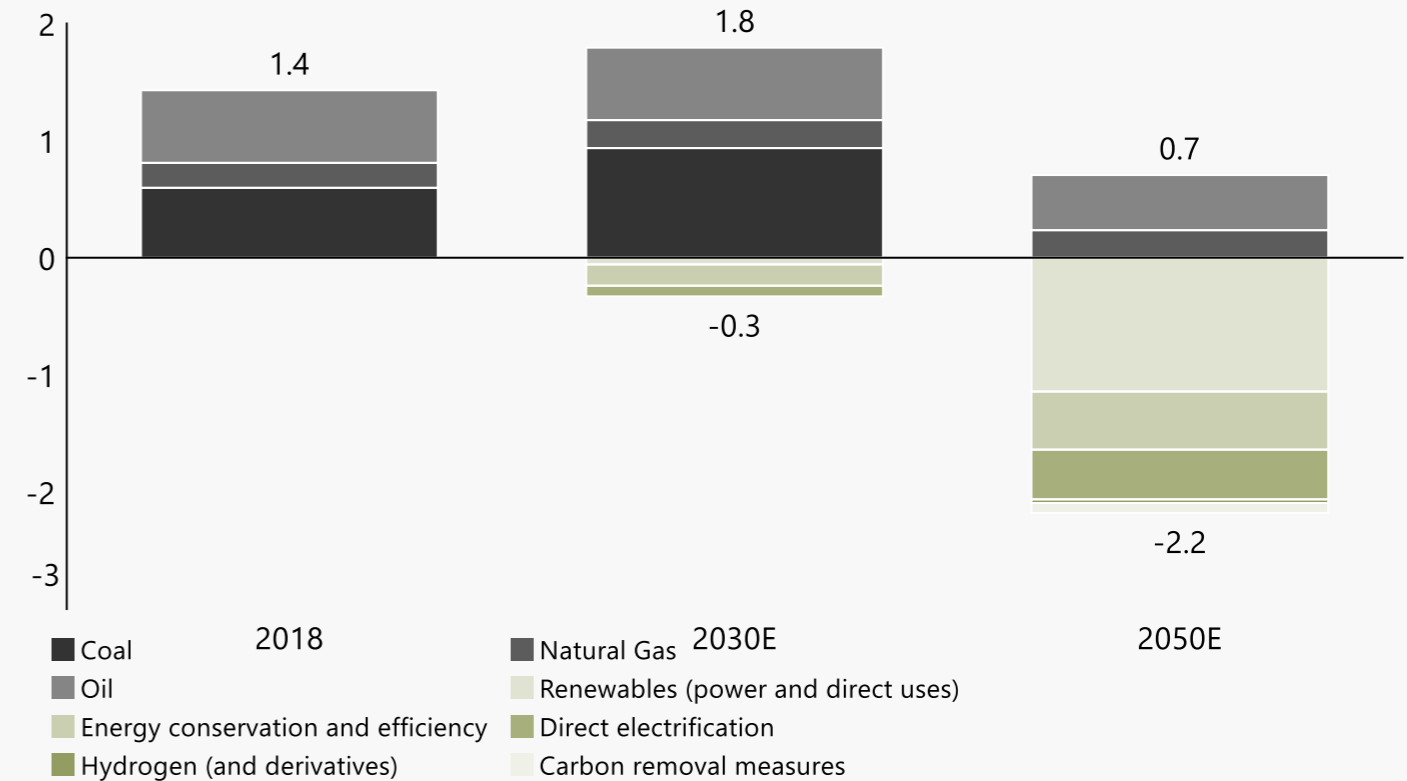
- **Renewable energy is one of the key pillars** in driving decarbonization across the energy sector—however, 100% decarbonization using RE alone is **challenging**
  - Low-carbon solutions are required to meet demand when **wind and solar production are depressed**
  - Cloud-enabled solutions (IoT, ML) can dynamically manage demand/supply, **reducing intermittency**
  - Other technologies, with potential for **negative emissions**, are required to neutralize positive emissions from **hard-to-abate sectors**

### Leveraging on other technologies

- Step change in other **pillars of decarbonization** are required, **in parallel with renewables**, to bridge the gap to Net Zero
  - Improvements in **energy efficiency** to minimize growth in energy consumption
  - Production of cleaner **hydrogen and hydrogen-based fuels** to shift away from existing fossil energy use, particularly in industry, refineries, and power plants
  - **CCUS<sup>1</sup>** use to address emissions from existing assets and hard-to-abate sectors (e.g., cement manufacturing, bioenergy plants)
  - **Electrification of end uses** (e.g., electric vehicles) to directly use low-emissions electricity

## SEA portfolio would require a broad mix of technologies to reach Net Zero by 2050

SEA energy-related emissions savings<sup>2</sup> based on 1.5°C scenario (GtCO<sub>2</sub>)



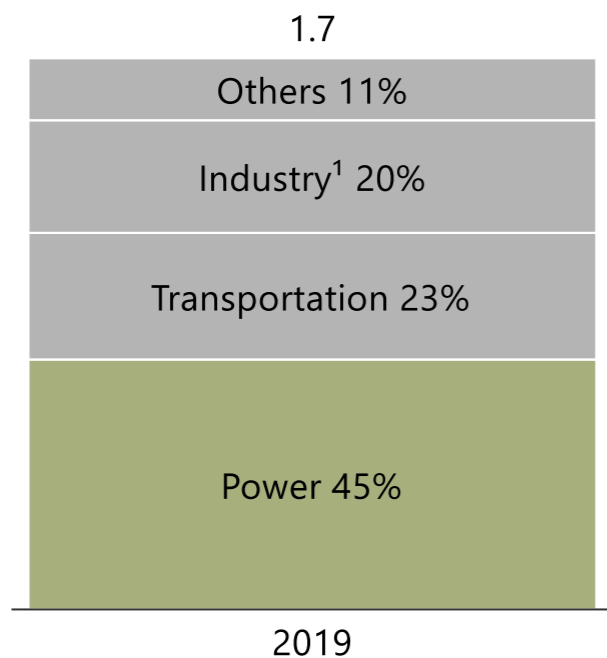
Notes: (1) Carbon capture, utilization and storage; (2) Relative to current policies scenario  
Sources: IRENA; IEA; UN; Lit. search

# B

## Power is the largest contributor to energy-related emissions; a transition to clean power generation via renewables is critical

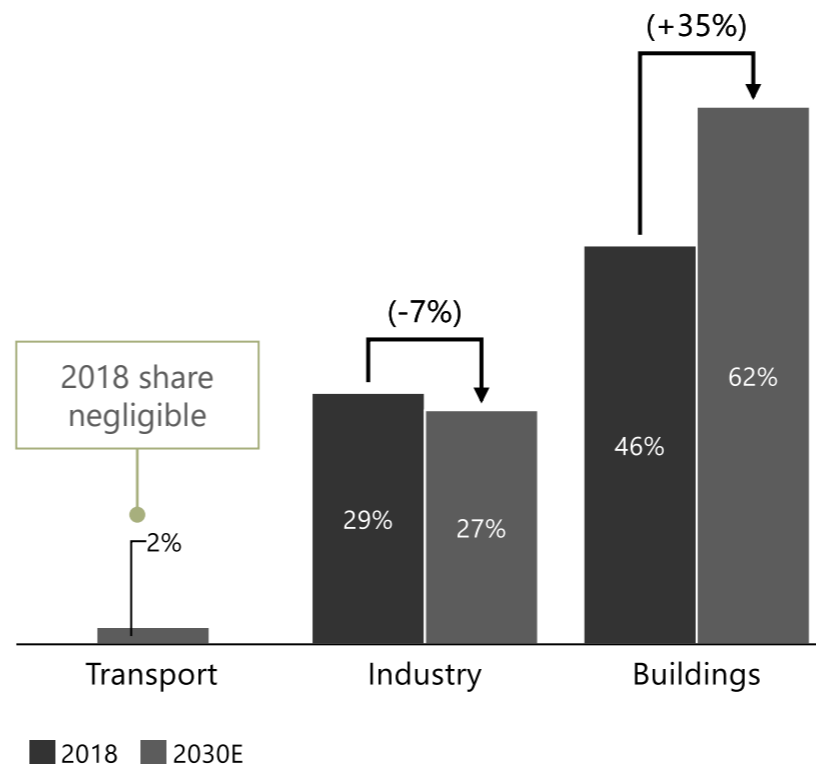
Power makes up ~45% of SEA's energy emissions ...

SEA energy GHG emissions (GtCO<sub>2</sub>e, 2019)



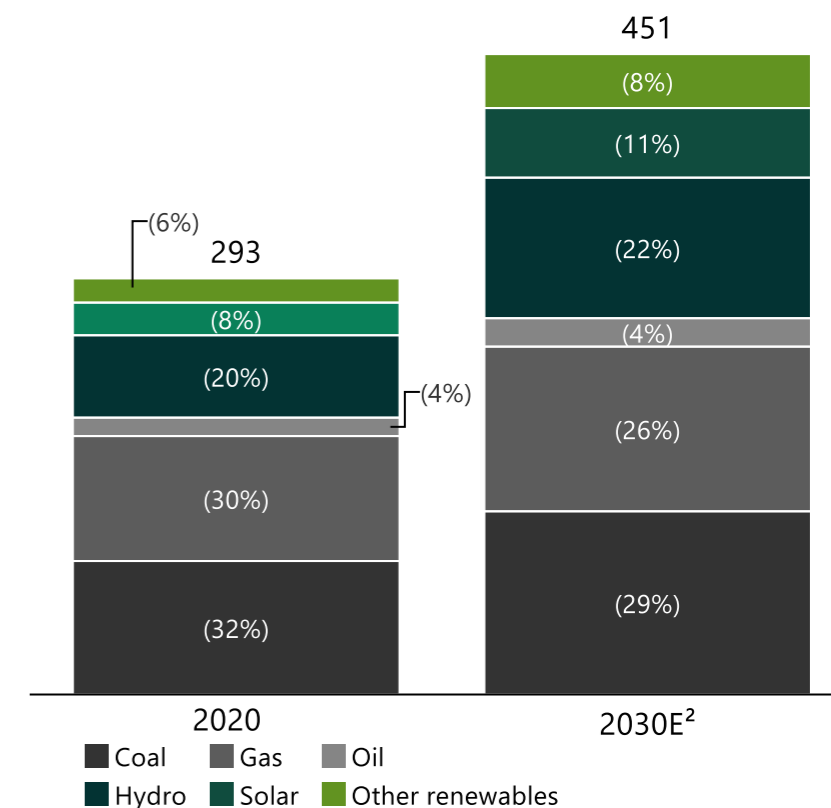
... which may grow with rising need and consumption of electricity

SEA electricity share of energy consumption (%)



Renewable energy only makes up ~40% of SEA's energy capacity mix by 2030

SEA power sector installed capacity (GW)

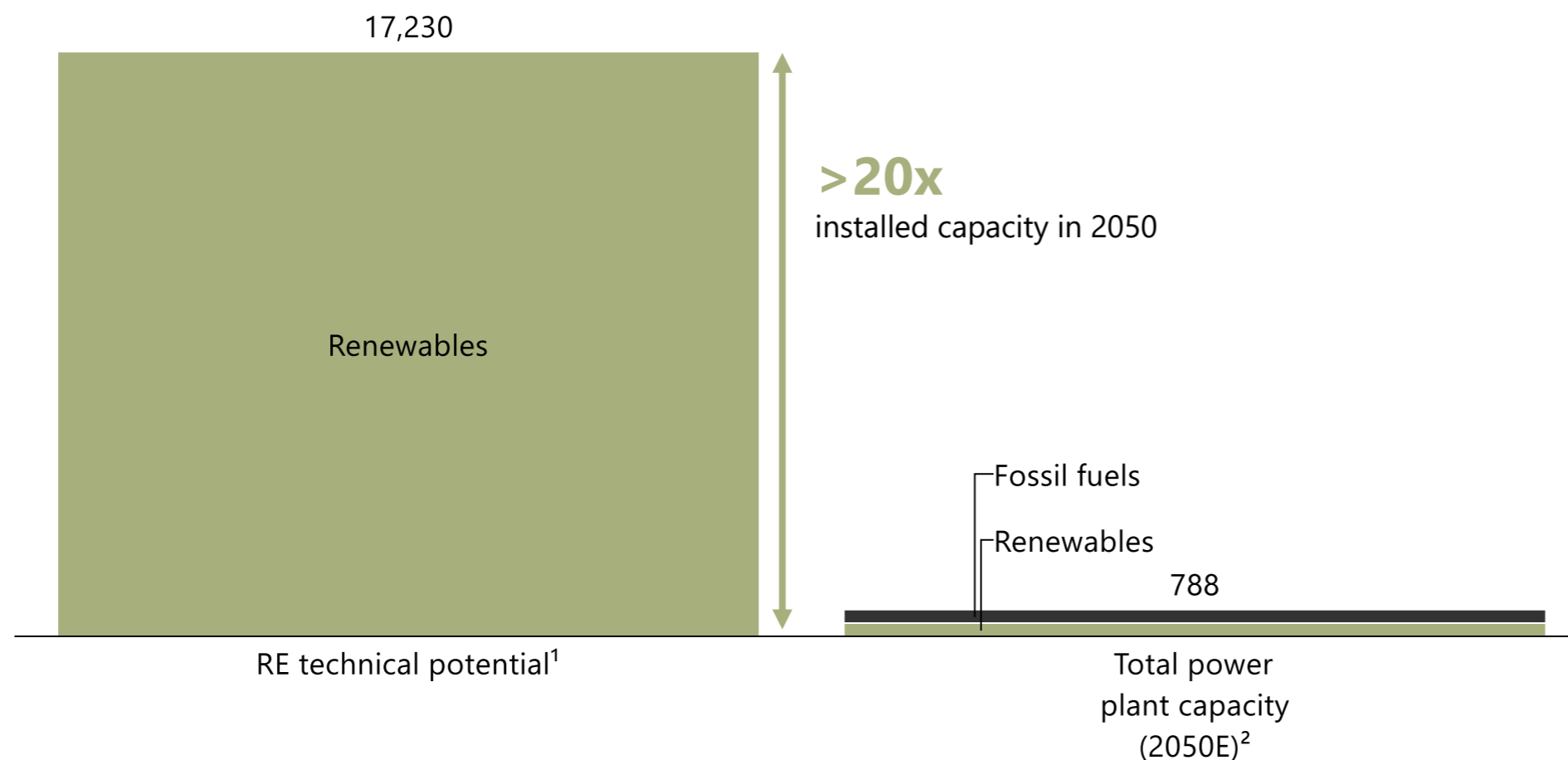


Notes: (1) Refers to mining and quarrying, construction, and manufacturing of iron and steel, chemical and petrochemical, non-metallic minerals, non-ferrous metals, transport equipment, machinery, food and tobacco, paper, pulp and printing, wood and wood products, textile and leather, and others; (2) Based on AMS Target Scenario—assuming SEA countries meet their most-recently announced targets  
Sources: Climate Watch; IRENA; ASEAN Center for Energy

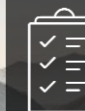
B

# SEA has abundant RE resources; the technical potential is >20 times greater than the capacity required for 2050 demand

## SEA RE technical potential<sup>1</sup> vs. expected total power plant capacity (GW)



Notes: (1) Renewable energy technical potential factors in geographical information, generation patterns and hourly profiles, and system and topographic constraints but does not include economic (e.g., cost competitiveness, grid connectivity) and market factors (e.g., investor interest); solar and wind potential excludes settlements and urban areas to consider wind parks and utility-scale PV systems (does not assess rooftop solar potential); (2) 41% RE mix in AMS Target Scenario from ACE – assuming SEA countries meet their most recently announced targets  
Sources: ASEAN Centre for Energy (ACE); IRENA; Industry participant interviews



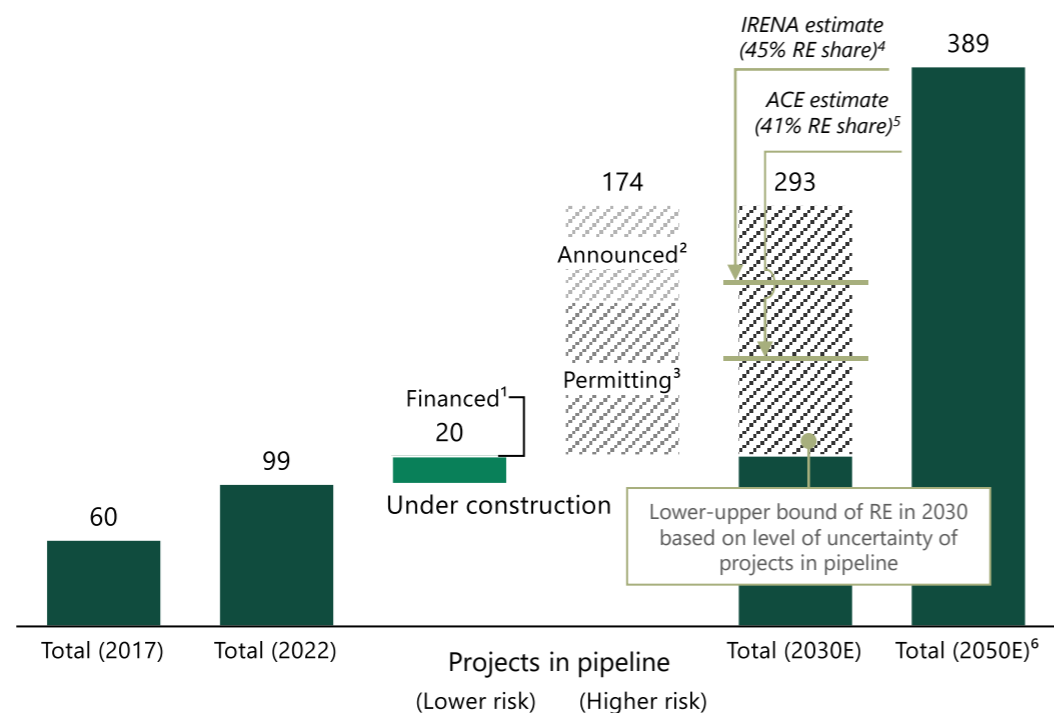
### Key takeaways

- **17 TW potential accounting for resource, topographic, and geographic constraints**
- **Addressable potential is expected to be lower** mainly due to political considerations, interconnectedness risk, and insufficient infrastructure
  - However, the addressable potential could still cover the region's demand given the abundant resources available
- **Solar and wind** are the main renewable resources for SEA, contributing ~98% of the total RE potential for the region

# B Despite this and the fact that SEA has made rapid progress in RE deployment in the past 5 years, it has a long way to go to achieve its RE target in 2030

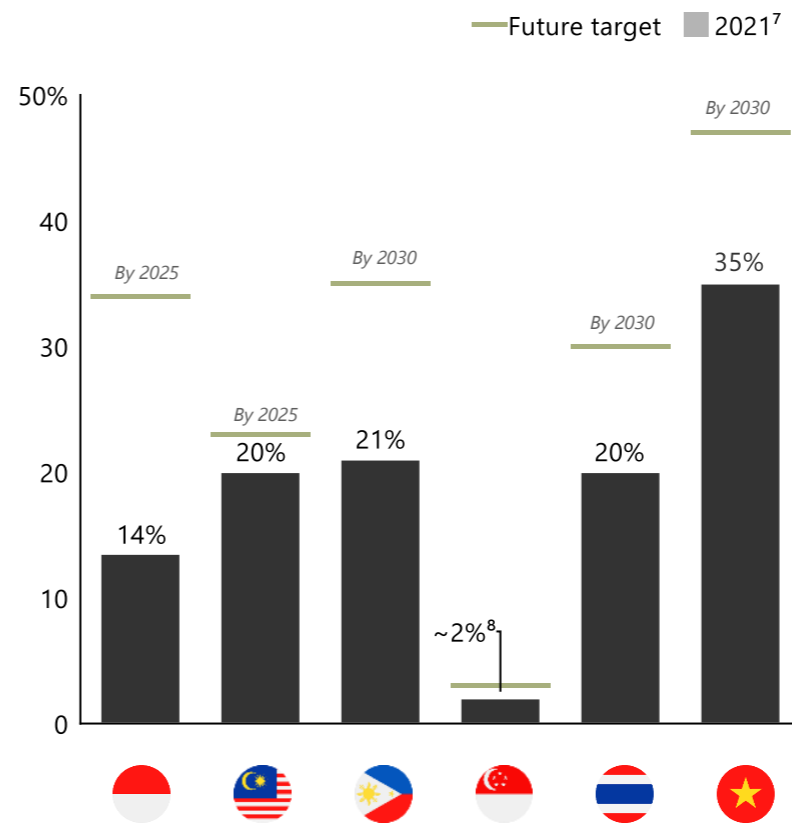
## The majority of RE projects in the pipeline are in early stages of development

SEA current and planned RE power plant capacity (GW)



## Only Malaysia and Singapore on track to reach future power generation goals

Renewable energy share for power generation (%)



### Key takeaways

- **Strong growth of 10% p.a.** in RE installed capacity from 2017 to 2022, largely driven by rapid installations in Vietnam
- **90% of planned RE capacity** (COD by 2030) is still in an **early stage of development** (55% in permitting and 35% in announced)
  - >50% of upcoming renewable capacity is in PH and VN
- **To meet the 2030 goal**, SEA needs to remove barriers and **accelerate deployment of projects** especially in permitting stage
- **Only Malaysia and Singapore on track to reach future power generation goals**

Notes: (1) Includes plants that have achieved financial closure and construction has not yet started; (2) Includes power plant plans that have been announced and there is no significant progress toward getting permitting and financing; (3) Includes plants that have applied or obtained some or all necessary government clearances and approvals; (4) 45% RE mix in PES scenario from IRENA – based on most recent policies committed by SEA countries; (5) 41% RE mix in AMS Target Scenario from ACE—assuming SEA countries meet their most recently announced targets; (6) AMS Target Scenario from ACE; (7) 2021 numbers are approximated from 2020 values for PH; (8) Solar power only  
Sources: GlobalData; ASEAN Centre for Energy (ACE); IRENA; Industry participant interviews

# C SEA must overcome several challenges to realize its renewables potential



## Slow deployment of infrastructure

RE generation and transmission facilities are **not fully prepared to integrate RE** due to lack of clarity over plans and who pays

**2 out of 6**

ASEAN-6 countries are struggling with congested grids



## Insufficient financial attractiveness

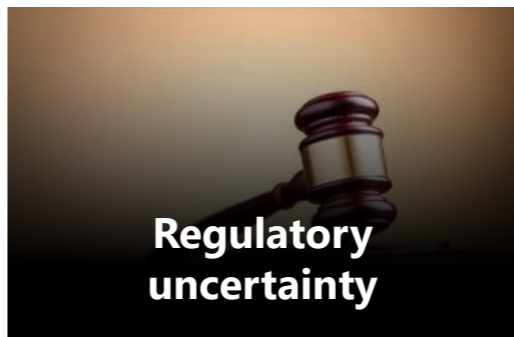
Financially unattractive due to lack of incentives, **high country risk** (e.g., currency and offtake), and shallow debt capital pools

*“Even though project IRRs may be lower in developed countries, they have **hard currencies, lower perceived risks, and greater pools of debt capital, resulting in better risk adjusted equity returns.**”*

Founder and CEO,  
Solar Development Company

**18%**

Cumulative energy FDI in SEA went to renewables<sup>1</sup>



## Regulatory uncertainty

**Regulatory/political uncertainties and inconsistent implementation** dissuades investment and development

**up to 8 years**

needed to clear necessary permits for RE deployment<sup>2</sup>

*“Authorities have **too much discretionary power.** This, along with **changes and discontinuation of policies, creates uncertainty and limits investors’ willingness to deploy capital.**”*

Head of Wind Development, Renewable Solutions Company



## Fossil fuel dependency

Fossil fuel has been **key contributor to economic development**, despite high environmental costs

**~80%**

SEA energy supply is of fossil-fuel origin

**30%+**

global coal exports came from SEA<sup>2</sup>

**~250K**

workers in Indonesia potentially at risk if coal is phased out



## Mismatch of RE demand and supply

**Demand/supply mismatch** due to **geographical dispersion** of RE resources both across and within SEA countries

**2 out of 10**






SEA countries (Singapore and Brunei) don't have sufficient renewable energy potential to meet 100% of the nations' electricity demand

**Significant RE potential in Kalimantan, Sulawesi, and West Papua** within Indonesia, areas that **lack large demand centers**

Notes: (1) As of 2021; (2) Time needed varies by type, scale, and country of respective projects  
Sources: Industry participant interviews; Lit search; IRENA; Global Atlas; Government websites

# C Infrastructure | Grids' ability to accommodate renewables varies across SEA; tangible actions to upgrade grids are required to accommodate RE expansion

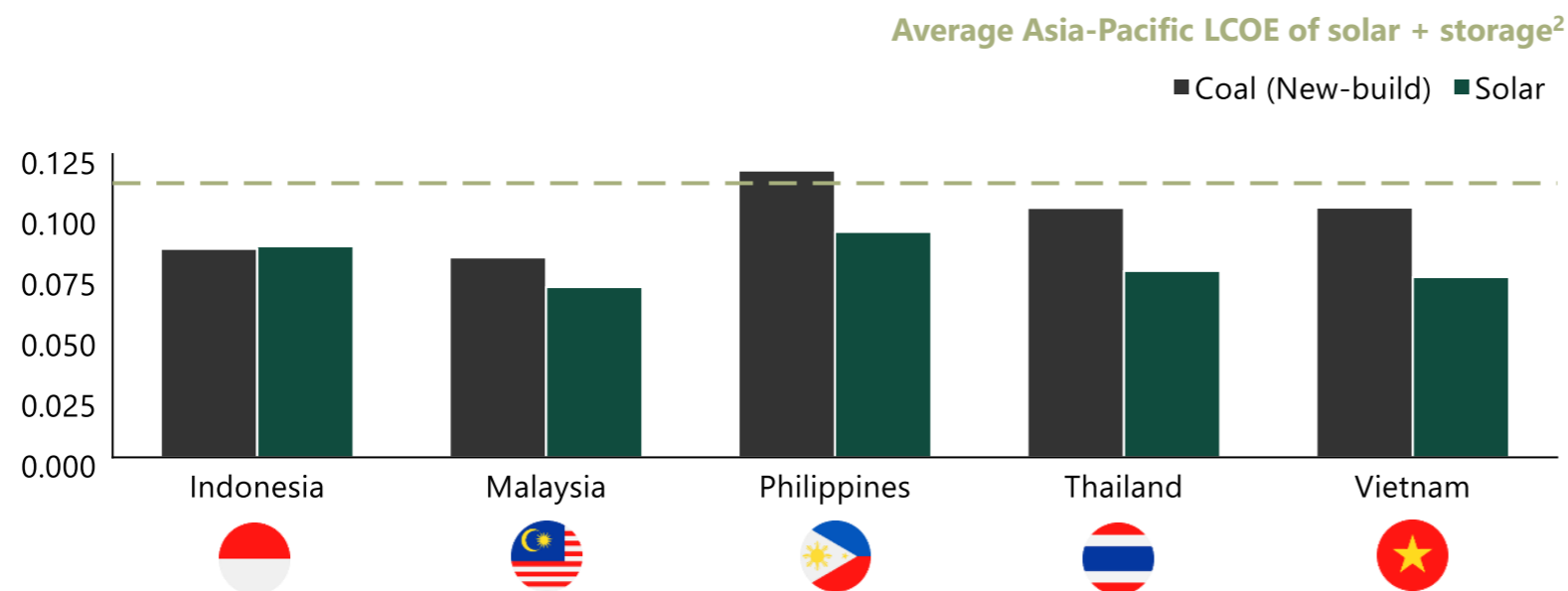
- Insufficient / not aligned
- Moderately sufficient / aligned
- Sufficient / aligned

Country	Grid's current ability to accommodate RE	Alignment of country's grid upgrade and RE expansion plans	Commentary
 <b>Indonesia</b>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<ul style="list-style-type: none"> <li>• Current <b>grid is congested</b>, and <b>inter-island connectivity is inadequate</b>, tough challenge in accommodating more renewables as stated in targets</li> <li>• Historical investment in coal resulted in <b>surplus of cheap electricity from coal</b>, adding difficulty to the RE transition</li> </ul>
 <b>Malaysia</b>	<span style="color: darkgreen;">●</span>	<span style="color: darkgreen;">●</span>	<ul style="list-style-type: none"> <li>• Grid is sufficient for <b>current relatively low RE penetration</b></li> <li>• Energy commission is <b>implementing measures to upgrade grid system</b> and increase grid resilience</li> </ul>
 <b>Philippines</b>	<span style="color: darkgreen;">●</span>	<span style="color: darkgreen;">●</span>	<ul style="list-style-type: none"> <li>• Grid is sufficient for <b>current relatively low RE penetration</b></li> <li>• <b>High flexibility in grid network</b>; plan in place to <b>expand and upgrade aged grid lines</b> to add capacity and allow contingency</li> </ul>
 <b>Thailand</b>	<span style="color: darkgreen;">●</span>	<span style="color: darkgreen;">●</span>	<ul style="list-style-type: none"> <li>• Grid is sufficient for <b>current relatively low RE penetration</b></li> <li>• <b>Plan to upgrade and transform transmission network</b> in the next decade has been launched</li> </ul>
 <b>Vietnam</b>	<span style="color: red;">●</span>	<span style="color: yellow;">●</span>	<ul style="list-style-type: none"> <li>• Current <b>grid is congested</b>, tough challenge in accommodating more renewables as stated in targets</li> <li>• <b>Grid development is planned</b>—application of smart grid and technology 4.0 has been researched and is being considered</li> </ul>

# C Infrastructure | Renewables appear cheaper than fossil fuels, but storage and integration costs make operating existing coal plants more competitive in reality

## Solar already cheaper than coal, but true system costs not reflected ...

LCOE<sup>1</sup> by energy type and country as of 31 Dec 2022 (USD/kWh)



On the surface, **solar** already cheaper than coal across ASEAN-6, reflecting its scalability and ease of installation. Indonesia solar cost expected to drop below coal LCOE in 2023

However, **scaling solar likely less cost-competitive than expected** due to costs associated with battery storage and grid integration, as well as the absence of construction costs for existing coal plants

## ... due to several factors

### Intermittency

- Dependence of **solar and wind on weather conditions** means steady and consistent supply of RE cannot be guaranteed without **expansion of battery storage capacity**, which is estimated to only be cost-effective post-2030

### Locked-in coal infrastructure

- Numerous **coal plants still exist in power systems** and planned phase-outs can be undermined by launching of coal plants, supported by **long-term financial agreements or regulatory loopholes**

### Higher VALCOE

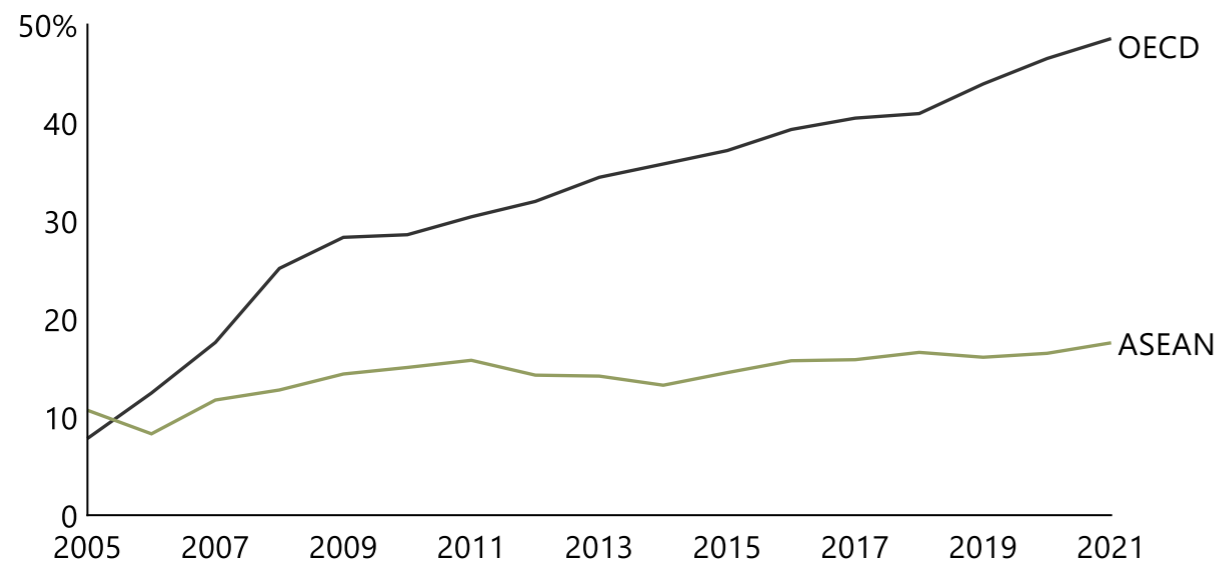
- The **value-adjusted LCOE (VALCOE)** accounts for **value of electricity generated** from power systems
- VALCOE of solar** found to increase with rise of solar share of energy mix in India, making it **more expensive than coal** due to increased flexibility costs
- Marginal cost of coal in Australia still found to be cheaper** than firmed/integrated wind and solar costs

Notes: (1) Levelized cost of electricity measures all-in expense of producing electricity from a new project, taking into account costs of development, construction and equipment, financing, feedstock, operation and maintenance; (2) Average of Australia, China, India, and Japan LCOE, assuming 50% capacity factor of 4-hour battery storage  
Sources: Bloomberg; Industry participant interviews

# C Financing/Regulations | Opportunities to improve market conditions and the regulatory environment to attract more foreign investment into the region

Renewables FDI<sup>1</sup> flows in the region have been underperforming relative to OECD countries ...

RE as % of cumulative energy FDI flows



"From 2016–2020, for every dollar invested in RE power capacity in SEA, **another dollar was invested in unabated fossil fuels**, compared with US\$0.5 in Sub-Saharan Africa, US\$0.3 in China, and US\$0.2 in Latin America."

Southeast Asia Energy Outlook 2022, IEA

... driven in large part by market and regulatory conditions, as well as the cost of capital



### Higher offtake risk

In 8/10 SEA countries, RE electricity power is heavily regulated and requires a **state-owned utility enterprise to be the sole offtaker**



### Lack of policy continuity

"One of the challenges in RE deployment is that there are many **changes in offtaking processes**. Thailand moved from FiT<sup>2</sup> to Quasi-bid offtaking mechanism; Vietnam from FiT to bidding and auction pricing."

Head of Wind Development, Renewable Solutions Company



### Higher costs of capital

"Vietnam's project financing is famously **expensive** with rates as high as 10%–12%, while in the Philippines, **I haven't seen as many local banks financing RE projects from smaller developers.**"

Founder and CEO, Solar Project Development Company



### Higher perceived risks lower project bankability

"Green infra investment needs are vast in SEA, however, **only 5%–10% of projects are bankable** given foreign capital's perception of relative risk reward, due to currency, regulatory risks, etc."

CEO, Debt Financing Company

Notes: (1) Foreign Direct Investment; (2) Feed-in Tariffs  
Sources: IEA; OECD; Industry participant interviews; Lit. search



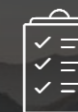
C

# Mismatch of RE demand and supply | SEA has the renewables potential<sup>1</sup> to be self-sufficient; regional collaboration can help connect supply with demand

	Renewable energy (RE) technical potential <sup>2</sup> (GW)						Total RE resources (GW)	2050 electricity demand <sup>3</sup> (GW)	RE sufficiency to meet demand
	PV	Onshore wind	Offshore wind	Biomass	Hydro	Geo-thermal			
BN	2	-	-	-	0.1	-	2	4	●
ID	2,898	20	589	43	95	30	3,674	261	●
KH	1,597	3	89	-	10	-	1,698	6	●
LA	983	12	-	1	26	0.1	1,022	7	●
MM	5,310	2	-	1	40	-	5,354	17	●
MY	337	-	53	4	29	-	424	63	●
PH	123	4	69	0.2	11	4	210	90	●
SG	0.3	0.1	-	-	-	-	0.4	18	●
TH	3,509	32	30	18	15	-	3,604	116	●
VN	844	31	322	9	35	0.3	1,241	126	●
<b>SEA</b>	<b>15,603</b>	<b>104</b>	<b>1,152</b>	<b>76</b>	<b>261</b>	<b>34</b>	<b>17,229</b>	<b>708</b>	●

● Insufficient   ● Sufficient to meet <10x of demand   ● Sufficient to meet >10x of demand

Notes: (1) Renewable energy technical potential factors in geographical information, generation patterns and hourly profiles, system and topographic constraints but does not include economic (e.g., cost competitiveness, grid connectivity) and market factors (e.g., investor interest); solar and wind potential excludes settlements and urban areas to consider wind parks and utility-scale PV systems (does not assess rooftop solar potential); (2) From technical resource potential vs. demand standpoint without accounting for feasibility due to regulations, economic reasons, etc.; (3) Based on peak electricity demand by 2050 in 1.5°C-compatible pathway  
Source: IRENA



## Key takeaways

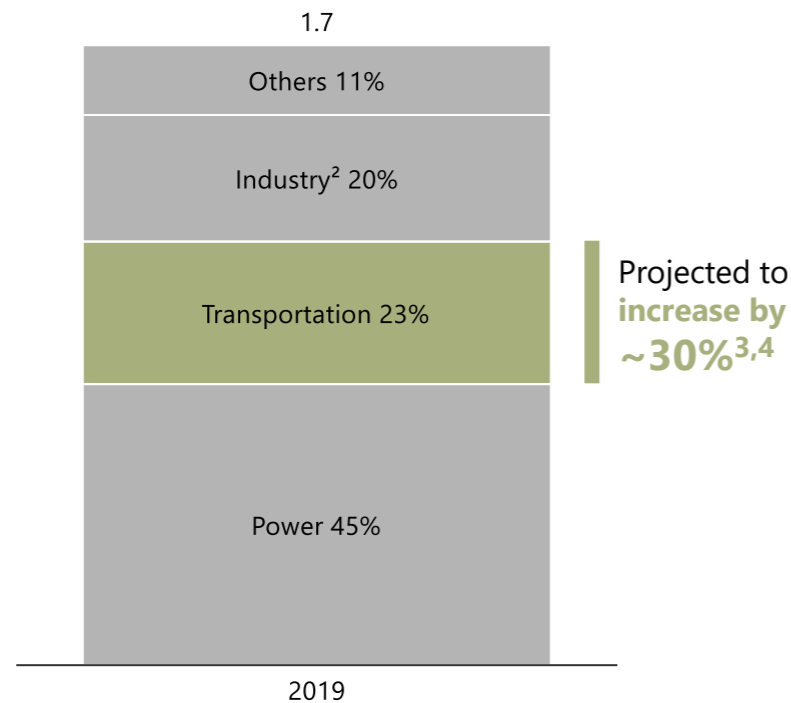
- SEA as a region has **adequate renewable resource potential to fulfil regional electricity needs**
- **Cambodia, Laos, Thailand, and Indonesia** have high potential to be net RE exporters from **technical resource potential** vs future demand standpoint<sup>2</sup>
- **Singapore demonstrates the strongest need to import clean energy** to achieve its 2030 goal and Net Zero in the longer term

B,C

# Energy use for transport contributes 23% of SEA energy emissions; emissions are projected to increase significantly to 2030

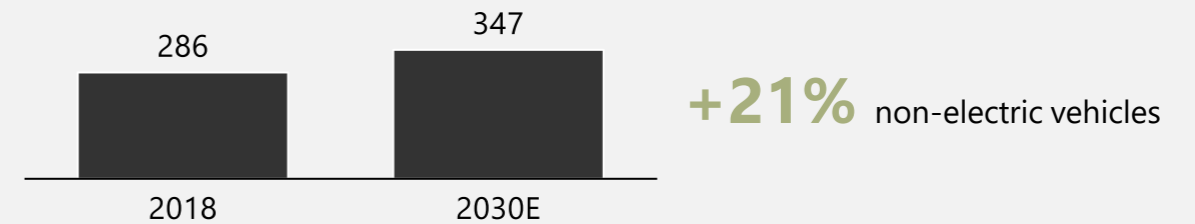
Transport is increasingly becoming a significant part of SEA emissions contributing to >20% ...

SEA energy GHG emissions<sup>1</sup> (GtCO<sub>2</sub>e, 2019)

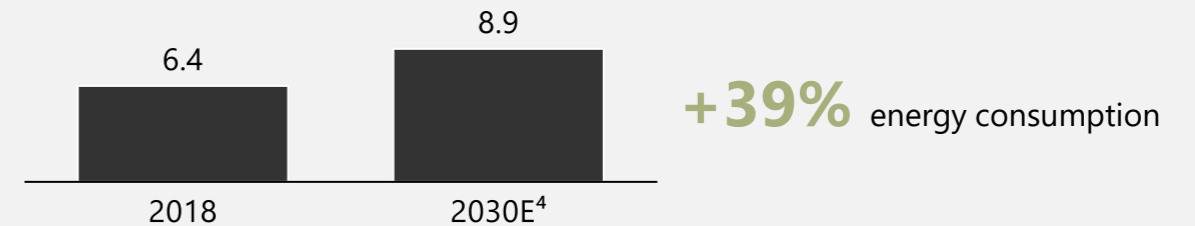


... mainly driven by increase in non-electric vehicles, and subsequent rise in demand for oil

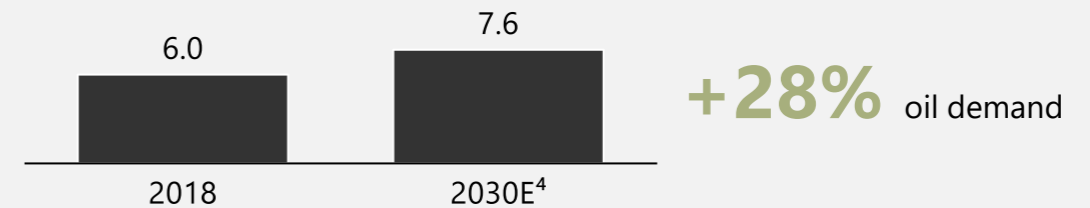
SEA non-electric vehicle stock (million units)



SEA transport sector energy consumption (EJ)



SEA transport sector oil demand (EJ)



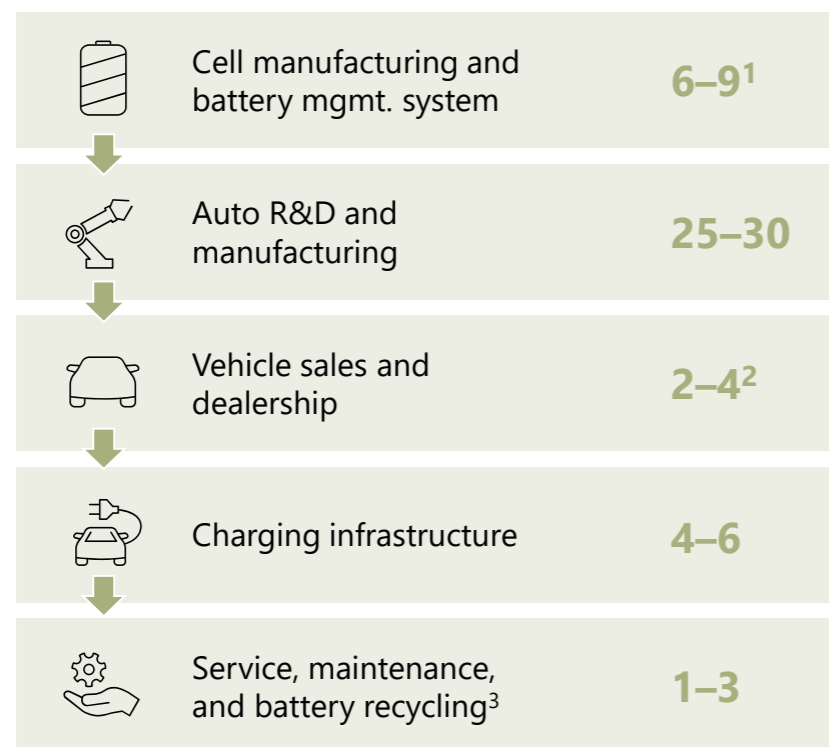
Notes: (1) Total and energy GHG emissions do not include emissions from bunker fuels, in line with Intergovernmental Panel on Climate Change methodologies; (2) Refers to mining and quarrying, construction, and manufacturing of iron and steel, chemical and petrochemical, non-metallic minerals, non-ferrous metals, transport equipment, machinery, food and tobacco, paper, pulp and printing, wood and wood products, textile and leather, and others; (3) From 2018 to 2030; (4) Considering current and planned policies  
Sources: Climate Watch; IRENA

B,C

# The past year witnessed increased momentum to capitalize on SEA's huge opportunities in the electric mobility supply chain, accelerating green economy

## SEA electric mobility supply chain represents \$38–\$52B opportunity by 2030

Estimated market size of SEA EV supply chain(\$B, 2030E)



## Green transport deal transaction value has increased 6% p.a. with leading SEA corporates making ambitious moves to grow the market

Notable SEA corporate activity



VinFast, the leading Vietnamese EV manufacturer, is expected to **upgrade annual production capacity from 250,000 to 600,000 cars per year** by 2026. VinFast recently **shipped its first batch of electric four-wheelers to the US**



Gentari, a Malaysian clean energy solutions provider, and Evolt, a Bangkok-based EV charging infrastructure provider, signed an MoU to explore **collaborations in expanding EV charging infrastructure and solutions across SEA**



Indika Energy and Foxconn are establishing a joint venture to **conduct commercial EV and electric battery business in Indonesia**



Charge+, an EV charging service provider, won the Singapore government's tender to **install and operate 4,000 EV charging stations around Singapore**

**Continuing tailwinds expected in electric vehicle production as well as demand**, given SEA regional stocks of essential battery minerals (cobalt, nickel, and tin), relative affordability of production, high levels of urbanization, government subsidies, and increased price competitiveness over time

Notes: (1) Majority from foreign OEMs; (2) Does not include leasing/secondhand market; (3) Battery recycling industry is not expected to be sizeable by 2030 as EV industry is still nascent in SEA and average battery life is 10 years  
Sources: SEA Green Economy Report 2022; Government websites; Pitchbook; AVCJ; S&P Capital IQ; Preqin; Lit. search

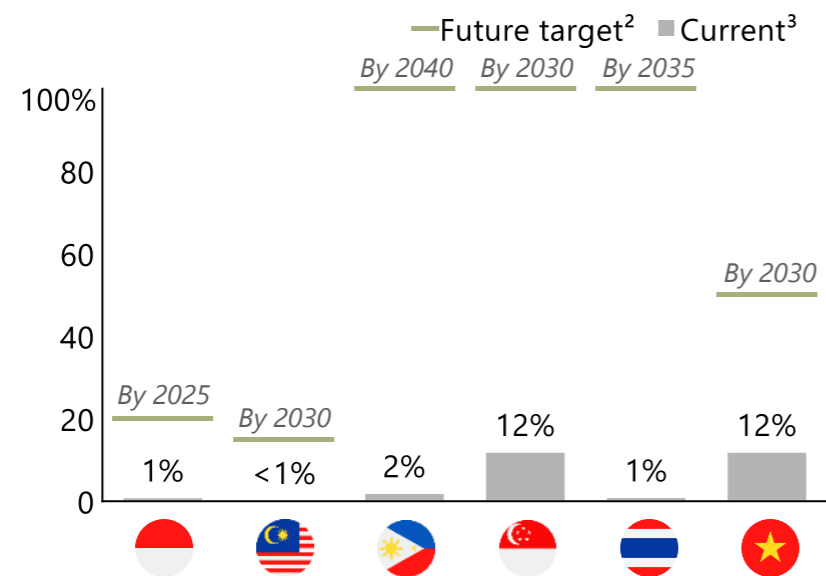
# B,C

## Despite momentum, ASEAN-6 will still need to overcome challenges to meet its EV commitments by 2030

Increased EV vehicle sales are still far away from 2030 commitments

~54% of transport sector emissions  
+30% energy consumption expected from 2018 to 2030

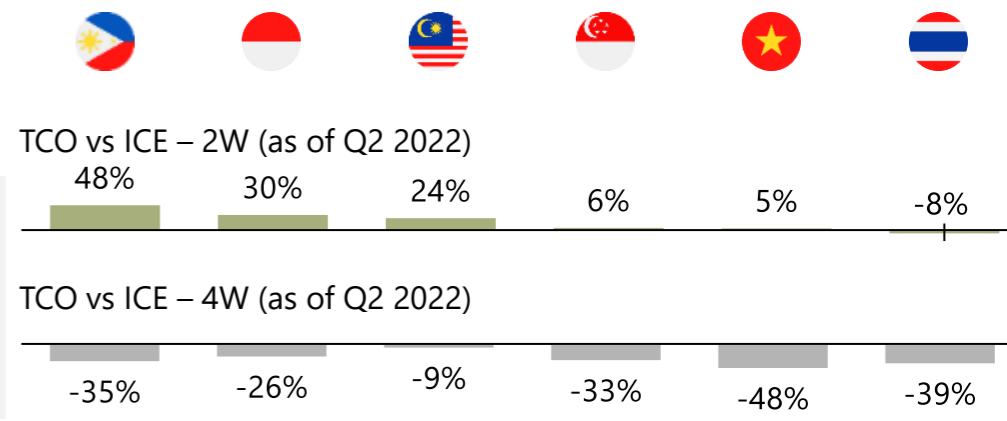
Electric vehicles share of new car sales<sup>1</sup> (%)



Three major challenges hold back EV adoption in SEA, with an important nuance between two-wheelers (2W) and four-wheelers (4W)

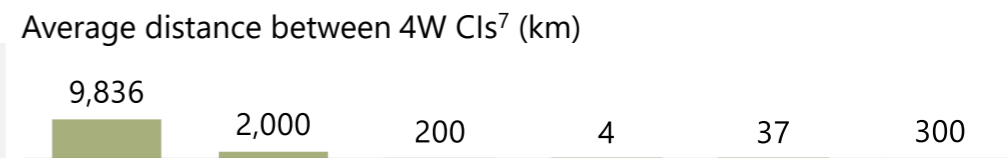
### EV affordability

Total cost of ownership (TCO) for locally produced EVs vs ICE<sup>5</sup> is lower for 2W<sup>4</sup> but still higher for 4W<sup>6</sup>



### Lack of charging infrastructure (CIs)

Customer range anxiety from few charging points prevents switching to EVs



### Consumer perception

Customers perceive EVs to be less economical and reliable

40% believe EV range is <100km/ charge for 4W (vs. current range far exceeds 100km)

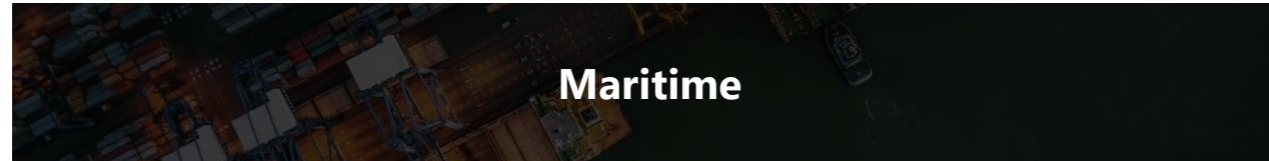
34% believe 10-year maintenance cost is higher than ICE (vs. it is lower in reality)

Notes: (1) MY figures measured with respect to total passenger and commercial vehicles sales, i.e., not limited to cars; VN figures based on total road transport penetration, i.e., not sales and not limited to cars; (2) Most targets include other green energy engines, e.g. hybrids, aside from EVs; (3) Share of EV cars registered or sold in 2022, VN based on 2021 EV penetration; (4) As of Q2 2022; 2-wheeler TCO estimated using equivalents of Yamaha Y15ZR in each market while EV uses EGAT model in TH, Scorpio in SG, Dat Bike in VN; Eclimo in MY and Gesits in ID, except for PH using motorstar zest X110-III for ICE and motorstar viber for EV, assuming 100% out-of-home charging or battery swapping figure is current as of Q2 2022; (5) Internal combustion engine; (6) As of Q2 2022; 4-wheeler TCO estimated using Hyundai Kona and Hyundai Kona Electric models in respective markets except for PH using BYD Dolphin for EV and Mitsubishi Mirage as ICE benchmark; (7) Taking number of CIs as of Q2 2022 over nationwide road distance

Sources: Country NDCs; Government roadmaps and energy plans; Government websites; Euromonitor; BMW; Lit. search; Bain analysis


# B,C


## SEA has seen momentum in decarbonizing maritime and aviation, with more impactful technology solutions under development



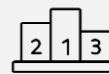


**~35%** of transport sector emissions      **~2x** energy consumption expected from 2018–2030

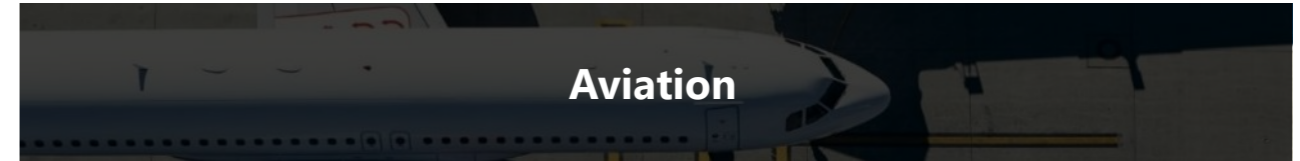
### Momentum in the region

 Maritime and Port Authority of Singapore and Port of Rotterdam signed an MoU to establish the world's longest **Green and Digital Corridor** that brings together a coalition of shippers, fuel suppliers, and other companies to **work on potential alternative fuel solutions and optimize maritime efficiency, safety, and transparent flow of goods** through a digital trade lane

 Malaysia Maritime and Heavy Engineering (MMHE) is collaborating with Silverstream Technologies, a cleantech company that has **pioneered an air lubrication system that reduces ship fuel consumption**, leveraging Silverstream's technology and MMHE's technical expertise to accelerate decarbonization through fuel efficiency


### Decarbonization challenges


 <p><b>Renewable supply constraints</b> due to competing uses for electrification in other modes of transport</p>	 <p>High-impact abatement levers, i.e., hydrogen and DACCS<sup>1</sup>, are still in <b>development stage and costly</b> to implement</p>	 <p><b>Lack of standardized approach</b> to ensure <b>compatible port facilities</b></p>
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**~11%** of transport sector emissions      **+70%** energy consumption expected from 2018–2030

### Momentum in the region

 Civil Aviation Authority of Singapore, Singapore Airlines, and GenZero **piloted blended sustainable aviation fuels (SAFs) on flights** departing from Changi Airport and sold SAF credits as part of the pilot

 PTT Global Chemical formed business alliance with aviation industry players on the **study and development of SAFs**

 Vietnam Airlines **reduced nylon usage to wrap luggage and cargo, and introduced fuel-efficient aircraft models** that help cut fuel usage by 16% and emissions by 50%

### Decarbonization challenges

 <p>SAF production <b>competes with alternative uses of biomass and agriculture land</b></p>	 <p><b>Lack of regulation on SAF mandates and GHG accounting</b> standards to reflect SAF's full lifecycle emissions</p>	 <p>High-impact abatement levers, i.e., hydrogen and DACCS are still in <b>development stage and costly</b> to implement</p>
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Note: (1) Direct Air Capture with Carbon Storage  
Sources: IRENA; Bain analysis; Company websites; Lit. search

# B,C

## EV is the main decarbonization lever for light vehicles, whereas other transport segments will rely heavily on alternative fuels in the medium to long term

There are three archetypes of investible solutions



### Low-risk investments

- Investments that **save cost and abate carbon**



### Effective solutions

- Commercialized **technology that is not yet cost-competitive** with conventional alternatives

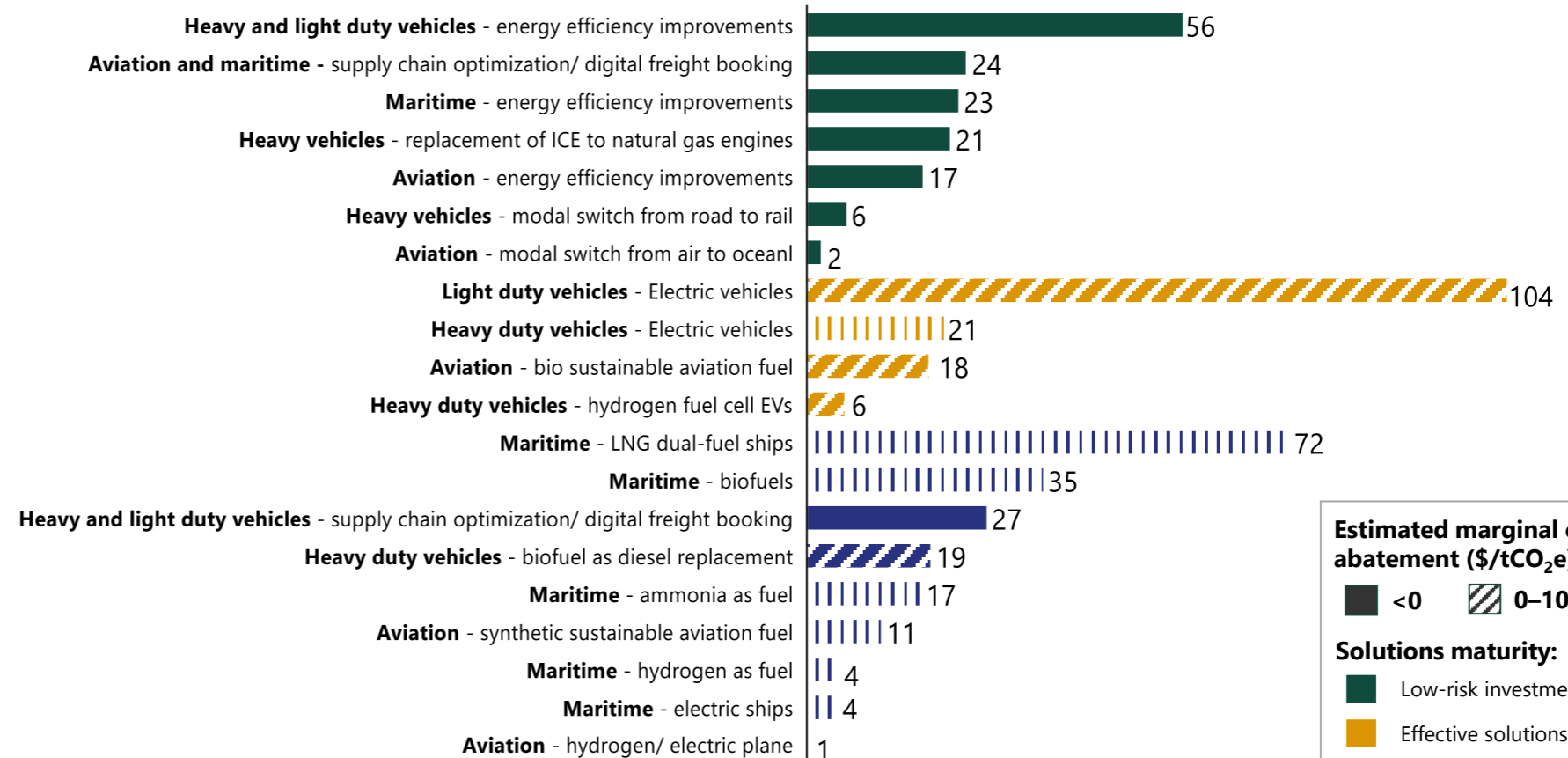


### Developing technologies

- Technologies in development or demonstration** stage that are not yet cost-competitive with conventional alternatives

Estimated annual cost to abate transport emissions in SEA is around USD 30B<sup>1</sup>; several low-risk investments can be leveraged today across vehicle types

### ASEAN-6 abatement potential<sup>2</sup> (MtCO<sub>2</sub>e)



**Estimated marginal cost of abatement (\$/tCO<sub>2</sub>e):**  
 ■ <0    ▨ 0-100    ▤ >100

**Solutions maturity:**  
 ■ Low-risk investments  
 ■ Effective solutions  
 ■ Developing technologies

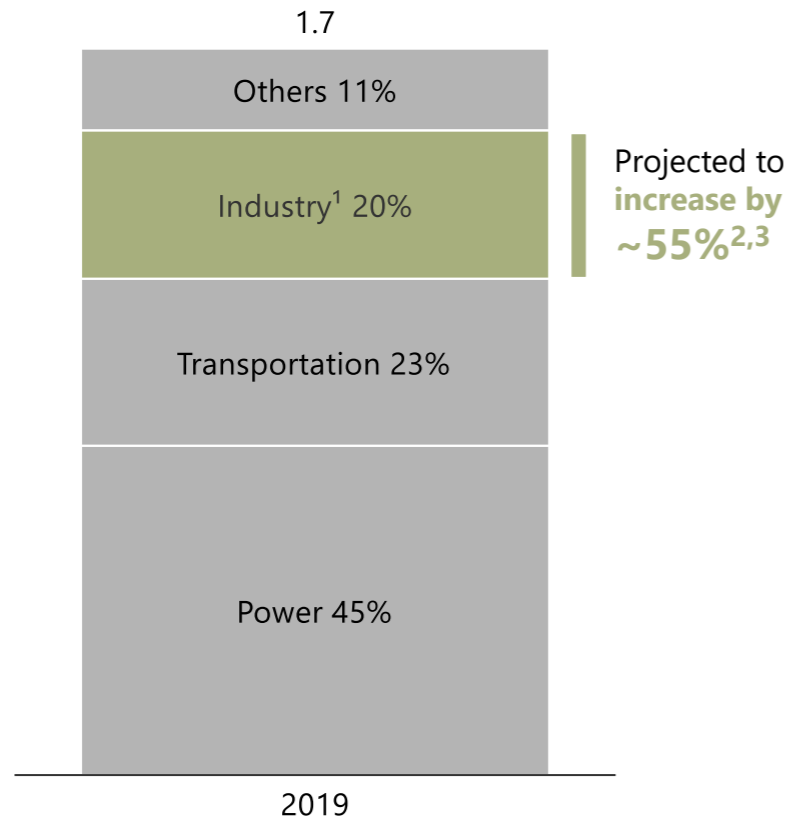
Notes: (1) Estimated cost to abate annual subsector carbon emissions for years before 2030, estimated by product of abatement potential with average abatement costs per tCO<sub>2</sub>e for each lever; (2) 18% of sector emissions is hard to abate and difficult to be addressed with currently available technologies  
 Sources: Bain internal Marginal Abatement Cost Curve (MACC) models; Lit. search

# B,C

# Industry<sup>1</sup> is the 3<sup>rd</sup> largest contributor to energy emissions and the hardest-to-abate sector; few relevant emissions targets communicated by governments

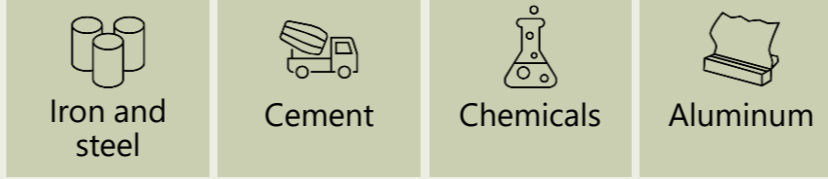
## Industry is another major contributor to SEA emissions and growing

SEA energy GHG emissions (GtCO<sub>2</sub>e, 2019)



## Challenging abatement as the sector is fast-growing and relies on fossil fuels

70% Industry sector emissions come from 4 subsectors



### Challenges in abating these subsectors

- 1 Energy-intensive and fast-growing**
  - Iron and steel, which accounts for 7.2% of SEA industrial energy demand, is one of the fastest growing sectors, i.e., over the past 20 years, SEA steel production nearly quadrupled
  - Cement and other non-metallic minerals make up 22.5% of SEA industrial energy demand
- 2 Fossil fuel reliant**
  - 75% of iron/steel energy consumption from coal
  - 65% of chemicals energy demand is met with natural gas, oil, and coal
- 3 Costly abatements**
  - Limited cost-savings from commercially viable solutions; high abatement technologies are still in development

## Only ID (in ASEAN-6) communicated industry-specific targets in NDC<sup>4</sup>

### Target communication

Indonesia's targets and mitigation actions for each industry subsectors are listed in NDC

Unconditional reduction target: **7 MtCO<sub>2</sub>e** (4% of overall)



### Progress in reaching target

- Ammonia plant joint studies and development agreements have been done**
  - Mitsubishi collaborated with Indonesia local industrial players to develop green hydrogen, green ammonia value chain, and CCUS business
  - Pupuk Indonesia, one of the largest fertilizer producer in SEA, started development of hybrid green ammonia
- Cement players have set targets and improved yearly emissions**
  - Semen Indonesia, the country's largest cement player with more than 40% market share, secured green loan of ~\$460M to support decarbonization targets

Notes: (1) Refers to mining and quarrying, construction, and manufacturing of iron and steel, chemical and petrochemical, non-metallic minerals, non-ferrous metals, transport equipment, machinery, food and tobacco, paper, pulp and printing, wood and wood products, textile and leather, and others; (2) From 2018 to 2030; (3) Considering current and planned policies; (4) Nationally Determined Contribution, climate action plan by countries to reduce emissions and adapt to climate impacts  
Sources: Climate Watch; IRENA; ASEAN Centre for Energy

# B,C

## Solutions with the highest abatement potential have yet to reach commercial readiness, with a lack of low-risk abatement levers available today

There are three archetypes of investible solutions



### Low-risk investments

- Investments that **save cost and abate carbon**



### Effective solutions

- Commercialized **technology that is not yet cost-competitive** with conventional alternatives

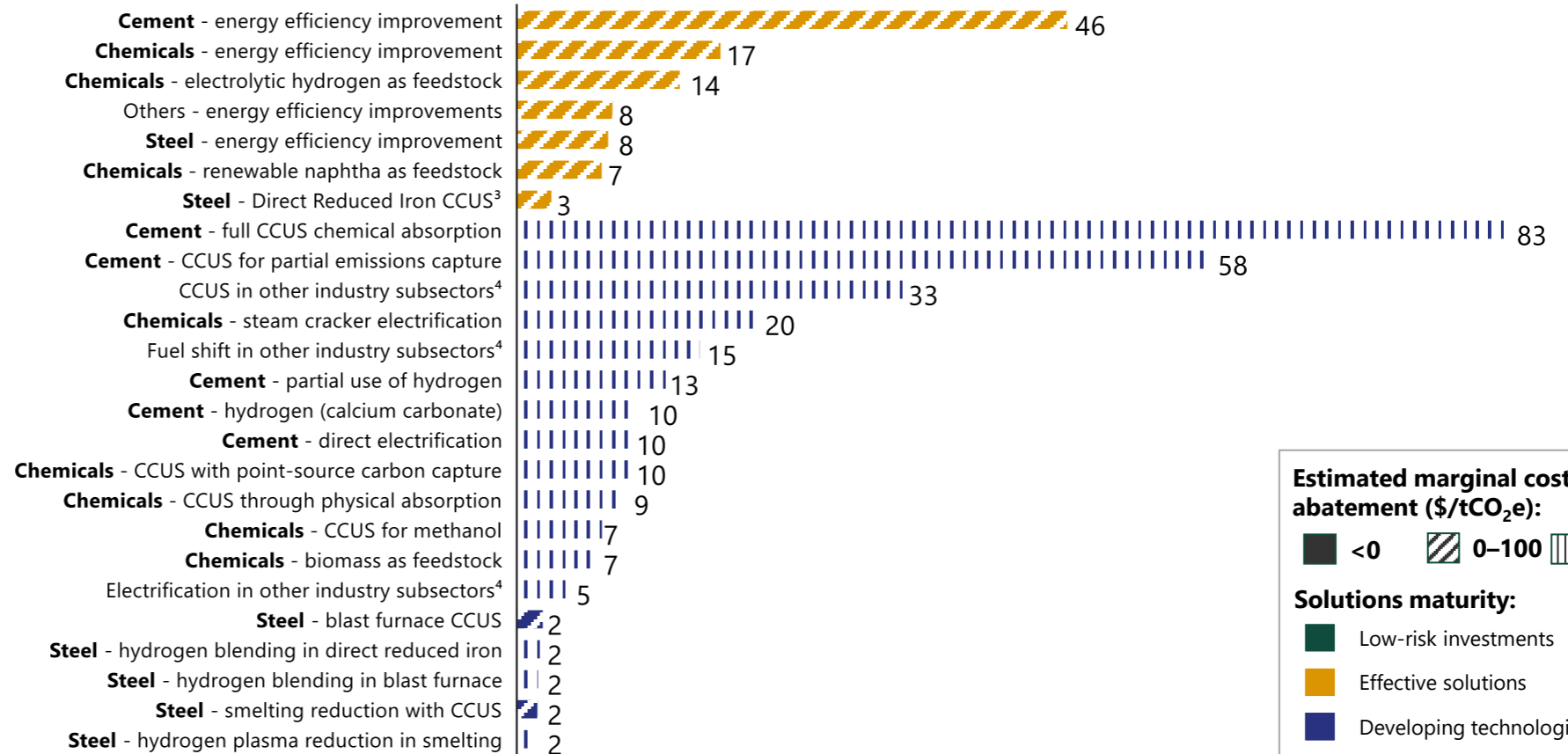


### Developing technologies

- Technologies in development or demonstration** stage that are not yet cost-competitive with conventional alternatives

Industry sector is expensive to abate; over \$45B<sup>1</sup> per year is needed to abate industry emissions and close to a third of emissions in the sector is hard-to-abate

### ASEAN-6 abatement potential<sup>2</sup> (MtCO<sub>2</sub>e)



**Estimated marginal cost of abatement (\$/tCO<sub>2</sub>e):**

- <0
- ▨ 0-100
- ▤ >100

**Solutions maturity:**

- Low-risk investments
- Effective solutions
- Developing technologies

Notes: (1) Estimated cost to abate annual subsector carbon emissions for years before 2030, estimated by product of abatement potential with average abatement costs per tCO<sub>2</sub>e for each lever; (2) 37% of sector emissions is hard to abate and difficult to be addressed with currently available technologies; (3) Carbon Capture, Utilization, and Storage; (4) Aside from steel, cement, and chemicals  
Sources: Bain internal Marginal Abatement Cost Curve (MACC) models, Lit. Search



# D

## Actions are required across multiple dimensions to drive decarbonization

■ Governments ■ Investors ■ Corporates



### Accelerate infrastructure development

Double down on **power master plans** to provide clarity on transition path



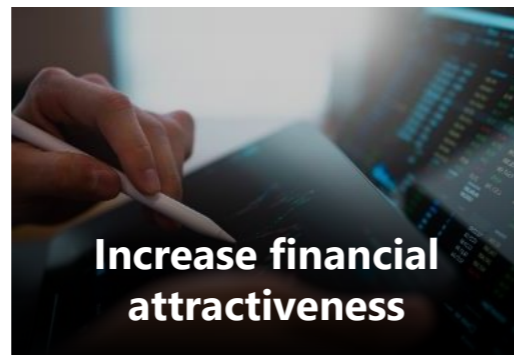
Accelerate effort in **grid upgrades** for the transition



**Streamline permitting and approval process** for RE deployment



Accelerate **EV charging station** infrastructure development



### Increase financial attractiveness

Leverage **private financing/ MDB<sup>1</sup> partnerships** for grid and RE development



Offer funding to support **early retirement of coal power plants**



**Adopt carbon pricing** to accelerate decarbonization



Introduce **financial incentives** such as FIT<sup>2</sup>, auction pricing, tax rebates



### Promote competitive market structure

Establish **open-access** power markets to enable **more stakeholders**



Align standards and allow access to **virtual PPAs** and **cross border investment**



Formalize **dedicated zones for RE** deployment



Offer support to promote **captive and C&I<sup>3</sup> power** generation



### Develop existing and emerging technologies

Incentivize and invest in **energy efficiency** and conservation levers



Promote **EV adoption** and build up **regional EV supply chains**



Mobilize funding to accelerate **solutions** to address **RE intermittency**



Advance **alternative fuel, hydrogen and CCUS<sup>4</sup>** development and application



### Realize a regional cross-border grid

Create **domestic and bilateral** grid connections to promote grid flexibility



Mobilize resources to plan and build **interconnection projects** where relevant



Align technical **standards, frameworks**, and role of regional power coordinator















← Create clear, integrated government plans on energy transition, including details on specific measuring and tracking methods →

Notes: (1) Multilateral development bank; (2) Feed-in tariff; (3) Commercial & Industrial; (4) Carbon capture, utilization, and storage

# D Infrastructure development | Acceleration of infrastructure deployment crucial for ensuring efficient RE transition and EV adoption

## Recommended actions for the short-to-medium term

 <p><b>Double down on power master plans to provide clarity on transition path</b></p>	<p>Develop country <b>power master plans and flesh out into actionable details</b>, supported by key milestones and comprehensive tracking to offer <b>clarity and certainty</b> to investors and developers</p>	<p><b>For example</b></p>	 <p>Singapore issued Singapore Green Plan 2030, with detailed targets, action plans, and measurements to move toward cleaner energy and reduce carbon emissions</p>	 <p>Denmark's Integrated National Energy and Climate Plan provides comprehensive guidelines on national targets, policies, measures and transition roadmap</p>
 <p><b>Accelerate effort in grid upgrades for the transition</b></p>	<p>Amplify efforts to upgrade national grid network to ensure <b>grid capacity and connectivity readiness</b> for future RE demand</p>	<p><b>For example</b></p>	 <p>The National Grid Corp. of the Philippines (NGCP) plans to invest ~\$8B by 2030 to transform the country's power grid to be the strongest in SEA</p>	 <p>UK's Greatest Grid Upgrade, aims to improve existing infrastructure across England and Wales, as part of National Grid's program with ~\$20B investments from 2021–2026</p>
 <p><b>Streamline permitting and approval process for RE deployment</b></p>	<p>Establish <b>clear permitting requirements and accelerated process timelines</b>, enabling RE developers to request all necessary permits from a single "one-stop" platform</p>	<p><b>For example</b></p>	 <p>Philippines Department of Energy is working on bringing Energy Virtual One-Stop Shop (EVOSS) to enable coordinated energy project submission and data processing</p>	 <p>Flagship Technical Support Project helps member states establish faster and more transparent RE permitting, including setting up one-stop application for developers</p>
 <p><b>Accelerate EV charging station infrastructure development</b></p>	<p>Seek public investments/PPPs<sup>1</sup> or form corporate joint deployment to <b>install infrastructure for EV charging and battery replacement</b></p>	<p><b>For example</b></p>	 <p>Malaysia government pledged to install 10,000 EV charging stations by 2025 in collaboration with local companies through Low Carbon Mobility Blueprint</p>	 <p>Singapore passed regulation that mandates EV charging points at all new buildings with carparks, with goal to deploy 60k charging points by 2030</p>

## Tangible benefits for SEA

**Greater effective renewables capacity**

Pace of RE deployment **less restricted by grid capacity and connectivity**

**Rapid deployment of RE projects**

Clear transition path and hassle-free permitting processes allow **shorter development period for RE infrastructure**

**Accelerated EV adoption**













Promote EV adoption and migration by ensuring **sufficient EV charging infrastructure**

Note: (1) Public-Private Partnership

Sources: U.S. Trade and Development Agency; U.S. Department of Energy; Thai Metropolitan Electricity Authority; EU; Gov. websites; Industry participant interviews; Lit..search

# D Financial attractiveness | Financing and incentives needed to accelerate the energy transition while driving attractive returns for all stakeholders

## Recommended actions for the short-to-medium term

 <p><b>Leverage private financing/MDB<sup>1</sup> partnerships for grid and RE development</b></p>	<p>Leverage <b>MDB<sup>1</sup> partnerships</b> and <b>private sector involvement</b> to unlock more capital for grid upgrades and RE projects</p>	<p><b>For example</b></p>	 <p>Pentagreen Capital uses blended finance to address the funding gap for marginally bankable projects, which accounts for ~30%–40% of investments in Asian infrastructure</p>	 <p>ADB has approved \$692M loan (first in Laos, one of the largest financing in SEA) to build a 600MW wind power plant in Laos and export electricity cross-border to Vietnam</p>
 <p><b>Offer funding to support early retirement of coal power plants</b></p>	<p>Finance <b>gradual phase-out of coal subsidies</b> and provide access to <b>alternative revenue streams</b>, e.g., sales of avoidance credits, as well as offering financing for CFPP<sup>3</sup> retrofits to reduce emissions</p>	<p><b>For example</b></p>	 <p>Through JETP<sup>2</sup>, international public and private sector funding are mobilized to support Vietnam and Indonesia transition away from fossil fuel energy</p>	 <p>Japan announced plans to fund conversion of traditional coal plants to run the coal plant partially on ammonia by adding “co-firing” capability</p>
 <p><b>Adopt carbon pricing to accelerate decarbonization</b></p>	<p>Implement <b>carbon tax or emissions trading scheme (ETS)</b> to accelerate the shift towards green economy and make renewables more attractive</p>	<p><b>For example</b></p>	 <p>Singapore is the only SEA country with a carbon tax (\$4/tCO<sub>2</sub>e), whereas Indonesia carbon tax expected in 2023 but has launched ETS pilot for coal in Q1 2023</p>	 <p>Carbon contracts on the EU Emissions Trading Scheme reached EUR 100 for the first time in Q1 2023</p>
 <p><b>Introduce financial incentives</b></p>	<p>Introduce <b>attractive financial incentives</b> such as feed-in tariffs, auction pricing, grants, and tax incentives, with consideration of the suitability to national and regional context</p>	<p><b>For example</b></p>	 <p>Upon FIT<sup>4</sup> approval in Malaysia, developers can participate in Green Technology Financing Scheme for interest subsidies, partial government guarantee, and training</p>	 <p>United States’ Inflation Reduction Act includes cleantech subsidies to accelerate decarbonization, expected to boost investment to \$114B per year by 2031</p>





## Tangible benefits for SEA

<p><b>Improved investor confidence</b></p>	<p><b>Greater willingness for investors</b> in SEA drives positive feedback loop for further investment</p>
<p><b>Increased green capital inflows</b></p>	<p><b>Higher share of investments</b> into energy transition relative to fossil fuels</p>
<p><b>Accelerate decarbonization journey</b></p>	<p><b>‘Carrot and stick’ and greater bankability</b> to further drive the transition</p>

Notes: (1) Multilateral development bank; (2) Just Energy Transition Partnership; (3) Coal-fired power plant; (4) Feed-in tariff  
Sources: ADB; IEA; Industry participant interviews; Lit. search

# D

## Financial attractiveness | Partnerships with MDBs<sup>1</sup> can play a key role in unblocking critical chokepoints; critical to increase MDB participation

	Description	Example tools
 <p><b>Transaction technical assistance</b></p>	<p><b>Project-specific support on specific PPP<sup>2</sup> transactions</b></p>	<p><b>Transaction structuring:</b> Analysis of project’s fundamentals, PPP<sup>2</sup> option review, financing modelling                      Contract preparation and implementation: Preparation of PPP<sup>2</sup> contract, tender procedure, winner selection                      Project implementation: Advisory on implementation challenges (e.g., land acquisition and clearance)</p>
 <p><b>Capability/ Capacity building</b></p>	<p><b>Country-wide/ sector-wide support</b> for country to take on PPPs</p>	<p><b>Policy advice:</b> Draft of national PPP policy, review PPP law, suggestions to harmonize legislation  <b>General institutional capacity building:</b> Train gov. officials to manage and deliver critical PPP projects  <b>Develop concession models</b> that mitigate revenue and payor risk</p>
 <p><b>Debt financing</b></p>	<p>Provision of <b>debt to finance PPP projects</b></p>	<p><b>Loans at market rates:</b> Funds made available at market/ competitive rates  <b>Loans at concessionary rates:</b> Funds made available on concessional terms to bring project costs down</p>
 <p><b>De-risking tools</b></p>	<p><b>To reduce political risk, currency and interest rate risk</b> of PPP<sup>2</sup> projects</p>	<p><b>Political risk guarantees:</b> Assurance to investors unwilling to take certain country, regional or political risk  <b>Currency/interest rate risk:</b> Local currency loans and client swaps for better management of forex risks  <b>Guarantee instruments:</b> Frameworks for sovereign guarantees on loans</p>

### Financing from MDB is lower in SEA compared to other regions

~\$1.6B bilateral and multilateral funding received in SEA region

~50% less MDB support received in SEA relative to South Asia (~\$3.3B)

- Multilateral and bilateral investments from MDBs is **significantly lower in SEA** compared to other regions
  - **Indonesia received the most MDB support**, taking ~70% of SEA’s total funding
- SEA region is considered **less attractive for MDBs** compared to other regions
  - **Insufficient scalable and repeatable RE projects** to demonstrate level of impact
  - **Lack of policies and standards** to access and sell RE in a transparent manner

*“SEA’s attractiveness is mixed based on our financing criteria. We want to see **high quality of projects**, typically meaning they’re backed by available land resources, strong tariff regimes, highly credible offtakers with strong PPAs<sup>3</sup>, and project sponsors with solid development track records and financial backing.*

*“That said, **MDBs also do not have as high a share of development financing as before**, given the decreasing RE cost and increasing viability, which has given rise to **more participation from private banks and financiers.**”*

Senior Portfolio Management Officer, Regional MDB

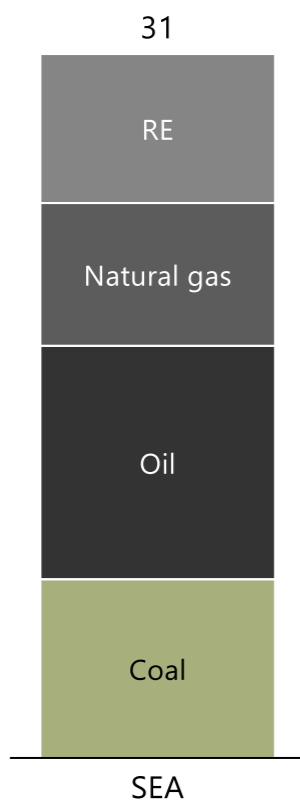
Notes: (1) Multilateral development bank; (2) Public-private partnerships; (3) Power purchase agreements  
 Sources: World Bank; Bain analysis; Industry participant interviews; Lit. search

# D

## Financial attractiveness | The managed phaseout of coal is an important lever to reduce SEA's reliance on fossil fuels

### Coal generates 25% of SEA energy

SEA energy supply by fuel (EJ, 2019)

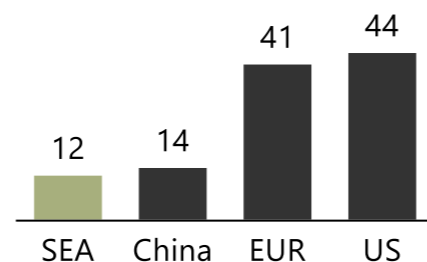


### MPO<sup>1</sup> of coal is a challenge for capital owners and coal asset interest holders



Coal asset interest holders (asset owners and utilities co.) have ...

Average age of CFPPs<sup>2</sup> (# of years, 2023)



Relatively new coal plants that are yet to naturally retire



Lack of subsidies from government to phase out coal plants



Capital sources (financial institutions, philanthropies, etc.) risk ...



Reputation if MPO perceived by public as greenwashing



Not meeting emission targets due to short-term spike in financed emissions (from the CFPPs<sup>2</sup>)



Integrity of internal policies as existing frameworks on allowed transactions need to be changed

### SEA to receive public and private supports to phase out coal through various partnerships



ETM

Energy Transition Mechanism (ETM), launched by ADB, aims to accelerate APAC's transition from coal to clean power through funding from both public and private investors

- ACEN has completed the first market-based ETM deal in the world, for early retirement of 246MW SLTEC coal plant in Philippines, cutting its operating life of 50 years by half
- MoU signed with Cirebon Electric Power to explore early retirement of 660MW coal-fired power plant in Indonesia



JETP

Indonesia and Vietnam have joined the Just Energy Transition Partnership (JETP) in 2022, a global model providing public and private climate financing for developing countries to accelerate decarbonization efforts

- Indonesia to receive \$20B and Vietnam to receive \$15.5B over next 3–5 years to phase out coal and increase RE capacity in energy mix by 2030



GFANZ













Glasgow Financial Alliance for Net Zero, a global coalition of financial institutions aiming to accelerate decarbonization (also part of JETP), is developing guidance on how CFPP<sup>2</sup> MPO<sup>1</sup> transactions could be structured, focusing on:

- Transition credibility in ensuring meaningful early coal asset retirements
- Financial viability in looking at practical levers to support
- Socio-economic inclusivity to ensure access to affordable electricity

Notes: (1) Managed phase-out; (2) Coal-fired power plants  
Sources: IEA; GFANZ

# D Competitive market structure | Open and competitive market environment to attract more stakeholders and accelerate faster transition

## Recommended actions for the short-to-medium term

 <p><b>Establish open-access power markets to enable more stakeholders</b></p>	<p>Promote involvement of more players in power market, e.g., via <b>direct PPAs<sup>1</sup></b> with corporates, <b>peer-to-peer trading</b>, etc., while also not compromising on national energy security</p>	<p><b>For example</b></p>	 <p>Malaysia launched Corporate Green Power Program, virtual PPA<sup>1</sup> program</p>	 <p>India established corporate PPAs<sup>1</sup> and introduced open access fee waivers</p>
 <p><b>Align standard and allow access to virtual PPAs and cross border investment</b></p>	<p><b>Streamline standards</b> of advanced financial instruments such as virtual PPAs to <b>accelerate market participation</b> and offer opportunities for cross border investment</p>	<p><b>For example</b></p>	 <p>Singapore leverages virtual PPAs to help enterprises accelerate RE adoption (e.g., Sunseap Group signed virtual PPAs to supply RE to Facebook's data center in SG)</p>	 <p>European Commission issued guidelines to Member States on good practices to speed up cross-border PPA, such as admin process simplification, RE purchase agreement</p>
 <p><b>Formalize dedicated zones for RE deployment</b></p>	<p><b>Introduce RE zones</b> to achieve economies of scale and provide confidence to developers</p>	<p><b>For example</b></p>	 <p>Philippines launched Competitive Renewable Energy Zones (CREZ) to improve transmission planning and accelerate RE development</p>	 <p>Australia's Renewable Energy Zones (REZs) combine renewable energy infrastructure, storage, and transmission infrastructure within a region</p>
 <p><b>Offer support to promote captive and C&amp;I<sup>2</sup> power generation</b></p>	<p>Offer regulatory/financial support to accelerate project development for <b>corporate captive clean energy generation</b></p>	<p><b>For example</b></p>	 <p>Singapore Airlines and SIA Engineering Company plan to deploy 8.2 MWp rooftop solar system (~20k solar panels) on its properties to supplement its energy use</p>	 <p>South Africa removed cap limit (current 100MW) for private RE power generation systems and offer financing to promote captive power generation projects</p>

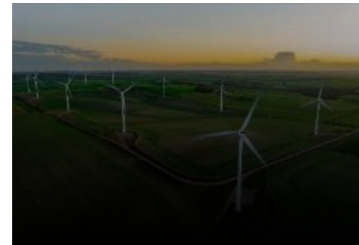
## Tangible benefits for SEA

<p><b>Reduced offtaker risk</b></p>	<p><b>Decoupled reliance on single offtaker</b> to provide developers more optionality in supplying energy</p>
<p><b>Attractive green investment climate</b></p>	<p>Increased 'green' investments driven by <b>competitive market structure</b></p>
<p><b>Accelerated deployment of renewables</b></p>	<p><b>Ease of market entry and confidence in offtaking</b> likely to attract more investments in renewables</p>

Notes: (1) Power purchase agreements; (2) Commercial & Industrial  
Sources: IEA; Government websites; Industry participant interviews; Lit. search

D

# Competitive market structure | India successfully transitioned to an open-access electricity market via corporate PPA program



## India leads APAC in corporate power procurement, accelerating RE deployment via corporate PPA program

- **Prior to the introduction of CPPAs<sup>1</sup>, power procurement was restricted** to state-owned and licensed distribution companies; corporates could only access RE by purchasing power from DISCOMs<sup>2</sup> or developing onsite power plants (significant capital required)
- **CPPAs eased RE power access**, reduced startup costs and expanded RE market (e.g., Infosys, a leading Indian IT company, leveraged corporate PPA program and achieved >40% of its electricity from RE sources in 2020)

### Key learnings



#### Open-access power market can enable more stakeholder involvement

- India introduced **green power exchanges** (e.g., GTAM and GDAM<sup>3</sup>) in 2020 to allow RE trading (**7.7B units** traded as of April 2022)
- **~44%** share of APAC's cumulative contracted capacity from 2016 to H1 2022
- **RE (excluding hydro) share of installed capacity increased from ~13% to ~21%** between 2016 and 2021 after launching the program



#### Supportive policies help accelerate market participation

- India revised **Green Energy Open Access** rules in 2022, reducing CPPA threshold **from 1MW to 100KW**
- High volume of CPPAs between 2017 and 18 due to **waivers on open access charges to promote more third party PPAs**



#### CPPA can serve as an effective means to reduce risks for RE projects

- **Reduction in offtake and curtailment risk** for developers (some DISCOMs<sup>2</sup> have history of payment delays/defaults)
- **High cash-flow stability for RE**, due to high predictability of sales and pricing through long-term PPA agreements

### Takeaways for SEA



**Leverage CPPAs<sup>1</sup>** to **encourage more RE deployment** and **reduce offtake and curtailment risks** for corporates

**Strengthen open-market regulations/policies** and ensure consistent implementation across all levels of government (from national to state/local)



**Augment with virtual PPAs** to further encourage corporate uptake of renewable energy

- Encourage companies to further **increase their renewables share** by **not being limited to the state and/or country**
- Provide RE developers an **additional source of revenue**

Notes: (1) Corporate power purchase agreements; (2) Distribution companies; (3) Green Term-Ahead Market (up to 11 days prior to delivery date) and Green Day Ahead Market;  
Sources: IEA; WBCSD; Government websites; Lit. search

# D Emerging technologies | Taking steps to develop future solutions today will position SEA to accelerate the energy transition after 2030

## Recommended actions for the short-to-medium term

 <p><b>Incentivize and invest in energy efficiency and conservation levers</b></p>	<p>Develop policies to offer regulatory support and financial incentives to drive toward more implementation of energy efficiency improvements</p>	<p><b>For example</b></p>	 <p>Malaysia Maritime and Heavy Engineering collaborate with Silverstream to pioneer air lubrication system that reduces ship fuel consumption in the maritime industry</p>	 <p>Germany offers lower energy and electricity tax to incentivize industry players to install energy efficiency measures and improvement initiatives</p>
 <p><b>Promote EV adoption and build up regional EV supply chains</b></p>	<p><b>Offer incentives/subsidies</b> for local players in EV manufacturing supply chain as well as <b>end users (consumer and public transport EV)</b></p>	<p><b>For example</b></p>	 <p>Thailand promotes domestic EV manufacturing by exempting import duties on significant electrical parts for EV until 2025</p>	 <p>Indonesia lowered VAT on EV from 11% to 1% until end of 2023 and plans to allocate \$466.7M to subsidize two-wheeler EV sales through 2024; E-buses also being explored</p>
 <p><b>Mobilize funding to accelerate solutions to address RE intermittency</b></p>	<p><b>Mobilize public funding</b> to accelerate development of energy storage technology and solutions that will help optimize supply and demand of electricity e.g., IoT, real-time monitoring, etc.</p>	<p><b>For example</b></p>	 <p>Singapore deployed utility-scale ESS<sup>1</sup> with capacity of 2.4MW/2.4MWh and started to pilot deploying ESS<sup>1</sup> to address solar intermittency in residential flats</p>	 <p>GreenKo is developing 3 GW of energy storage capacity based on pumped storage technology across India, to provide round-the-clock power to the national grid</p>
 <p><b>Advance alternative fuel, hydrogen, and CCUS<sup>2</sup> development and application</b></p>	<p>Support development of <b>new innovations</b> such as hydrogen and CCUS<sup>2</sup> to <b>overcome technical and commercial challenges</b></p>	<p><b>For example</b></p>	 <p>Civil Aviation Authority of Singapore, Singapore Airlines, and GenZero piloted blended sustainable aviation fuels (SAFs) on flights departing from Changi Airport</p>	 <p>Linde plans to develop CCS<sup>3</sup> capabilities at its gasification facility on SG Jurong Island, to capture emissions from the production and supply of hydrogen and synthetic gas</p>

## Tangible benefits for SEA

<p><b>Increased readiness to scale clean energy</b></p>	<p>Supportive policy and financial incentives enable <b>faster route to market for emerging tech</b> as economic viability increases</p>
<p><b>Greater flexibility and reliability of energy system</b></p>	<p>Emerging technologies help <b>overcome variability and reliability challenges</b> within renewables</p>
<p><b>Emission offset for hard-to-abate sector</b></p>	<p>CCUS, with <b>negative emissions</b>, to neutralize positive emissions especially from <b>hard-to-abate sectors</b></p>

Notes: (1) Energy storage system; (2) Carbon capture, utilization, and storage; (3) Carbon capture and sequestration  
Sources: IEA; EnergyWatch; ACE; ADB; EU; Singapore Ministry of Trade and Industry; Industry participant interviews; Lit. search



## D

# Emerging technologies | Across emerging technologies, longer-term breakthroughs are essential to overcome technical and commercial challenges



## Electrification of end uses

- Penetration of electricity, built on existing technologies
  - **Transport:** Shift to electric vehicles
  - **Buildings:** Improving energy efficiency in buildings (e.g., space cooling)
  - **Industry:** Including process heat, cooling systems, and machinery

- Commercializing electrification of high-temperature process heating
  - **Customization** based on size, temperature, flow rates, etc.
- Other innovations to significantly **lower operating costs**, relative to fossil fuel-based heating



## Energy storage

- Cost-effective solution for deep decarbonization while **maintaining reliability**
  - As the world relies more on renewable sources, it becomes increasingly important to **balance increasing energy needs** and **intermittency of energy supply**

### INNOVATION REQUIRED TO ACCELERATE DECARBONIZATION

- **Efficiency improvements:** storage is currently most **advanced in the transport sector**, but slow at implementation at the grid level and significantly below estimated capacity



## Carbon capture

- CCUS<sup>1</sup> plays an important role to:
  - **Retrofit existing assets** (e.g., coal-fired power plants)
  - Maintaining **energy security** with CCUS-equipped power plants
  - Achieve **negative emissions** from power generation by combining with bioenergy CCS (**BECCS**)

- **Upgrades in monitoring and maintenance** to minimize risk of leakage from underground storage
- **Scalability of CO<sub>2</sub> use for alternative pathways**, e.g., for synthetic fuel production, enhanced oil recovery, etc.



## Green hydrogen










- Green hydrogen refers to hydrogen produced from **electrolysis**, powered by electricity from **renewable energy**
  - It can be used directly as a fuel or feedstock in the industrial sector
  - There are also alternative methods of producing clean hydrogen (e.g., methane pyrolysis)

- New ways to **distribute and transport** hydrogen
  - High capital expenditure required to build necessary infrastructure
  - Alternative solutions are not demonstrated at scale
- Tech to enable **transformation of H<sub>2</sub>** at end-market supply chain

Note: (1) Carbon capture, utilization, and storage  
Sources: IRENA; IEA; OECD; Lit. search

# D Regional cross-border grid | A regional grid can unlock even greater renewables potential while driving down costs and increasing energy security for the region

## Recommended actions for the short- to medium-term

 <p><b>Create domestic and bilateral grid connections to promote grid flexibility</b></p>	<p>Design and install <b>domestic and bilateral grid</b> to <b>connect demand and supply</b>, as well as optimize resources between participating countries</p>	<p><b>For example</b></p>	 <p>Singapore imports up to 100MW RE, equiv. to 1.5% of SG's peak electricity demand, from Laos since 2022, leveraging grid interconnections through the LTMS-PIP<sup>1</sup> project</p>	 <p>North Sea Link is a 1400MW, 720km-long subsea grid interconnector linking electricity systems of the UK and Norway to enable RE sharing and enhance grid flexibility</p>	<h3>Tangible benefits for SEA</h3> <p><b>Unlocked renewable energy potential</b></p> <p>Enable <b>increased VRE<sup>5</sup> integration</b> for decarbonization whilst maintaining system flexibility</p> <p><b>Cheaper energy access for the region</b></p> <p><b>Connect supply to demand centers, enabling cost-effective electricity</b> from clean energy resources</p> <p><b>Increased energy security as a region</b></p> <p>Interconnected networks enable <b>effective utilization and resource sharing</b> to ensure reliability of power supply across the region</p>
 <p><b>Mobilize resources to plan and build interconnection projects where relevant</b></p>	<p>Develop clear <b>regional roadmap and milestones</b> for interconnection projects; <b>continue existing projects</b> while <b>mobilizing new construction</b></p>	<p><b>For example</b></p>	 <p>ASEAN laid out priority bilateral interconnection projects and is piloting first multilateral trade pilot projects through LTMS-PIP<sup>1</sup></p>	 <p>EU shortlists key cross-border interconnections under Projects of Common Interest. Completed projects include COBRACable, connecting Denmark and the Netherlands</p>	
 <p><b>Align technical standards, multilateral frameworks, and role of regional power coordinator</b></p>	<p>Leverage the existing GMS<sup>2</sup> grid code to <b>develop ASEAN-wide interoperability standards</b>, standardize <b>contracts and wheeling guidelines</b> for regional trade and expand HAPUA<sup>3</sup> or AERN<sup>4</sup> role to be <b>regional power coordinator</b></p>	<p><b>For example</b></p>	 <p>GMS Regional Grid Code helped China and 5 ASEAN countries to define technical requirements, rules, and procedures to standardize transmission systems</p>	 <p>EU network codes provide guidelines on energy market and trading, as well as connection and system operation codes and guidelines</p>	

Notes: (1) Lao PDR-Thailand-Malaysia-Singapore Power Integration Project; (2) Greater Mekong Subregion; (3) Heads of ASEAN Power and Utilities/Authorities; (4) ASEAN Energy Regulator Network; (5) Variable renewable energy  
Sources: IEA; EnergyWatch; ACE; ADB; EU; RERA; Lit. search

# D Regional cross-border grid | Political will, regional collaboration, and private sector involvement are needed to successfully realize an SEA regional grid

## Xlinks Morocco – UK Power Project



**Unidirectional** trade (solar and wind energy) from **Morocco to UK** through 3,800km HVDC<sup>1</sup> cables



~\$22B of investments required (~\$90M secured as of April 23 for development)

### Key learnings



Developing own **manufacturing facilities** to overcome HVDC<sup>1</sup> supply chain constraints



Extensive **private sector involvement** and **alignment of political and economic interest**



Deep **multi-year engagements** with **both UK and Morocco** governments

### Takeaways for SEA

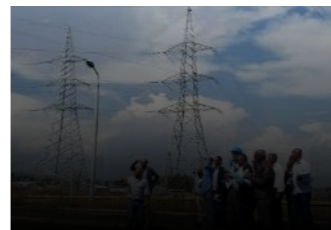


**Adopt effective planning and mitigate supply chain risks** by developing relevant in-house capabilities

Create private sector confidence and accelerate project completion by maintaining **reliability, consistency, and continuity in regulatory environment**

**Leverage CPPAs<sup>2</sup>** to secure offtake agreements to cover power capacity and de-risk projects

## Eastern Africa Power Pool (EAPP)



**Regional grid** across 13 member countries in **Eastern Africa**



\$33B estimated investment costs for 2015 to meet national targets for access rates

### Key learnings



**Harmonization of technical standards** through establishing an **Independent Regulatory Board**



Lack of **leadership and political will** and preference for **long-term bilateral trade agreements**



Governments' **unwillingness to allocate funds** in regional project

### Takeaways for SEA



Drive political will and regional collaboration across participating countries to **seek consensus on regional agenda and establish an independent regulatory board** to enforce changes

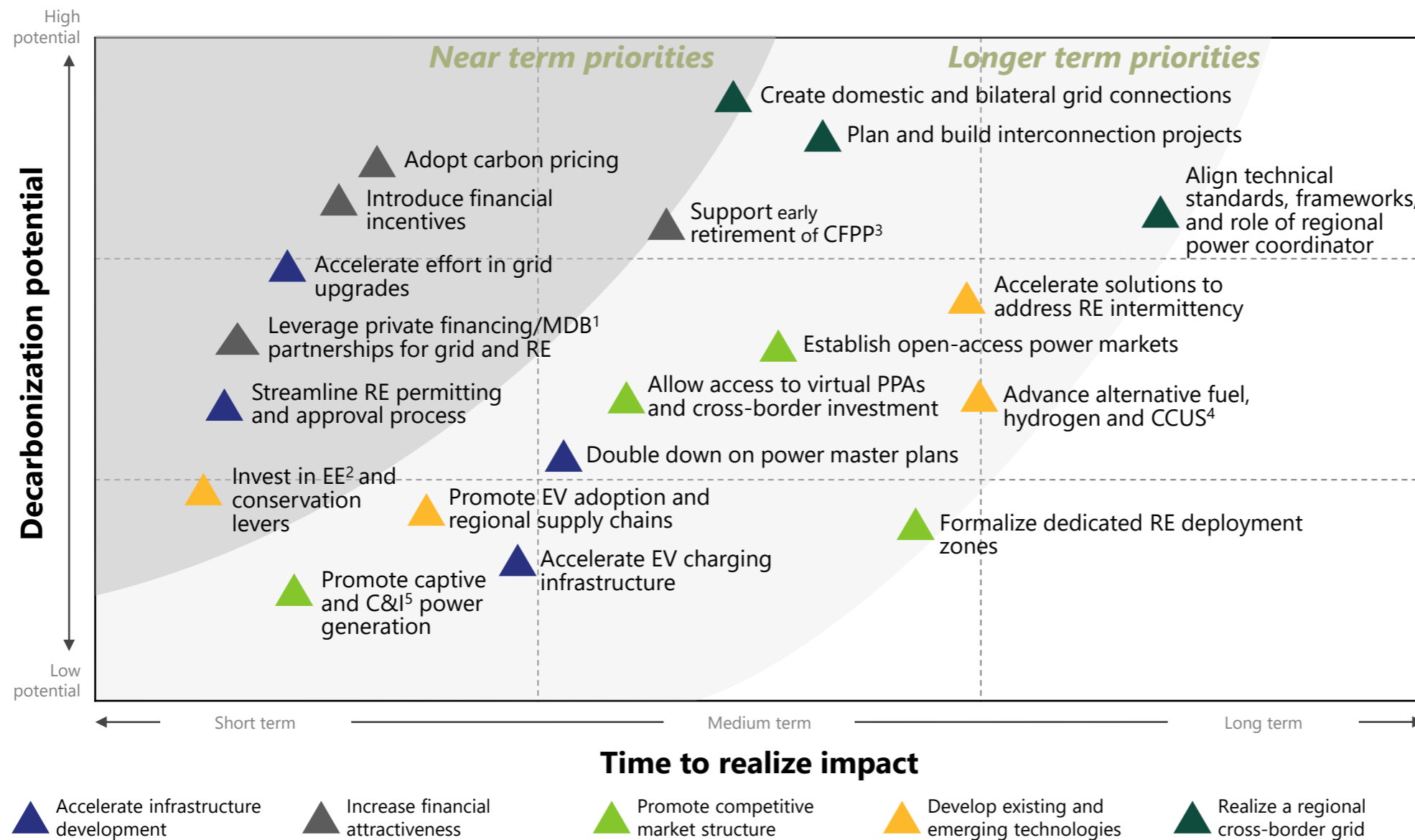
Develop clear **roadmap and frameworks** to drive **step-wise change** and accountability of milestones

Encourage private investment through **innovative financing models** to bridge financing gap

Notes: (1) High voltage direct current; (2) Corporate power purchase agreements  
Sources: Gov. websites; Lit. search

# D

## Priority Actions | Prioritize actions that are “here today” and can deliver a faster “time to carbon” impact, notably grid infrastructure, renewables, and financing



### Key takeaways

- **Policy and partnership-oriented levers** are both highly impactful and relatively actionable in the near term to accelerate decarbonization
  - **Government actions** to introduce **carbon taxes, financial incentives, development funding, and grid investments** are most critical in the immediate term
  - **Private sector** to participate more in RE deployment through **financing and partnership agreements**
- Highly impactful levers within **emerging technologies** and **regional grid networks** are longer-term solutions requiring high R&D and financial investment. However, **interim steps can be taken today** to accelerate these levers, e.g.,
  - **Strategic opportunities for battery storage investments** to complement RE infrastructure deployment
  - **Cross-border RE trade deals** e.g., Singapore’s arrangements with Laos, Cambodia, and Indonesia

Notes: (1) Multilateral development bank; (2) Energy efficiency; (3) Coal-fired power plant; (4) Carbon capture utilization and storage; (5) Commercial and Industrial

# Accelerating the energy transition

## Summary

1

### Energy plays a crucial role in economy and climate action

- ~35% of SEA GDP is driven by energy-intensive sectors today
- Energy is the **largest source of SEA emissions**, ~45% and growing
- **Competing agenda** between economic growth and climate action creates a **unique challenge for the region**
  - SEA energy consumption expected to **increase by >40%** to 2030 (vs. 2018)
  - 4.9 GtCO<sub>2</sub>e unconditional target in 2030
- **Power, transport, and industry** make up ~90% of SEA's energy emissions
  - Power sector, accounting for nearly half of sector emissions, is the most addressable part of the energy complex

2

### Abundant resources, but fundamental challenges holding back progress

- SEA has **abundant renewable potential, yet path to realize the potential is still unclear**
  - Technical potential of ~17TW, or **20x capacity needed** for 2050 demand
  - Multiple RE projects in pipeline (194 GW), but **90%** still in **permitting/announced stages**
- **EVs have strong momentum**, but still **far from countries' bold commitment**
  - SG, TH, and PH aim for 100% EV new car sales by 2030–2040, vs. current EV share 2 – 12%
- **Slow approval/launch of infrastructure, insufficient financial attractiveness, and regulatory uncertainty** are key barriers
  - **ID and VN's grid** present challenges to accommodate more RE as per the targets
  - ~**20% cumulative energy FDI**<sup>1</sup> in SEA went to renewables vs. ~**50% for OECD** countries
  - **Up to 8 years** is needed to clear **necessary RE permitting** for ID and TH wind projects

3

### Infra deployment, financial attractiveness, and competitive market structure are key levers

- **Acceleration of infrastructure development and clear transition path** to promote RE and EV
  - e.g., The National Grid corp. of the **PH** (NGCP) plans to invest ~\$8B by 2030 to **transform the country's power grid**
  - SG mandates **EV charging points at all new buildings** with carparks, with goal to deploy 60k charging points by 2030
- **Increased financial attractiveness** to unlock more capital
  - e.g., **ADB-backed cross-border wind project** to export power from LA to VN, and **MY's Green Technology Financing Scheme**
- **Open market structure** to attract more market participation by enabling VPPAs
  - e.g., **MY's virtual PPA**<sup>2</sup> helps encourage competition and market efficiency

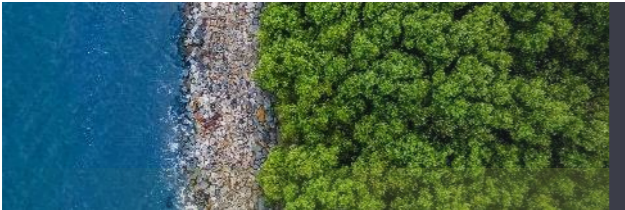
4

### Bold moves and collaboration will signal commitment and foster confidence

- **Bold moves can catalyze the transition** by attracting investors, building capability and driving innovation required for Net Zero
  - e.g., world's longest subsea interconnector linking UK and Norway supports energy security and economic growth in both countries
- **Cross-border interconnections** can unlock RE potential and help match supply and demand across the region
  - e.g., Singapore imports up to 100MW RE from Laos since 2022, leveraging grid interconnections through LTMS-PIP<sup>3</sup> project
- **Early investment** in nascent low-carbon technologies is a long-term play to start now
  - **Commercialization of CCUS**<sup>4</sup>, **hydrogen**, and other low carbon technologies are required to **neutralize hard-to-abate sector emissions**
  - E.g., **Linde** plans to develop **CCS**<sup>5</sup> capabilities in its gasification facility in SG, to capture **emissions** from the production of **hydrogen**

Notes: (1) Foreign direct investment; (2) Power purchase agreement; (3) Lao PDR-Thailand-Malaysia-Singapore Power Integration Project; (4) Carbon capture, usage and storage; (5) Carbon capture and storage

# Contents



**Introduction: Context and challenges**



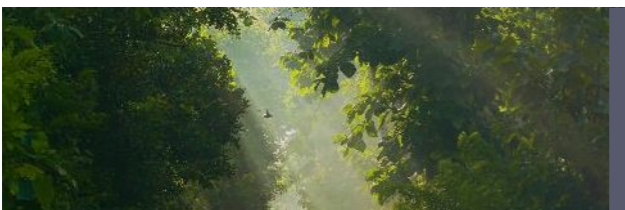
**Progress towards decarbonization**



**Accelerating the energy transition**



**Valuing nature for impact**



**Recommendations and call for action**

An aerial photograph of a tropical coastline. The left side shows clear turquoise water with some darker patches. A narrow strip of white sand beach runs along the coast, dotted with dark rocks. To the right of the beach is a dense, lush green forest. The overall scene is vibrant and natural.

# **Valuing nature for impact**

# Valuing nature for impact

## Key takeaways

1



### SEA depends on nature to meet 2030 reduction targets

Nature-related emissions are SEA's<sup>1</sup> second largest source (44% of total); protecting, restoring, and sustainably managing natural ecosystems comprise ~41% of 2030 emission reduction targets<sup>3</sup>

2



### NBS<sup>2</sup> can significantly abate CO<sub>2</sub> and represent a large investible opportunity

NBS offer up to ~1.7 GtCO<sub>2</sub>e/year in abatement potential, with an estimated annual investment opportunity of ~\$20B–\$30B; co-benefits include biodiversity preservation, water security, improved livelihoods, and lower disaster risk

3



### However, net forest loss continues due to commodity-driven deforestation

Though 5 out of 8 SEA countries have nature-specific emissions targets, SEA overall continues to experience net forest loss (7% average from 2000 to 2020), with plantation expansion as a primary driver

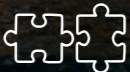
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### Gaps in regulation/enforcement and a nascent NBS market slow progress

Domestic forest conservation policies lack consistency and strong enforcement; countries are just beginning to establish rules for carbon market structures and trading; NBS development experience and skills are low relative to other regions

5



### The right enabling environment is needed for the NBS market to mature

Policies, incentives, and carbon markets are needed to make ecosystem restoration/protection economically attractive relative to other land uses; an ecosystem of actors must also build capabilities, innovate financing, and tech solutions

Notes: (1) Southeast Asia; (2) Nature-based solutions

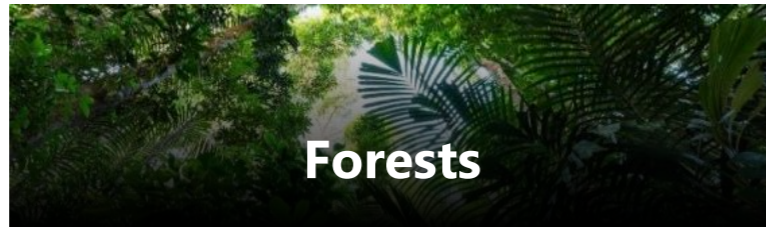


# Key questions in this chapter

<b>A</b> <b>Role of the sector</b>	<b>B</b> <b>Context &amp; Progress</b>	<b>C</b> <b>Challenges</b>	<b>D</b> <b>Recommendations</b>
<ul style="list-style-type: none"><li>• <b>Why are natural environments important</b> for SEA countries and <b>what role</b> can the sector play in helping the region meet its <b>2030 NDC targets</b>?</li><li>• <b>What role can nature-based solutions</b> play in accelerating decarbonization within the region?</li></ul>	<ul style="list-style-type: none"><li>• <b>Where do SEA countries stand today</b> and how far are they from achieving 2030 targets?</li><li>• <b>How have SEA countries progressed</b> in reducing natural environment degradation over recent years and what have been the <b>historical underlying drivers</b>?</li><li>• How does <b>agriculture</b> contribute to emissions?</li><li>• How do <b>carbon abatement potential and cost-effectiveness</b> vary across initiatives and <b>which levers are critical</b> in the near term?</li></ul> <p><i>2 separate sections for Nature and Agriculture</i></p>	<ul style="list-style-type: none"><li>• What are the <b>key challenges</b> that stand in the way of the region's ability to further harness nature's untapped potential?</li></ul>	<ul style="list-style-type: none"><li>• What are <b>critical levers to overcome barriers</b> and accelerate decarbonization?</li><li>• What are the <b>immediate to medium-term</b> solutions that can help the region unlock nature's full potential?</li></ul>

A

# SEA is home to vital, varied ecosystems with significant stores of carbon



**Forests**



**Peatlands**



**Mangroves**

Tropical terrestrial forestlands composed of mostly evergreen trees that are typically the **richest, most biodiverse areas** on Earth and are the **largest ecosystem in SEA**

Biodiverse terrestrial wetland ecosystems formed from partially decomposed plant material that can act as **a significant carbon sink and reduce impacts of floods**

Saltwater coastal intertidal areas with **high carbon sequestration potential** (~3x higher vs. terrestrial forests) and **rich biodiversity** are **critical to stabilize coastlines** and reduce soil erosion

**Description**

**Total size of ecosystem (M ha)**

~200 M ha<sup>1</sup>

~35 M ha<sup>2</sup>

~5 M ha<sup>1</sup>

**Geographic concentration (% of SEA ecosystem area)**

~45% 🇮🇩 ~14% 🇲🇲 ~10% 🇵🇭

~90%<sup>2</sup> 🇮🇩 ~10%<sup>2</sup> 🇲🇲

~61% 🇮🇩 ~11% 🇲🇲 ~11% 🇲🇲

**Estimated carbon stock (GtCO<sub>2</sub>e)**

~110 GtCO<sub>2</sub>e<sup>3</sup>

~36 GtCO<sub>2</sub>e<sup>2</sup>

~9 GtCO<sub>2</sub>e<sup>4</sup>

**Carbon sequestration potential (ktCO<sub>2</sub>e/ha)**

~0.6 ktCO<sub>2</sub>e/ha

~1 ktCO<sub>2</sub>e/ha

~1.8 ktCO<sub>2</sub>e/ha

**Primary drivers of ecosystem degradation**

Commodities (~86%) largely led by palm oil, logging, etc.

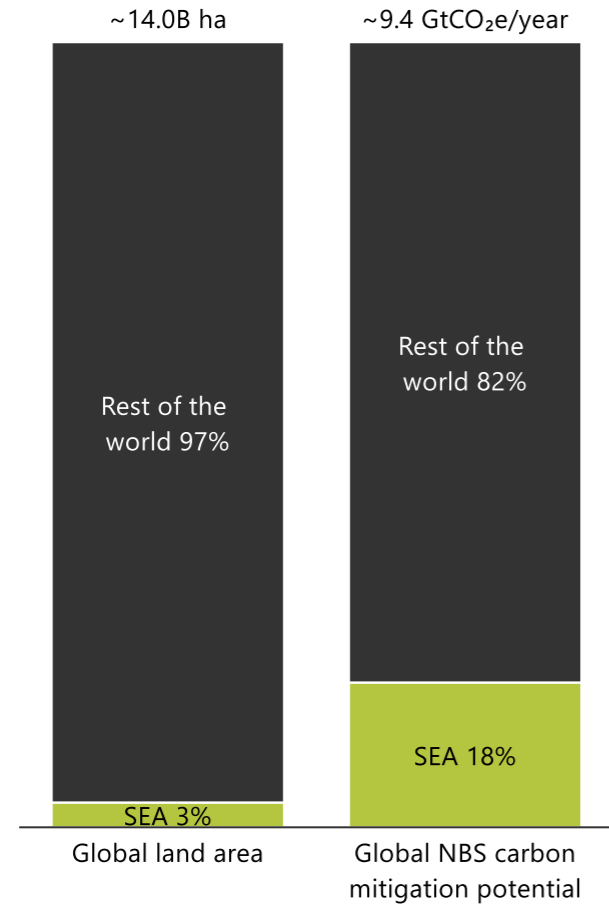
Smallholder/commercial palm oil, pulpwood plantations, and intensive logging

Aquaculture (~30%), rice (~22%), and oil palm (~16%) plantations<sup>5</sup>

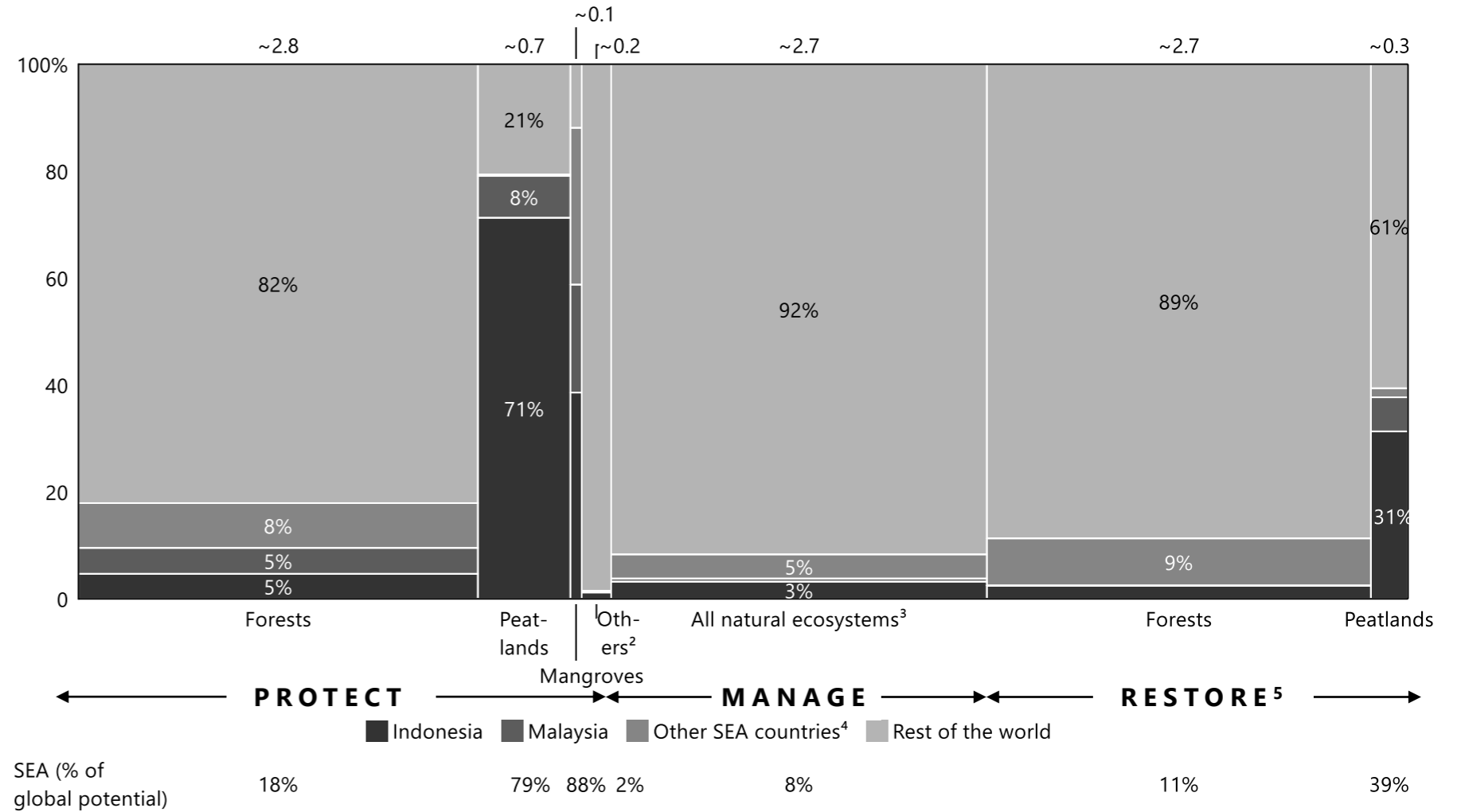
Notes: (1) 2020 data; (2) 2022 data, only includes Indonesia and Malaysia (rest of SEA not sized by UNEP's 2022 Peatland Assessment); (3) Includes soil carbon, aboveground, and belowground carbon for forestland with 10%+ tree canopy cover; (4) Includes above ground biomass and soil carbon (upper 1m of soil) from 2016; (5) Between 2000–2012 period  
Sources: UNEP; Global Forest Watch; Global Mangrove Watch; FAO; Peer-Reviewed Journals; Lit. search

A

# In the global context, SEA holds a disproportionate share (~18%) of the world's carbon mitigation potential relative to its share (~3%) of the global land area



Global NBS carbon mitigation potential<sup>1</sup> (GtCO<sub>2</sub>e/year)



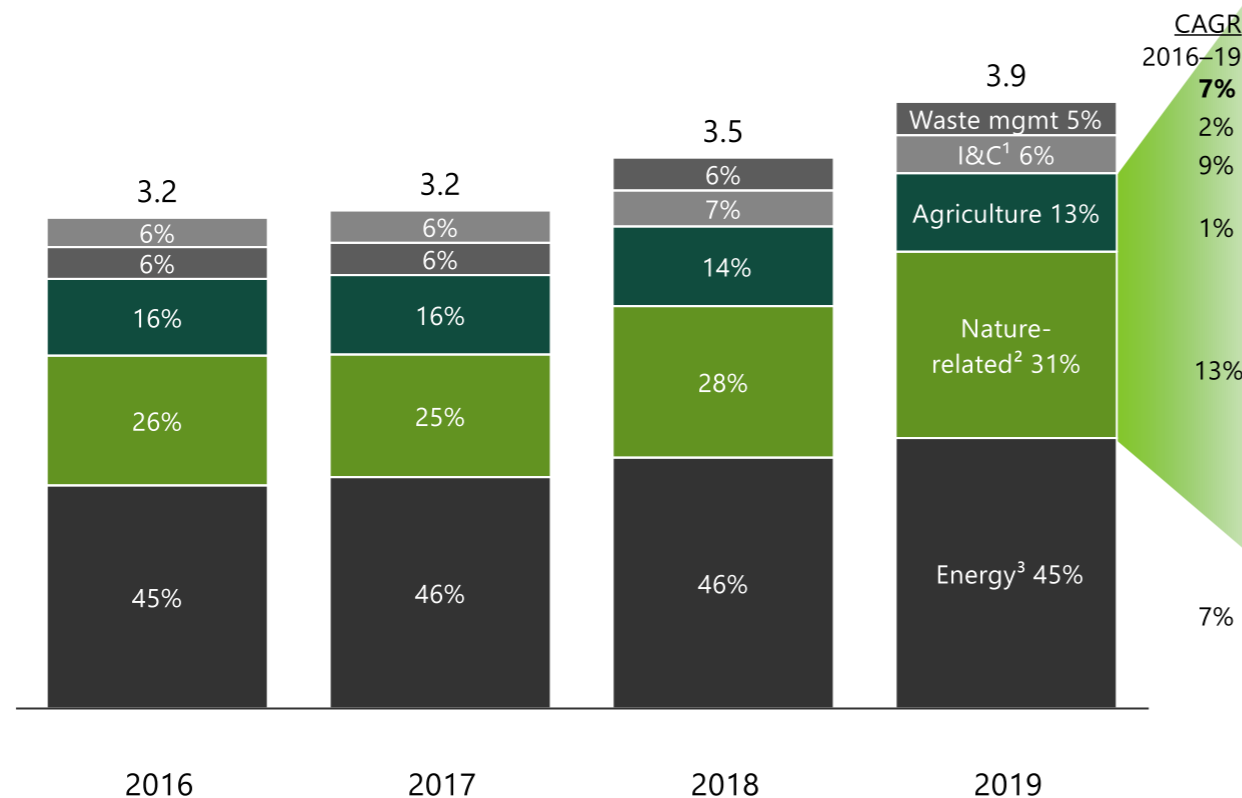
Notes: (1) Considers cost-effective carbon mitigation potential, which excludes global and regional marginal abatement costs >\$100/tCO<sub>2</sub>e in 2030; (2) Grasslands; (3) Ecosystem breakdown unavailable due to overlapping mitigation levers (e.g., trees on agriculture land, nutrient management); (4) Excludes Singapore; (5) Mangrove restoration only accounts for a small proportion of global carbon potential of <0.1 GtCO<sub>2</sub>e/year and has been excluded from the chart  
Sources: Climate Watch; FAO; Nature4Climate

A

# SEA's ecosystems could be carbon sinks; instead, ecosystem degradation and agriculture collectively make up ~44% of SEA's GHG emissions

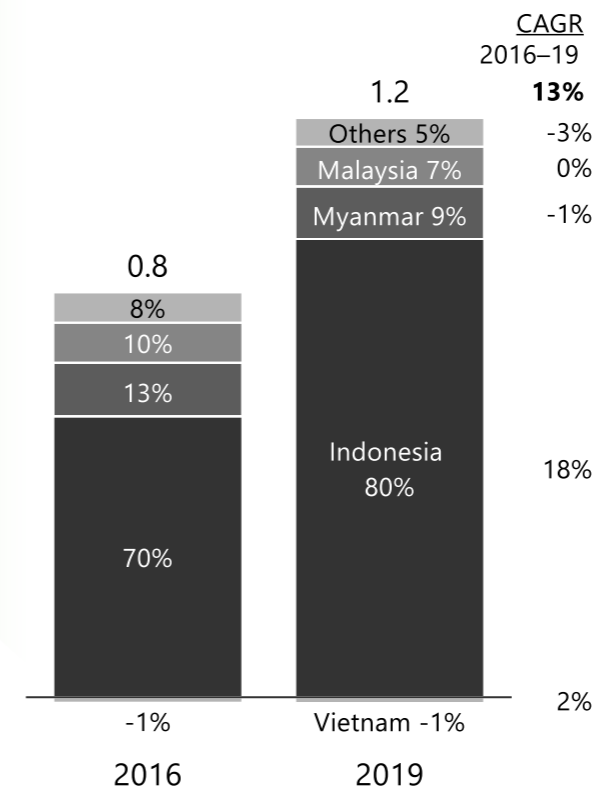
Natural environment degradation and agriculture are the largest sources of SEA's emissions behind the energy sector ...

SEA GHG emissions (GtCO<sub>2</sub>e)

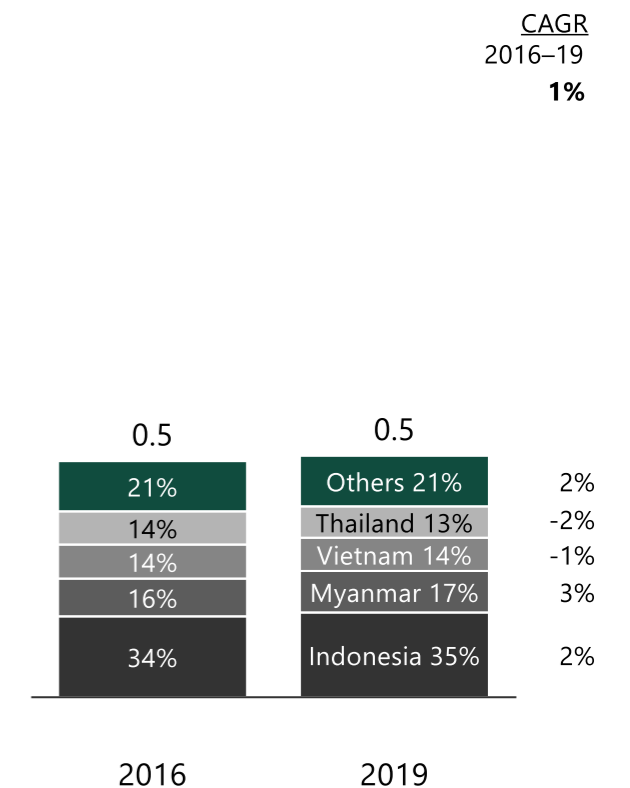


... with Indonesia accountable for ~80% and ~35% of nature and agriculture-related emissions respectively

SEA nature-related emissions (GtCO<sub>2</sub>e)



SEA agri-related emissions (GtCO<sub>2</sub>e)



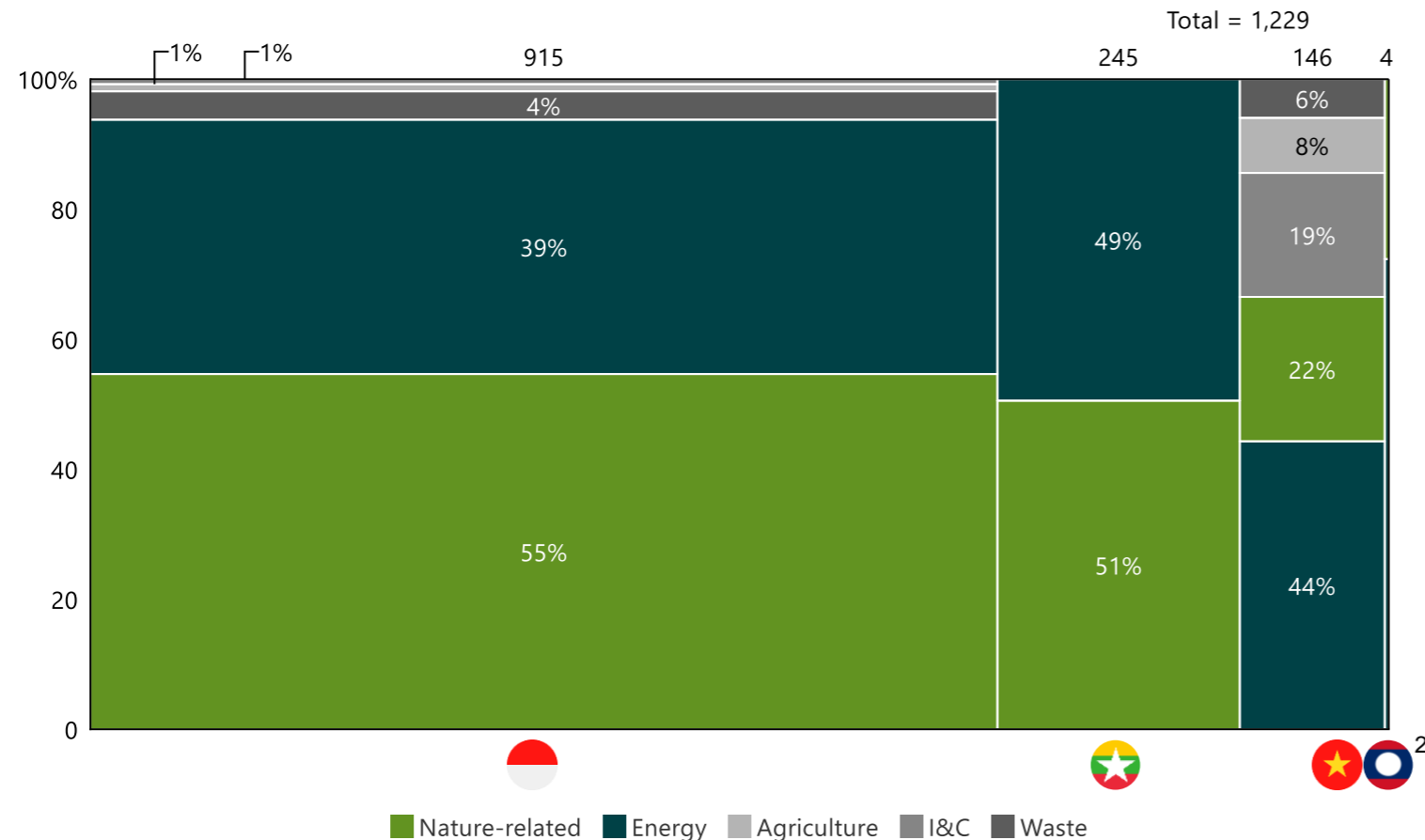
Notes: (1) Industrial and construction; (2) 70% degree of uncertainty in nature-related GHG emissions vs. ~8% within fossil fuels from IPCC estimates; (3) Includes emissions from electricity and heat from plants and industries, manufacturing and construction, transport, building, combustion of agriculture and fishing, and fugitive emissions  
Source: Climate Watch

A

# Reducing and preventing environmental degradation contributes to ~41% of all emissions reduction, therefore critical for SEA to meet its NDC commitments

## Emissions reduction from BAU scenario based on NDC unconditional 2030 targets

GHG unconditional emissions reduction by 2030<sup>1</sup> (MtCO<sub>2</sub>e)



### Key takeaways

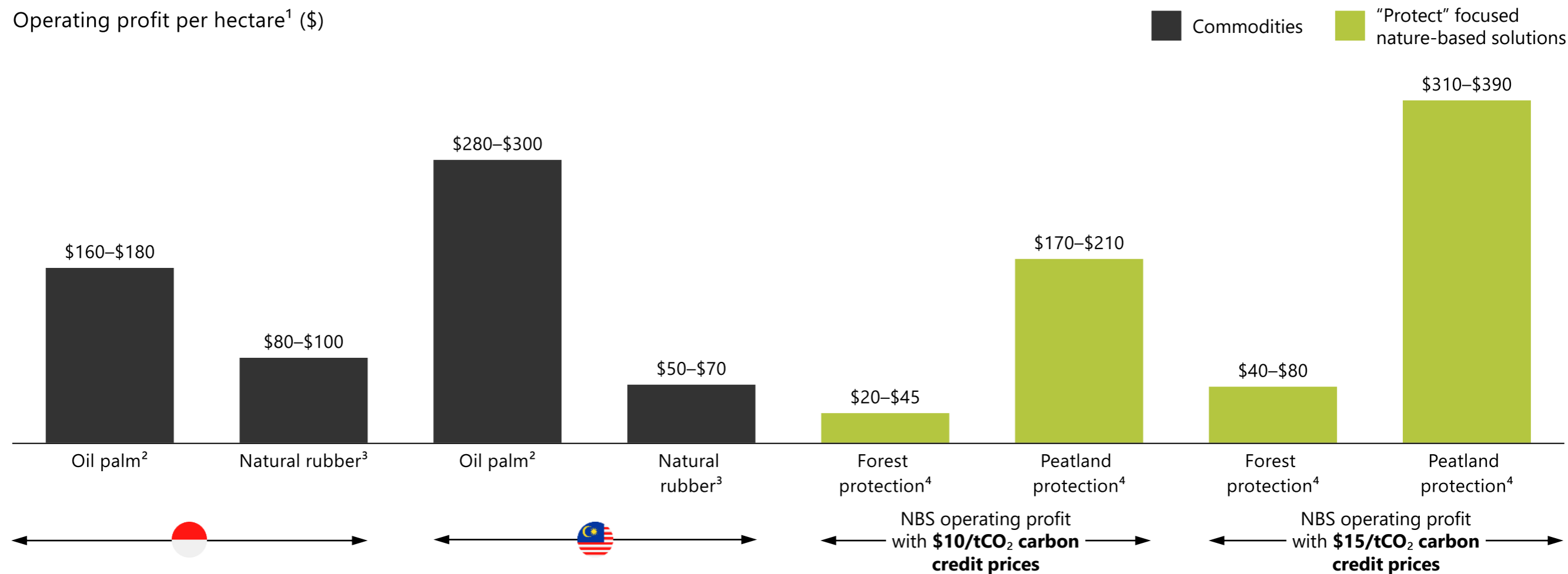
- Nature sector is consistently the **largest component of emission reduction ambitions across both 2030 conditional and unconditional targets** for Indonesia and Myanmar
  - Nature-related emissions comprised **~50% of both unconditional and conditional emissions reduction targets<sup>3</sup>**
- Most countries, **particularly Indonesia, rely heavily on natural sinks** to meet NDC targets
  - Indonesia's commitments are largely driven by its **source of emissions, which were dominated by LUCF** incl. peat fires (~50%) and energy (~35%) in 2019
  - Nature-related targets are driven by the following pillars:
    - Avoiding deforestation (~55%–79% reduction in deforestation from BAU from 2020–2030)
    - Reducing forest degradation through controlling illegal logging and improving sustainable extraction of timber
    - Land rehabilitation and peatland restoration
- Myanmar's land sector targets** rely on successful implementation of their **REDD+ strategy**
  - 30%–50% reduction in deforestation
  - 50%–100% of MRRP4 activities implemented to achieve >30MtCO<sub>2</sub>e enhancement from baseline

Notes: (1) Emission reduction from BAU scenario based on 2030 NDC targets, Thailand not included as LT-LEDS provides absolute emissions rather than emissions reduction information; (2) Total based on emissions reduction from sector-specific initiatives, does not tally total emissions reduction target; (3) Unconditional emissions reduction calculation does not include Cambodia, which does not provide an unconditional emissions reduction target; (4) Myanmar reforestation and rehabilitation program  
Sources: Country NDCs; LT-LEDS; Lit. search

A

# Nature-based solutions may need carbon prices of at least \$10–\$15/tCO<sub>2</sub> to become economically competitive with alternative uses such as palm oil, rubber

Operating profit per hectare<sup>1</sup> (\$)



Notes: (1) Revenue per hectare based on 2019 gross production value estimates from FAO as a proxy; (2) Based on estimates of commercial plantation operating margins of ~15% across both ID and MY; (3) Estimates of ~20% based on commercial plantation benchmarks from other developing countries (e.g., India); (4) Annual average carbon credit issuance per hectare based on actual projects within SEA (e.g., Rimba Raya Biodiversity Reserve project for peatland protection and Southern Cardamom project for forest protection), Forest protection: 5–10 credits/ha, Peatland protection: 40–50 credits/ha, ~20% of total carbon credits have to be shared with Indonesian government to create a temporary buffer to meet NDC commitments, however ~10% of total carbon credits assumed to be returned to project owners. Operating margin representative of an NBS project at steady state, primary fixed OPEX are fees to project developers/managers, primary variable OPEX are community costs and carbon credit sharing with project developers/managers

Sources: FAO; Chain reaction research; Industry participant interviews; Lit. search; Ecosystem marketplace; Bain experience; Verra; Berkeley VCS offset database

A

# To meet NDCs, SEA can protect and restore natural carbon sinks with nature-based solutions ...

Nature-based solutions can abate up to ~1.7 GtCO<sub>2</sub>e/year ...

## Nature-based solutions

### “Protect”

**Emissions avoidance** from protecting intact lands and avoiding deforestation (e.g., REDD+)

### “Manage”

**Emissions avoidance and removal** from sustainable management of existing agricultural and forestlands (e.g., regenerative agriculture)

### “Restore”

**Emissions removal** from restoration of degraded and deforested lands (e.g., afforestation and reforestation)

### Description

**SEA abatement full potential<sup>1</sup>**  
(MtCO<sub>2</sub>e/year)

~1,100

~200

~400

**Abatement cost**  
(\$/tCO<sub>2</sub>)

<\$10<sup>2</sup>

**\$(50)–\$5<sup>3</sup>**

*Based on estimates on cover crops, crop rotation etc.*

**\$5–\$25<sup>4</sup>**

... while driving additional co-benefits for the region

### Preserving biodiversity

4

Global biodiversity hotspots in SEA, with the highest proportion of endemic bird and mammal species

~70%–90%

Potential habitat loss by 2100 without increased protection efforts

### Lowered disaster risk and climate adaptation benefits

5/10

SEA countries ranked in the top 25 countries in the World Risk Index<sup>5</sup>

Maintaining forestlands can help **reduce soil erosion, reduce moisture levels, and absorb excess rainwater**

### Improving air and water quality

~6%

Tree cover loss in major watersheds from 2000–2014

**Forest and vegetation fires** are major sources of air pollution in SEA (e.g., 2019 forest fires in Indonesia)

### Enhancing livelihoods of local communities

~70–140M

Rural population in SEA dependent on forests as a source of income, nutrition, and food security

NBS can enable farmers to manage resources more effectively, **improving food security and incomes** for local communities

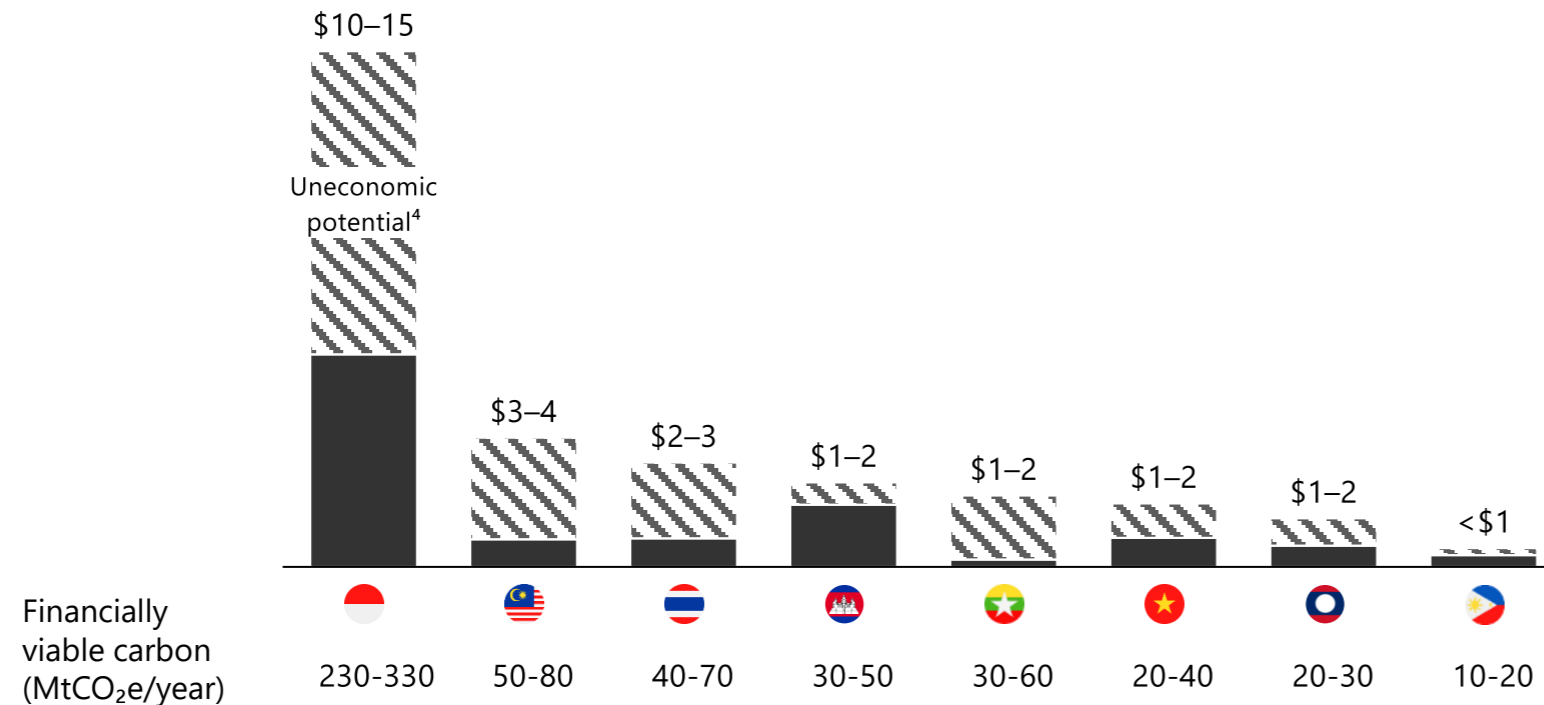
Notes: (1) Considers cost-effective carbon mitigation potential, which excludes global and regional marginal abatement costs >\$100/tCO<sub>2</sub>e in 2030; (2) Based on REDD+ and peatland conservation projects in Indonesia and Malaysia; (3) Based on global benchmarks, negative abatement driven by efficiency and cost savings; (4) Based on afforestation/reforestation and peatland restoration projects in Indonesia and Malaysia; (5) Created by Ruhr University Bochum and Bündnis Entwicklung Hilft to assess the country's exposure (i.e., frequency and intensity of earthquakes, floods, droughts, etc.) and vulnerability (e.g., susceptibility, lack of coping capabilities) to natural disasters  
Sources: Country NDCs; IEA; Nature4Climate; ADB; UN ECLA; ASEAN Centre for Biodiversity; Wetlands International; AIPP; World Risk Report 2022; Lit. search; Industry participant interviews

A

# ... while also representing a potential \$20B–\$30B annual investible opportunity across 0.4–0.7 GtCO<sub>2</sub>e/year of financially viable protection/ restoration projects

## Investible carbon potential in SEA ecosystems estimated at 0.4–0.7 GtCO<sub>2</sub>e/year, representing a \$20B–\$30B annual NBS opportunity

Potential investible opportunity from financially viable forest protection projects<sup>2</sup> (\$B/year)



### Key takeaways

- **0.4–0.7 GtCO<sub>2</sub>e/year carbon stock** is financially viable for forest protection projects across SEA, which accounts for **~77% of Asia-Pacific's total potential**
  - Standing carbon stock qualifies to meet VCS criteria (incl. additionality), do not contain human settlements, and can yield a positive NPV
- **Large investible opportunity of \$20B–\$30B/year** across the financially viable carbon stock in SEA
  - **Indonesia has the highest investible opportunity**, representing ~50% of SEA's potential
- SEA's potential is **significantly underpenetrated with <10% share of full potential** (based on voluntary carbon credits issued in 2021)
- Potential impacts of **opportunity costs<sup>4</sup>** could put **~60% of the potential opportunity at risk** (~\$18B/year), but remains a sizeable opportunity for SEA
- **Potential of restoration projects not included** due to emerging methodologies on studying financial, land-use and operational constraints

Notes: (1) Investible carbon calculated by applying key criterion for the validation and verification of forest carbon projects (e.g., forests under threat of deforestation) on the total abatement potential. Carbon stock is deemed financially viable if it yields a positive NPV, focus of remaining section excludes Singapore and Brunei as they make up <1% of the investible carbon stock and <1% of total forest area; (2) NPV for financially viable forest carbon, with the following assumptions: a) Constant carbon price of \$5.8/tCO<sub>2</sub> for the first 5 years, followed by a 5% price appreciation for subsequent years over 30-year project time frame; b) \$25/ha for initial project establishment costs, and \$10/ha for subsequent years for project maintenance; c) Incorporates VCS criteria (e.g., requirement to set aside buffer credits); d) Risk-adjusted discount rate of 10%; (3) Assumed \$5.8/tCO<sub>2</sub> starting price, based on average carbon price across avoided deforestation projects on Ecosystem Marketplace between 2006 and 2018; (4) Assumes a proportionate impact of opportunity costs on financially viable carbon and potential return on investment; (4) Considers opportunity costs from agricultural rents and timber production  
Sources: Peer-reviewed journals; Lit. search

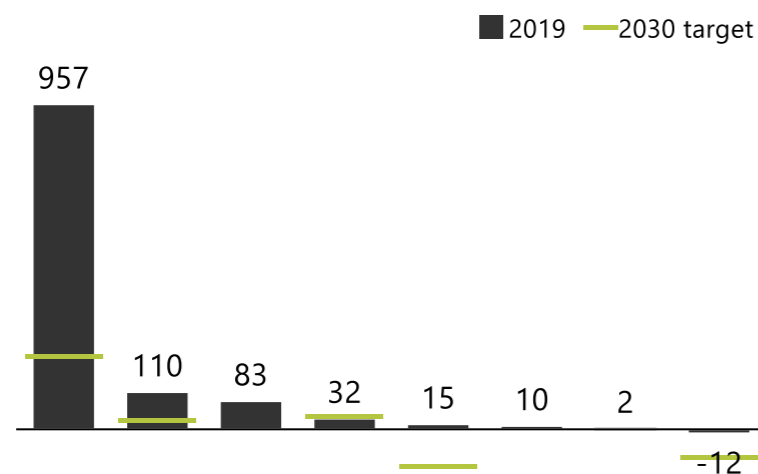


B

# Indonesia has largest gap to NDC nature commitments; 6/8 SEA countries with net forest loss

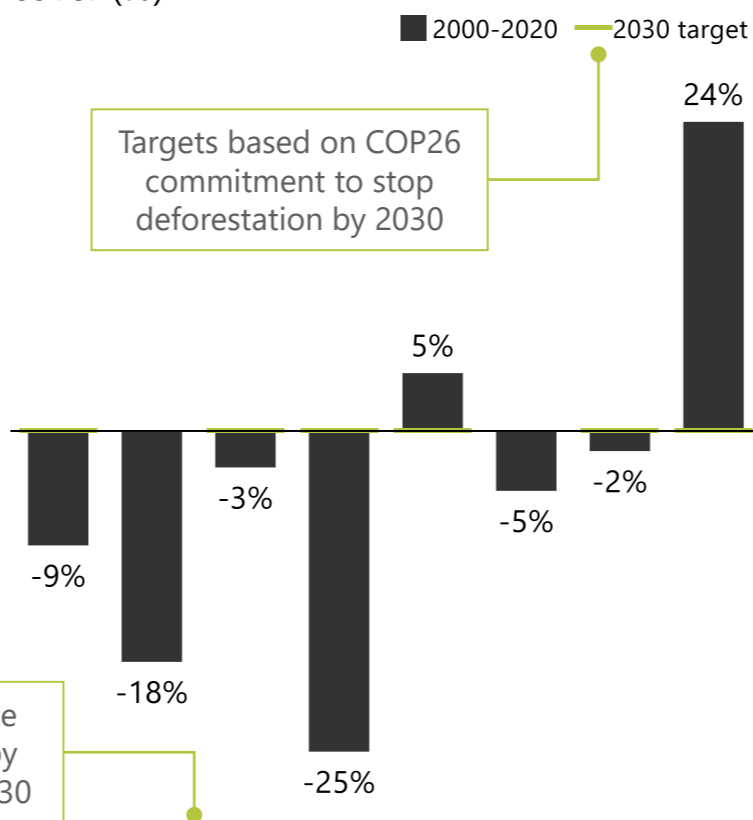
## Only 5/8 SEA countries have set nature-specific emission targets ...

Nature-related GHG emissions vs. unconditional targets (MtCO<sub>2</sub>e)



## ... with most SEA countries still seeing a net reduction in forestland from 2000–2020

Net change in tree cover (%)



## Key takeaways

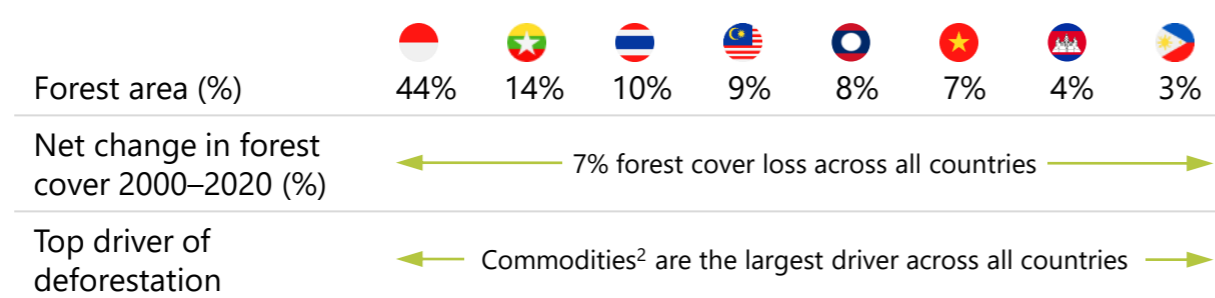
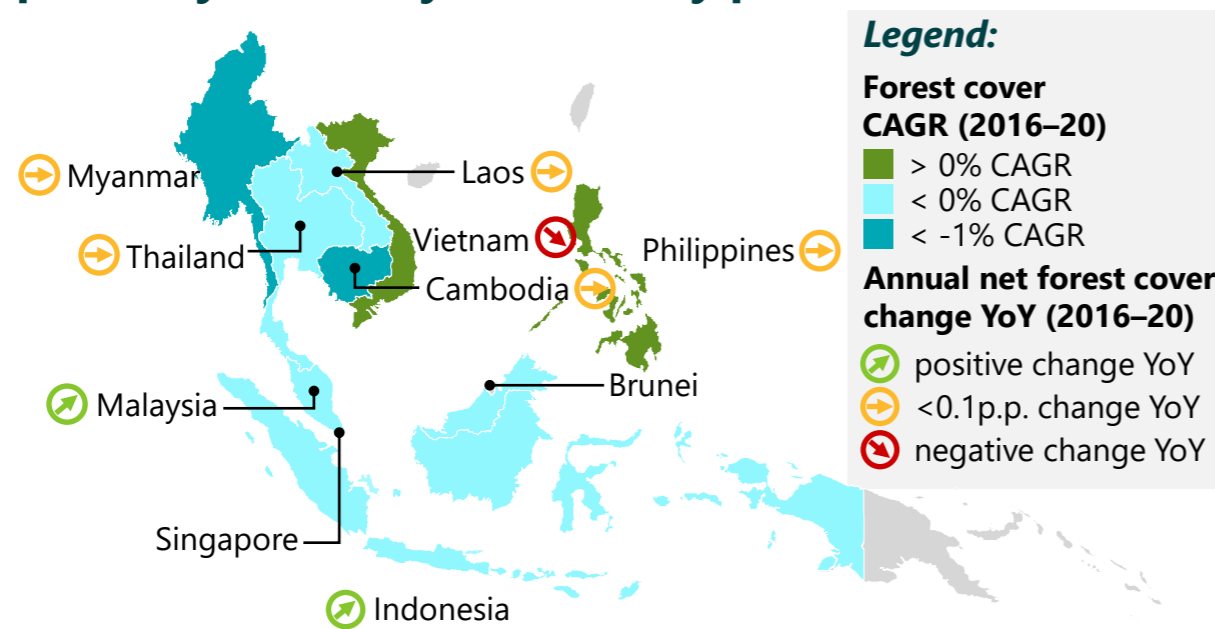
- **Significant challenges** for SEA countries to **measure progress** of the Nature sector
  - **High degree of uncertainty** (~70%) in nature-related emissions based on 2014 IPCC estimates
  - **Lack of consistency in measuring impact**, with variances in metrics across countries (e.g., forest coverage, deforestation, restoration)
- Across the 8 SEA countries with significant natural resources, **5 out of 8 countries have set nature-specific targets**, with Indonesia having the largest gap to close to meet its NDC targets
- **Most SEA countries are not on track** to meet Glasgow Declaration on Forests and Land Use voluntary pledge for Zero Deforestation by **2030**
  - 6 out of 8 SEA countries have had a cumulative net reduction in tree cover from 2000–2020
  - Since signing the pledge in 2021, Indonesia has reversed their commitment for zero deforestation, but instead focuses on offsetting potential deforestation with forest restoration programs to achieve net sink in the FOLU sector by 2030

Notes: (1) Based on 2030 NDC conditional targets; (2) Laos' 2030 sector-specific targets only include emissions reduction from sector-specific initiatives, do not tally to total emissions reduction target; (3) Laos and Myanmar did not sign agreement in COP26 to stop deforestation by 2030  
Sources: FAO; Climate Watch; Government websites; Lit. search

B

# Despite recent improvements, most SEA countries continue to see reductions in forest and other ecosystems due to widespread commodity production

## Most countries still experience a net forest reduction primarily driven by commodity production



## Market takeaways

- Indonesia's deforestation is largely driven by palm oil production** (~23% from 2001 to 2016), with spikes of conversion to grasslands and shrublands (~20% from 2001 to 2016) from **slash-and-burn activities** in 2015; reduction post-2017 driven by higher humidity and enforcement of moratorium on forest-clearing in primary forests and peatlands
- Large-scale agriculture of common crops** (e.g., rice, maize, rubber, and oil palm) is the largest deforestation driver in Myanmar, responsible for ~1M ha of forest conversion from 2002 to 2014
- Thailand's forest loss is largely attributed to agricultural conversion, which accounted for planting of mostly **pulpwood (~26%), rubber (~24%) and oil palm (~14%)** from 2000 to 2015
- Palm oil production** accounts for the majority of Malaysia's deforestation (~61%), followed by **industrial logging and mining and extraction activities** (e.g., tin)
- Agricultural expansion** is a major driver of forest loss in Laos, with ~51% of commodity-driven deforestation due to **herbaceous crops** (e.g., cereal crops, sugarcane)
- Vietnam's PFES<sup>3</sup> policies and 2014 logging ban** incentivized more **sustainable forest management**, but **illegal logging** persists due to strong demand for timber; **pulpwood plantations** account for ~29% of commodity-driven deforestation from 2000 to 2015
- ~30% of Cambodia's deforestation from 2000 to 2019 was driven by **commercial agriculture plantations** (e.g., rubber), while **illegal logging** remains a challenge
- Herbaceous crops** (e.g., grains, sugarcane, and cassava) accounted for ~48% of cleared forests in Philippines from 2000 to 2015, while **coconut plantations** (~15%) were the largest identifiable crop expansion

Notes: (1) Annual net forest cover change calculated based on % forest area change from previous year – Forest area includes land spanning more than 0.5ha of trees higher than 5m with a canopy cover > 10%, does not include land under agricultural or urban land use; (2) Commodity-driven deforestation: Large-scale permanent deforestation primarily linked to agricultural expansion, mining, and energy infrastructure; (3) Payments for forest environmental services  
 Sources: FAO; Lit. search; Government websites; Global Forest Watch



# SEA faces several challenges in further harnessing nature's untapped potential

## Inconsistencies in domestic policies

Difficulties in reconciling **economic and environmental objectives**, resulting in inconsistent and opaque domestic policies

*"Sometimes regulations have **conflicting clauses**, with **issues and dependencies**, making it unclear how it fits all together."*  
Chief Executive Officer,  
Nature Project Company

For example, Indonesia's 2020 Omnibus Bill **weakened legal protections for natural forests**, contradicting the **2019 moratorium** on forest clearing for plantations.

## Weak enforcement of forest conservation policies

**Gaps** between forest conservation regulations and enforcement

**~20%**

of Indonesia's palm oil plantations are illegally operating inside designated forest areas

**~12%**

of Cambodia's protected forests were lost between 2001 and 2018

## Absence of solutions to price nature effectively

**Low carbon prices and the importance of alternative land use** (e.g., agriculture) limit the financial incentive to scale development of NBS projects

**<\$10/tCO<sub>2</sub>e**

weekly whole market average REDD+ carbon credit price<sup>1</sup> for majority of 2023

**~28%**

of SEA's land area is cropland as of 2020, an increase from 2010 at ~25%

## Limited knowledge and experience to develop/monitor NBS projects

Due to the lack of NBS projects in SEA, there is **limited knowledge to develop, monitor, report, and verify** emissions avoidance/reduction

*"One reason for a lack of application of NBS in SEA may be the **very different constraints in terms of the knowledge and capacity** [among other additional challenges]."*

ISEAS – Yusof Ishak Institute

**~3%**

of registered nature-based projects are based in SEA (13 projects in SEA vs. 92 in South America)<sup>2</sup>

Note: (1) Based on Trove intelligence weekly average whole market REDD+ project prices as of 30th April 2023; (2) SEA's total investible potential is 0.4–0.7 GtCO<sub>2</sub>e/year vs. South America's 0.7–1.2 GtCO<sub>2</sub>e/year investible potential

Sources: FAO; Forest Trends; Berkeley Carbon Trading Project's Voluntary Registry Offsets Database; Ecosystem Marketplace; Government websites; Industry participant interviews; Lit. search; Carbon Pulse; Peer-reviewed journal; Trove intelligence

## C

# Policies | Ineffective enforcement has historically slowed down conservation

Domestic policies are often inconsistent across policy documents, at national and subnational levels ...



## Inconsistencies across policy documents

Regulatory regime has some inconsistencies across policy documents and national commitments, resulting in investor uncertainty

E.g., **Indonesia's 2020 Omnibus Bill<sup>1</sup>** was inconsistent with the **2019 permanent moratorium** on forest clearing for plantation development

- Many applauded the 2019 move, which appears to have reduced deforestation. However, the 2020 Bill somewhat weakened legal protections, leaving investors unclear on the public direction



## Lack of alignment at national and subnational levels

National targets are challenging to cascade, resulting in **misaligned actions at national and state levels**

E.g., **Malaysia's pledge** of minimum 50% forest cover was made at national level, but state governments in **Sabah and Sarawak** hold authority over **land usage and environmental protection**

- Sabah and Sarawak have historically governed their own systems, and have pushed against attempts at control by the national government

... with ineffective law enforcement resulting in high levels of illegal logging and land clearing

**Ineffective enforcement and monitoring** of forest conservation policies due to **lack of manpower and financial resources** results in exploitation of protected resources through illegal logging and land clearing



of Indonesia's palm oil plantations were illegally operating inside designated forest areas in 2019

Indonesia suffers from one of the most significant **illegal logging and land clearing** conditions

~600 plantation companies were found with >10ha of illegal plantings in protected areas, including companies under RSPO<sup>2</sup> and ISPO<sup>3</sup> schemes

**Insufficient effort** to enforce regulations (e.g., policies were relaxed to stimulate growth during COVID-19)



of Cambodia's protected forests were lost from 2001–2018

Deforestation largely driven by the ELC<sup>4</sup> policy, encouraging land clearing for **plantation development**, as well as **illegal logging on concession borders**










~14% of protected forests overlapped with ELCs<sup>4</sup> as of 2013

US cut funding to the Prey Lang Forest in 2021 due to **continued forest loss from protected areas**, especially from illegal logging

Notes: (1) Although the Constitutional Court has ruled the Omnibus Law as conditionally unconstitutional, Indonesia's parliament passed an emergency regulation in 2023 that is largely similar to the original legislation with some improved provisions; (2) Roundtable on Sustainable Palm Oil; (3) Indonesian sustainable palm oil; (4) Economic land concessions  
Sources: Greenpeace; Global Initiative Against Transnational Organized Crime; Government websites; News articles; Lit. search

C

# Carbon markets | Most SEA countries have not yet established clear regulations and standards for carbon markets

	Voluntary carbon credit guidelines	Involved in Article 6 pilot projects	Compliance carbon market regulations
 <b>Indonesia</b>	✓ Ministerial Regulation issued in 2022, uncertainty exists around export of carbon credits	✓	✓ Presidential Regulation No. 98/2021 provides national framework for carbon pricing instruments, including ETS
 <b>Malaysia</b>	✓ Guidelines for VCM mechanisms and for the launch of Bursa Carbon Exchange	✓	✗
 <b>Thailand</b>	✓ T-VER program, launched in 2013 by TGO, is harmonized with international standards	✓	✗
 <b>Myanmar</b>	✗	✗	✗
 <b>Cambodia</b>	✗	✓	✗
 <b>Vietnam</b>	✗ Broad carbon pricing regulations with no detailed framework around VCMs and international carbon trading	✓	✓ Decree No. 06/2022/ND-CP states that the pilot ETS will commence in 2025
 <b>Laos</b>	✗	✓	✗
 <b>Philippines</b>	✓ Established partnerships for Joint Crediting Mechanism and Energy Transition Mechanism	✓	✗
 <b>Singapore</b>	✗	✗	✓ Progressive carbon taxes under Carbon Pricing (Amendment) Act 2022





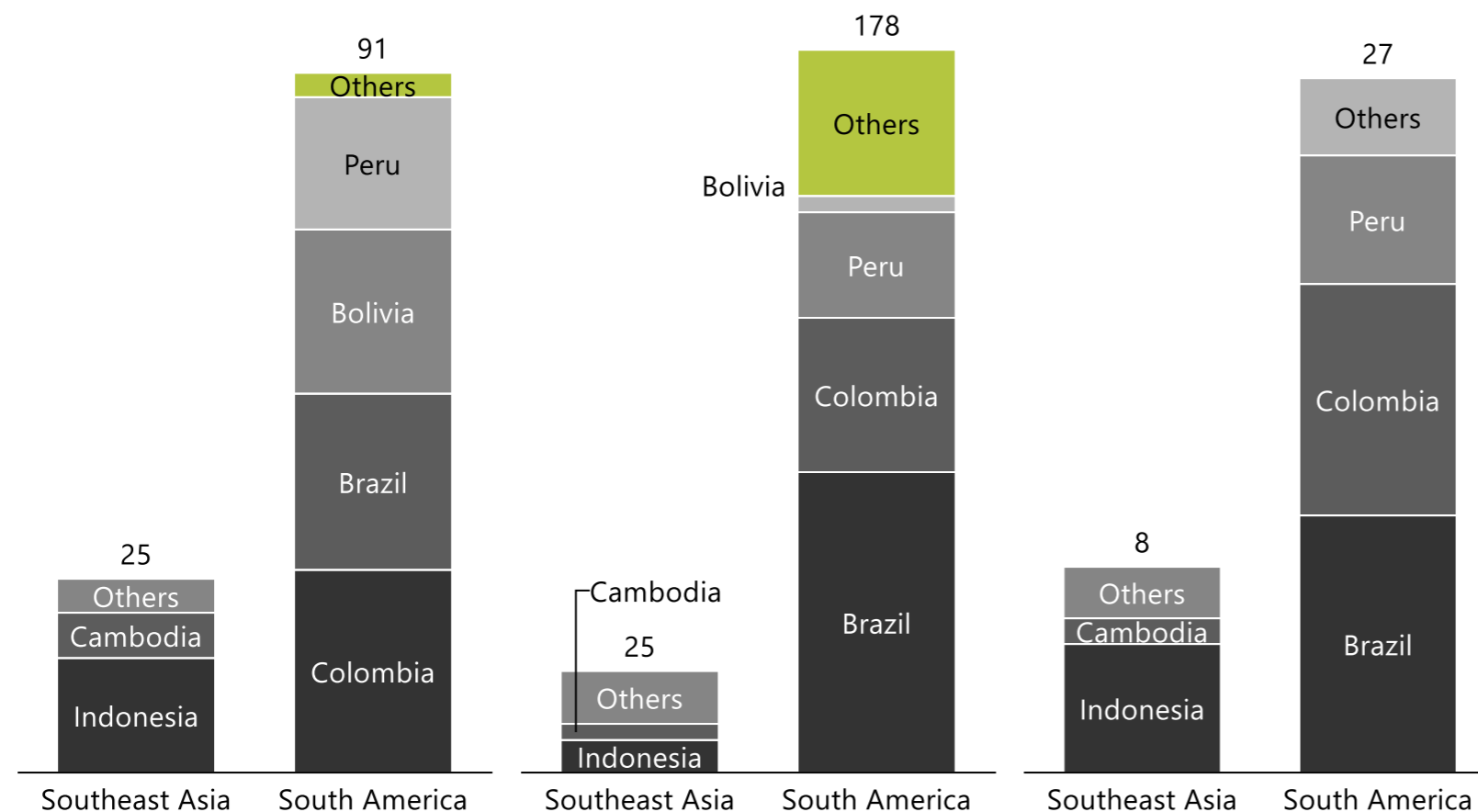
# Limited NBS project knowledge | SEA landscape more nascent vs. other regions

## SEA countries are less mature in developing NBS projects, compared to other regions

Total emission reduction from NBS projects<sup>1</sup> (MtCO<sub>2</sub>/yr)

Number of NBS projects<sup>1</sup>

Number of NBS developers with NBS project > 1MtCO<sub>2</sub>/yr<sup>1</sup>



### Key takeaways

- SEA has a less developed NBS landscape due to **regulatory, governance, and business environment challenges**
  - SEA accounts for ~6% of the world's estimated annual emission reductions from NBS projects vs. ~25% of financially viable investible opportunity in NBS
  - **South America has ~7x more NBS projects** vs. SEA despite its investible financially viable carbon potential only being ~1.7x higher than SEA's
- Developer ecosystem is less mature in the SEA region, with ~16 developers in SEA vs. ~98 in South America<sup>2</sup>
  - **PT Rimba Makmur Utama** is the largest scale player in the region (~30% of SEA's estimated emission reduction), managing the Katingan Mentaya Project reaching ~160K ha peat swamp forest
  - **Limited developments from international players** (~20%), due to high investment risks and uncertainties
  - All four Cambodian projects were managed by the government

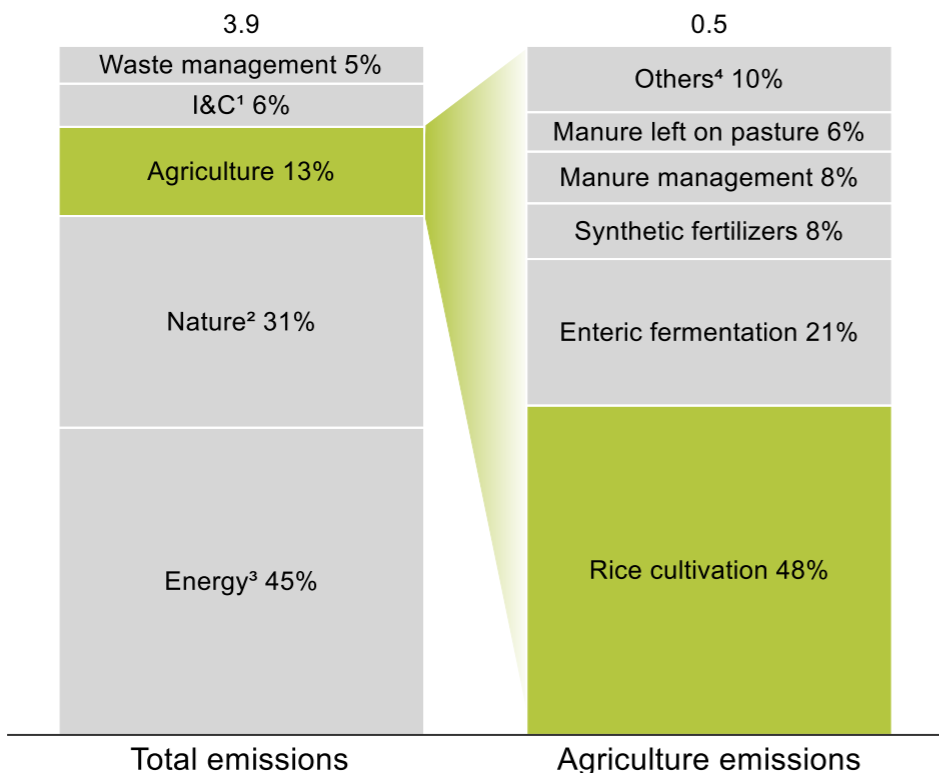
Notes: (1) Includes FOLU projects up until 2022 whose status is marked as completed, crediting period renewal and verification approval requested, crediting period renewal requested, registered, registration and verification approval requested, registration requested, under development and under validation; (2) Developer count excludes projects with multiple proponents  
Sources: Berkeley Voluntary Registry Offsets Database; Peer-reviewed journals; Industry participant interviews

B

# Commodities are largest driver of deforestation, yet agriculture will be critical to any solution

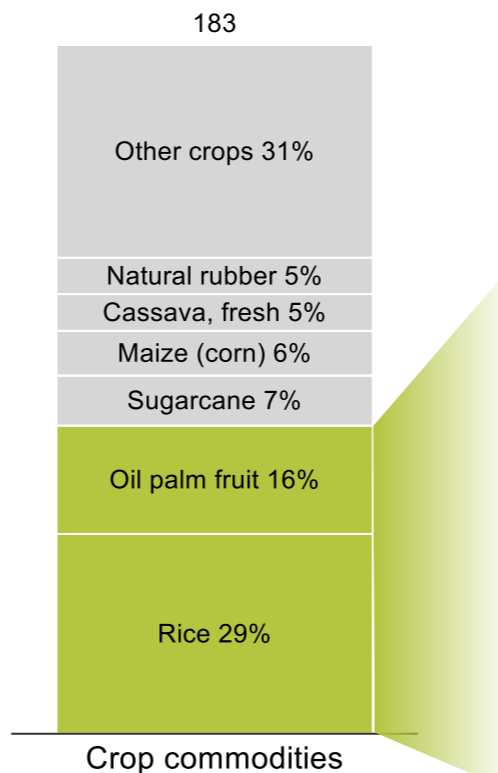
Agriculture is 3<sup>rd</sup> largest source of emissions in SEA, ~48% of which is driven by rice cultivation

SEA GHG emissions (GtCO<sub>2</sub>e, 2019)



Transitioning agriculture will be critical given the region's economic and workforce dependence on the sector

SEA Agricultural Gross Production Value<sup>5</sup> (current \$B, 2019)



~10% of SEA's GDP contribution from agriculture, forestry, and fishing (vs. ~4% globally)

~29% of SEA's total labor force is employed in agriculture, forestry, and fishing

~45% of SEA's gross production value comes from rice and palm oil



Rice accounts for ~25%–33% of SEA methane emissions (vs. ~10% globally)

However, it also plays a critical role in ending hunger and malnutrition in SEA as it provides 50% of calorie intake for the population

Palm oil production is a key contributor to several environmental issues, including peatland exploitation and biomass burning

Palm oil is a vital industry in tropical regions due to high demand for affordable vegetable oil (~40% of global demand for vegetable oil; ID and MY exported \$27B and \$14B worth of palm oil in 2021)

Notes: (1) Industrial and construction; (2) 70% degree of uncertainty in Nature GHG emissions vs. ~8% within fossil fuels from IPCC estimates; (3) Includes emissions from electricity and heat from plants and industries, manufacturing and construction, transport, building, combustion of agriculture and fishing, and fugitive emissions; (4) Includes N<sub>2</sub>O emissions from drained organic soils, manure applied to soils, crop residues, burning of crop residues and savanna fires; (5) Excludes livestock and dairy  
Sources: Climate Watch; IRENA; ASEAN Centre for Energy; FAO; World Bank; Lit. search

**B**

# Regen agriculture represents the highest abatement potential and lowest-cost solution, but faces grassroots implementation challenges (e.g., long transition)

## Key enablers for Sustainable Intensification

**Objective:** increase yield per hectare to reduce demand for new land conversion without degrading soil health



### Regenerative and sustainable agriculture

- Farming practices that **enhance and restore soil health and biodiversity** to promote **sustainable and resilient agroecosystems** (e.g., cover crops, crop rotation, nutrient management, reduced tillage, organic soil restoration)

**70–80**

**\$(50)–\$5**

- Highly beneficial to smallholder farmers** (e.g., increased income, food security)
- Obstacles include **land rights disputes, lack of technical knowledge, and financing**
- Estimated **5-year transition period** to recover original levels of yield and profitability



### Improved rice cultivation

- Climate-smart rice farming techniques** (e.g., shallow flooding, rice and nutrient management, alternate wetting and drying) to **reduce emissions** from rice production

**20–30**

**\$(5)–\$5**

- Potential to **increase yield and income and reduce labor** with fewer resources
- Hindered by **low awareness and lack of financing and incentives** to adopt sustainable practices
- Aggregate implementation** across many small farms needed to achieve **economies of scale**



### High-tech farming

- High-precision tech-enabled farm management** (e.g., drip irrigation) and **data analytics** to **maximize crop yields** with **minimal inputs**

**15–25**

**\$5–\$15**

- Adoption in SEA limited by **high implementation cost, limited access to financing, and lack of technical support/training programs**
- Implementation will need to be **government- or private sector-led and funded** to be successful



### Vertical farming

- Indoor farming** in vertically stacked layers in space-constrained areas, typically using **soil, hydroponic, aeroponic, or aquaponic** methods

**5–15**

**\$75–\$125**

- Facilitates **year-round high-yield production** with **efficient use of resources** and **fewer pesticides**
- Current technology requires high **upfront capital investment** (~\$100M for 60ha) and **operational costs** in urban areas
- Less need in most SEA countries with **abundance of farmland**

**Description**

**SEA abatement full potential (MtCO<sub>2</sub>e/year)**

**Abatement cost (\$/tCO<sub>2</sub>)**

**Challenges and viability of solutions in SEA**

Sources: Bain internal Marginal Abatement Cost Curve (MACC) models; Lit. search



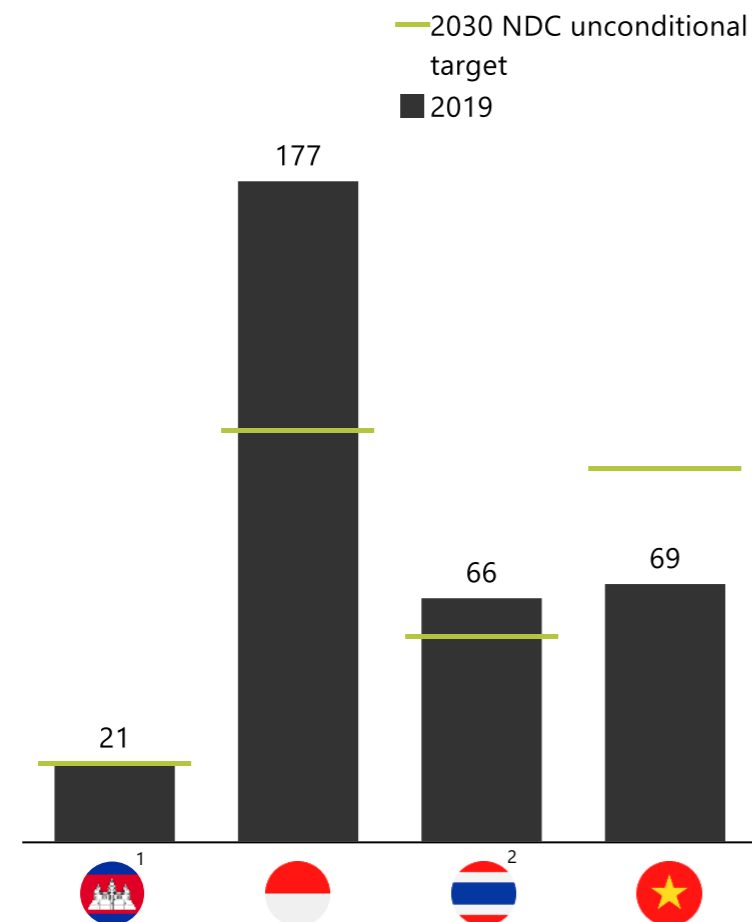
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# Only 4 of 10 SEA countries have set agri-specific emissions targets; regional challenges

Only 4/10 countries have agriculture specific emissions targets

Although sustainable intensification can support smallholders and drive economic growth, the region will need to overcome several challenges to unlock potential

## SEA GHG agriculture emissions (MtCO<sub>2</sub>e, 2019)



### Balancing decarbonization efforts against economic growth and development

- **Agriculture is a major component of SEA's economy**, supporting majority of employment in the low-income population, where **yield improvements** through sustainable practices can drive further growth
- **Balancing food security and decarbonization efforts** is essential; rice is a critical source of nutrition in SEA with **demand expected to increase by ~18% by 2050**, but accounts for **>25% of methane emissions** as a result of indigenous farming practices
- **Regulatory pressure from the EU** to decarbonize agricultural products incentivizes shift toward sustainable agriculture, but SEA also **risks diversion of exports to less regulated countries**
  - Regulation on **deforestation-free supply chains for commodities (i.e., wood, palm oil, soya, coffee, cocoa)** gives companies only **18 months to adjust**
  - **Currently, CBAM<sup>3</sup> tariff only covers fertilizers but may expand to include other agricultural products**

### Smallholder farmers have limited access to funding, resources and technologies

- With **~100M smallholder farmers** in the region, many livelihoods may be **affected by climate change** (e.g., droughts and heatwaves resulting in lower yields)
- **Land rights and ownership issues** leave smallholders with little to no decision-making authority to determine farming techniques (e.g., Indonesia's Plasma Farmer Scheme<sup>4</sup> scrapped due to inconsistencies in land titling and weak enforcement)
- **Limited access to financing** is an obstacle to investing in resources and equipment necessary for sustainable farming practices, which often requires some upfront capex
- **Low awareness and technical knowledge** impede adoption of new agritech, as rural areas have limited access to education and technology
- **Lack of public and private sector incentives** resulting in continued use of existing practices

Notes: (1) Based on 2030 NDC conditional targets; (2) Based on Thailand's 2065 Net Zero GHG emission pathway in LT-LEDs; (3) Carbon Border Adjustment Mechanism; (4) Policy required palm oil companies to allocate 20% of land for smallholder farmers, ultimately scrapped due to weak enforcement and pressure from private sector  
Sources: Climate Watch; IRENA; ASEAN Centre for Energy; FAO; ADB; World Bank; Lit. search

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# Actions required across multiple dimensions to drive decarbonization in nature

■ Governments ■ Investors ■ Corporates

Enforce domestic policies and increase incentives	Accelerate NBS development	Build and scale carbon markets	Sustainable agriculture	Promote R&D and tech innovation
<p>Build capacity for better <b>enforcement of existing conservation policies</b></p> <p>■</p>	<p><b>Launch national and private sector initiatives</b> to generate awareness and provide clarity on NBS' decarb. role and co-benefits</p> <p>■ ■ ■</p>	<p>Implement market measures to <b>allow export of carbon credits to international offtakers</b></p> <p>■</p>	<p>Institute capability-building initiatives for smallholders and farms on <b>sustainable and regenerative practices</b></p> <p>■ ■</p>	<p>Fund and implement <b>geospatial monitoring and land optimization technology</b></p> <p>■ ■ ■</p>
<p>Incentivize (e.g., PES<sup>1</sup>) the <b>restoration/protection of forestlands</b> vs. new land clearing for plantations</p> <p>■ ■</p>	<p><b>Implement best practice standards</b> regarding MRV<sup>2</sup> to ensure high-quality carbon offsets</p> <p>■ ■</p>	<p>Promote demand via <b>purchase of credits as alternative to carbon tax</b></p> <p>■</p>	<p>Build smallholder capability to obtain <b>industry-leading sustainable certification</b> standards (e.g., RSPO<sup>3</sup>, FSC<sup>4</sup>)</p> <p>■ ■</p>	<p>Establish digitally enabled smallholder <b>microfinance platforms</b></p> <p>■ ■</p>
<p>Incentivize (e.g., compensatory schemes) <b>mangrove and peatland restoration/protection</b> at scale</p> <p>■ ■</p>	<p>Leverage <b>innovative financing</b> to support NBS project development</p> <p>■ ■</p> <p>Develop <b>NBS and carbon services</b> workforce</p> <p>■ ■</p>	<p>Align domestic carbon <b>project standards with int'l ones</b> (e.g., Verra, GS)</p> <p>■</p> <p><b>Harmonize VCM standards and regulations</b> across the region</p> <p>■</p>	<p>Scale investments in <b>agritech and regenerative agriculture</b></p> <p>■ ■</p>	<p><b>Fund and establish research institutes</b> to advance science of natural ecosystems</p> <p>■ ■</p>










← Create clear integrated government plan on natural ecosystems and sustainable agriculture →

Notes: (1) Payment for ecosystem services; (2) Measurement, reporting, and verification; (3) Roundtable on Sustainable Palm Oil; (4) Forest Stewardship Council

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# Policies | Consistent enforcement of conservation policies and incentives are most critical

## Recommended actions for the short-to-medium term

 <p><b>Build capacity for better enforcement of existing conservation policies</b></p>	<p>Build <b>institutional capacity</b> for forest law enforcement at the <b>local, subnational, and national</b> levels through increasing funding and leveraging strategic alliances</p>	<p>For example</p> 	<p>Vietnam implemented project management units at provincial and grassroots levels for executive steering and execution of policies and efficiency improvement measures</p>		<p>Costa Rica's SINAC<sup>1</sup> centralizes management of conservation strategies and enforces forest conservation policies, including execution of the PES<sup>2</sup> program</p>
 <p><b>Incentivize the restoration/protection of forestlands vs. new land clearing for plantations</b></p>	<p>Implement incentives to encourage <b>forest protection, restoration of degraded lands, and sustainable practices for land clearing</b> (e.g., PES<sup>2</sup> schemes, certification programs, grants, and subsidies)</p>	<p>For example</p> 	<p>Thailand's DASTA<sup>3</sup> Sustainable Tourism Management Standard is GSTC<sup>4</sup>-certified to empower and recognize local communities in enabling community-based tourism</p>		<p>Brazil has implemented the National Policy of Payments for Environmental Services, to create a market for environmental services and remunerate environmental protection</p>
 <p><b>Incentivize mangrove and peatland restoration/protection at scale</b></p>	<p>Increase <b>protection and restoration of mangroves and peatlands</b> through improving investment potential and implementing incentives (e.g., tax incentives, compensatory schemes, grants, and subsidies)</p>	<p>For example</p> 	<p>As part of SMPEI<sup>5</sup> in Indonesia, community working groups have been formed in 14 villages to empower local communities to facilitate restoration of the peatland system</p>		<p>Ireland's Pearl Mussel Project 2018 leveraged result-based payment schemes to reward farmers for managing their lands for good peatland habitat quality</p>

## Tangible benefits for SEA

**Improve forest governance and sustainability**

Strengthen forest governance to drive sustainable forest management among actors across all levels

**Boost private sector confidence**

Consistent enforcement of regulations to boost private sector confidence and attract investments

**Reduce emissions and environmental impacts**

Enhance natural ecosystems to increase carbon stock and other environmental benefits (e.g., water and air quality)

Notes: (1) National System of Conservation Areas; (2) Payment for ecosystem services; (3) Designated Areas for Sustainable Tourism Administration; (4) Global Sustainable Tourism Council; (5) Sustainable Management of Peatland Ecosystems in Indonesia  
Sources: UNFCCC; UNEP; Lit. search

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# Policies and incentives | Costa Rica's conservation reforms helped increase forest cover from ~40% to ~59% due to improved policy consistency and enforcement



Costa Rica is a **global leader for its environmental accomplishments** and has received the 2019 Champions of the Earth award, the UN's highest environmental honor for nature protection. As the first tropical country to reverse deforestation, forest cover increased from ~40% in 1986 to ~59% today, with its successes due to **strong climate leadership, clear forest conservation policies, and involvement in global carbon markets**

## Key learnings



Encouraging forest conservation and restoration through **providing landowners with compelling incentives and promoting ecotourism**

- First in the region to introduce **PES<sup>1</sup> program** to compensate landowners for forest conservation, which benefited 18K+ families from 1997 to 2019
- With ~70% of international visitors coming to Costa Rica for their wildlife, natural protected areas have **reduced poverty of neighboring communities by ~16%**, mainly due to **ecotourism**



**Biodiversity Act 1998** provides a legal framework that protects endangered species while giving the state power to enforce sustainable practices

- The law was created through a **participatory process**, consulting with political parties, academic and private sector experts, environmental organizations, indigenous groups, and local communities
- With 6% of the world's biodiversity found in Costa Rica, protected areas contain ~98.5% of terrestrial mammal species



**Strengthening of protected areas** through strong political will, centralized management and power-sharing systems

- With ~26% of its land territory protected, Costa Rica aims to extend protection of its seas from ~3% to 30%
- Each conservation area has **regional and local councils** with five elected members from different sectors, preventing total control over genetic resources, promoting benefit-sharing and prevent exploitation
- SINAC<sup>2</sup> centralizes management of national parks, conservation areas, and other protected natural areas and enforces forest conservation policies

## Takeaways for SEA



Leverage **incentives** and other schemes to drive permanent behavior in improving forest conservation

Establish a **clear and consistent legal framework** to drive the country toward **environmental sustainability and economic growth**, with **strong climate leadership**

Introduce a **participatory system** to ensure forest conservation strategies and enforcement are developed with informed consent of all relevant stakeholders













**Strengthen conservation enforcement** in protected areas through **centralized management structure** supported by regional and local councils

Notes: (1) Payments for Ecosystem Services; (2) National System of Conservation Areas  
Sources: UN; World Future Council; IDB; World Bank; Government websites; Lit. search

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# Accelerate NBS development | Financing, training, and process improvement will help accelerate NBS deployment

## Recommended actions for the short-to-medium term

 <p><b>Launch national and private sector initiatives to generate awareness of NBS' decarb. role and co-benefits</b></p>	<p>Ensure <b>role of NBS in national plans</b> while implementing <b>education and outreach initiatives</b> to improve understanding of NBS and its co-benefits for all stakeholders (e.g., local communities)</p>	<p><b>For example</b></p>	 <p>FAFD<sup>1</sup> of the ASEAN Secretariat conducted a study in 2021 to assess and promote the role of NBS in ASEAN with results feeding into further dialogues, policies, and beyond</p>	 <p>People's Plan for Nature aims to drive national conversation and participation across the UK while building a public mandate for the plan's recommendations</p>
 <p><b>Implement best practice standards regarding MRV<sup>2</sup> to ensure high-quality carbon offsets</b></p>	<p>Ensure offset quality, using the <b>latest methodologies</b> (e.g., digital technology to streamline data collection) to assess project boundaries and additionality against <b>emerging rating agencies</b> (e.g., Sylvera), while collaborating with third-party organizations (e.g., SBTi)</p>	<p><b>For example</b></p>	 <p>Verra and Pachama are conducting a pilot for digital MRV<sup>2</sup> platforms for NBS projects to enhance the efficiency and scalability of carbon markets</p>	 <p>Charm Industrial converts CO<sub>2</sub> in waste plants to bio-oil, with an open registry to allow transparency and traceability of emission reductions linked to carbon credits</p>
 <p><b>Leverage innovative financing to support NBS project development</b></p>	<p>Improve <b>bankability</b> and <b>financial attractiveness</b> of projects through financial incentives and innovative financing strategies (e.g., blended finance to leverage public financing and reduce investment risk)</p>	<p><b>For example</b></p>	 <p>World Bank issued a \$50M emission reduction-linked bond in Vietnam to mobilize private capital and increase upfront support by providing investor returns linked to VCUs<sup>3</sup></p>	 <p>UK launched 3 new environmental schemes, including the Sustainable Farming Incentive, which pays farmers to adopt sustainable farming practices</p>
 <p><b>Develop NBS and carbon services workforce</b></p>	<p><b>Enhance capabilities</b> (e.g., project development, research) in NBS and carbon services across <b>public and private sectors</b> through knowledge-sharing initiatives and open-access resources</p>	<p><b>For example</b></p>	 <p>Singapore is working toward becoming a carbon services and trading hub (e.g., carbon advisory, project development, etc.) to support regional growth in sustainability</p>	 <p>ECO Canada, part of the sector council initiative, provides training and funding to workers leaving the natural resource sector to transition to NBS-related employment</p>

## Tangible benefits for SEA













<p><b>Realize ecosystem co-benefits</b></p>	<p>Increase biodiversity protection, reduce disaster risk, protect local communities, and improve air and water quality</p>
<p><b>Drive long-term growth of NBS</b></p>	<p>Increase success of NBS projects through lower cost of capita and increase in demand and reliability</p>
<p><b>Boost economic growth for local communities</b></p>	<p>Create green jobs for the local communities and private sector while generating additional revenue streams for smallholders</p>

Notes: (1) Food, agriculture, and forestry division; (2) Measurement, reporting, and verification; (3) Verified carbon units  
Sources: The Nature Conservancy Business Council; ADB; ASEAN-CRN; Earth Security Group; Government websites; Lit. search

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# Scale carbon markets | Regulatory clarity and standardization needed to unlock and scale supply

## Recommended actions for the short-to-medium term

 <p><b>Implement market measures to allow export of carbon credits to international offtakers</b></p>	<p>Enable a <b>clear and consistent open market structure</b> for international offtake agreements while encouraging <b>cooperative approaches</b> and setting up mechanisms <b>for ITMO and corresponding adjustments</b> under Articles 6.2 and 6.4</p>	<p><b>For example</b></p>	 <p>Malaysia allows the export of carbon credits from local projects to boost the market competitiveness in Malaysia as part of Bursa Carbon Exchange's launch in 2022</p>	 <p>Ghana authorized a bilateral agreement to transfer mitigation outcomes under its new climate-smart rice project to Switzerland under Article 6.2 of the Paris Agreement</p>
 <p><b>Promote demand via inclusion of carbon credits as part of carbon pricing schemes</b></p>	<p>Leverage compliance markets to <b>stimulate greater corporate demand</b> while also using carbon prices (e.g., carbon tax) as a <b>potential price signal</b> and reference point for voluntary carbon credit prices</p>	<p><b>For example</b></p>	 <p>Singapore's carbon tax is set at ~\$4/tCO<sub>2</sub>e<sup>1</sup>, with plans to reach ~\$40–\$60/tCO<sub>2</sub>e<sup>1</sup> by 2030, where corporates can use international carbon credits to offset up to 5%</p>	 <p>Japan is trialing emissions trading between companies (full launched FY26/27) while imposing carbon levy, starting with fossil fuel importers (to be launched FY28)</p>
 <p><b>Align domestic carbon project standards with international ones</b></p>	<p>Establish domestic carbon market frameworks in alignment with international standards (e.g., Verra, Gold Standard) for <b>greater credibility, increased investment flows</b> and participation in <b>global markets</b></p>	<p><b>For example</b></p>	 <p>Launched T-CER3, a type of high-quality carbon credit, that is aligned with Article 6 and is consistent with UN's Sustainable Development Goals</p>	 <p>Peru's RENAMI4 coexists with third-party international standards (e.g., Verra) to ensure transparency and accuracy of credits in local and international markets</p>
 <p><b>Harmonize VCM standards and regulations around the region</b></p>	<p>Adopt a more <b>unified regulatory system</b> for the region to encourage greater <b>cross-border cooperation</b>, increase market efficiency and open new corridors of demand</p>	<p><b>For example</b></p>	 <p>Singapore and Malaysia signed a bilateral agreement in January 2023 to cooperate on the green economy, including the exchange of information on carbon markets</p>	 <p>Singapore and Cambodia will sign a legally binding bilateral agreement to set out framework for carbon credits aligned with Article 6 by end of 2023 to help achieve NDC targets</p>

## Tangible benefits for SEA

<p><b>Drive economic growth</b></p>	<p>Potential offsets generated in the SEA region can offer ~\$10B in annual revenue pools across the value chain by 2030</p>
<p><b>Boost investor confidence and corporate demand</b></p>	<p>Attract investors and corporates through capturing full value of carbon credits, stable market prices, increased transparency, and high-quality offsets</p>
<p><b>Unlock and scale supply of NBS</b></p>	<p>Encourage NBS development and generate traction through clear guidelines and smooth processes</p>

Notes: (1) Assumes 1 SGD = 0.75 USD; (2) Assumes 1 EUR = 1.09 USD; (3) Thailand Certified Emission Reduction; (4) National Registry of Mitigation Measures  
Sources: World Bank; Government websites; Carbon Pulse; CIFOR; News articles; Lit. search

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# Scale carbon markets | Peru's carbon markets reform has helped inject more investor confidence and boost momentum of NBS projects in the country



Peru has been an **early supporter of international market mechanisms**, including the Clean Development Mechanism, Kyoto Protocol, and NDCs; as one of REDD+'s<sup>1</sup> early movers, Peru has **>30 REDD+<sup>1</sup> projects** on ID-RECCO<sup>2</sup> at different stages, some of which are aligned to various international standards (e.g., Verra)–2021 carbon credit issuances account for **~20% of their investible potential** vs. ~7% for Indonesia

## Key learnings



### Clear policy signals on importance of carbon markets to meet broader climate goals

- Clear indication of **government's position on international and national carbon markets** to other stakeholders across policy documents (e.g., **NDCs, national strategy**); for example, Peru's REDD+ strategy promotes establishment of carbon markets, with several projects aligned to VCM standards
- Regulations are aligned to allow emission reductions to contribute to the **country's NDCs** whilst in compliance with **REDD+ safeguards**
- MINAM<sup>3</sup> is responsible for the implementation of REDD+ and relevant policies to ensure coordination within the national framework



### Recognize and promote the contributions of public and private organizations

- Revision to RENAMI's<sup>4</sup> policies undergoes **public consultation**, which promotes **transparency** with buy-in from all stakeholders before finalization
- Peru Carbon Footprint mechanism **recognizes public and private organizations for their climate change efforts**, while also acting as an additional MRV<sup>5</sup> tool and promoting additional financing of emission reduction projects
- However, lack of clear regulations around carbon rights results in local communities having no power in deciding sale of carbon offsets



### Utilize MRV<sup>5</sup> systems and national registries to guarantee transparency and promote investments

- RENAMI<sup>4</sup> aims to **register, monitor, manage** GHG emission reductions from mitigation measures while **providing investors with confidence** in the REDD+ credits which are validated by the government
- RENAMI<sup>4</sup> coexists with **third-party international standards** (e.g., Verra, Gold Standard) to facilitate participation in international carbon markets
- However, uncertainties still exist due to **lack of regulatory clarity** on whether emission reductions not authorized by RENAMI<sup>4</sup> are legally valid

## Takeaways for SEA



Establish a **clear legal framework** on international and national carbon markets, consistent with national strategies and plans

Recognize and promote contributions of the **private sector** while protecting the **socioeconomic interests of indigenous groups and local communities**










Implement and enforce **MRV<sup>4</sup> systems and national registries** that meet **international standards** to facilitate international carbon market participation and boost greater investor confidence

Notes: (1) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (2) International Database on REDD+ Projects; (3) Ministry of Environment of Peru; (4) National Registry of Mitigation Measures; (5) Measurement, reporting and verification  
Sources: CIFOR; ICRAF; Conservation International; Carbon Footprint International; Koh et. al; Lit. search

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# Sustainable agriculture | Empowering smallholders can potentially deliver greater benefits beyond ecosystem protection and positive carbon impacts

## Recommended actions for the short-to-medium term

 <p><b>Institute capability-building initiatives for smallholders and farms on sustainable and regenerative practices</b></p>	<p>Upskill smallholders on <b>sustainable and regenerative management</b> (e.g., agroforestry, alternate wetting and drying for paddy fields) and <b>productivity improvement practices</b> via training programs (e.g., community-based agricultural extensions) on <b>farm practices, business skills</b>, etc.)</p>	<p><b>For example</b></p>	 <p>Farmer Field School approach has expanded from Indonesia to 90+ countries for more efficient and sustainable production systems through small-group learnings</p>	 <p>Better Life Farming connected 600K+ smallholders with training, financing, and supplier and distribution services for higher-quality production with lower ecological footprint</p>	<h3>Tangible benefits for SEA</h3> <p><b>Increase rural food security and incomes</b></p> <p>Enable smallholders to generate higher yields, increase incomes, and improve standards of living</p> <p><b>Promote sustainable and regenerative agriculture</b></p> <p>Promote social responsibility to maintain soil fertility, preserve biodiversity, and reduce environmental impact</p> <p><b>Improve accessibility to tech for smallholders</b></p> <p>Empower smallholders with tech innovations to increase access to better farming practices</p>
 <p><b>Build smallholder capability to obtain industry-leading sustainable certification standards</b></p>	<p>Promote <b>industry-leading sustainable certification</b> standards (e.g., RSPO<sup>1</sup>, FSC<sup>2</sup>) through <b>financial incentives and technical assistance</b>, which can build smallholder capability and awareness to sustainably manage their land, improve yields and reach international markets</p>	<p><b>For example</b></p>	 <p>RSPO<sup>1</sup> Smallholder Support Fund (RSSF) helps oil palm smallholders to adopt sustainable management practices and obtain the RSPO<sup>1</sup> certification (e.g., AMANAH project was backed by RSSF in the Pelawan district in Indonesia)</p>	 <p>Germany encourages forest owners to be certified by FSC<sup>2</sup> or Naturland by providing ~\$130/ha<sup>3</sup> area bonus to make high-standard forest management certifications more economically attractive</p>	
 <p><b>Scale investments in agritech and regenerative agriculture</b></p>	<p><b>Mobilize funding to accelerate development</b> in agritech and regenerative agricultural innovations to reduce information asymmetry, improve access to tech, and enable more sustainable farming practices</p>	<p><b>For example</b></p>	 <p>Singapore established a \$45M<sup>4</sup> Agri-food Cluster Transformation fund in 2021 to support technology adoption in the agri-food sector</p>	 <p>USDA<sup>5</sup> provides funding to the Natural Resources and Sustainable Agricultural Systems Program to support research in agricultural technologies and strategies</p>	

Notes: (1) Roundtable on Sustainable Palm Oil; (2) Forest Stewardship Council; (3) Assumes 1 USD = 1.09 EUR; (4) Assumes 1 SGD = 0.75 USD; (5) United States Department of Agriculture  
Sources: RSPO; FSC; UN; Lit. search



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# Promote tech innovation | Accelerate developments to enable decarbonization

## Recommended actions for the short-to-medium term

**Fund and implement geospatial monitoring and land optimization technology**

Improve forest management through **land mapping and monitoring tools using geospatial technology** (e.g., remote sensing) for faster detection and response to illegal deforestation/forest fires and increased supply chain traceability

**For example**



Malaysia's NFMS<sup>1</sup> supports the MRV<sup>2</sup> of emission reductions from REDD+ activities using on-the-ground observation and remote sensing to detect forest cover changes



CENIGA, the technical intelligence unit for Costa Rica's environmental data, built its infrastructure on AWS Cloud for ecosystem modeling to predict biodiversity patterns

**Establish digitally enabled smallholder microfinance platforms**

Create digitally enabled MFIs<sup>3</sup> to improve **reach and delivery of last-mile financing** for smallholders to purchase necessary inputs, increase productivity, and improve access to tech

**For example**



Impact Terra's Golden Paddy leverages agritech and MFI<sup>3</sup> partnerships to facilitate access to finance and provide tailored agronomic support to smallholders in Myanmar



Musoni, the first cashless MFI<sup>3</sup> in Kenya, served ~31K farmers with easy and affordable access to finance in 2019, particularly among women and youth

**Fund and establish research institutes to advance the science of natural ecosystems**

Accelerate R&D efforts through **funding and partnering with research institutes** to improve understanding of natural ecosystems (e.g., measuring NBS co-benefits, maximizing carbon potential)

**For example**



The International Blue Carbon Institute was established by Conservation International and Amazon to build capacity for restoration/protection of mangroves and seagrasses in SEA



Forest Research Institute Malaysia is one of the leading institutions for tropical forestry research, receiving UNESCO's Sultan Qaboos Prize for Environmental Concern in 2021

## Tangible benefits for SEA

**Increase transparency and accountability**

Increase data transparency to verify forest conservation efforts and identify high-potential NBS sites

**Expand potential for higher value capture**

Advance science to expand opportunities for higher-value capture and accurate impact measurement

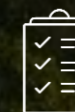
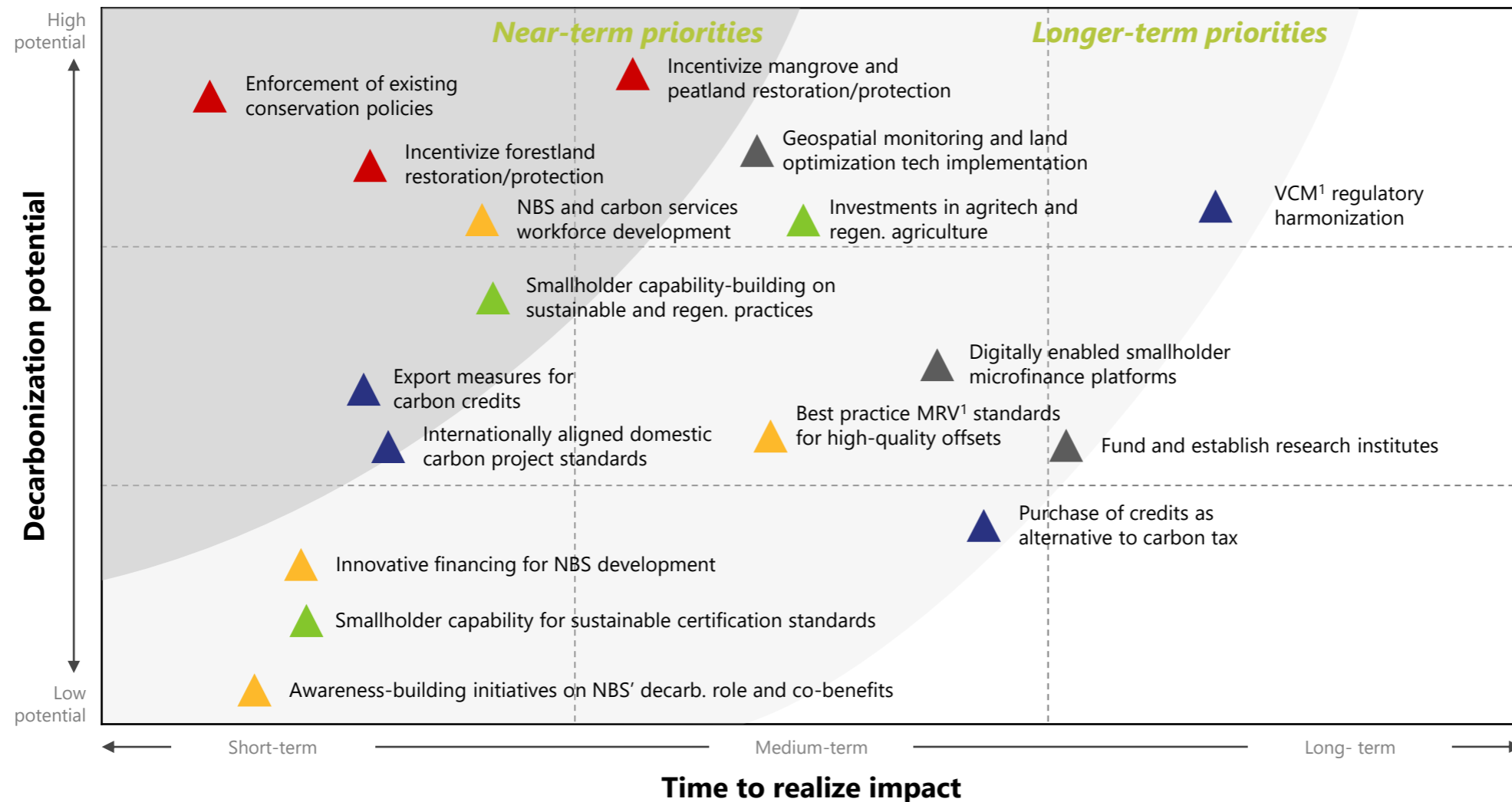
**Improve smallholder access to financing**

Empower smallholders with tech innovations to increase access to financing

Notes: (1) National Forest Monitoring System; (2) Measurement, reporting, and verification; (3) Microfinance institutions  
Sources: Chatham House; WWF; IDH; UNESCO; Government websites; Lit. search

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# Priority Actions | Need to prioritize actions “here today” that deliver a faster “time to carbon” impact, like incentives for protection/restoration, markets








## Key takeaways

- **Policy incentives and enforcement are critical** to meet 2030 commitments
  - **Protecting/restoring** ecosystems must be economically competitive with commodity production
  - Both **tech and active forest management** can improve enforcement
- Beyond policy, an **ecosystem of players can act** to tackle gaps to accelerate NBS momentum
  - Build **NBS talent pipeline** with training programs/accelerators
  - **Train smallholders in sustainable agriculture practices**; leverage certifications
  - **Support development and use of NBS tech** for project lifecycle and market development (MRV, etc.)
  - **Bilateral/regional agreements on project standards and credit trading** aligned with international agreements (Article 6)

Notes: (1) Measurement, reporting, and verification

# Valuing nature for impact

## Summary

<p><b>1</b> </p> <p><b>Nature-related emissions are SEA's<sup>1</sup> 2nd largest source; Nature sector key to meet 2030 targets</b></p>	<p><b>2</b> </p> <p><b>NBS5 represent a large investible opportunity and can drive significant CO<sub>2</sub> abatement with additional co-benefits</b></p>	<p><b>3</b> </p> <p><b>Despite some improvements in recent years, most countries still experience net forest loss driven by widespread commodity production</b></p>	<p><b>4</b> </p> <p><b>Regulations, absence of market-based solutions, nascent NBS ecosystem, and limited smallholder support are key barriers</b></p>	<p><b>5</b> </p> <p><b>Policy enforcement, financial incentives, scaling carbon markets and NBS, sustainable agriculture, and tech innovations critical to fulfill nature's potential</b></p>
<ul style="list-style-type: none"> <li>• Nature and agri-related emissions account for <b>~44% of total 2019 SEA emissions</b>, up from ~42% in 2016</li> <li>• SEA has <b>~18% share of the full global mitigation potential<sup>2</sup></b> vs. just ~3% of global land area             <ul style="list-style-type: none"> <li>– Indonesia has the largest mitigation potential in SEA with ~50% region's share</li> </ul> </li> <li>• Protecting, restoring, and sustainably managing natural ecosystems contribute <b>~41% of 2030 emission reduction targets<sup>3</sup></b> <ul style="list-style-type: none"> <li>– Natural environment protection contributes <b>~55% of Indonesia's emission reduction target</b> vs. ~39% from energy sector<sup>4</sup></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Nature-based solutions present up to <b>~1.7 GtCO<sub>2</sub>e/year in full abatement potential</b> <ul style="list-style-type: none"> <li>– Potential largely driven by avoided deforestation and restoration at a relatively low abatement cost of &lt;\$20/tCO<sub>2</sub>e</li> </ul> </li> <li>• Various co-benefits include <b>biodiversity preservation</b>, improved livelihoods, <b>lowered disaster risk</b>, etc.</li> <li>• SEA forest protection projects have the potential to generate a <b>\$20B–\$30B annual investible opportunity</b>, but competing land use (e.g., oil palm) is a critical consideration</li> </ul>	<ul style="list-style-type: none"> <li>• <b>5/8 SEA countries</b> (that have significant natural resources) have <b>nature-specific emissions targets</b> <ul style="list-style-type: none"> <li>– <b>Indonesia has the largest gap to close</b>, requiring ~78% reduction in natural environment degradation emissions from 2019 to 2030</li> </ul> </li> <li>• <b>~7% overall net forest loss</b> between 2000 and 2020 with <b>6/8 SEA countries continuing to experience net forest loss</b> despite improvements in recent years driven by <b>widespread commodity production</b> and agriculture's importance to region's workforce and economy</li> </ul>	<ul style="list-style-type: none"> <li>• Domestic <b>forest conservation policies</b> lack consistency and strong enforcement             <ul style="list-style-type: none"> <li>– <b>~12% of Cambodia's protected forests were lost</b> between 2001 and 2018</li> </ul> </li> <li>• <b>Absence of solutions to price nature effectively</b> and nascent NBS knowledge             <ul style="list-style-type: none"> <li>– <b>REDD+ carbon credit prices<sup>6</sup> have seen a consistent downward trend</b> and have mostly stayed &lt;\$10/tCO<sub>2</sub>e in 2023</li> <li>– <b>~28% of SEA's total land area used as cropland</b> up from ~25% in 2010</li> </ul> </li> <li>• Smallholders <b>lack sufficient financing, resources, and access to technologies</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Capability building for better policy enforcement</b> alongside <b>financial incentivization</b> for natural ecosystem restoration/protection</li> <li>• <b>Carbon credit export measures, internationally aligned domestic carbon project standards, and regional regulatory harmonization</b> to scale carbon markets</li> <li>• <b>Capability building, microfinance schemes, and agritech investments</b> are required to empower smallholders</li> </ul>

Notes: (1) Southeast Asia; (2) Global cost-effective (<\$100/tCO<sub>2</sub> marginal abatement cost) nature-based solutions potential; (3) Based on the four SEA countries (Indonesia, Myanmar, Vietnam, Lao PDR) that have released sector-specific emissions targets; (4) Unconditional scenario; (5) Nature-based solutions; (6) Based on Trove intelligence weekly average whole market REDD+ project prices as of 30<sup>th</sup> April 2023

# Contents



**Introduction: Context and challenges**



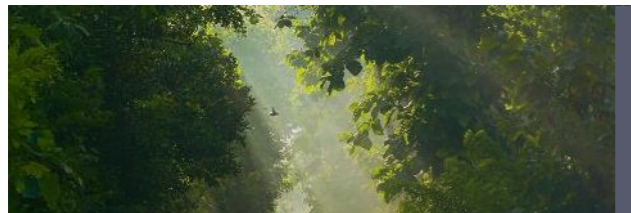
**Progress towards decarbonization**



**Accelerating the energy transition**



**Valuing nature for impact**



**Recommendations and call for action**



# **Recommendations & call for action**

# SEA has stepped up ambition, but is challenged to balance growth and climate



SEA countries have raised commitments on carbon ...



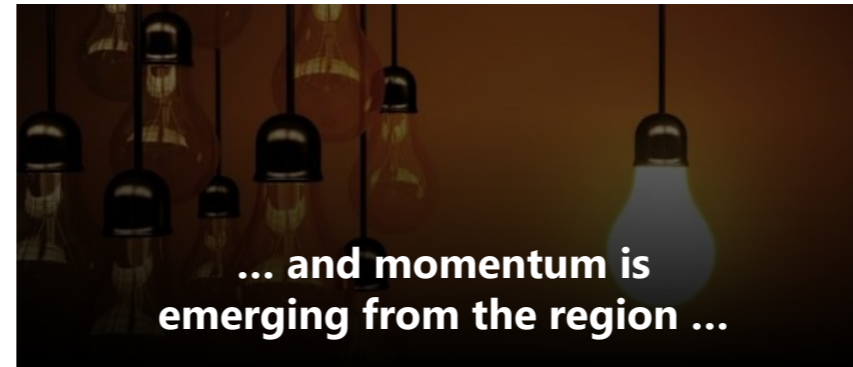
4 out of 10

SEA countries have improved NDC<sup>1</sup> commitment from 2021 to 2022



4x

increase in SBTi<sup>2</sup> commitments from SEA corporates from 2021 to 2022



... and momentum is emerging from the region ...



~\$17B

green capital<sup>3</sup> flow into the SEA region from 2020 to 2022



10%

annual growth in RE installed capacity from 2017 to 2022<sup>4</sup>



... yet is challenged to reconcile growth, carbon, and a just transition



42%

projected energy demand increase from 2020 to 2030



33%

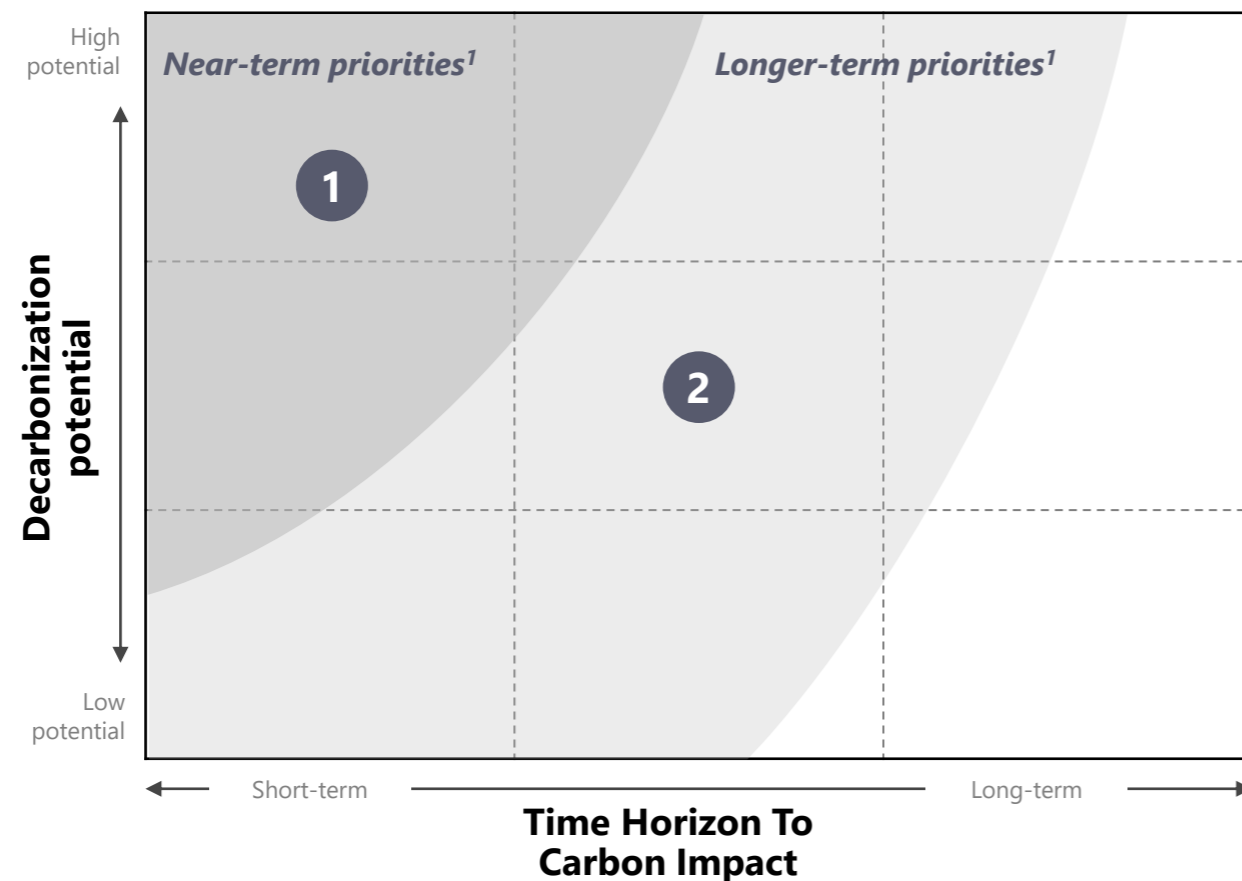
reduction in GHG emission required by 2030 to achieve government pledged conditional target

Notes: (1) Nationally Determined Contribution; (2) Science-Based Target initiatives; (3) Refers to private sector deal transactions >\$10M in size, including private placements and excluding initial public offerings (IPOs). Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (4) Largely driven by rapid installation in Vietnam  
Sources: IEA; IRENA; GlobalData; ASEAN Centre for Energy (ACE); AVCJ; Prequin; S&P Capital IQ; Pitchbook

# Translating NDC ambitions to action will take time; the good news is many proven economic solutions to accelerate carbon impact are actionable today

## Actions prioritized based on time value of carbon

A function of a solution or technology's decarbonization potential and speed at which it can be implemented and deliver results



Note: (1) Detailed matrices with specific levers can be found in energy and nature chapters in this report

## 1 Near-term priority solutions

**No-regret, proven solutions** that have **high carbon abatement potential** and can be implemented in a **short timeframe** like:

- Laying the foundation with grid upgrades, energy efficiency, and conservation measures
- Participating in bilateral RE trade agreements
- Piloting financial innovation (e.g., new incentives for NBS project development, mechanisms for Managed Phase-out of Coal, and blended financing)
- Enforcing nature conservation policies and promoting carbon markets

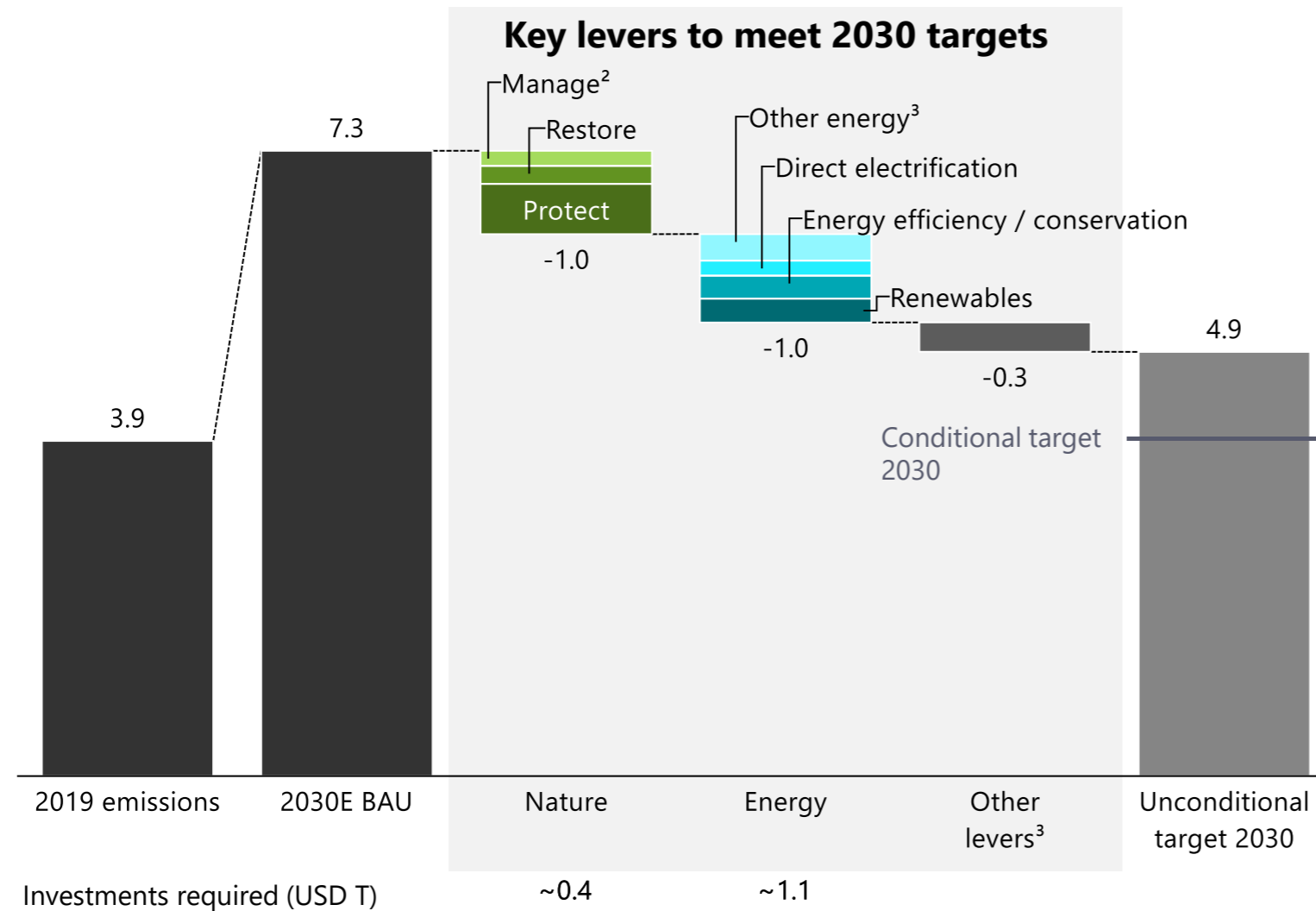
## 2 Longer-term, effective solutions

**Initiatives to invest in today**, but **not at the expense of proven priorities**. Some of these solutions will deliver the highest impact post-2030 when commercial viability increases. For example:

- Regional power grid infrastructure
- NBS and carbon services workforce development
- Piloting Carbon Capture, Utilization, and Storage across all sectors
- Testing hydrogen and derivatives as energy sources

# Proven solutions are key levers to deliver the NDCs when deployed consistently

Cumulative contribution to SEA's 2030 emission reduction targets<sup>1</sup> (GtCO<sub>2</sub>e)



- **Nature and energy solutions** can address a majority (~85%, ~2.0 GtCO<sub>2</sub>e) of SEA's 2030 emissions reduction goals
- Halting deforestation through **greater protection of land** is capable of addressing >25% of reduction to 2030
- **Greater renewables deployment and energy efficiency** measures target >50% of energy-related emission reductions

**Effective deployment of levers requires an aligned plan and concerted action**

Notes: (1) Contribution of key decarbonization levers across Energy and Nature sectors towards 2030 NDC unconditional targets, estimated through triangulation of country's commitments and industry expertise; (2) Due to the overlapping nature between Agriculture and Nature sectors, it can be difficult to draw the distinction between the two sectors; Manage NBS excludes improving rice cultivation and considers improving natural forest management, reduced woodfuel harvest, trees in agricultural land, etc.; (3) Includes building-related emission reduction upgrades, alternative fuels, and minimal contributions from carbon offsets; (4) Includes other agrifood, industry and construction, and waste-related emission reduction levers;  
Sources: Climate Watch; Country NDCs; Industry participant interviews; Nature4Climate; Bain Analysis



# Other countries are successfully overcoming similar challenges, lessons for SEA

## Private player grid investments in Brazil



**Brazil effectively privatized its power transmission system but still controls** the regulatory model of capital, returns, efficiency measures, etc. This increases **private capital investment into the grid** to unlock renewables potential while the government maintains control, in line with traditionally strong private sector investment (8 out of 11 foreign energy firms increased power sector investment from 2016 to 2018, **some by >200%**)

### Key learnings



**Public-private cooperation** can unlock operational, financial, and governance gains for the companies



**Open-market regulations** allow increase in capital inflows and better financing models from private sector players

### Takeaways for SEA



**Allow more market participants to invest in power grid** to accelerate renewable energy adoption and integration

**Drive use of blended private and public sector** funding to de-risk investments in domestic grid infrastructure

**Carefully design frameworks and policies** to maintain stable control of national grid where appropriate

## Electric mobility incentives in India



**India's second edition of their flagship clean mobility incentives program**, the Faster Adoption and Manufacturing of Electric Vehicles (FAME) Scheme, was **extended to 2024**, and has resulted in a **>220% growth in EVs manufactured** from 2020 to 2021, supporting India's estimated EV market growth of 49% per annum between 2022 and 2030

### Key learnings



- Governments can use **attractive financial incentives to drive:**
- **Increased production demand** for low-carbon technologies
  - **Growth in local talent and expertise** for electric mobility
  - **Accelerated decarbonization** through direct electrification

### Takeaways for SEA



**Evaluate national budgets and include attractive financial incentives** to accelerate decarbonization technologies that would otherwise require a longer time horizon to develop

**Include diverse incentives, but tailor to Southeast Asian context** (e.g., FAME provided incentives across two-wheelers, three-wheelers, four-wheelers, and electric buses, but focused ~70% of investments into two-wheelers)

# All stakeholders need to mobilize to see results tomorrow on the road to 2030



## Governments

Lead with **clear integrated transition plans** with a focus on accelerating **infrastructure development**, improving regulatory clarity on **carbon markets**, and enforcing **conservation policies**



## Corporates

**Set clear climate ambition** with detailed roadmap, while taking appropriate actions to build **sustainability capabilities**, and **deploy green solutions** that deliver both **business and climate outcomes**







## Investors

Shift investing **focus** to **high-quality, high-impact** green projects while collaborating with other stakeholders to **improve project quality and bankability** and champion **innovative financing models** and **capabilities**


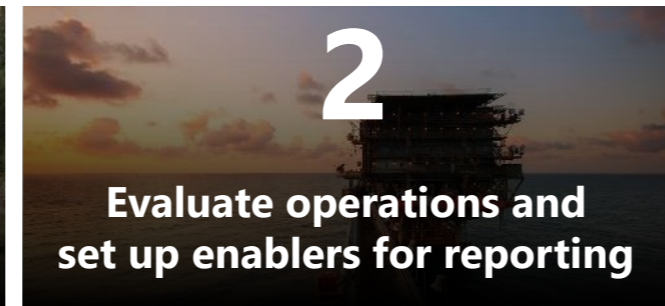






Collective actions across stakeholders and countries so SEA can accelerate action

# Governments to step up development of clear transition roadmaps, accelerating infrastructure, unlocking incentives, and enforcing regulations

<p><b>1</b></p> <p><b>Establish integrated transition roadmaps</b></p>	<p><b>2</b></p> <p><b>Accelerate new grid and renewables infrastructure</b></p>	<p><b>3</b></p> <p><b>Enhance voluntary carbon markets</b></p>	<p><b>4</b></p> <p><b>Enforce conservation and incentivize protection</b></p>
<ul style="list-style-type: none"> <li>• <b>Create clear roadmaps for decarbonization with job transition plans and reporting</b></li> <li>• <b>Engage in bilateral shared infrastructure and energy trade planning</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Clarify full system costs of infrastructure and clarify the extent to be borne by government budget</b></li> <li>• <b>Streamline permitting processes for renewable energy and storage projects</b></li> </ul>	<ul style="list-style-type: none"> <li>• Implement market measures to <b>allow international exports of carbon credits</b></li> <li>• <b>Create internationally aligned domestic carbon project standards</b></li> </ul>	<ul style="list-style-type: none"> <li>• Build <b>institutional capacity for forest law enforcement</b> through funding and strategic alliances</li> <li>• <b>Provide incentives to protect and restore natural ecosystems</b> through grants, subsidies, and tax incentives</li> </ul>
<p><b>Recent momentum</b></p> <p><i>In 2022, <b>Indonesia issued Presidential Regulation No. 112</b>, which includes accelerating the termination of coal-fired power plant and financial incentives for RE projects, <b>to support the country's RE transition</b></i></p>	<p><i><b>Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP)</b> commenced in <b>June 2022</b>, a multilateral <b>cross-border infrastructure project</b> to supply RE-based electricity from Laos to Singapore</i></p>	<p><i>Thailand and Malaysia established <b>voluntary carbon credit trading platforms and exchanges</b> in 2022</i></p>	<p><i><b>Vietnam's PFES<sup>3</sup> program</b> increased the income of the local communities, while <b>promoting sustainable management</b> and increasing the <b>awareness of forest conservation</b></i></p>
			

Note: (1) Palawan Electric Cooperative; (2) US Department of Energy; (3) Payment for ecosystem services

# Corporates must move beyond setting climate ambitions and expand their emissions reduction activities to support government commitments at scale

 <p><b>1</b> Set structured climate action and resources</p>	 <p><b>2</b> Evaluate operations and set up enablers for reporting</p>	 <p><b>3</b> Selectively invest in high-impact solutions</p>	 <p><b>4</b> Build decarbonization capability and awareness</p>
<ul style="list-style-type: none"> <li>• <b>Create integrated corporate decarbonization roadmap</b> aligned to government emission reduction goals</li> <li>• <b>Allocate resources</b> to implement roadmap and set up <b>trackable milestones</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Assess baseline Scope 1–3 emissions</b> throughout operations</li> <li>• <b>Create robust reporting and governance framework as well as emission targets with key performance indicators (KPIs)</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Deploy proven solutions for decarbonization</b> (e.g., rooftop solar, energy efficiency, high quality NBS carbon credits, etc.)</li> <li>• <b>Form strategic partnerships</b> to accelerate decarbonization with trackable goals</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Grow sustainability team with expertise</b> relevant to organization (e.g., energy transition in industrial processes)</li> <li>• <b>Collaborate with government, nongovernment organizations (NGOs), etc.</b>, to run sustainability awareness programs in-house</li> </ul>
<p><b>Recent momentum</b></p> <p><i>Wilmar signed up to the SBTi<sup>1</sup> in 2022 and issued commitment to Corporate Climate Action, supported with a detailed palm oil sectoral roadmap</i></p> 	<p><i>In 2022, Petronas joined Oil and Gas Methane Partnership (OGMP) 2.0, a multi-stakeholder initiative aimed at improving the accuracy and transparency of methane emissions reporting</i></p> 	<p><i>Sembcorp was awarded new tender from the Singapore government in 2022 to install 75 MWp solar PVs at public sites such as schools, government buildings, and public housing blocks</i></p> 	<p><i>Keppel Land launched second phase of its public outreach program in 2022, raising awareness on the impact of rising sea levels and the imperatives for climate actions</i></p> 

Note: (1) Science-Based Target initiatives

# Investors should facilitate more blended financing and assess existing fossil fuel assets while investing in enabling technology; transition finance is essential

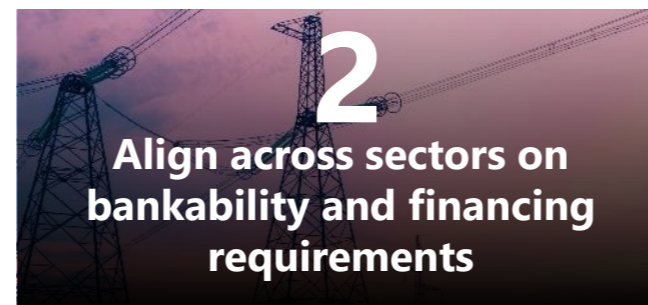


**1**  
Shift green investment focus to high-impact solutions

- **Focus near-term investments** on proven renewables, energy efficiency, and NBS projects
- **Diversify portfolio** away from carbon-intensive projects and **fund coal phase-out** projects

## Recent momentum

*ASEAN financial sector policymakers updated "ASEAN Taxonomy for Sustainable Finance" in 2023, adding coal phase-out projects to the scope of sustainable financing, as a move to support the transition of coal-fired power plants*

**2**  
Align across sectors on bankability and financing requirements

- **Align with governments on investing criteria** for high-capex infrastructure projects (e.g., renewables and grid)
- **Publish thought leadership articles or reports** on investment requirements in SEA

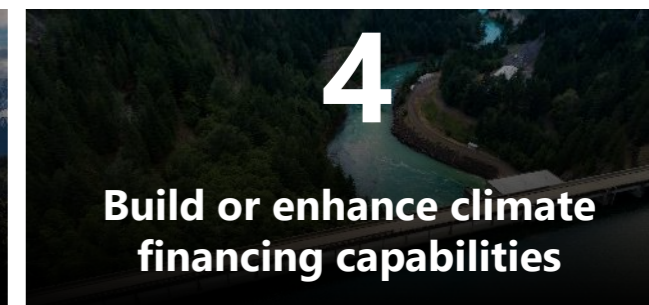
*ADB unveiled new climate financing program "Innovative Finance Facility for Climate in Asia and the Pacific (IF-CAP)" in 2023, aiming to create up to \$15B in new investment to accelerate financing needs of high capex projects*




**3**  
Create and facilitate innovative financing models

- **Partner with corporates/ developers** to pilot **novel financing models** for both clean energy and NBS projects
- **Lobby governments to support blended financing** and establish PPP<sup>1</sup> frameworks

*The Monetary Authority of Singapore (MAS) launched "Finance for Net Zero Action Plan" in 2023, aiming to scale blended finance and private sector partnerships to support development of climate solutions*

**4**  
Build or enhance climate financing capabilities

- **Further develop climate/ sustainability financing expertise** in-house
- **Provide advisory services to RE and NBS developers** to improve project bankability

*The Mekong-U.S. Partnership hosted dialogue on nature-based solutions in 2023, offering recommendations on financing and governance of nature-based solutions to country members involved in the project*



Note: (1) Public-Private Partnerships

# Individual SEA countries should seek out regional collaboration opportunities

## Increase cross-border interconnections

### Description

**Cross-border interconnection** projects, starting with **bilateral connections** to match pockets of supply with demand between countries, as a foundation toward a **harmonized regional power grid** to further optimize resources in the region

### Regional benefits

**Increased regional energy security** from effective resource sharing and higher renewable energy utilization through integration to regional grid

### Regional actions

Develop **cross-border interconnection milestones and roadmaps**, leveraging existing and planned bilateral agreements for cross-border energy trading and grid interconnection

### Recent momentum

- 500–700MW worth of cross-border **interconnection projects ongoing** in SEA
- SG began **importing hydropower** from LA, while signing agreements with ID and KH for **renewable energy trade**
- **ADB-backed cross-border wind project** to export power from LA to VN
- In 2023, Malaysia announced intention to **lift export ban on renewable energy to accelerate** country's RE transition and support bilateral energy trading

## Develop regional voluntary carbon markets

### Description

Unified **regional voluntary carbon markets** to enable international carbon market participation, improve access to high-quality carbon credit projects, and offer new avenues of demand

### Regional benefits

**Virtuous cycle of increased demand stimulating greater supply of offsets** due to improved investor confidence driven by **increased transparency and offset quality**

### Regional actions

Increase **carbon market bilateral agreements and harmonize carbon project standards** across SEA countries to facilitate cross-border cooperation and trade

### Recent momentum

- **CIX launched Project Marketplace and auction platforms** to provide regional and global high-quality projects, including forest conservation, blue carbon, RE, clean cook stoves, and others
- Various **bilateral agreements signed between SG and SEA countries to deepen collaboration on carbon market data exchange** (MY) & carbon credits (VN, ID, KH)

# Taking action will alter SEA's trajectory and allow it to meet economic and climate goals

By harnessing the collective will to **challenge the status quo** and **lead the carbon transition**, SEA in 2030 can achieve:

- ✓ Collaboration across stakeholder groups
- ✓ Significant green investment unlocked
- ✓ Clear plan and results-driven prioritization



**33%**

reduction in GHG emission<sup>2</sup> vs. BAU



**Up to \$2T**

in new investment to transition SEA's economies<sup>1</sup>



**>25%**

regional power generation fulfilled by RE



**5-6M**

new jobs created through SEA green economy



**100%**

electricity access across all SEA countries



**~1.7 Gt**

Co<sub>2</sub>e/year in full abatement potential from nature-based solutions



... however, if SEA fails to act with no to slow progress, the region will **fall short of their NDC targets and economic potential, miss out on catalytic capital, and witness lower quality of life**

Note: (1) ~\$2T is needed for SEA to meet NDC unconditional targets across all sectors – figure is in excess of the total economic opportunity, estimated at ~\$1T (2) Reduction from forecast emissions in 2030 estimated to meet unconditional emissions targets  
Sources: Country NDCs; IRENA; ASEAN Centre for Energy; Peer-reviewed journals; Bain analysis



# Country Insights



# This chapter provides insights around the state of play, recent momentum, opportunities, and challenges at the country level, focusing on ASEAN-6

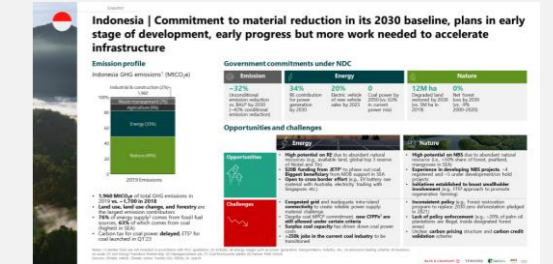
## Section

## Key content

## Sample output

### Country snapshot

- **Current GHG<sup>1</sup> emission profile**
- **Government commitments under NDC<sup>2</sup>** at national level, with sectoral targets for Energy and Nature
- **Opportunities and challenges** for Energy and Nature sectors



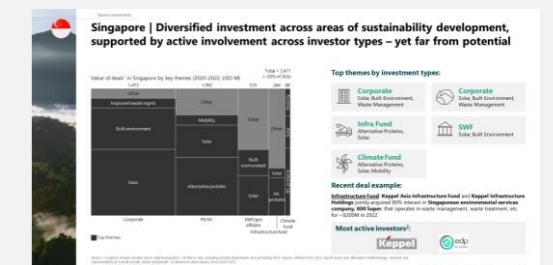
### Progress assessment scorecard

- **Results on decarbonization progress assessment** (likely/unlikely to be on track to deliver climate goals) across key areas: ambition, progress, roadmap, and enablers
- **Quantitative/qualitative evidence** of country's progress on key assessment areas



### Recent investments

- **Green capital flow** into the country broken down by **investment themes** and **investor types**
- Highlight of **recent deal examples** and **most active investors** for green investment of the country



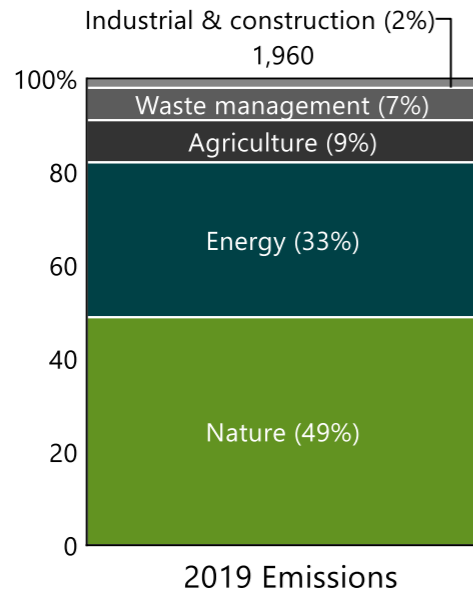
Notes: (1) Greenhouse gases; (2) Nationally Determined Contributions



# Indonesia | Commitment to material reduction in its 2030 baseline, plans in early stage of development, early progress but more work needed to accelerate infra

## Emission profile

Indonesia GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **1,960 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. ~1,700 in 2018
- **Land use, land use change, and forestry** are the largest emission contributors
- **76%** of energy supply<sup>2</sup> comes from fossil fuel sources, **63%** of which comes from coal (highest in SEA)
- Carbon tax for coal power **delayed**, ETS<sup>3</sup> for coal launched in Q1 2023

## Government commitments under NDC

Emission	Energy	Nature
<p><b>~32%</b></p> <p>Unconditional emission reduction vs. BAU<sup>4</sup> by 2030 (~43% conditional emission reduction)</p>	<p><b>34%</b></p> <p>RE contribution for power generation by 2030</p> <p><b>20%</b></p> <p>Electric vehicle of new vehicle sales by 2025</p> <p><b>0</b></p> <p>Coal power by 2050 (vs. 63% in current power mix)</p>	<p><b>12M ha</b></p> <p>Degraded land restored by 2030 (vs. 5M ha in 2019)</p> <p><b>0%</b></p> <p>Net forest loss by 2030 (vs. -9% 2000–2020)</p>

## Opportunities and challenges

	Energy	Nature
<p><b>Opportunities</b></p>	<ul style="list-style-type: none"> <li>• <b>High potential on RE</b> due to abundant natural resources (e.g., available land, global top 3 reserve of nickel and tin)</li> <li>• <b>\$20B funding from JETP<sup>5</sup></b> to phase out coal; <b>Biggest beneficiary</b> from MDB support in SEA</li> <li>• <b>Open to cross border effort</b> (e.g., EV battery raw material with Australia, electricity trading with Singapore, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>High potential on NBS</b> due to abundant natural resource (i.e., &gt;50% share of forest, peatland, mangroves in SEA)</li> <li>• <b>Experience in developing NBS projects</b>, ~4 registered and ~5 under development/on hold projects</li> <li>• <b>Initiatives established to boost smallholder involvement</b> (e.g., FFS<sup>8</sup> approach to promote regenerative farming)</li> </ul>
<p><b>Challenges</b></p>	<ul style="list-style-type: none"> <li>• <b>Congested grid</b> and inadequate intra-island <b>connectivity</b> to create reliable power supply; material challenge</li> <li>• Despite coal MPO<sup>6</sup> commitment, <b>new CFPPs<sup>7</sup> are still allowed under certain criteria</b></li> <li>• <b>Surplus coal capacity</b> has driven down coal power costs</li> <li>• <b>&gt;250k jobs in the current coal industry</b> to be transitioned</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Inconsistent policy</b> (e.g., forest restoration program to replace 2030 zero deforestation pledged in 2021)</li> <li>• <b>Lack of policy enforcement</b> (e.g., ~20% of palm oil plantations are illegal, inside designated forest areas)</li> <li>• Unclear <b>carbon pricing</b> structure and <b>carbon credit validation</b> scheme</li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Emissions trading scheme; (4) Business-as-usual; (5) Just Energy Transition Partnership; (6) Managed phase out; (7) Coal-fired power plants; (8) Farmer Field School  
Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Lit. search



# Indonesia | Well-defined ambition and sectoral roadmaps, but much work still required on infra and regulatory schemes, greater grid access to deliver targets

Energy 
 Nature 
 Highly unlikely to be on track 
 Unlikely to be on track 
 Likely to be on track 
 Highly likely to be on track

## Unlikely to be on track

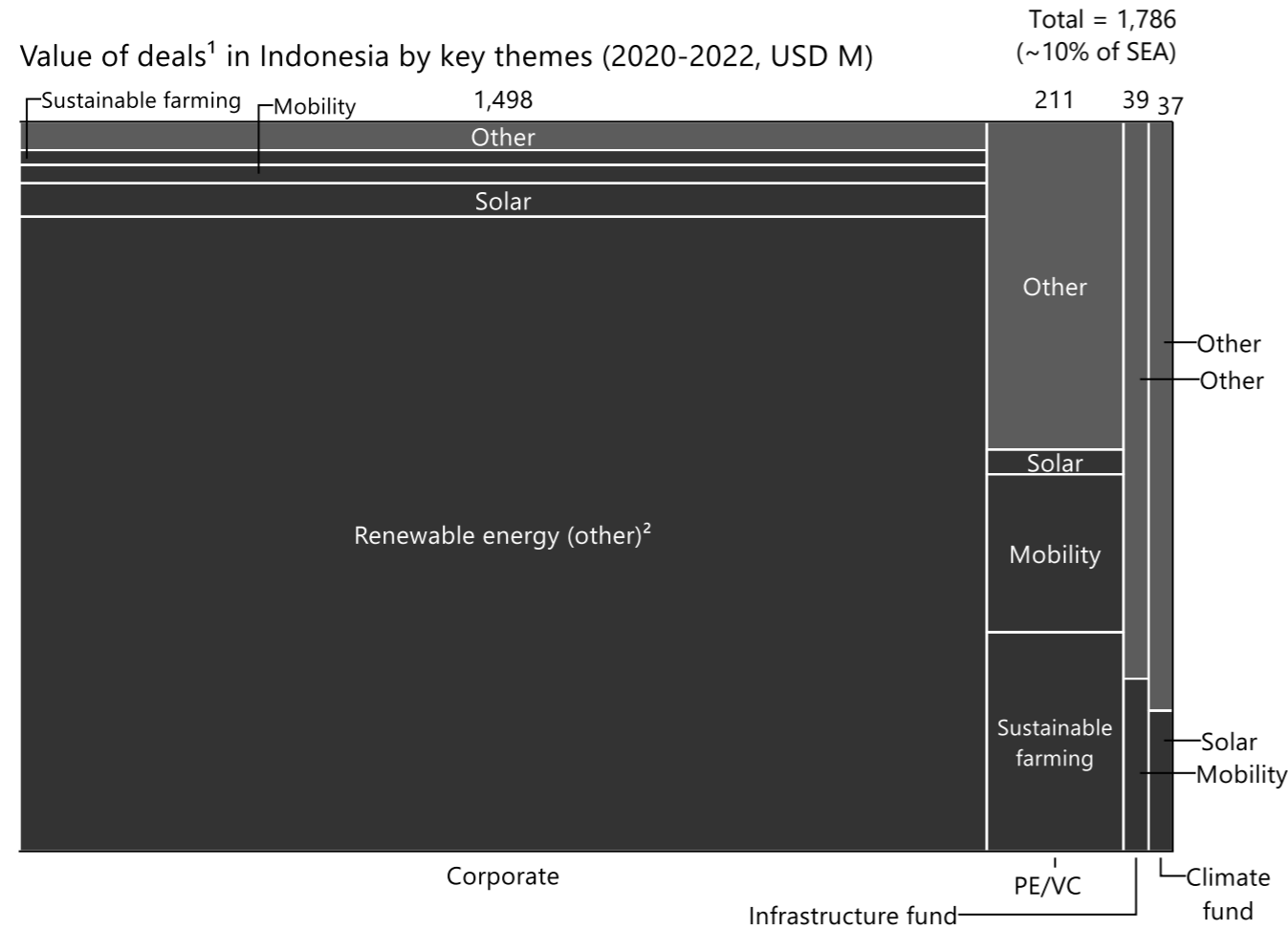
- **Clear ambition cascaded** to sectors and corporations, supported by **sector specific and corporate roadmaps**
- **Requires inter-island grid connectivity and more streamlined permitting** process to accelerate renewables development
- Although **carbon tax is delayed, EU and G20 countries have pledged \$20B** for financial assistance to phase out coal
- **First to receive REDD+<sup>3</sup> results-based payment** in the region; have also recently renewed \$56M REDD+<sup>3</sup> agreement with Norway

	Requirements	Commentary	Assessment
Ambition	<b>Target setting and quality</b>	• <b>Non-legally binding 2060 Net Zero target</b> with 2030 conditional and unconditional <b>emission targets from BAU levels</b> , insufficient to meet 1.5°C global target; 2019 emissions at ~1,960 MtCO <sub>2</sub> e vs. ~1,953 MtCO <sub>2</sub> e 2030 unconditional target	
	<b>Target cascading</b>	• Emission reduction targets <b>cascaded to all sectors and top corporates in key sectors</b> such as PLN and Pertamina	
Progress	<b>Current state of progress</b>	• <b>Energy:</b> 14% renewable energy in power generation in 2021 (target 34% in 2030), <1% EV sales of new vehicle sales in 2022 (target 20% in 2025), installed renewable energy capacity grew by 4% annually from 2018–2021 • <b>Nature:</b> 5M ha rehabilitation of degraded land in 2019 (target 12M ha in 2030), ~ -9% net change in tree cover loss between 2000–2020 (target for net FOLU sink by 2030)	 
	<b>Sectoral roadmap</b>	• <b>Energy transition roadmaps</b> co-developed by MEMR <sup>1</sup> and IEA <sup>2</sup> with detailed milestones for each subsector; lack actionable implementation details • Ministry of Environment and Forestry released <b>detailed operational roadmap for forestry and land use</b> decarbonization	 
Roadmap	<b>Corporate roadmap</b>	• <b>Top firms such as</b> PLN, Pertamina, etc., have <b>released roadmap focused on renewables deployment</b> and reducing emissions to achieve targets	
	<b>Regulatory framework</b>	• Ranked 66 <sup>th</sup> globally in Economic Freedom Index • <b>No requirements to disclose emissions</b> , only large facilities currently reporting to respective ministerial departments; no differentiating permit to supply renewables electricity, national electricity company is sole buyer; perceived regulatory gaps allow new coal plant launches under certain conditions • ~43% forest area under protection; <b>First in SEA to receive REDD+<sup>3</sup> results-based payments</b> ; large gap in law enforcement, with measures introduced to reduce illegal activities; national registry exists, with plans to evolve under NDC <sup>4</sup> plan; carbon market regulated under Ministerial Regulation; participating in Article 6 pilot projects	  
Enablers	<b>Financial prerequisites</b>	• <b>ETS for coal power plants was launched, but its carbon tax implementation</b> at ~\$2/tCO <sub>2</sub> e <b>has been postponed</b> , likely until 2025; <b>incentives in place</b> for solar and electric vehicles; solar LCOE <sup>5</sup> (~\$0.087/kWh) on par with new-build coal (~\$0.086/kWh) • ~77 MtCO <sub>2</sub> e <b>carbon credits issued</b> by 2022 cumulatively (total forest area: 921,300 sq km), <b>highest in the region</b> ; experience in PES projects for over a decade, with <b>weak institutional arrangement to support the schemes</b>	 
	<b>Infrastructure, technology, and human capital</b>	• <b>Inadequate inter-island grid connectivity currently, but plan to develop Super Grid</b> in 2025 with <b>smart grid and ESS<sup>6</sup></b> ; ~300 EV chargers currently exist, with plans of reaching ~25K chargers in 2030 • <b>Mix of international and local developers for NBS<sup>7</sup></b> with ~4 registered and ~5 under development/on hold projects based on Voluntary Registry Offset Database (estimated annual emission reduction accounts for ~7% of investible carbon)	 

Notes: Absence of energy or nature logo on assessment implies country level assessment; (1) Ministry of Energy and Mineral Resources; (2) International Energy Agency; (3) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (4) Nationally determined contributions; (5) Levelized cost of electricity; (6) Energy Storage Systems; (7) Nature-based solutions  
Sources: IEA; MEMR; MEF; UNFCCC; Berkeley Carbon Trading Project; Lit. search



# Indonesia | Investment to date driven by private sector; opportunities to grow investment in solar and wind given low penetration rates and need for capital



■ Top themes

## Top themes by investment types:

<p><b>Corporate</b> Geothermal, Solar, Mobility, Sust. farming</p>	<p><b>PE/VC</b> Sustainable farming, Mobility, Solar</p>
<p><b>Infra Fund</b> Mobility</p>	<p><b>Climate Fund</b> Solar</p>

## Recent deal example:

**Corporate:** Singapore-based **Green Era** acquired ~33% stake in **Star Energy** (a group owning controlling stakes in Indonesian **geothermal** energy assets) for ~\$450M in 2022

## Most active investors<sup>3</sup>:

**Green Era**

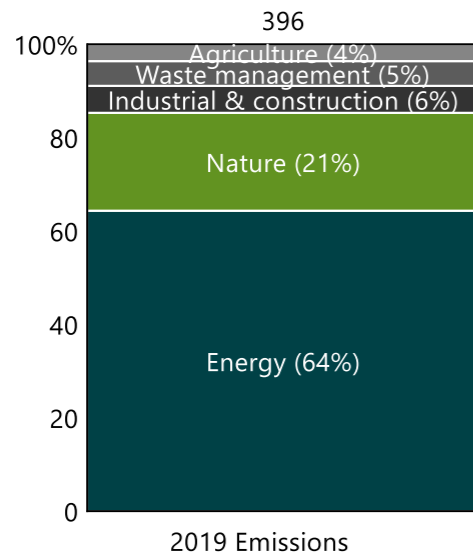
Notes: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Other renewable energy sources aside from wind and solar, such as hydropower and geothermal; (3) Based on deal volume from 2020-2022  
Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook



# Malaysia | Largest proposed reduction in ASEAN-6 vs. BAU; high ambition not yet matched by clear sector roadmaps and committed strategies/plans at scale

## Emission profile

Malaysia GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **396 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. **~390 in 2018**
- **~95%** of energy supply<sup>2</sup> comes from fossil fuel sources
- Carbon tax or ETS under consideration

## Government commitments under NDC

Emission	Energy	Nature
<b>~45%</b> Unconditional emission reduction by 2030 vs. 2005	<b>40%</b> RE contribution for power generation by 2035	<b>50%</b> Forest coverage by 2030
	<b>15%</b> Electric vehicle of new vehicle sales by 2030 (vs. 1% in 2022)	<b>0%</b> Net forest loss by 2030 (vs. -3% 2000–2020)
	<b>10k</b> New EV charging station installations by 2025	<b>&gt;20%</b> Terrestrial areas protected by 2025

## Opportunities and challenges

	Energy	Nature
<b>Opportunities</b>	<ul style="list-style-type: none"> <li>• <b>Innovative green financing available</b> (e.g., ADB-backed Green Technology Financing Scheme)</li> <li>• <b>Open market structure</b> (e.g., virtual PPA3, corp. green power program), with the plan to lift the RE export ban</li> <li>• Development of <b>ship fuel efficiency technology</b> study through government–corporate collaboration<sup>4</sup></li> </ul>	<ul style="list-style-type: none"> <li>• <b>High potential on NBS</b> due to abundant natural resource (i.e., ~10% share of forest, peatland, mangroves in SEA)</li> <li>• <b>Deployment of technology to monitor forestry preservation</b> (e.g., NFMS<sup>6</sup> supports MRV7 of emissions using on-the-ground observation and remote sensing)</li> <li>• <b>VCM guidelines</b> established with Bursa Carbon Exchange</li> </ul>
<b>Challenges</b>	<ul style="list-style-type: none"> <li>• <b>High dependence on fossil fuel</b> for energy generation (~95% of total energy supply in 2019) and economic growth (~20% of national GDP)</li> <li>• <b>Lack of national level sector roadmap</b> to cascade climate target to actions (LT-LEDS<sup>5</sup> under development)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>National targets not cascaded</b>, resulting in misaligned policies and strategy at national and state levels</li> <li>• <b>Nascent NBS ecosystem</b> with only 1 registered NBS project, despite strong potential; Only SEA country <b>not involved in Article 6 pilot projects</b></li> <li>• <b>Lack of compliance carbon market regulation; Limited PES<sup>8</sup> schemes</b> available</li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Power purchase agreements; (4) Partnership between Malaysia Maritime and Heavy Engineering (MMHE) and Silverstream Technologies; (5) Long-term low-emission development strategy; (6) National Forest Monitoring System; (7) Measurement, Reporting and Verification; (8) Payment for Ecosystem services  
Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Lit. search



# Malaysia | Noticeable progress in RE, but need clear long-term strategy and actionable roadmap to deliver ambitious target the country has defined

Energy 
 Nature 
 ■ Highly unlikely to be on track 
 ■ Unlikely to be on track 
 ■ Likely to be on track 
 ■ Highly likely to be on track

## Unlikely to be on track

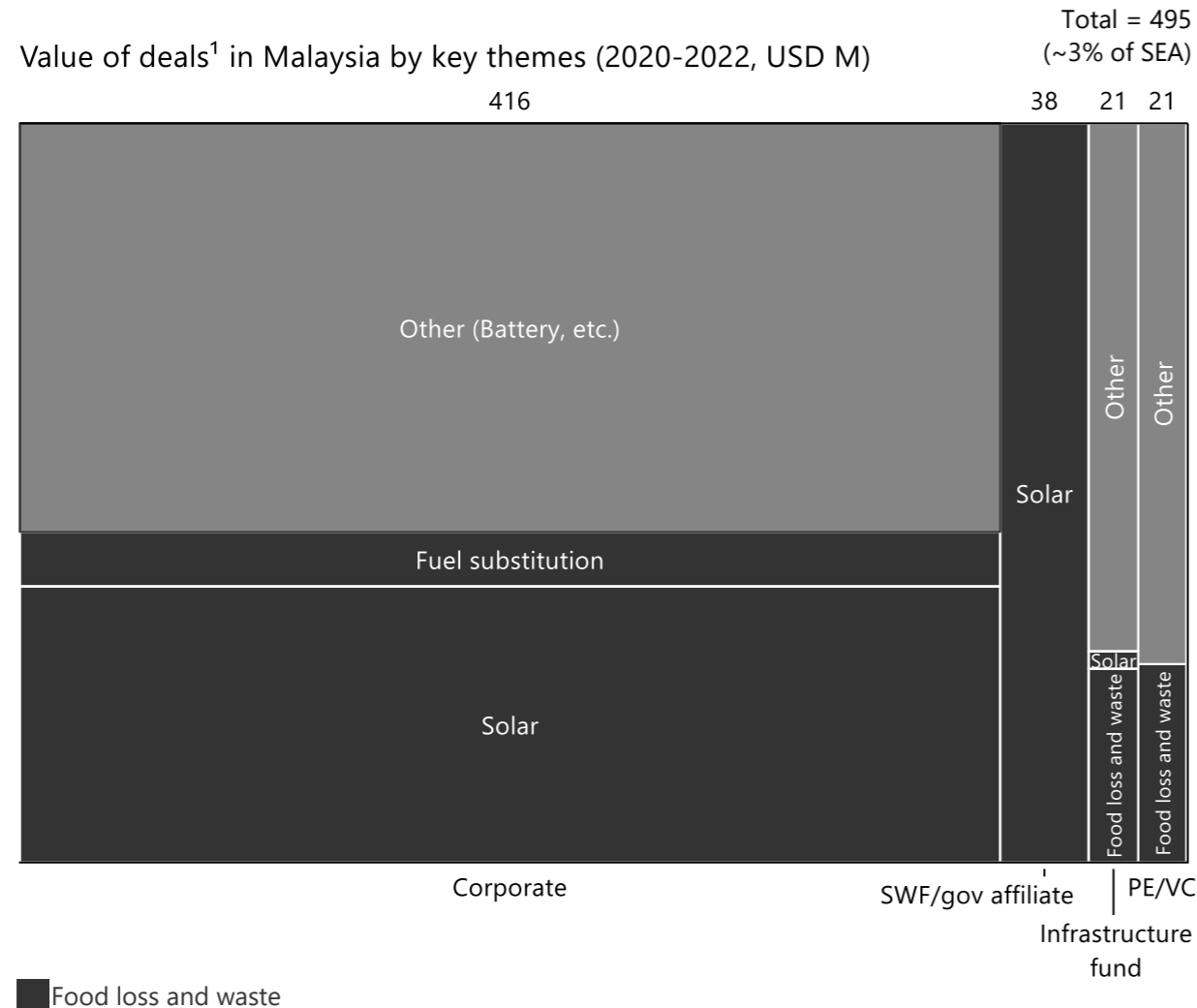
- **Signs of national progress and corporate participation overall, mainly for energy sector**
- **Incentives and supporting policies are in place**, such as Net Energy Metering and special permit for renewables electricity generation; carbon tax in plans
- Sarawak area designated to be renewable energy powerhouse
- **REDD+<sup>2</sup> framework implementation on progress** with decent activity on carbon credits trading and nature-based solutions project development

	Requirements	Commentary	Assessment
Ambition	Target setting and quality	• <b>Non-legally binding Net Zero target by 2050 earliest</b> with <b>2030 unconditional emission reduction targets</b> , insufficient to meet 1.5°C global target; 2019 emissions at ~396 MtCO <sub>2</sub> e vs. ~736 MtCO <sub>2</sub> e 2030 unconditional target	
	Target cascading	• Emission targets are <b>not broken down by sectors</b> ; <b>top corporates</b> such as Petronas and Tenaga have shown <b>commitment towards decarbonization</b> with Net Zero emission targets and roadmap	
Progress	Current state of progress	• <b>Energy:</b> Renewable energy share for power generation at ~20% in 2021 (target at 23% by 2025), EV penetration at ~1% in 2022 (target 15% by 2030), installed renewable energy capacity grew by 6% annually from 2018–2021 • <b>Nature:</b> ~55% forest coverage in 2022 (target of maintaining forest cover above 50%), % net change in tree cover ~ -3% between 2000–2020 (target to stop deforestation in 2030)	
Roadmap	Sectoral roadmap	• <b>LT-LEDS<sup>1</sup> still under development</b> ; no specific sectoral roadmap for both energy and nature, only overall National Energy Policy for 2022–2040 exists	
	Corporate roadmap	• <b>Top firms</b> such as Petronas and Tenaga <b>released roadmap</b> focusing on different decarbonization levers	
Enablers	Regulatory framework	• Ranked 49 <sup>th</sup> globally in Economic Freedom Index • <b>No mandatory emission reporting</b> ; <b>more structured renewable energy</b> permitting process by Sustainable Energy Development Authority; Tenaga is the sole buyer • ~25% of forest area is protected; <b>REDD+<sup>2</sup> implementation is in progress</b> with clear strategy; illegal logging persists, with monitoring systems in place to reduce illegal activities; National registry exists; <b>VCM<sup>3</sup> guidelines established</b> to support Bursa Carbon Exchange; participating in Article 6 pilot projects	
	Financial prerequisites	• <b>Carbon tax in plans</b> ; <b>wide range of incentives</b> from solar, electric vehicles, and green buildings are available; Solar LCOE <sup>4</sup> (~\$0.07kWh) less than new-build coal (~\$0.08/kWh) • ~510k tCO <sub>2</sub> e carbon credits issued by 2022 (total forest area: 191,100 sq km); <b>Limited PES<sup>5</sup> schemes available</b> , with ongoing discussions to introduce in Sabah and Sarawak	
	Infrastructure, technology, and human capital	• <b>Limited grid connectivity for variable renewables, but RE expansion aligned with grid upgrade plan</b> ; ~600 public electric vehicle charging stations available • <b>Local and international developers</b> available but only ~1 registered and ~1 pending approval projects currently based on Voluntary Registry Offset Database (estimated annual emission reduction accounts for ~1% of investible carbon)	

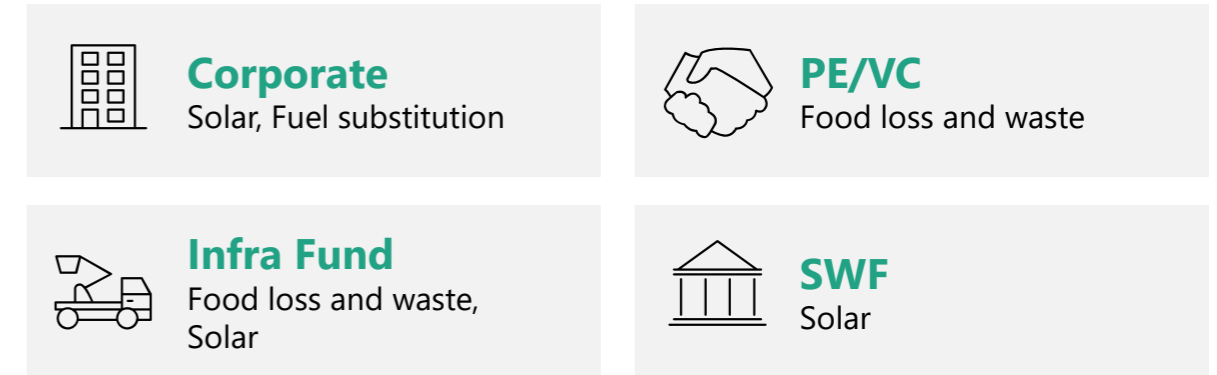
Notes: Absence of energy or nature logo on assessment implies country level assessment; (1) Long-term low-emission development strategy; (2) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (3) Voluntary carbon markets; (4) Levelized cost of electricity; (5) Payments for ecosystem services  
 Sources: IEA; IRENA; SEDA; UNFCCC; Berkeley Carbon Trading Project; Lit. search



# Malaysia | Current level of green economy investment lags region on a relative basis; solar attracted the most, immense potential for nature/hydro untapped



## Top themes by investment types:



## Recent deal example:

**Corporate: Tenaga Nasional Bhd**, Malaysian electricity and utility company, allocated ~\$40M in 2022 for **50MWac (75MWdc) solar project** in Bukit Selambau, Kuala Muda, Kedah, as part of the government's Large Scale Solar 4 (LSS4) program

## Most active investors<sup>2</sup>:

No green investor has substantial activity in Malaysia

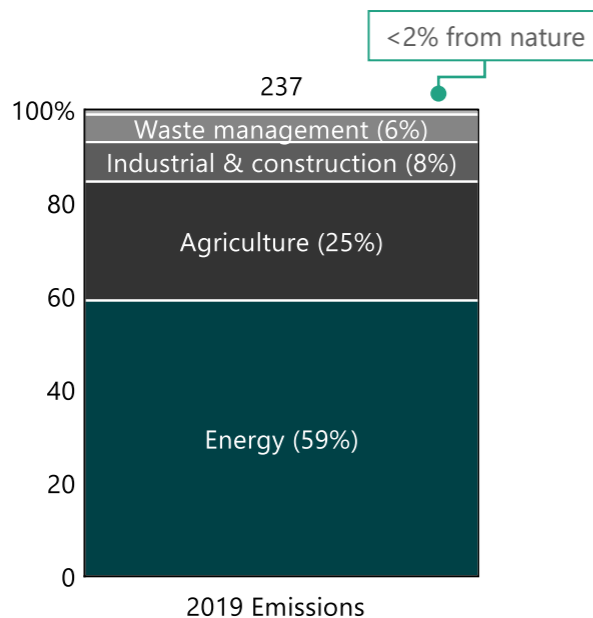
Notes: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Based on deal volume from 2020–2022  
Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook



# Philippines | NDC commitments are modest, government supports grid infrastructure development, but more to be done for EV and nature

## Emission profile

Philippines GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **237 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. **~240 in 2018**
- **~65%** of energy supply<sup>2</sup> comes from fossil fuel sources (one of the lowest in SEA)
- Carbon tax and ETS under consideration

## Government commitments under NDC

Emission	Energy	Nature
<p><b>~3%</b> Unconditional emission reduction by 2030 vs. 2005</p>	<p><b>35%</b> RE contribution for power generation by 2030</p> <p><b>100%</b> Electric vehicle of new vehicle sales by 2040 (vs. 2% in 2022)</p>	<p><b>0%</b> Net forest loss by 2030 (vs. -2% 2000–2020)</p>

## Opportunities and challenges

	Energy	Nature
<p><b>Opportunities</b></p>	<ul style="list-style-type: none"> <li>• <b>High potential on RE</b> due to abundant natural resource (e.g., top nickel producer, strong solar and wind resource)</li> <li>• <b>Open market structure, 100% foreign ownership</b> allowed on RE infrastructures</li> <li>• <b>Sufficient and flexible grid network</b></li> <li>• One-stop solution for <b>RE permitting</b> under development</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Implementation of REDD+<sup>4</sup> strategy in progress</b></li> <li>• <b>Ongoing NBS projects</b> by local and international developers (one registered, two under development)</li> </ul>
<p><b>Challenges</b></p>	<ul style="list-style-type: none"> <li>• <b>Insufficient EV charging infrastructure</b> (~10k km average distance between 4W CIs<sup>3</sup>, highest in SEA)</li> <li>• Lack of <b>national sector roadmap</b></li> <li>• <b>Limited investment in technology</b> (e.g., alternative fuels) vs. other SEA countries such as SG, MY, TH</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Lack of regulations</b> on voluntary carbon credit guidelines and compliance carbon markets</li> <li>• Minimal traction on NBS projects, with no carbon credit issuances</li> <li>• Inadequate <b>forest law enforcement and monitoring</b></li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Taking number of CIs as of Q2 2022 over nationwide road distance; (4) Reducing emissions from deforestation and forest degradation framework by UNFCCC  
Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Berkeley Carbon Trading Project; Lit. search





# Philippines | Initial progress across carbon tax and permitting process, but overall level of climate ambition is low and lacks sectoral details

Energy   
 Nature   
 Highly unlikely to be on track   
 Unlikely to be on track   
 Likely to be on track   
 Highly likely to be on track

## Unlikely to be on track

- **Some progress** In decarbonization supported by the right incentives and regulatory frameworks
- Requires more **inter-island grid connectivity**
- Plan to accelerate renewable energy development through **allowing full foreign ownership and providing attractive incentives**; recently received ~\$14B investment pledge by Chinese companies

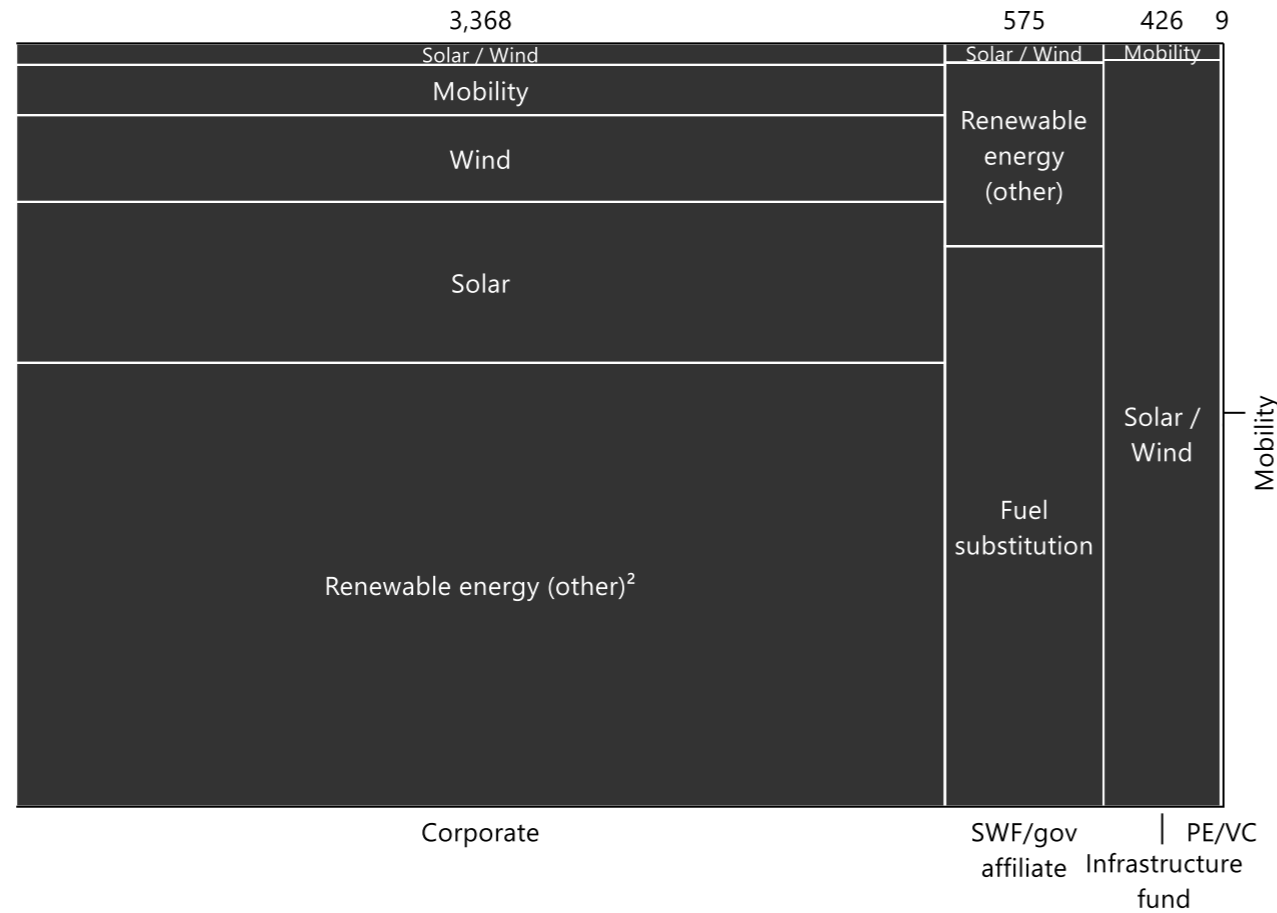
	Requirements	Commentary	Assessment
Ambition	Target setting and quality	• <b>No Net Zero commitments</b> but has 2030 unconditional and conditional targets; 2019 emissions at ~237 MtCO <sub>2</sub> e vs. ~351 MtCO <sub>2</sub> e 2030 unconditional target	
	Target cascading	• <b>Lacking both sectoral specific and corporate specific ambition</b>	
Progress	Current state of progress	• <b>Energy:</b> Renewable energy share for power generation at ~21% in 2020 (target at 35% by 2030), EV sales as percentage of new vehicles at ~2% in 2022 (target 100% by 2040), installed renewable energy capacity grew by 5% annually from 2018–2021 • <b>Nature:</b> ~23% forest coverage in 2021 (no target on forest cover), % net change in tree cover ~ -2% between 2000–2020 (target to stop deforestation in 2030 and zero net cover change in natural forest by 2028)	 
	Sectoral roadmap	• <b>No LT-LEDS<sup>1</sup></b> available but additional 2040 Energy Plan and Philippine Master Plan for Climate Resilient Forestry Development exist	 
Roadmap	Corporate roadmap	• <b>Some top firms</b> such as Meralco <b>have roadmap</b> with implementation strategies and initiatives	
	Regulatory framework	• Ranked 66 <sup>th</sup> globally in Economic Freedom Index • No streamlined process for obtaining permit of renewable electricity (but solution under development); no mandatory emission reporting requirements but guidelines are in place • ~39% of forest area is protected; Implementation of <b>REDD+<sup>2</sup> strategy in progress</b> ; inadequate forest law enforcement, with measures taken (e.g., monitoring and patrolling, reduction of forest communities in close proximity); no national registry or VCM <sup>3</sup> guidelines/policies in place; participating in Article 6 pilot projects	  
Enablers	Financial prerequisites	• <b>Carbon tax being explored; Complete set of incentives available</b> for solar, electric vehicles, and green buildings; LCOE <sup>4</sup> of solar (~\$0.09/kWh) lower than new-build coal (~\$0.12/kWh) • No carbon credits traded to date (total forest area: 71,900 sq km); Current PES <sup>5</sup> schemes lack definitive national policy and framework, only supported by provisions for similar mechanisms lodged in several policies	 
	Infrastructure, technology, and human capital	• <b>In progress of unifying three grids</b> to improve connectivity, but perceived to be comparatively flexible grid in SEA; ~300 electric vehicle charging stations in place • <b>One registered project and two under development/approval projects</b> managed by local and international developers (estimated annual emission reduction accounts for ~14% of investible carbon)	 

Notes: Absence of energy or nature logo on assessment implies country level assessment; (1) Long-term low-emission development strategy; (2) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (3) Voluntary carbon markets; (4) Levelized cost of electricity; (5) Payments for ecosystem services  
 Sources: IEA; IRENA; DOE; UNFCCC; Berkeley Carbon Trading Project; Lit. search



# Philippines | Active multi-year renewables investment from multiple sources of funding; opportunity to further grow invest in mobility and fuel substitution

Value of deals<sup>1</sup> in Philippines by key themes (2020-2022, USD M) Total = 4,377 (~25% of SEA)



■ Top themes

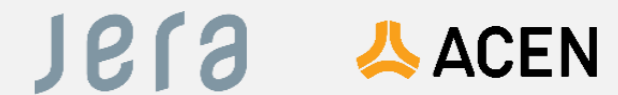
## Top themes by investment types:

<p><b>Corporate</b> Geothermal, Solar, Wind, Mobility</p>	<p><b>PE/VC</b> Mobility</p>
<p><b>Infra Fund</b> Solar/Wind, Mobility</p>	<p><b>SWF</b> Fuel substitution</p>

## Recent deal example:

**Corporate: Total Eren**, a French renewable energy independent power producer, committed ~\$300M in 2022 for the **development of a 336MW/440MWp solar project** in Ilagan, Isabela province

## Most active investors<sup>3</sup>:



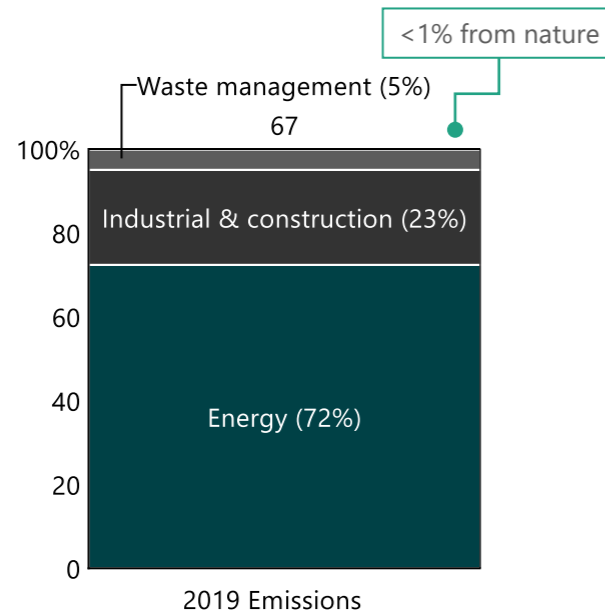
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Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook



# Singapore | Scaling government actions across sectors; clear national ambition to reduce emissions, but challenges with large carbon-intensive industries

## Emission profile

Singapore GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **67 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. **~70 in 2018**
- **~98%** of energy supply<sup>2</sup> comes from fossil fuel sources
- Carbon tax (~\$4/tCO<sub>2</sub>e) implemented, plan to increase to \$40–\$60 by 2030

## Government commitments under NDC

Emission	Energy	Nature
<b>60 MtCO<sub>2</sub>e</b> Unconditional emission reduction by 2030 vs. 2005	<b>3%</b> RE contribution for power generation by 2030	<b>0%</b> Net forest loss by 2030 (vs. -8% 2000–2020)
	<b>100%</b> Electric vehicle of new vehicle sales by 2030 (vs. 12% in 2022)	<b>200ha</b> Additional green area by 2030
	<b>2 GWp</b> Solar capacity by 2030	

## Opportunities and challenges

	Energy	Nature
<b>Opportunities</b>	<ul style="list-style-type: none"> <li>• Development of <b>national green plan</b> and <b>hydrogen lab</b></li> <li>• <b>Deployment of utility-scale ESS<sup>3</sup></b> (2.4MW capacity) and piloting project in residential flats</li> <li>• MoU to establish of <b>world’s longest Green and Digital Corridor</b> by Singapore and Rotterdam port authority</li> <li>• Successful pilot of <b>SAF<sup>4</sup> on flights</b> by Civil Aviation Authority of Singapore, Singapore Airlines, and GenZero</li> </ul>	<ul style="list-style-type: none"> <li>• Plans to become a <b>regional hub for carbon services and carbon trading</b> (e.g., Climate Impact)</li> <li>• <b>Clear carbon credit demand signals</b> as corporates can offset up to 5% of carbon taxes from 2024</li> <li>• <b>Strong regulation enforcement</b> of tree protection through PRIME<sup>5</sup> system</li> </ul>
<b>Challenges</b>	<ul style="list-style-type: none"> <li>• <b>Significant lack of natural resource for RE</b> (lowest PV and wind reserve in SEA, no biomass/hydro/geo-thermal)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Minimal NBS potential</b> due to lack of land and forest area</li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Energy Storage System; (4) Sustainable Aviation Fuel; (5) Park Integrated Management System  
Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Lit. search



# Singapore | Material progress over the last 2 years with newly regulatory frameworks and financial incentives, carbon tax; on track to deliver climate goals



## Likely to be on track

- **Significant progress** overall; targets set based on solid scenario modelling
- **Leads in financing and policies** in the region with carbon tax, incentives, emission reporting, etc.
- Strong infrastructure with **ongoing renewable electricity imports** from neighboring countries such as Laos and, more recently, **largest battery energy storage system in SEA**
- Due to its limited land resources, nature sector is not a focus, but **realistic goals and progress have been made**

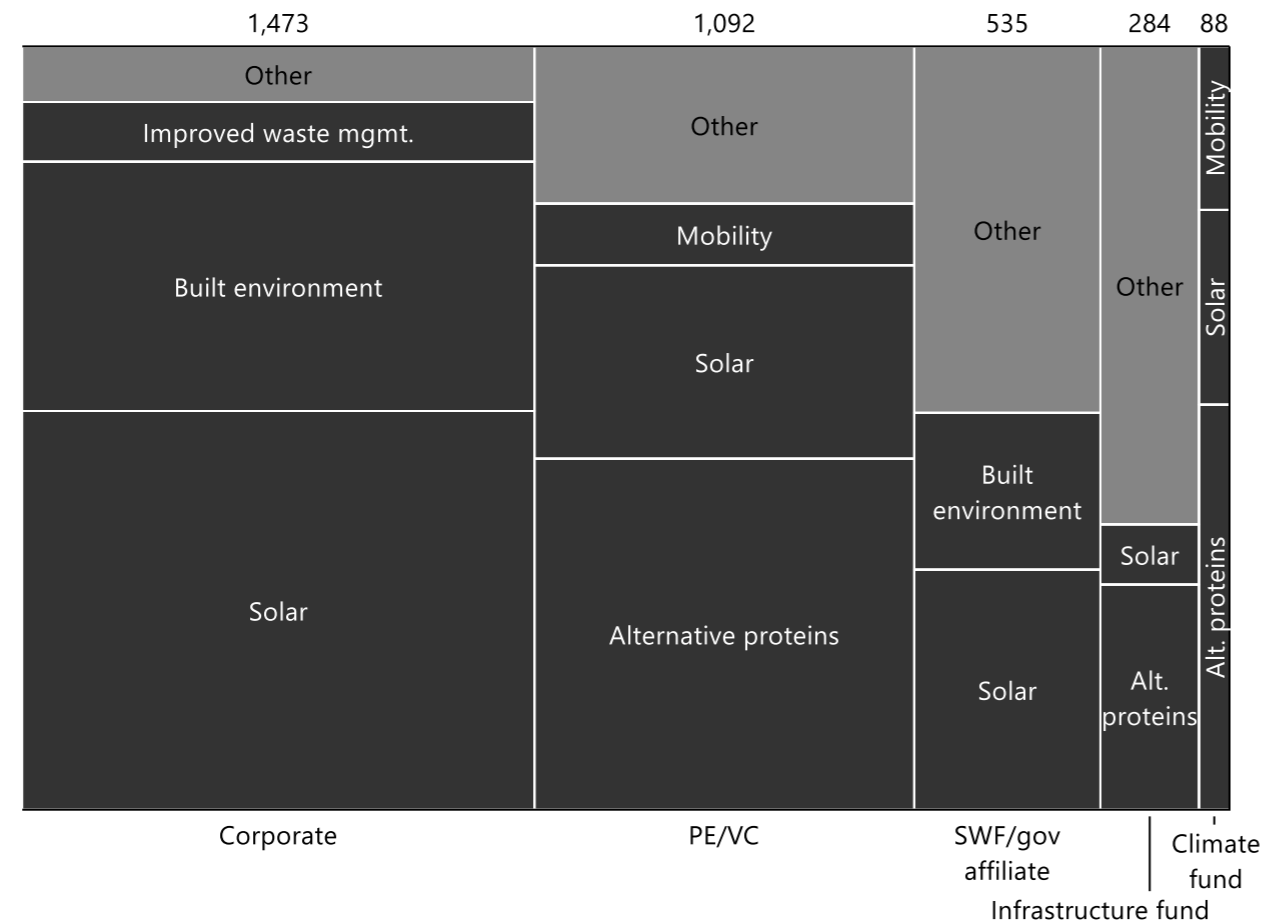
	Requirements	Commentary	Assessment
Ambition	<b>Target setting and quality</b>	• <b>Non-legally binding 2050 Net Zero target</b> with an overall 2030 absolute emissions target of 60MtCO <sub>2</sub> e, insufficient to meet 1.5°C global target; 2019 emissions at ~67 MtCO <sub>2</sub> e vs. ~60 MtCO <sub>2</sub> e 2030 unconditional target	
	<b>Target cascading</b>	• <b>Absence of sector-specific emission targets</b> but with <b>presence of Net Zero and emission targets at top corporates</b> (e.g., Sembcorp)	⚡
Progress	<b>Current state of progress</b>	<ul style="list-style-type: none"> <li>• <b>Energy:</b> ~1%–2% share of solar in power generation (target ~3% of demand in 2030), ~12% new cars registration are EVs<sup>1</sup> in 2022 (target to stop diesel car registrations by 2025 and 100% cleaner fuel vehicles by 2030), installed renewable energy capacity grew by 20% annually from 2018–2021</li> <li>• <b>Nature:</b> Revamped Rifle Range Park (~66 ha) opened in 2022 (target to add 200 ha of nature parks by 2030), % net change in tree cover ~ -8% between 2000–2020 (target to stop deforestation in 2030)</li> </ul>	🌿
	<b>Sectoral roadmap</b>	<ul style="list-style-type: none"> <li>• <b>Green Plan</b> released in 2021 <b>addresses targets and milestones for each sector</b>, but <b>lacks actionable details</b> to achieve those targets</li> <li>• <b>LT-LEDS<sup>2</sup></b> details out long-term road map for each sector</li> </ul>	⚡ 🌿
Enablers	<b>Corporate roadmap</b>	• <b>Some published roadmaps</b> amongst top corporates (e.g., Sembcorp)	
	<b>Regulatory framework</b>	<ul style="list-style-type: none"> <li>• Ranked 3<sup>rd</sup> globally in Economic Freedom Index</li> <li>• <b>Mandatory emission reporting</b> for industrial facilities emitting &gt;2K tCO<sub>2</sub>e/ year, <b>no differentiating permit to supply renewable electricity</b></li> <li>• Not involved in REDD+<sup>3</sup>; Strong enforcement of trees and parks through PRIME<sup>4</sup> system; to become <b>connection point for global carbon registries</b>; <b>carbon credits</b> can be used to <b>offset 5% of carbon taxes from 2024</b>; not participating in Article 6 pilots</li> </ul>	⚡ 🌿
	<b>Financial prerequisites</b>	<ul style="list-style-type: none"> <li>• Existing <b>carbon tax</b> for facilities that emit &gt;25K tCO<sub>2</sub>/year, plans to increase carbon price from ~\$4/tCO<sub>2</sub>; <b>wide range of incentives</b> for renewables, electric vehicles and green buildings, solar LCOE<sup>5</sup> at \$0.1/kWh</li> <li>• <b>No carbon credits issued in 2022</b> due to limited land area (total forest area: 160 sq km); Community in Bloom program encourages local community engagement in creating gardening culture</li> </ul>	⚡ 🌿
	<b>Infrastructure, technology, and human capital</b>	<ul style="list-style-type: none"> <li>• ~4K EV charging stations in place with target of ~60K stations by 2030; currently importing electricity from Laos with additional <b>grid infra with AI/ML<sup>6</sup></b> planned to support DER<sup>7</sup> and energy imports</li> <li>• Limited land resources for forestry projects, but <b>sufficient for developers to continue with nature parks and green area ambition</b></li> </ul>	⚡ 🌿

Notes: Absence of energy or nature logo on assessment implies country level assessment; Energy sector assessment considers higher weightage for power subsector due to its larger impact on decarbonization; (1) Inclusive of plug-in hybrid vehicles; (2) Long-term low-emission development strategy; (3) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (4) Park Integrated Management System; (5) Levelized cost of electricity; (6) Artificial Intelligence/Machine Learning; (7) Distributed Energy Resources  
Sources: EMA; MAS; NCCS; UNFCCC; LTA; Berkeley Carbon Trading Project; Lit. search



# Singapore | Diversified investment across areas of sustainability development, supported by active involvement across investor types—yet far from potential

Value of deals<sup>1</sup> in Singapore by key themes (2020-2022, USD M) Total = 3,471 (~20% of SEA)



■ Top themes

## Top themes by investment types:

- Corporate** (Icon: Building): Solar, Built environment, Waste management
- Corporate** (Icon: Handshake): Solar, Built environment, Waste management
- Infra Fund** (Icon: Forklift): Alternative proteins, Solar
- SWF** (Icon: Temple): Solar, Built environment
- Climate Fund** (Icon: Wind turbine): Alternative proteins, Solar, Mobility

## Recent deal example:

**Infrastructure Fund:** Keppel Asia Infrastructure Fund and Keppel Infrastructure Holdings jointly acquired 80% interest in Singaporean environmental services company, **800 Super**, that operates in waste management, waste treatment, etc., for ~\$200M in 2022

## Most active investors<sup>2</sup>:

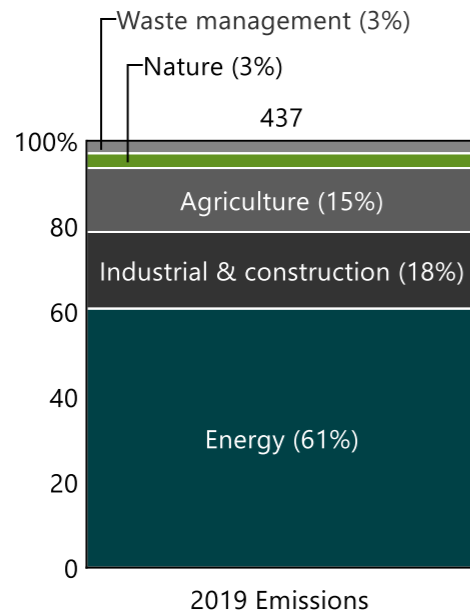
Notes: (1) Figures include private sector deal transactions > \$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Based on deal volume from 2020–2022  
Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook



# Thailand | Material ambition for 2030 with large increases expected in RE and EVs – yet progress on actual invest is slow and plans still in progress

## Emission profile

Thailand GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **437 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. **~430 in 2018**
- **~80%** of energy supply<sup>2</sup> comes from fossil fuel sources
- Carbon tax under consideration; **ETS exchange launched**

## Government commitments under NDC

Emission	Energy	Nature
<b>~30%</b> Unconditional emission reduction vs. BAU by 2030 (~40% conditional emission reduction)	<b>30%</b> RE contribution for power generation by 2030	<b>55%</b> Forest coverage by 2037
	<b>100%</b> Electric vehicle of new vehicle sales by 2035 (vs. 1% in 2022)	<b>0%</b> Net forest loss by 2030
	<b>725k</b> EV units/year to be produced by 2030	

## Opportunities and challenges

	Energy	Nature
<b>Opportunities</b>	<ul style="list-style-type: none"> <li>• <b>Strong EV capability</b> (a <b>global top 15 car manufacturer</b>) and <b>favorable policies for EV dev.</b> (import duties exempted on significant EV electrical parts)</li> <li>• <b>RE by VSPPs<sup>3</sup></b> allowed to be sold to national grid</li> <li>• <b>Active RE technology development</b> (e.g., Smart grid national pilot project on EGAT<sup>4</sup> system; SAF and hydrogen development by PTT)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>National voluntary carbon credit guidelines</b> (i.e., T-VER<sup>6</sup> program) exist and harmonized with international standards</li> <li>• Participation in <b>Article 6 pilot projects</b></li> </ul>
<b>Challenges</b>	<ul style="list-style-type: none"> <li>• <b>Climate Change Act</b> still under drafting process</li> <li>• <b>Long lead time for RE permitting</b> (up to 8 years)</li> <li>• <b>Lack of policy continuity</b> (e.g., moved from FIT<sup>5</sup> to Quasi-bid offtaking mechanism)</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of <b>compliance carbon market regulation</b> and nationwide <b>PES<sup>7</sup> policy</b></li> <li>• <b>Limited demonstrated expertise in NBS</b> and early traction of projects (e.g., Kuan Kreng Peat Swamp Forest)</li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Very small power producers; (4) Electricity Generating Authority of Thailand; (5) Feed-in Tariff; (6) Thailand Voluntary Emission Reduction Program; (7) Payment for Ecosystem services  
 Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Lit. search



# Thailand | Sectoral emission target in place but detailed action plan and regulatory framework required to deliver the ambition



**Unlikely to be on track**

- **Some progress** on overall decarbonization, with general long-term roadmap developed
- **Collaboration with Japanese government** to accelerate decarbonization; corporate partnerships also exist, e.g., PTT and Toyota
- Some incentives and mandatory emission reporting in place to support transition
- **Nascent NBS ecosystem**, with continuance of **illegal logging** and **lack of nationwide PES policy**; however **national registry of mitigation actions** and **local T-VER carbon credit standards** already in place

	Requirements	Commentary	Assessment
Ambition	<b>Target setting and quality</b>	• <b>Non-legally binding 2065 Net Zero target</b> with carbon neutrality milestone by 2050 and 2030 targets, insufficient to meet 1.5°C global target; 2019 emissions at ~437 MtCO <sub>2</sub> e vs. ~389 MtCO <sub>2</sub> e 2030 unconditional target	Highly likely to be on track
	<b>Target cascading</b>	• <b>Sectoral emissions targets detailed out</b> in LT-LEDS <sup>1</sup> , coupled with <b>corporate Net Zero and emission reduction ambitions</b> from top firms such as PTT and Siam Cement Group • Targets are cascaded into top sectors as well as several top firms such as PTT, Siam Cement Group, etc.	Highly likely to be on track
Progress	<b>Current state of progress</b>	• <b>Energy: Renewable energy share</b> for power generation at ~20% in 2021 (target at 30% consumption by 2037), <b>EV sales</b> as percentage of new vehicles at ~1% in 2022 (target 100% by 2035), installed renewable energy capacity grew by 2% annually from 2018–2021 • <b>Nature: ~32% forest coverage</b> in 2020 (target 55% in 2037), % net change in tree cover ~5% between 2000–2020, however has experienced net reduction in forest cover in between 2015–2020 (~ -0.2%), driven by commodities	Unlikely to be on track (Energy) Unlikely to be on track (Nature)
	<b>Sectoral roadmap</b>	• <b>General LT-LEDS<sup>1</sup></b> published, 2018–2037 <b>Power Development Plan</b> exists from 2019; update pending in 2023 • <b>No specific roadmap for nature sector</b> in addition to LT-LEDS <sup>1</sup>	Likely to be on track (Energy) Unlikely to be on track (Nature)
Roadmap	<b>Corporate roadmap</b>	• <b>Top firms</b> such as PTT <b>have detailed strategy and targets, but are only now commencing operationalization</b>	Highly unlikely to be on track
Enablers	<b>Regulatory framework</b>	• Ranked 86 <sup>th</sup> globally in Economic Freedom Index • <b>Mandatory emission reporting</b> for large facilities; no streamlined permitting process for renewables electricity; <b>Climate Change Act</b> still under drafting process • ~56% of forest area under protection; REDD+ readiness phase funded by FAO <sup>2</sup> in 2018; illegal logging persists, but with measures to improve enforcement; <b>national registry of mitigation actions</b> in place with local T-VER aligned with international standards; participating in Article 6 pilot projects	Unlikely to be on track (Energy) Highly unlikely to be on track (Nature)
	<b>Financial prerequisites</b>	• <b>Carbon tax in plans; incentives in place</b> for solar, wind, and electric vehicles; LCOE <sup>3</sup> of solar cheaper compared to new-build coal (~\$0.08/kWh vs ~\$0.10/kWh for coal) • <b>~2.2k tCO<sub>2</sub>e certified carbon credits issued</b> by 2022 (total forest area: 198,700 sq km) much lower vs. other countries (e.g., Cambodia, Indonesia); lacks nationwide PES <sup>4</sup> policy (mainly focused on pilot projects today)	Likely to be on track (Energy) Highly unlikely to be on track (Nature)
	<b>Infrastructure, technology, and human capital</b>	• Strong intra-island grid connectivity, <b>grid upgrades and RE expansion plans aligned</b> ; ~1200 electric vehicle charging stations available for public use • <b>No registered projects with Verra</b> , but early traction within nature-based projects (e.g., Kuan Kreng Peat Swamp Forest)	Likely to be on track (Energy) Unlikely to be on track (Nature)

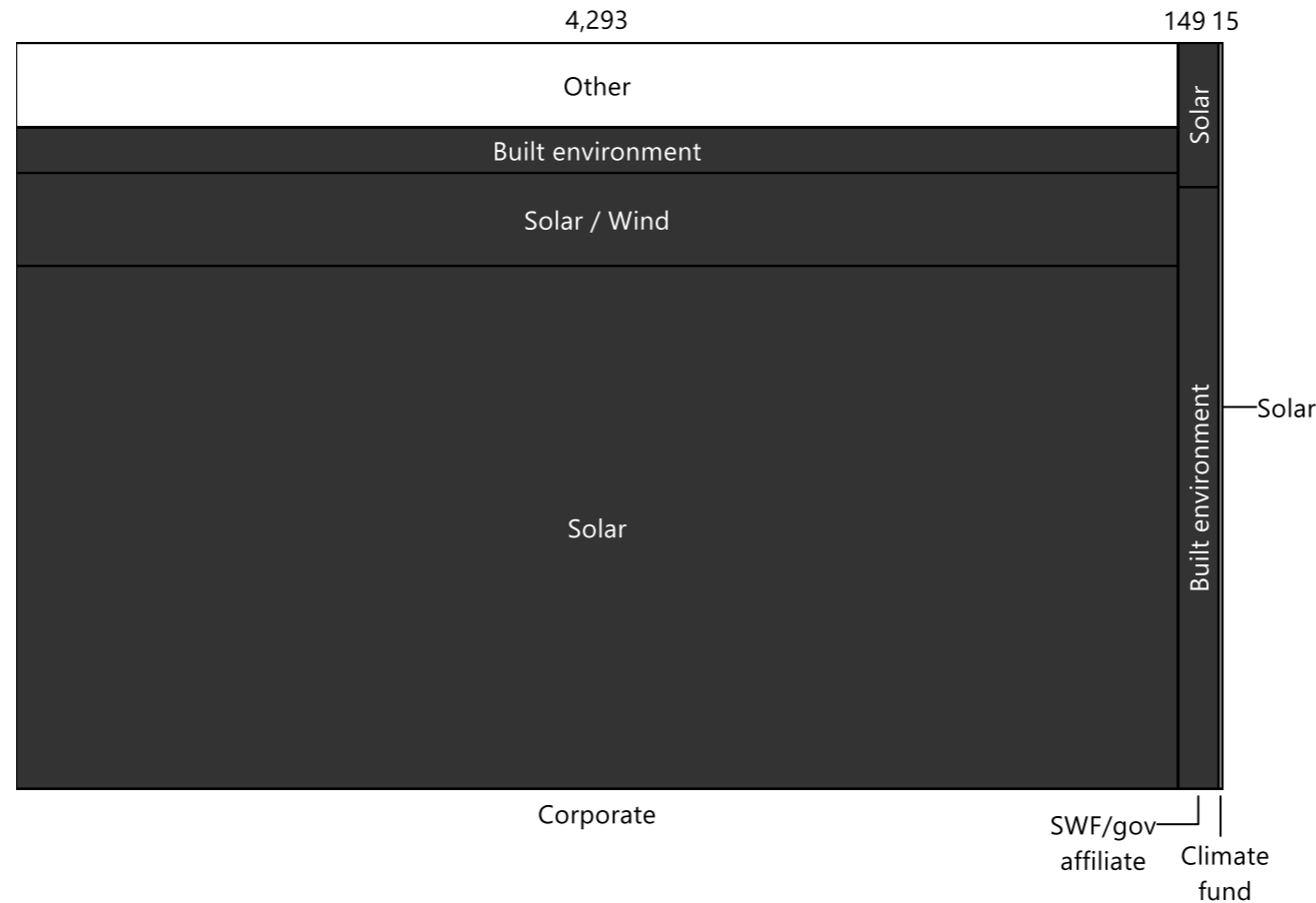
Notes: Absence of energy or nature logo implies country level assessment; (1) Long-term low-emission development strategy; (2) Food and Agriculture Organization; (3) Levelized cost of electricity; (4) Payment for Ecosystem services  
Sources: IEA; IRENA; FTI; UNFCCC; Berkeley Carbon Trading Project; Bloomberg; Lit. search



# Thailand | Capital deployment driven by corporate players in the solar energy field; opportunity to accelerate involvement from public sectors


Value of deals<sup>1</sup> in Thailand by key themes (2020-2022, USD M)

Total = 4,457  
(~26% of SEA)




■ Top themes

## Top themes by investment types:




**Corporate**  
Solar, Solar/Wind, Built environment



**SWF**  
Built environment, Solar



**Climate Fund**  
Solar

## Recent deal example:

**Corporate:** Sahacogen (Chonburi), Thai power production company, **increased share capital in solar power plant business** of Solarist Holding by ~\$68M

## Most active investors<sup>3</sup>:

**Yuan Feng New Energy**



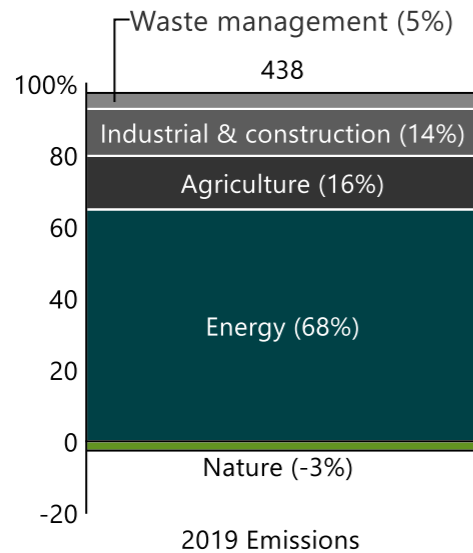
Notes: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Based on deal volume from 2020–2022  
Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook





# Vietnam | Ambitious target for RE contribution for power generation; grid congestion and illegal logging as main challenge; investment now on sidelines

Vietnam GHG emissions<sup>1</sup> (MtCO<sub>2</sub>e)



- **438 MtCO<sub>2</sub>e** of total GHG emissions in 2019 vs. **~360 in 2018**
- **~84%** of energy supply<sup>1</sup> comes from fossil fuel sources
- Carbon tax under consideration; ETS legalized, pilot from 2025 onwards

## Government commitments under NDC

Emission	Energy	Nature
<p><b>~16%</b></p> <p>Unconditional emission reduction vs. BAU by 2030 (~44% conditional emission reduction)</p>	<p><b>47%</b></p> <p>RE contribution for power generation by 2030</p> <p><b>50%</b></p> <p>Electric vehicle of new vehicle sales by 2030 (vs. 12% in 2022)</p>	<p><b>42%</b></p> <p>Forest coverage by 2030</p> <p><b>0%</b></p> <p>Net forest loss by 2030</p>

## Opportunities and challenges

	Energy	Nature
<p><b>Opportunities</b></p>	<ul style="list-style-type: none"> <li>• <b>High potential on RE</b> due to natural resource (e.g., offshore wind from long coastline, sunlight abundance)</li> <li>• Policy allows <b>private investment</b> in electricity transmission</li> <li>• <b>\$15.5B funding from JETP<sup>3</sup></b> to phase out coal</li> <li>• Development of <b>fuel-efficient aircraft models</b> by Vietnam Airlines</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Financial incentives</b> for household via implementation of <b>PFES<sup>3</sup> program</b> while driving forest conservation effort</li> <li>• <b>Well-established regulatory framework</b> (e.g., VFDS<sup>4</sup>) through collaborated effort from national to grassroot levels, supported by <b>strong policy enforcement and activity monitoring</b> (e.g., VNTLAS<sup>5</sup> to ensure legality of timber)</li> </ul>
<p><b>Challenges</b></p>	<ul style="list-style-type: none"> <li>• <b>Congested grid</b> to accommodate RE ambitions (RE plants are curtailed due to grid insufficiency to move power from south to north)</li> <li>• <b>Lack of policy transparency</b> (e.g., 2-year delay in Power Development Plan review, lack of corporate PPA regime)</li> <li>• <b>High cost of project financing</b> (up to 10%–12%)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Lacks existing NBS development ecosystem</b></li> <li>• <b>Broad carbon pricing regulation exists</b> with plans to develop compliance carbon market regulations, <b>but no detailed framework</b> on VCMs<sup>6</sup> and intl. carbon trading</li> <li>• <b>Logging ban</b> has resulted in <b>increased illegal activities</b> in countries exporting to Vietnam's wood processing industry</li> </ul>

Notes: (1) Bunker fuels are not included in accordance with IPCC guidelines; (2) Includes all energy usages such as power generation, transportation, industry, etc.; (3) Energy Storage System; (4) Sustainable Aviation Fuel; (5) Park Integrated Management System  
 Sources: Climate Watch; Climate Action Tracker; IEA; IRENA; Lit. search



# Vietnam | Emission target cascaded down to sectors, but pending detailed roadmaps for action; grid infrastructure as main bottleneck for RE transition



## Unlikely to be on track

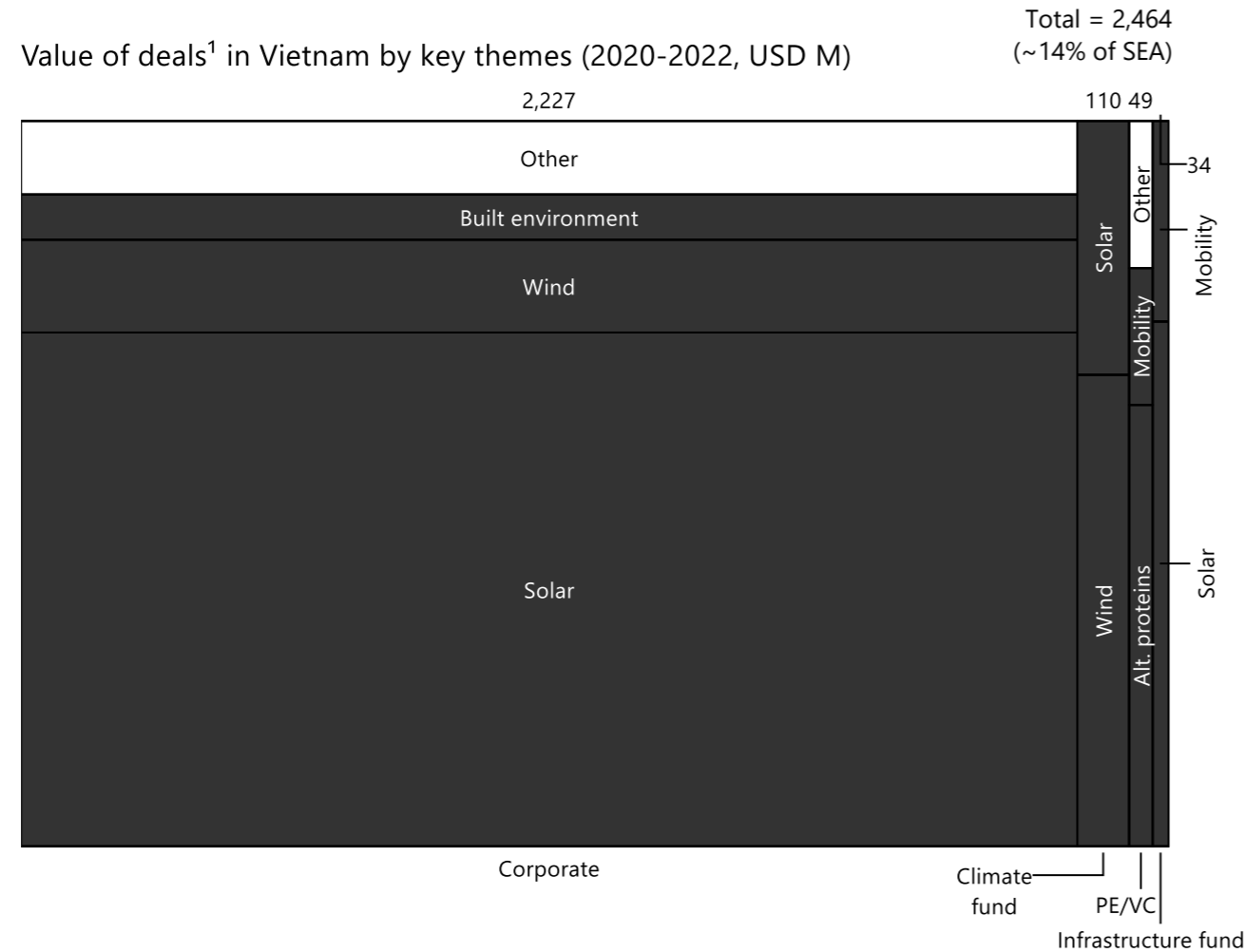
- **Progress indexed heavily on energy** vs. nature, **rapid deployment of solar** and wind, making it the 7<sup>th</sup> in the world recently, but progress was **inhibited due to grid transmission limitations**
- **Delayed release of Power Development Plan VIII to finalize plans** on grid transmission and renewable energy
- **G7 and EU countries plan to support coal phase out** by providing ~\$15.5B
- **New to nature-based solutions, progress on plans to adopt REDD+<sup>2</sup> frameworks**

	Requirements	Commentary	Assessment
Ambition	Target setting and quality	• <b>Non-legally binding 2050 Net Zero target</b> with emission reductions target for 2030, insufficient to meet 1.5°C global target; 2019 emissions at ~438 MtCO <sub>2</sub> e vs. ~781 MtCO <sub>2</sub> e 2030 unconditional target	
	Target cascading	• <b>2030 targets are cascaded to each sector, but lack of decarbonization commitments from corporates</b> such as Vingroup.	
Progress	Current state of progress	<ul style="list-style-type: none"> <li>• <b>Energy:</b> ~35% renewables share for power generation in 2020 (target 47% by 2030), 12% electric vehicles penetration rate in 2021 (target 50% by 2030), installed renewable energy capacity grew by 32% annually from 2018–2021, largely driven by rapid deployment of solar (&gt;400% annual growth)</li> <li>• <b>Nature:</b> ~42% forest coverage in 2021 (target 42% in 2030), % net change in tree cover ~24% between 2000–2020 (target to stop deforestation in 2030)</li> </ul>	
	Sectoral roadmap	<ul style="list-style-type: none"> <li>• <b>No LT-LEDS<sup>1</sup></b> published to date, short-term Power Development Plan VIII, which was planned to be released in 2020 is delayed due to requiring further finalization</li> <li>• <b>No specific roadmap for nature sector</b>, plan to create carbon market roadmap with Norway</li> </ul>	
Roadmap	Corporate roadmap	• <b>Corporates</b> such as Vingroup <b>do not have decarbonization roadmap</b>	
	Regulatory framework	<ul style="list-style-type: none"> <li>• Ranked 113<sup>th</sup> globally in Economic Freedom Index</li> <li>• <b>No special permitting process</b> for renewables electricity, open buyer market; <b>mandatory emission reporting for 21 sectors in 2023</b></li> <li>• <b>~47% forest area under protection</b>; made <b>significant progress on REDD+<sup>2</sup> framework implementation</b>, addressing major drivers such as monitoring, reporting, and verification, as well as forest reference emission level; illegal deforestation persists, with measures taken to reduce illegal activities (e.g., VNTLAS<sup>3</sup>); no national registry or VCM<sup>4</sup> guidelines in place; participating in Article 6 pilot projects</li> </ul>	
Enablers	Financial prerequisites	<ul style="list-style-type: none"> <li>• <b>Carbon tax being explored</b>; current incentives in place for solar and electric vehicles, plans for green building incentives; LCOE<sup>5</sup> for solar cheaper than new-build coal (\$0.07/kWh vs. \$0.10/kWh respectively)</li> <li>• <b>No carbon credits issued in 2022</b> (total forest area: 146,400 sq km); PFES<sup>6</sup> scheme established as part of country's legal framework, providing ~\$130M/yr to households for protecting forests</li> </ul>	
	Infrastructure, technology, and human capital	<ul style="list-style-type: none"> <li>• <b>Grid transmission bottleneck issues</b> that prevent new solar projects to be added into the system; only ~500 EV charging stations are currently available for public; plans to adopt solar, wind and carbon capture</li> <li>• <b>New to nature-based solutions project</b> development, no ongoing projects</li> </ul>	

Notes: Absence of energy or nature logo on assessment implies country level assessment; (1) Long-term low-emission development strategy; (2) Reducing emissions from deforestation and forest degradation framework by UNFCCC; (3) Vietnam Timber Legality Assurance System; (4) Voluntary carbon markets; (5) Levelized cost of electricity; (6) Payments for forest environmental services  
 Sources: IEA; ACE; IRENA; UNFCCC; Berkeley Carbon Trading Project; Lit. search



# Vietnam | Solar and wind attracted the most capital from corporates and climate funds; opportunity to accelerate PE/VC involvement into this field



■ Top themes

## Top themes by investment types:

 <p><b>Corporate</b> Solar, Wind, Built environment</p>	 <p><b>PE/VC</b> Alternative proteins, Mobility</p>
 <p><b>Infra Fund</b> Solar, Mobility</p>	 <p><b>Climate Fund</b> Wind, Solar</p>

## Recent deal example:

**Corporate:** EDP Renewables acquired 2 solar PV projects in Thuan Bac district from Xuan Thien Group, one of the main Vietnam renewable energy developers, for ~\$300M in 2022

## Most active investors<sup>2</sup>:



Notes: (1) Figures include private sector deal transactions >\$10M in size, including private placements and excluding IPOs. Figures refined from 2022 report using new allocation methodology. Amount not representative of overall private sector investment; (2) Based on deal volume from 2020–2022  
Sources: AVCJ; S&P Capital IQ; Preqin; Pitchbook

# Glossary of acronyms (1/2)

Acronym	Acronym	Acronym			
2W	Two-wheelers (e.g., motorbikes)	EJ	Exajoule	GtCO2e	Gigatons of CO2 equivalent emissions
4W	Four-wheelers (e.g., cars)	ELC	Economic land concessions	GW	Gigawatt
ACE	ASEAN Center for Energy	ESG	Environmental, social, and governance	GWp	Gigawatt peak
ACEN	ACEN Corporation (formerly AC Energy)	ESS	Energy storage system	H2	Hydrogen
ADB	Asian Development Bank	ETM	Energy Transition Mechanism	ha	Hectare
APAC	Asia-Pacific	ETS	Emissions trading scheme	HAPUA	Heads of ASEAN Power and Utilities/Authorities
ASEAN	Association of Southeast Asian Nations	EU	European Union	HVDC	High voltage direct current
B	Billion	EUR	Euro	I&C	Industrial and construction
BAU	Business-as-usual	EV	Electric vehicle	ICE	Internal combustion engine
BN	Brunei Darussalam	FAFD	Food, agriculture, and forestry division	ID	Indonesia
C&I	Commercial and industrial	FAME	Faster Adoption and Manufacturing of Electric Vehicles	ID-RECCO	International Database on REDD+ Projects
CAGR	Compound annual growth rate	FAO	Food and Agriculture Organization	IEA	International Energy Agency
capex	Capital expenditure	FDI	Foreign direct investment	IF-CAP	Innovative Finance Facility for Climate in Asia and the Pacific
CBAM	Carbon border adjustment mechanism	FFS	Farmer Field School	IoT	Internet of things
CCS	Carbon capture and storage	FiT	Feed-in tariff	IPCC	Intergovernmental Panel on Climate Change
CCUS	Carbon capture, utilization, and storage	FOLU	Forestry and other land uses	IRA	Inflation reduction act
CENIGA	National Center for Geoenvironmental Information	Forex	Foreign exchange	IRENA	International Renewable Energy Agency
CFPP	Coal-fired power plant	FSC	Forest Stewardship Council	IRR	Internal rate of return
CI	Charging infrastructure	G20	Group of 20	ISEAS	Institute of Southeast Asian Studies
CO2	Carbon dioxide	G7	Group of Seven	ISPO	Indonesian sustainable palm oil
COD	Commercial operation date	GDAM	Green Day Ahead Market	IT	Information technology
COP	Conference of the Parties	GDP	Gross domestic product	ITMO	Internationally transferred mitigation outcomes
COVID-19	Coronavirus disease 2019	GEF	Global Environment Facility	JETP	Just Energy Transition Partnership
CPPA	Corporate power purchase agreement	GHG	Greenhouse gases	k or K	Thousand
DACCS	Direct air capture with carbon storage	GIC	Government of Singapore Investment Corporation	KH	Cambodia
DASTA	Designated Areas for Sustainable Tourism Administration	GMS	Greater Mekong Subregion	KKR	Kohlberg Kravis Roberts & Co.
Decarb	Decarbonization	Gov	Government	km	Kilometer
DOE	Department of Energy	GS	The Gold Standard	KPI	Key performance indicator
E	Expected	GSTC	Global Sustainable Tourism Council	ktCO2e	Kilotons of CO2 equivalent emissions
EE	Energy efficiency	GTAM	Green Term-Ahead Market	kW	Kilowatt
EGAT	Electricity Generating Authority of Thailand	GtCO2	Gigatons of CO2 emissions	kWh	Kilowatt-hour

# Glossary of acronyms (2/2)

Acronym		Acronym		Acronym	
LA	Lao PDR	OECD	Organisation for Economic Cooperation and Development	TCO	Total cost of ownership
Lao PDR	Lao People's Democratic Republic	OGMP	Oil and Gas Methane Partnership	tCO2e	Tons of CO2 equivalent emissions
LCOE	Levelized cost of electricity	PALECO	Palawan Electric Cooperative	TGO	Thailand Greenhouse Gas Management Organization
LNG	Liquefied natural gas	PDP	Power development plan	TH	Thailand
LT-LEDS	Long-term low emissions and development strategies	PE	Private equity	TPES	Total primary energy supply
LTMS-PIP	Lao PDR-Thailand-Malaysia-Singapore Power Integration Project	PES	Payments for ecosystem services	T-VER	Thailand Voluntary Emission Reduction Program
LUCF	Land use change and forestry	PFES	Payments for forest environmental services	TW	Terrawatt
M	Million	PH	Philippines	UK	United Kingdom
MAS	Monetary Authority of Singapore	PPA	Power purchase agreement	UN	United Nations
MDB	Multilateral development bank	PPP	Public-private partnership	UNESCO	United Nations Educational, Scientific, and Cultural Organization
MEMR	Ministry of Energy and Mineral Resources	PRIME	Park Integrated Management System	US	United States
MFI	Microfinance institution	PV	Photovoltaic	USD	United States Dollar
MINAM	Ministry of Environment of Peru	Q	Quarter	USDA	United States Department of Agriculture
MM	Myanmar	R&D	Research and development	VALCOE	Value-adjusted levelized cost of electricity
MoU	Memorandum of understanding	RE	Renewable energy	VAT	Value-added tax
MPO	Managed phase-out	REDD	Reducing emissions from deforestation and forest degradation	VC	Venture capital
MRRP	Myanmar Reforestation and Rehabilitation Program	Regen	Regenerative	VCM	Voluntary carbon market
MRV	Measurement, reporting, and verification	RENAMI	National Registry of Mitigation Measures	VFDS	Vietnam Forestry Development Strategy
MtCO2e	Megatons of CO2 equivalent emissions	RSPO	Roundtable on Sustainable Palm Oil	VN	Vietnam
MW	Megawatt	SAF	Sustainable aviation fuel	VNTLAS	Vietnam Timber Legality Assurance System
MWac	Megawatt, alternating current	SBTi	Science based targets initiative	VPPA	Virtual power purchase agreement
MWdc	Megawatt, direct current	SEA	Southeast Asia	VRE	Variable renewable energy
MWh	Megawatt-hour	SG	Singapore	VSPP	Very small power producer
MWp	Megawatt peak	SINAC	National System of Conservation Area	YoY	Year-on-year
MY	Malaysia	SME	Small and medium-sized enterprises	yr	Year
NBS	Nature-based solutions	SMPEI	Sustainable Management of Peatland Ecosystems in Indonesia		
NDC	Nationally determined contributions	sq	Square		
NFMS	National Forest Monitoring System	SWF	Sovereign wealth funds		
NGCP	National Grid Corporation of the Philippines	T	Trillion		
NGO	Non-governmental organization	T-CER	Thailand Certified Emission Reduction		