INTERNATIONAL MONETARY FUND

ASIA AND PACIFIC DEPARTMENT

Asia's Perspectives on Climate Change

Policies, Perceptions, and Gaps

Prepared by Era Dabla-Norris, Thomas Helbling, Kenichiro Kashiwase, Giacomo Magistretti, and Mouhamadou Sy

DP/2023/008

DEPARTMENTAL PAPER

2023
NOV

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Cataloging-in-Publication Data
IMF Library

Names: Dabla-Norris, Era, author. | Helbling, Thomas, author. | Kashiwase, Kenichiro, author. | Magistretti, Giacomo, author. | Sy, Mouhamadou, author. | International Monetary Fund, publisher.
Title: Asia's perspectives on climate change : policies, perceptions, and gaps / Prepared by Era Dabla-Norris, Thomas Helbling, Kenichiro Kashiwase, Giacomo Magistretti, and Mouhamadou Sy.
Other titles: Policies, perceptions, and gaps. | International Monetary Fund. Asia and Pacific Department (Series).
Description: Washington, DC : International Monetary Fund, 2023. | Nov. 2023. | DP/2023/008. |Includes bibliographical references.
Identifiers: ISBN:
9798400254291 (paper)
9798400257148 (ePub)
9798400257018 (Web PDF)
Subjects: LCSH: Climate change mitigation—Economic aspects—Asia. | Climate change mitigation—Government policy—Asia. | Climate change mitigation—Planning—Asia.
Classification: TD171.75 .D3 2023

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Acknowledgments

The team was led by Era Dabla-Norris (Fiscal Affairs Department) and Thomas Helbling (Asia and Pacific Department), and comprised Kenichiro Kashiwase, Giacomo Magistretti, and Mouhamadou Sy (all from the Asia and Pacific Department of the IMF), under the general guidance of Krishna Srinivasan. The authors are grateful to a team who put together IMF country authority climate surveys, comprising Ritu Basu, Yan Carriere-Swallow, Era Dabla-Norris (lead), Kenichiro Kashiwase, Yosuke Kido, Cheng Hoon Lim (co-lead), Kevin Rivas, Mariam Souleyman, and Mouhamadou Sy; information technology assistance was provided by Kevin Bailey, and Kym Fisher; research assistance was provided by Ruihua Yang; production assistance was provided by Patricia Tanseco and Lorraine Coffey; and assistance with our original proposal was provided by Patricia Loo.

The paper reflects various IMF country staff reports based on discussions with country authorities and interlocutors in the private sector in bilateral surveillance of Asia and Pacific Department countries, and the authors are grateful to desk economists covering those countries mentioned in this report. The paper has also benefited from excellent comments from Ritu Basu, Yan Carriere-Swallow, Chen Chen, Hasan Dudu, Alberto Garcia, Fabien Gonguet, Chai Hua, Linda Kaltani, Koralai Kirabaeva, Grace Li, Anthony Liu, Yinqiu Lu, Margaux MacDonald, Natalija Novta, Jochen Schmittmann, Baoping Shang, John Spray, Vimal Thakoor, Nico Valckx, and Bruno Versailles.

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Executive Summary

Asia and the Pacific's green transition will have far-reaching implications for the global economy. Over the past decades, the region has become the engine of global economic growth. With relatively heavy reliance on coal and high energy intensity, the region has recently become the largest contributor to growth in global greenhouse gas emissions, accounting for nearly 40 percent of the total emissions in 2020. Achieving net zero by 2050 requires an energy transition at an unprecedented scale and speed, even as the region must ensure energy security and affordability. The region must also address its vulnerability to climate change as it comprises many countries highly exposed to climate hazards increasing in severity and frequency with global warming. If managed well, the green transformation in Asia and the Pacific will create opportunities for economies not only in the region but also around the world for inclusive and sustainable growth.

The global economy is still far from achieving net zero by 2050, and the Asia and the Pacific region must play its part to deliver on mitigation and adaptation goals. Understanding Asia's perspectives on the constraints and issues with climate ambitions, climate policy actions, and constraints is central for devising climate strategies to meet climate goals. To this end, this paper draws on novel surveys of country authorities and the public in the region to distill climate ambitions and challenges faced, and to identify sources of major gaps in achieving mitigation and adaptation goals. Measures to help close the gaps are drawn from policy discussions with country authorities in bilateral surveillance and related studies. Key policy recommendations include the following:

- Policymakers must adopt a holistic, multipronged approach to climate mitigation as all policies entail costs and benefits. Renewables are key to the energy transition, and they must be complemented by investments in energy efficiency, electrification, and other emerging green technologies along with infrastructures to address intermittency problems. Carbon pricing should ideally play a more central role in the policy mix as it contributes to synergies across policy instruments. To maximize the efficacy of carbon pricing, accompanying structural reforms are needed to ensure that price signals best align incentives of different economic agents. When carbon pricing is not feasible, alternative (but equivalent) approaches would be needed to achieve mitigation goals. Sectoral policies can fill in policy gaps, including feebates, fossil fuel subsidy reforms, carbon sink, and regulations (for example, energy efficiency standards).

- Managing potential side effects, such as rising energy costs for households and firms, labor displacement, and a regional disparity on transition impacts, will be equally important to ensure a just and durable transition. Recycling revenues from carbon pricing to cushion vulnerable groups can increase public acceptance of carbon pricing policies.

- Gaining public ownership of climate policies is key for reform durability and efficacy. Policymakers need to raise awareness of climate change impacts and how mitigation policies work. Educating the public about the benefits of acting now against the costs of inaction can garner public support for translating climate mitigation and adaptation strategies into necessary policies to realize climate goals.

- Asia and Pacific economies must build adaptive capacity, which urgently requires quantifying their investment needs as what is not measured is not funded. Comprehensive assessment of investment needs can lead to identification of viable and deliverable projects and determination of the underlying financing gaps that must be appropriately integrated into the medium-term fiscal frameworks. Strengthening climate public financial management and infrastructure governance can improve accountability of governments' actions.

- Mobilizing climate finance is paramount to realizing mitigation and adaptation goals. Revenue mobilization and spending prioritization and efficiency will help create domestic financing resources for this purpose, while easing growth-debt trade-offs. Concessional financing and grants made available by multilateral development banks and the international community offer alternatives to low-income countries with limited fiscal space. Unleashing substantial amounts of private capital will be critical to finance investments needs.
- Mobilizing private finance requires conducive business environments, underpinned by a sound climate ecosystem that maximizes opportunities for cross-border investments in the green transition, while minimizing risks of regulatory arbitrage and greenwashing. This involves establishing climate taxonomies, disclosure requirements, and regulations, harnessed by climate data, that meet international standards.
- The region's climate change mitigation needs have global implications. The region is at the forefront of innovation, production, and adoption of clean and low-emission technologies. Increasing concerns of geopolitical fragmentation and concentration of access to critical minerals underscore the importance of international cooperation to ensure that green technologies are made available to those in need, with technology transfer and financial assistance. While green industrial policy measures can promote state-driven structural transformation for the energy transition under nationally determined contributions, they should remain narrowly targeted to specific objectives and address market failures. Authorities should resist calls to use such tools to provide a competitive advantage to domestic industries.

1. Introduction

Asia and the Pacific is heavily impacted by, and greatly contributing to, climate change. The region comprises some of the largest greenhouse gas (GHG) emitters as well as countries most vulnerable to climate change. Temperatures are rising two times faster in Asia than the global average, increasing the frequency and severity of climate hazards. As such, climate change poses significant risks for lives and livelihoods, and clouds the region's long-term economic outlook, with significant global implications.

Governments in the region have stepped up their commitment to achieve net zero carbon emissions and have adopted a range of measures to tackle climate change. Virtually, all countries have made or updated commitments under the 2015 Paris Agreement, the landmark global agreement on GHG emissions reduction, and have announced numerous policies to lower the carbon intensity of their economies. The region is also at the forefront of green technology and innovative green financing and sees climate change as an opportunity to develop new drivers of growth and innovation. Many countries in the region are leaders in adaptation efforts, adopting and implementing frameworks for identifying, assessing, and reducing natural disaster risks.

As elsewhere, current goals and efforts in the region still fall short of what is needed to achieve the goal of limiting the increase in the global average temperature to well below 2 degrees Celsius above preindustrial levels. Despite the adoption of a variety of mitigation policies, such as carbon pricing and sectoral policies, large gaps remain as emission reduction goals and policies often fall well short of the emission reductions needed to achieve the overarching goals of the Paris Agreements. Closing these gaps requires fundamental changes in production and consumption patterns and the transformation of energy, transportation, and land use.

This paper has a dual purpose: it presents an overview of the current state of climate change goals, policies, and shortfalls in the Asia and Pacific region, and it brings a regional perspective on the issues. It aims to present an overview of country climate change strategies, achievements, and gaps to date. The paper draws on IMF surveillance to identify policy issues and offer policy recommendations, and it aims to provide a regional perspective on the policy debate, distilling views from policymakers and the public in the region. It also analyzes recent developments in green technologies in the region, given their central roles in climate change ambitions. The intersection of current trends and developments, and the views of country authorities and a larger public, should provide valuable insights on how to secure public support for climate change strategies and polices for a just and durable green transition.

The paper draws on novel country climate surveys to characterize authorities' perspectives and on perception surveys to reflect broader public views. The climate surveys were administered to country authorities and encompass mitigation, adaptation, and green finance issues (see Annex 1 and accompanying questionnaire). They allow for an assessment of how climate action plans under nationally determined contributions (NDCs) and national adaptation plans (NAPs) have been translated into supportive policies to achieve climate goals. They also help elucidate common themes across countries in the region, including key perceived trade-offs and opportunities from green transitions. The surveys also help gain better understanding of challenges confronted by the region's economies and identify policy gaps and areas for improvement. The paper also integrates key findings from recent public perception surveys of climate mitigation policies around the world (Dabla-Norris and others 2023).

The paper is structured into two main chapters. Chapter 2 focuses on climate mitigation. It lays out the landscape of emissions in the region, distills countries' ambitions and plans, highlights implementation gaps, and identifies key challenges reported by country authorities and compares them with public perceptions of

climate mitigation policies from the region. The chapter concludes with in-depth discussions of the policies needed to close ambitions and implementation gaps and deliver on country-specific and global climate goals. Chapter 3 discusses adaptation and ways to build resilience to climate change. It highlights the region's exposure and vulnerability to climate hazards; institutional frameworks and adaptation gaps (estimating investment needs, macro-fiscal frameworks, and risk-sharing mechanisms) to strengthen fiscal and social resilience. The chapter concludes with recommendations to build resilience and mobilize financing. Discussions of climate finance critical to achieving both mitigation and adaptation goals are integrated into the respective chapters. Finally, Chapter 4 draws conclusions from the key policy discussions in the paper.

2. Climate Change Mitigation

A. Asia and the Pacific in the Emissions Landscape

Rapid economic development in Asia and the Pacific has increased the living standards in the region and transformed it into the world's manufacturing hub. GHG emissions have increased substantially in the process and now account for about 40 percent of the global total, up from 20 percent three decades ago. Heavy reliance on coal as the primary source of secure and affordable energy has contributed to this outcome. Climate change mitigation poses a conundrum for the region, as it will need to reconcile the goals of economic development and GHG emissions reduction, with solutions likely impacting the global economy.

Rapid economic expansion in Asia and the Pacific has been underpinned by fast growth in energy use. In 2021, the Asia-Pacific region accounted for 40 percent of global GDP (in 2017 purchasing power parity dollars), up from 20 percent in 1990. Primary energy consumption in Asia-Pacific more than tripled in the same period. For instance, energy consumption in China was only one-third of the level of the United States in 1990, but it is now 70 percent higher than in the United States.

The region includes the biggest GHG emitters in the aggregate but not on a per capita income basis (Figure 1).

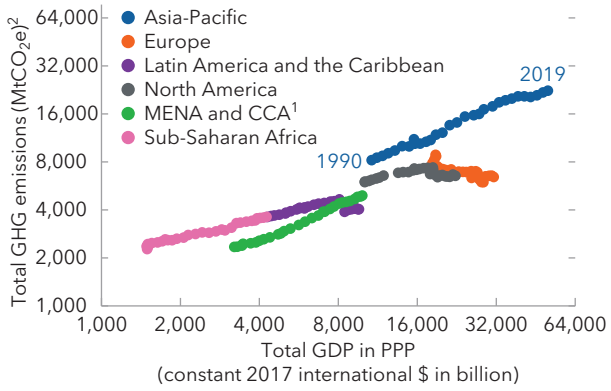
- China, India, Indonesia, Japan, and Korea are Asia's large five emitters ("the Big Five"), accounting for a third of the global GDP and 40 percent of global emissions in 2021, up from 20 percent in 1990. Primary energy consumption in the Big Five has nearly quadrupled, resulting in more-than-threefold increases in GHG emissions.
- While China and India are among the largest emitters in the world at the national level, their per capita emissions are still relatively low, with India ranked among the lowest in the Group of Twenty countries. In contrast, national emissions are low in Singapore and other Association of Southeast Asian Nations (ASEAN) economies, such as Malaysia and Vietnam. However, their per capita emissions are relatively high, with Singapore among the highest in per capita emissions from energy.
- Agriculture accounts for nearly 15 percent of the region's total GHG emissions, equivalent to 48 percent of the global emissions by the sector.

Economic growth in Asia and the Pacific continues to be energy- and emissions-intensive. In advanced economies (AEs) outside the region, growth has become less energy- and emissions-intensive, as the energy used to produce a given level of output has declined. In Asia, Japan is the only country where energy consumption has declined in the past two decades or so. Elsewhere in the Asia and the Pacific region, energy intensity remains high, and economic growth has not yet decoupled from growth in primary energy consumption. This fact highlights that reconciling the goals of further expanding economic growth and improving living standards with that of reducing GHG emissions could pose policy challenges.

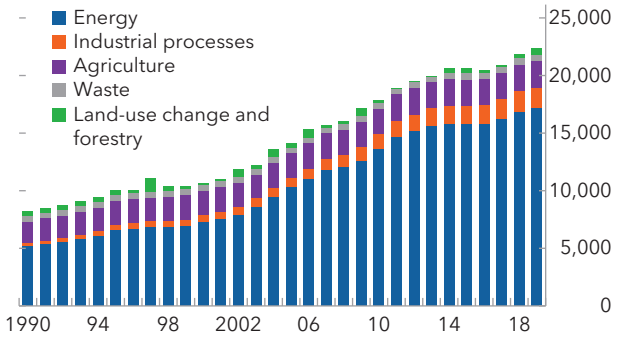
Countries in the region depend heavily on coal for energy production (Figure 2). Globally, the energy mix is skewed toward the use of oil (31 percent of the total), followed by coal (27 percent) and natural gas (24 percent). In contrast, coal accounts for nearly 50 percent of the region's energy mix (translating into nearly 80 percent of global consumption), compared to 10 percent in the rest of the world. Beyond global warming, GHG emissions from coal-based power generation and carbon-intensive manufacturing have also resulted in dangerously high levels of particulate matter in the air in the region.

Figure 1. Divergence in Economic Growth and GHG Emissions Driven by Energy Use

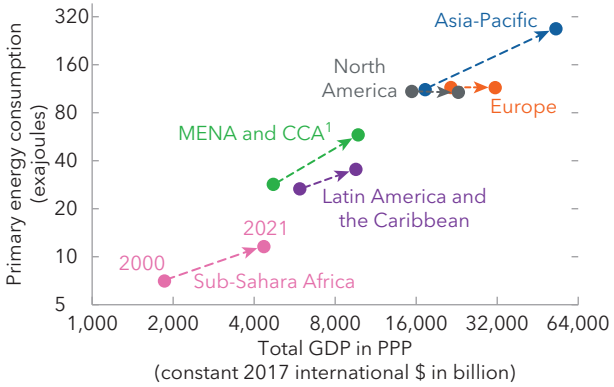
1. Evolutions of GDP and GHG Emissions by Region, 1990–2019
(Log scale, sum of the country value in each region)



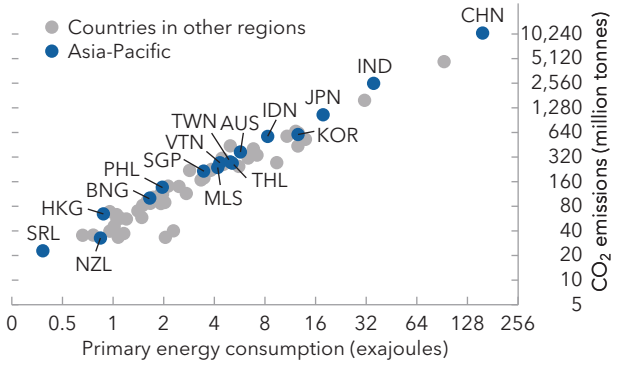
2. Asia-Pacific: GHG Emissions by Sector, 1990–2019
($MtCO_2e$)



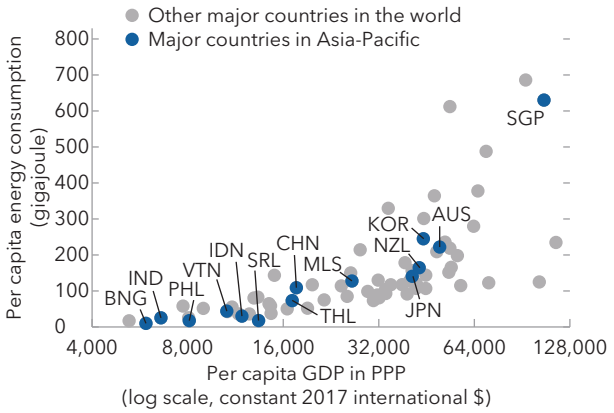
3. GDP and Primary Energy Consumption by Region, 2000 and 2021[3]
(Log scale, sum of the country value in each region)



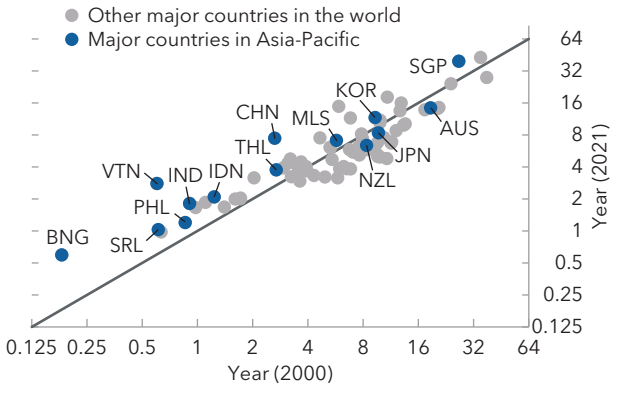
4. Primary Energy Consumption and CO_2 Emissions in Asia-Pacific, 2021
(Log scale)



5. Per Capita GDP and Energy Consumption, 2021
(Log scale)

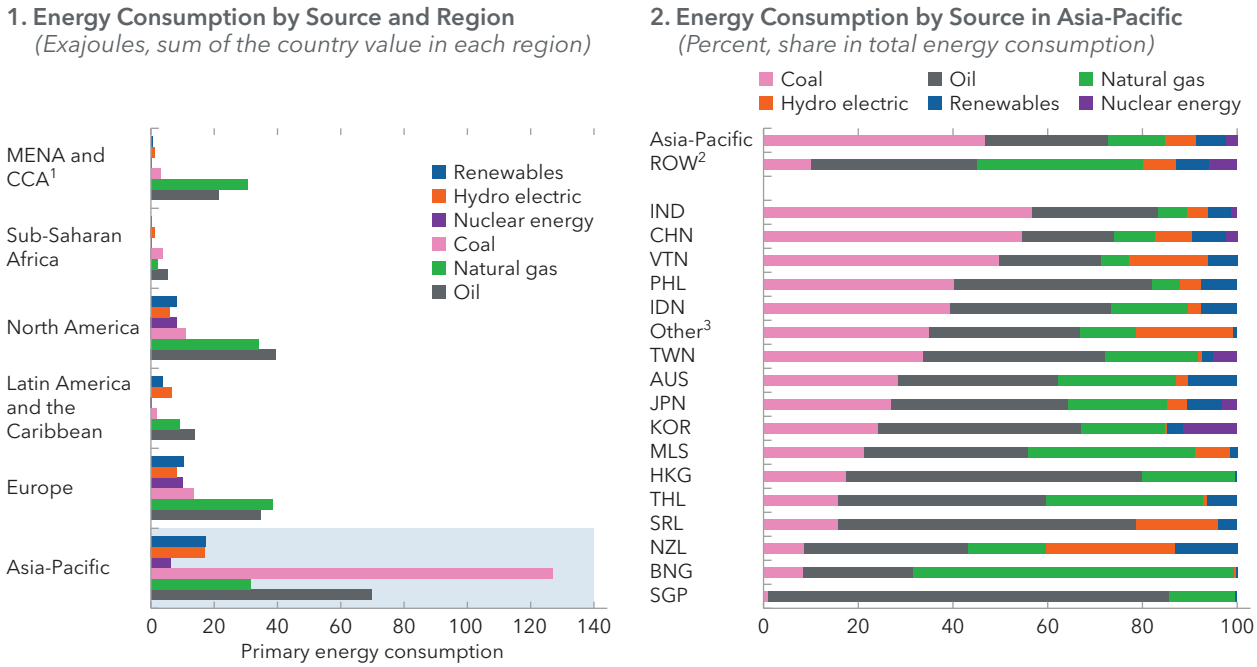


6. Per Capita CO_2 Emissions from Energy[4]
(Log scale, million tons of carbon dioxide)



Sources: BP Statistical Review of World Energy, 2022; Climate Watch Historical GHG Emissions, 2022; World Bank; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. CO_2 = carbon dioxide; GHG = greenhouse gas; $MtCO_2e$ = metric tons of carbon dioxide-equivalent; PPP = purchasing power parity.
[1]Including countries in Middle East and North Africa (MENA) and the Caucasus and Central Asia (CCA).
[2]The underlying data includes emissions from land use change and forestry.
[3]Primary energy consumption comprises commercially traded fuels, including modern renewables used to generate electricity
[4]CO_2 emissions reflect only those through consumption of oil, gas, and coal for combustion-related activities.

Figure 2. High Reliance on Coal but Less on Gas for Energy Consumption in Asia-Pacific, 2021



Sources: BP Statistical Review of World Energy, 2022; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1]Including countries in Middle East and North Africa (MENA) and the Caucasus and Central Asia (CCA).
[2]The rest of the world (ROW) excludes countries in Asia-Pacific.
[3]Other includes countries in the Asia-Pacific region that do not appear in the chart.

As the region has become the global manufacturing hub, it now accounts for the bulk of global production in some of the most emission-intensive economic sectors. The Big Five emitters, along with Australia and Vietnam, play critical roles in industrial production processes, converting raw materials into basic inputs for various industries and manufacturers in the world (Figure 3). More than two-thirds of the global supplies of crude steel, iron, cement, and aluminum are produced in Asia and the Pacific. Nevertheless, GHG emissions from these processes only account for about 8 percent of total emissions of the region, although such process emissions might be harder to abate (Annex 2).

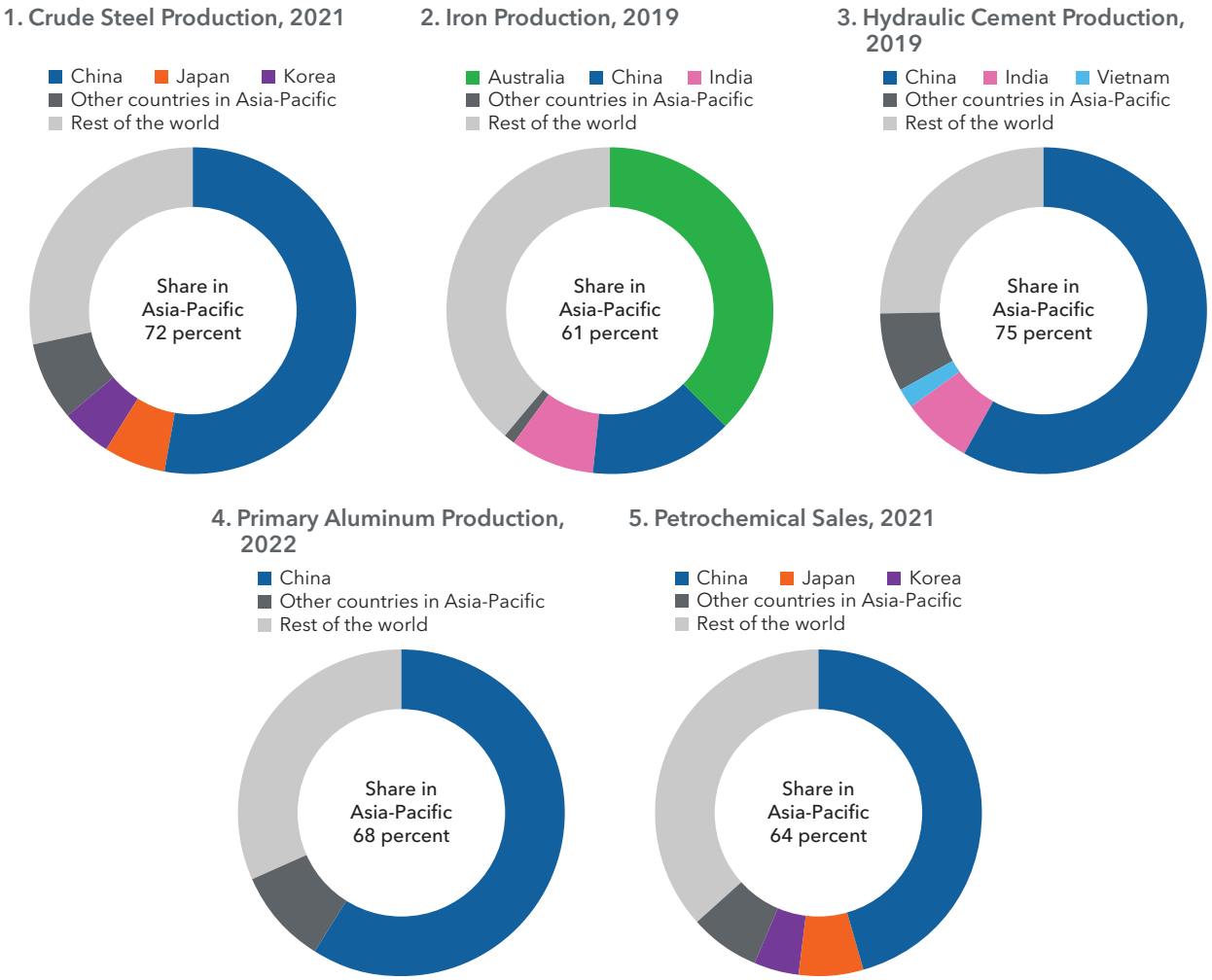
B. Pathways to Net Zero: Distilling Asia's Ambitions, Commitments, and Policies for Identifying Gaps

Since the adoption of the Paris Agreement in 2015, countries in Asia and the Pacific have submitted their climate ambitions and policy commitments in NDCs. Progress toward achieving the NDCs has been slow so far. Despite their efforts, the region still faces multiple gaps in policies, action, and financing. The first global stocktaking planned in late 2023 will evaluate the progress against the global targets and chart future pathways to achieve the goals.

A Synthesis of Climate Ambitions in the Region

Countries' NDCs reflect the strength of or ambition in their commitment to reducing GHG emissions (Figure 4). Since the adoption of the Paris Agreement in 2015, many countries in the region have issued and subsequently updated their NDCs, reflecting their jurisdictions' ambition to mitigate GHG emissions (Box 1). Their climate ambition can be characterized along several dimensions, including, for example, an end target to achieve the mitigation goal over the long horizon, a year by which the target needs to be

Figure 3. Asia's Contributions to the Global Production and Sales in Some Hard-to-Abate Sectors[1]
(Share in global production or indicated otherwise)



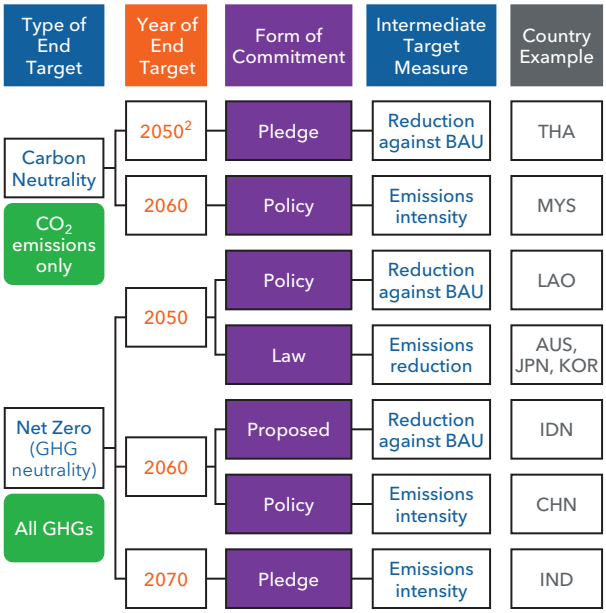
Sources: International Aluminum Institute; U.S. Geological Survey; World Bank; World Steel Association; and IMF staff calculations.
[1]The region's share is computed based on production levels for crude steel in million tons, iron, hydraulic cement, and aluminum in thousand metric tons, and on distribution of petrochemical sales worldwide in percent.

achieved, coverage of GHGs with treatment of carbon offsets, and an intermediate target to meet the end target. The end target can be broadly classified into two types, with "carbon neutrality" targeting on carbon dioxide (CO_2) emissions only and "net zero" targeting on GHG emissions more comprehensively. Achieving end targets in NDCs are not binding commitments since the agreement does not enforce countries to implement mitigation measures consistent with the targets. Hence, countries are free to choose the form and the level of commitments to realize the targets which can be a rhetorical pledge, integrated into policy documents, or binding legally. Intermediate targets are often quantified with numerical goals of emission (or carbon intensity) reductions against business-as-usual baselines or emission (or carbon intensity) levels prevailed in specific years.

Climate ambition and commitment vary across countries, reflecting the stage of economic development, *speed of energy transitions*, *political constraints*, and *national consensus*. The end targets in AEs are typically grounded in net zero emissions by 2050 in line with the Paris Agreement, and they have codified the net zero end target in law. The respective intermediate targets are usually more narrowly focused on emissions reduction goals. They tend to have specific mitigation measures in place to achieve the targets.

In contrast, ambition and commitment in the region's emerging market and developing economies (EMDEs) vary considerably, with targets formulated differently in sector and gas coverage and some developing economies explicitly counting on international assistance to reduce emissions. Large differences prevail even among the Big Five emitters. Overall, there remains scope for countries to deliver ambitious actions, requiring higher ambitions with strong and credible commitments that implement mitigation measures to realize the Paris Agreement.

Figure 4. Variability of Climate Ambition and Commitment in Asia-Pacific[1]



Sources: Country Climate Surveys 2022; and The Net Zero Tracker.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. BAU = business as usual; CO_2 = carbon dioxide; GHG = greenhouse gas.
[1]Countries shown in this figure are the ones responded to the country climate surveys and large GHG emitters. Colors on the left and right panel correspond to each other.
[2]Thailand committed to reach net zero GHG emissions by 2065, following the target of carbon neutrality by 2050.

An Overview of the Current State of Mitigation Policies in Asia and the Pacific

Mitigation policies in Asia and the Pacific comprise a range of instruments. The country climate surveys show that countries in the region have adopted a multipronged policy approach to climate mitigation. They apply a variety of market-based instruments, sectoral policies, regulatory policies, and other policies for carbon removal (Table 1). Nearly all responding economies indicated reliance on the deployment of green technologies through means other than carbon pricing and other market-based instruments. Some countries (Australia, Cambodia, Japan, Malaysia, Thailand) noted that their policy approach to promote green technologies was still under development (Annex 2). Australia and Thailand stated that their current policy mix may be insufficient to achieve their end targets, and new technologies could help fill gaps, including through the use of carbon capture, utilization, and storage (Thailand).

Market-Based Policy Instruments

Momentum in the use of carbon pricing instruments is growing in the region but implementation has been slow to date. Several countries have introduced an emissions trading system (ETS), under which firms can trade their allowances for CO_2 emissions at market prices. For instance, Korea has launched a national ETS, while China and Indonesia have launched a mandatory, intensity-based ETS for the power generation sector (Box 2). Japan and Singapore have a carbon tax in place. These carbon pricing measures globally cover more than 40 percent of total GHG emissions in 2021, with China's ETS currently being the single largest carbon pricing instrument in the world (OECD 2022). Some countries (Vietnam) have committed to implementing an ETS in the near future.[1] India is designing a carbon credit trading scheme. Some emerging markets (Malaysia, Philippines, Thailand) are conducting feasibility studies for carbon-pricing implementation, and other ASEAN countries (Brunei Darussalam, Cambodia, Lao P.D.R.) are similarly considering its implementation (Andriansyah and Hong 2022).

[1] In November 2017, the National Assembly of Vietnam adopted legislation establishing a mandate for the Ministry of Natural Resources and Environment to design a domestic emissions trading market (https://icapcarbonaction.com/en/news/new-law-vietnam-creates-mandate-ets).

Table 1. Selection of Policy Instruments to Achieve Emissions Reduction

	A. Market-Based Instruments					B. Technology, Low Emission Infrastructure, and Green Finance							C. Regulations		D. Carbon Sinks	
	Carbon Tax	ETS	Feebates	Fossil-Fuel Subsidy Reforms	Others[1]	Already Available	Not Yet Available	Renewables	Technology Transfer and Financial Support by AEs	Low Emission Infrastructure	Grants, Subsidies, and Other Financial Incentives to Promote R&D	Green Finance	Regulations for High Emissions Activities	Other Regulations	Afforestation	Natural Capital Conservation
Australia			☑		☑	☑	☑	☑	☑		☑	☑		☑		
Hong Kong SAR												☑				
Japan	☑	☑	☑		☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑
China		☑						☑								
Malaysia	☑		☑			☑	☑	☑		☑		☑				
Thailand		☑				☑	☑	☑	☑			☑			☑	
Cambodia		☑			☑	☑	☑	☑	☑	☑		☑	☑		☑	
Lao, PDR				☑		☑		☑				☑			☑	☑

Source: Country Climate Surveys 2022.

Note: AEs = advanced economies; ETS = emissions trading system; R&D = research and development.

[1]Include the Emission Reduction Fund and the safeguard mechanism for Australia under which companies have emissions limits and purchase credits if they exceed them, carbon credit for Japan, and renewable energy certificates for Thailand.

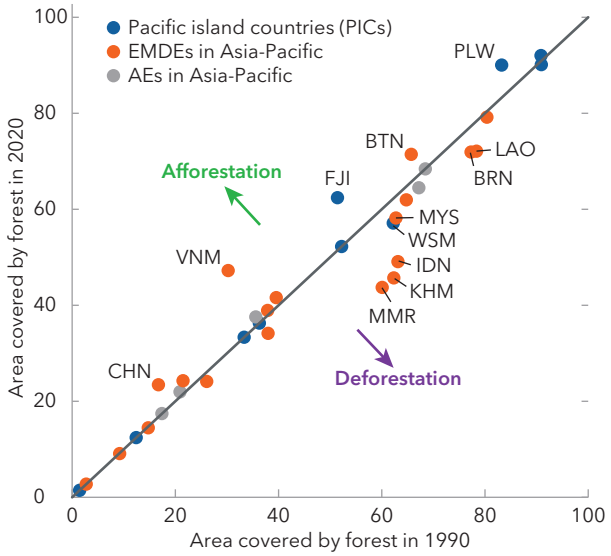
Sectoral Policies

Feebates are increasingly used in the region. Feebates are revenue-neutral and can find a wide range of applications, including in transportation, power, industry, buildings, forestry, and agricultural sectors (Parry 2021b). They impose a sliding scale of fees or rebates for particular products and activities above or below certain emission rates. A number of countries (Australia, Japan, Malaysia) identify feebates as a policy option for mitigation, particularly to promote purchases of electric vehicles (EVs). Australia (applicable to the Australian Capital Territory), Japan, Singapore, and Thailand currently have taxes determined by vehicle fuel consumption or CO_2 emissions. In Singapore, the Enhanced Vehicular Emissions Scheme defines a rebate or surcharge rate based on emissions standards. China offers a tax discount for purchase of efficient vehicles.

Oher sectoral policies broaden the scale and the scope of emissions reduction under NDCs. Some policy and reform measures include:

- **Fuel and energy subsidy reforms.** A number of countries in the region continue to have fossil fuel subsidies in place. Nevertheless, the country climate surveys show that Lao P.D.R. and the Philippines consider subsidy reforms as part of the mitigation policy mix.
- **Energy efficiency and clean cooking.** India has implemented an economy-wide Unnat Jyoti by Affordable LED for All program that installs LED bulbs to reduce energy intensity[2] and is promoting clean cooking fuels. In Korea, a stricter energy conservation design is applied to new structures and targeted industries for retrofitting. Indonesia requires all companies to develop an energy conservation plan, which allows implementation of energy audits and tradable energy savings certificates in emitting sectors.
- **Carbon sink** is another mitigation measure identified by countries in the region, as many countries have experienced rapid deforestation, exacerbating net emissions of CO_2 (Figure 5). The country climate surveys show that Cambodia, Japan, Lao P.D.R., and Thailand consider afforestation an important policy instrument in their policy mix. In Indonesia, the authorities target forest management (lower rates of deforestation coupled with reforestation efforts) and land use in the country's 2022 enhanced NDC to limit GHG emissions. Vietnam is also one of the few countries where a forest transition has taken place with direct government interventions (Meyfroidt and Lambin 2008).

Figure 5. Deforestation and Afforestation in Asia-Pacific, 1990–2020
(Share of land area covered by forest, percent[1])



Sources: Forest Resources Assessment 2020; Our World in Data; and UN Food and Agriculture Organization.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. AEs = advanced economies; EMDEs = emerging market and developing economies.
[1]Country names are indicated when the share has either increased or decreased by around 5 percent or more between 1990 and 2020.

Promoting Technology-Based Solutions

The region is at the frontier of green technology adoption and innovation (Annex 2), aided by government strategic directions and policies.

[2] It is estimated that over 368.6 million LED bulbs have been sold, resulting in an annual savings of 47.87 billion kilowatts of electricity and annual emissions reduction of 38.78 metric tons of CO_2.

Table 2. Country Views: Factors to Promote Renewables and Green Technologies

	AUS	KHM	JPN	LAO	MYS	THA
Targeted subsidies to industries to develop technologies			√		√	√
Tax incentives for R&D	√		√			√
Imports of new technologies developed by other countries	√	√		√		√
Commitment for support by AEs to transfer technology	√	√			√	
Other factors:						
Loans and equity investments by government agency	√					
Grants by government agency	√					
International financial assistance						√
Collaboration with key partner countries	√					
Development of clean energy supply chains	√					
Bilateral and international partnerships and multilateral fora	√					

Source: Country Climate Surveys 2022.

Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. AEs = advanced economies; R&D = research and development.

- China has used government policies to support the domestic solar industry, including subsidies (for example, a multi-tiered feed-in tariff system across different regions) and tax incentives (Black and others 2023). The Made in China 2025 plan promotes the use of domestic content of core materials to 70 percent by 2025, bolstering production of alternative fuel vehicles and other strategic sectors.
- India established the National Solar Mission in 2010 to promote solar power with specific targets to increase its generation capacity over time, with production-linked incentive schemes that provide government support to promote domestic manufacturing of batteries and solar panels.

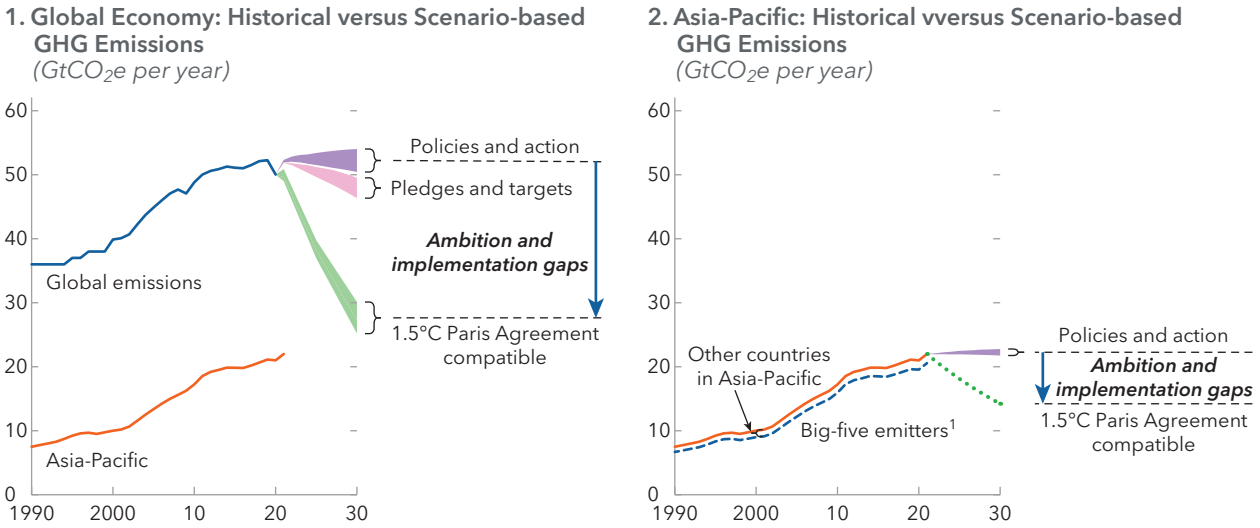
The country climate surveys also show that Japan, Malaysia, and Thailand see a key role for targeted subsidies to industries for developing and deploying low carbon technologies (Table 2). Australia, Japan, and Thailand identified tax incentives for research and development and innovation as important for accelerating the green transition. Some EMDEs in the surveys point to the importance of technology transfer and diffusion.

Ambition and Implementation Gaps[3]

Climate ambitions, commitments, and policies will be evaluated against the global climate goals at the first-ever global stocktaking in late 2023. The twenty-eighth UN Climate Change Conference of the Parties (COP28) in Dubai is expected to conduct a review—the first global stocktaking—of the collective progress made toward meeting the goals of the Paris Agreement. The 2022 assessment of the NDCs by the UN Environment Programme (UNEP) indicated an immense emission gap between where GHG emissions are predicted to be in 2030 and where they should be, with no credible pathways yet to close the gap to achieve the temperature goal of the Paris Agreement (UNEP 2022).

[3] The Intergovernmental Panel on Climate Change, the UN body for assessing the science related to climate change, defines and assesses two types of gaps (IPCC 2022), including an implementation gap between implemented policies and NDCs (median) and an emissions gap between NDCs and pathways limiting global warming to specific levels (for example, 1.5 degrees Celsius). We call the latter "ambitious gap," following Black and others (2021).

Figure 6. Large Ambition and Implementation Gaps Remain, Both Globally and in Asia and the Pacific



Sources: Climate Analytics and NewClimate Institute, Climate Action Tracker; and IMF staff calculations.
Note: GHG = greenhouse gas; $GtCO_2e$ = gigaton of carbon dioxide equivalent.
[1]"Big-five emitters" include China, India, Indonesia, Japan, and Korea.

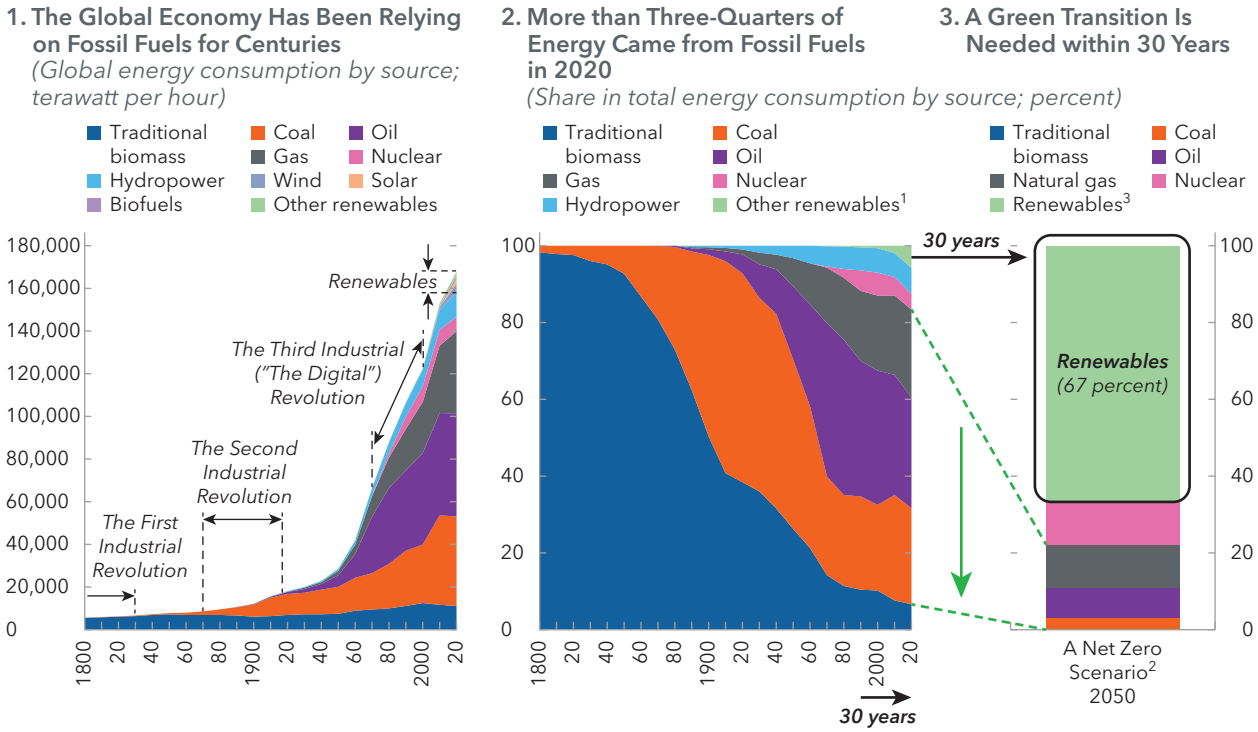
The Asia-Pacific region must substantially cut GHG emissions in 2030 to achieve Paris temperature goals. A 2022 UNEP assessment shows that the global economy would need to reduce GHG emissions by 45 percent from the 2021 levels by 2030. Another study estimates a required range of 25 to 50 percent below 2021 levels by 2030 (Black and others 2021). Such reductions are substantial by recent historical standards. Illustratively, if the emission reductions would be achieved equiproportionally across regions, the Asia and Pacific region would need to reduce its emissions by around 10 gigatons of CO_2 equivalent by 2030, implying substantial cuts in the consumption of coal, oil, and natural gas combined.

Despite updates to NDCs with higher ambition in countries in the Asia and Pacific region, goals and policies still leave large implementation gaps in 2030, making it difficult to achieve net zero by 2050. Despite higher ambitions in the region and elsewhere, the UNEP assessment validated little progress made to reduce the implementation gap since COP26 in 2021. Updates to NDCs since COP26 are expected to reduce GHG emissions by an additional 0.5 gigaton of CO_2 equivalent, mainly resulting from more ambitious targets announced by Australia, Indonesia, and Korea. However, irrespective of the distribution of the emission reduction by country regions, it is reasonable to conclude that most countries in the region still face large implementation gaps and must reduce GHG emissions in 2030 by more than what is implied by current targets (Figure 6).

C. The Challenges in Addressing Mitigation Gaps—An Asian Political Economy Perspective

Achieving the goals of the Paris Agreement will require a radical transformation of economies and societies, including a dramatic energy transition. Country authorities and the public must work together in this green transition. Country authorities need to ensure a just transition, realize co-benefits of policy reforms, and reach out to the public to communicate the benefits and garner its support for policy implementation. Gaining the public ownership of the reform programs is indispensable to promoting behavioral changes and ensuring durability of the reforms over the long haul.

Figure 7. Global Energy Transitions Have Been Slow, but the One Coming Must be Fast



Sources: BP Statistical Review of World Energy; IEA (2021a); Our World in Data on Vaclav Smil (2017); and IMF staff calculations.
[1]Includes wind, solar, biofuels, and other renewables.
[2]"Net Zero by 2050" is a scenario assuming net zero emissions by 2050, envisaged by the International Energy Agency.
[3]Includes hydropower, wind, solar, biofuels, and other renewables.

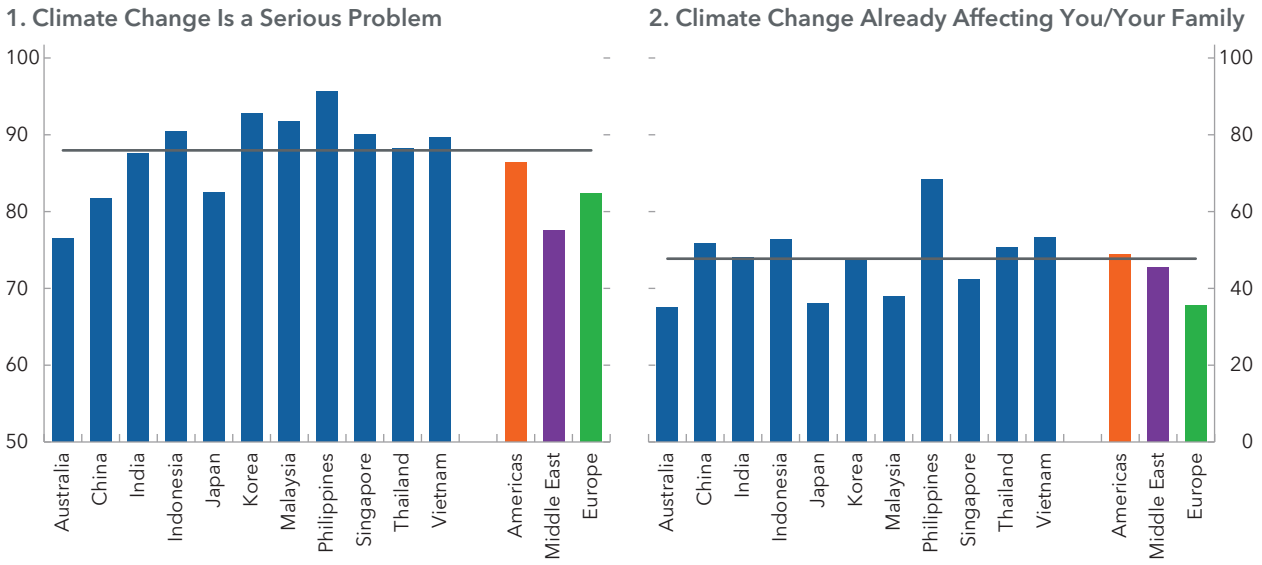
Achieving net zero by 2050 will require dramatic energy transitions across the world, and Asia will have to play its part. The goal of reducing GHG emissions and reaching net zero is expected to change the energy mix at historical scale and speed, with reliance on fossil fuels declining to around 20 percent of total energy (Figure 7).[4] The green transition needed within 30 years will require enormous investments and fundamental changes in energy consumption and production patterns around the world. Behavioral changes will have to play a critical role, as the energy transition requires awareness of mitigation needs and active participation by household and firms (IEA 2021a). Policy measures are also needed to shape incentives (Box 2). Raising the carbon price would create incentives for firms and households to use energy more efficiently and encourage a shift to renewables in the region. Since carbon pricing might not be feasible in all countries, alternative (but equivalent) approaches would be needed to achieve net zero, such as feebates, energy efficiency standards, regulations, or green subsidies, possibly applied to specific sectors like industry, power, buildings, forestry, and extractives.

Perceived Challenges to Achieving Net Zero

Both country authorities and the public in the region acknowledge the imminence of climate change and the need to change behaviors. As damaging consequences of climate change are becoming more apparent, governments and the public overwhelmingly perceive climate change as a threat (Figure 8; Box 4). A recent cross-country study on public perceptions of climate mitigation policies (Dabla-Norris and others 2023) shows that 85 percent of the respondents across the globe recognize climate change as a serious problem, and almost half of the sample reports a personal experience of climate change impacts. This concern is even

[4] The International Energy Agency's net zero emissions scenario assumes that carbon prices, differentiated by climate ambition and income levels, must increase to the range of $25 to $140 per ton by 2030, including to incentivize adoption of green technologies.

Figure 8. Feeling the Imminence of Climate Change
(Percentage of respondents)



Sources: IMF Public Perception Survey; and IMF staff calculations.
Note: The horizontal line denotes the average value across Asia-Pacific countries. Bars for Americas, Middle East, and Europe correspond to regional averages. Americas include Argentina, Brazil, Canada, Colombia, Mexico, and the United States. Middle East includes Egypt and Saudi Arabia. Europe includes France, Germany, Italy, the Netherlands, Norway, Poland, Spain, Türkiye, and the United Kingdom.

higher, on average, in the 11 countries surveyed in the region.[5] Around 80 percent of the region's respondents (75 percent in the rest of the world) report that they are willing to reduce energy consumption to help address climate change.

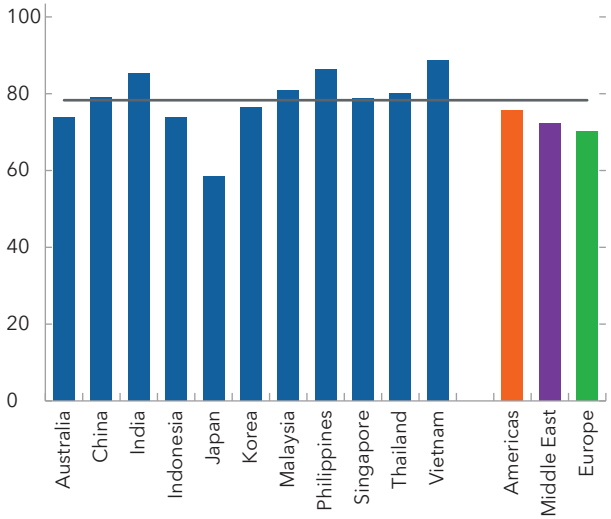
Despite general public awareness and support, governments in the region point to political economy constraints as a major impediment to implementing climate mitigation policies. Despite recent updates to NDCs, as elsewhere in the world, governments in Asia identify the lack of public support as one of the main factors preventing them from taking more forceful action on climate mitigation. For instance, Australia and Cambodia point to political infeasibility as a key reason for shying away from a carbon tax in the country climate surveys. Political constraints in terms of opposition from industry groups (Cambodia, Malaysia, Thailand), labor unions (Japan), consumer groups (Cambodia), and lack of consensus in parliament (Indonesia, Malaysia) are also cited as factors preventing the implementation of climate mitigation policies.

Despite government concerns, the public in Asia appears more supportive of climate mitigation policies than expected. For instance, 78 percent of respondents in the Asia-Pacific countries support the introduction of either subsidies to renewable energy, a carbon pricing mechanism, or emission regulations—an even larger share than the 72 percent observed in the rest of the world (Figure 9). In terms of individual policies, subsidies to renewable energy are the most preferred option (64 percent support in Asia-Pacific, 60 percent in the rest of the world). Support for carbon pricing and emission regulations is somewhat limited (58 percent and 52 percent, respectively) but significantly higher in Asia-Pacific than in the rest of the world (45 percent and 42 percent, respectively).[6]

[5] When comparing results in the IMF Public Perception Surveys across countries, it is important to recognize that, by being conducted online, the surveys may not be equally representative in countries with different internet penetration and overall level of development. To alleviate this concern, all results presented in this paper are adjusted using sample weights that balance each country's sample with the whole population by age, gender, education, regional profiles, employment, and socioeconomic status. See Dabla-Norris and others (2023) for details.

[6] High support for subsidies is often due to poor understanding of the fiscal costs entailed by this policy (Dabla-Norris and others 2023).

Figure 9. Support for Climate Mitigation Policies[1]
(Percentage of respondents)



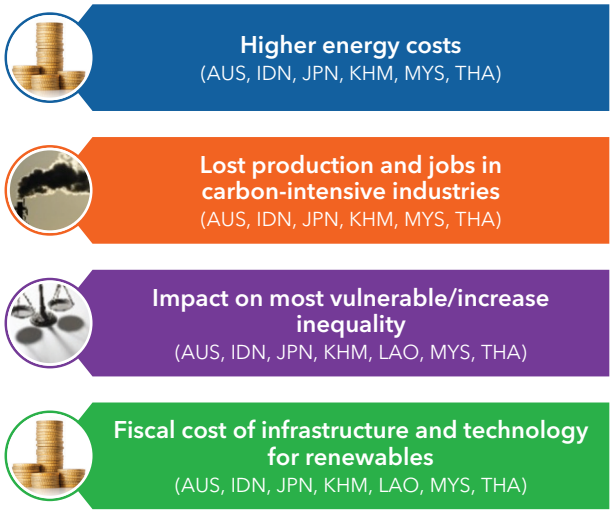
Sources: IMF Public Perception Survey; and IMF staff calculations.
[1]Shares are calculated on the sample of respondents who oppose carbon pricing. Multiple answers were possible.

Some obstacles in implementing mitigation policies identified by country authorities resonate with public opinion in the region. Governments in the region are concerned about the socioeconomic consequences of mitigation policies. Top concerns are higher energy costs and the growth impact from lower production in carbon-intensive industries, which also resonates with the public (Figure 10). High on authorities' and citizens' lists of concerns are also the distributional implications of climate mitigation policies. The country climate surveys indicate that governments in almost all countries mention the impact on vulnerable households as a major obstacle to implementing mitigation policies, particularly carbon pricing. This is consistent with concerns expressed by respondents from the public perception surveys, who identify low-income households as the group that will lose the most from a carbon pricing policy.[7]

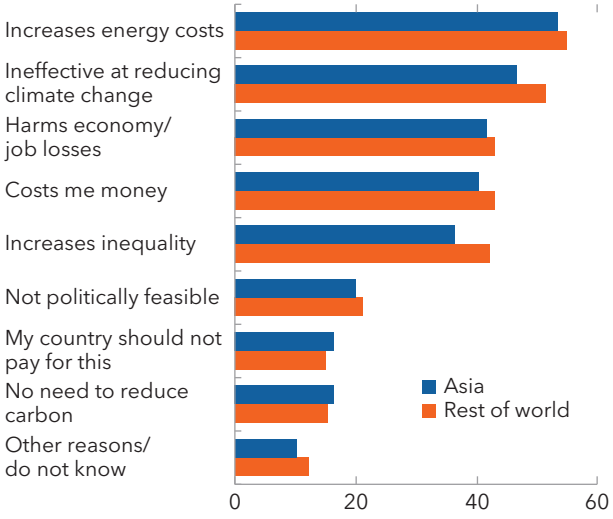
While the broad public supports multilateral actions to achieve mitigation targets, country authorities point to limited international collaboration as a key obstacle. The call for multilateral actions emerges unequivocally from the public perception surveys in both AEs and EMDEs. For instance, 64 percent of respondents

Figure 10. Domestic Roadblocks in Implementing Mitigation Policies–Authorities and Public Perspectives

1. Main Domestic Obstacles for Authorities



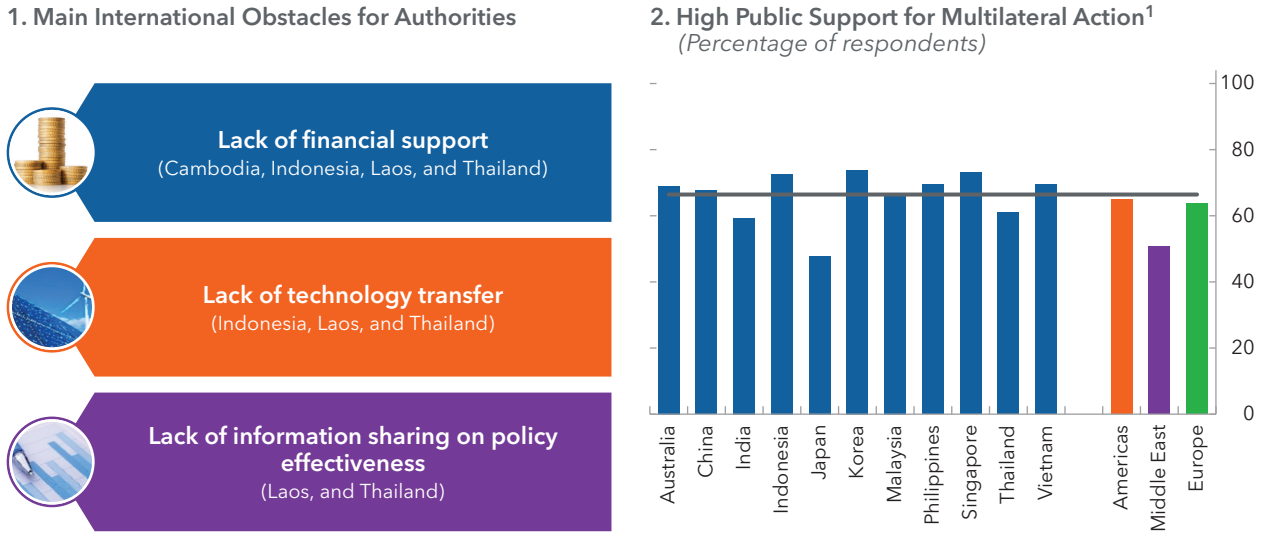
2. Reasons for People to Oppose Carbon Pricing[1]
(Percentage of respondents)



Sources: Country Climate Surveys 2022; IMF Public Perception Survey; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1]Shares are calculated on the sample of respondents who oppose carbon pricing. Multiple answers were possible.

[7] In the public perception surveys, 23 percent of respondents in Asia and the Pacific stated that low-income households would lose a lot from a carbon pricing policy, with 11 percent saying so for middle-income households and only 6 percent for high-income households.

Figure 11. International Cooperation in Mitigation–Obstacles and Public Opinions



Sources: Country Climate Surveys 2022; IMF Public Perception Survey; and IMF staff calculations.
Note: For details on the format and sample composition in panel 2, see Figure 9.
[1]Share of responses who agree with the statement "All countries should contribute to reduce carbon emissions, not only rich countries."

(66 percent in Asia-Pacific) think that all countries, not only rich countries, should be paying to reduce carbon emissions (Figure 11). Moreover, a vast majority (69 percent globally, 70 percent in Asia-Pacific) believe that climate change policy will only be effective if most countries adopt measures to reduce emissions. However, the country climate surveys point to concerns about limited financial support (Cambodia, Indonesia, Lao P.D.R., Thailand) and lack of technology transfer (Indonesia, Lao P.D.R., Thailand) from AEs.

Transition risks stem from fiscal costs of green transitions, limited access to finance (Annex 3), and structural impediments to deliver decarbonization. The country climate surveys highlight strong concerns about higher economy-wide and sector-specific production costs, and possible social unrest from employment losses. Regulatory and supervisory frameworks to assess and address climate-related risks are widely acknowledged as gaps. Likewise, addressing financial risks of stranded assets in fossil fuel and carbon-intensive industries is also noted as a key challenge. Virtually all countries in the surveys expressed concerns about the budgetary costs of acquiring the necessary infrastructure and technology to support energy transitions, with governments in EMDEs emphasizing limited market access (Cambodia, Lao P.D.R.) and high upfront costs of securing green finance (Indonesia, Lao P.D.R., Malaysia, Thailand). Finally, structural impediments, including lack of technical capacity and expertise (Australia, Thailand), were also identified as key challenges.

Understanding of Opportunities from the Green Transition

Despite implementation challenges, both the authorities and the public in the region see opportunities in the transition to net zero. The country climate surveys point to a widespread acknowledgment that the green transition will reduce climate change risks and create co-benefits, including improved health outcomes, enhanced conservation of natural capital, the creation of green jobs, and improved quality of economic growth (Figure 12). This recognition is aligned with the public's perceptions of climate mitigation policies (Dabla-Norris and others 2023). Both the authorities and the public also agree that revenues from carbon pricing can be recycled for socially desirable purposes. A plan by Thai authorities to reinvest some of the ETS proceeds into social safety nets resonates well with the 51 percent of Thai respondents in the public perception surveys who would support carbon pricing polices if revenues were used to help low-income households cope with the higher costs of living. Reinvestment in climate-related projects and general

Figure 12. Opportunities from the Net Zero Transition

Source: Country Climate Surveys 2022.
Note: Most selected answers to the question: "As the country makes a transition to net zero and a greener economy, which major opportunities is the transition likely to bring over time?"

social services such as health and education are also popular public choices that could increase support for carbon pricing policies in the region.

Overall, general public support for climate mitigation polices may be higher than perceived by authorities, but more needs to be done to build support for specific measures. Although the results of the public perception surveys paint a somewhat rosier picture of people's support for climate mitigation policies in the region than expected, more needs to be done to align people's views with governments' objectives and climate experts' recommendations. Filling information gaps (Box 4) is a priority to garner support for key policies, such as carbon pricing, which are integral parts to the solution of the policy trilemma of meeting climate goals, designing politically feasible policies, and preserving debt sustainability (IMF 2023c). Highlighting policy co-benefits and carefully designing policy packages aligned with people's preferences would also be important to foster buy-in by the public.

D. Closing Ambition and Implementation Gaps

Governments in the region need a multipronged approach to close the still-sizable ambition and implementation gaps to avoid costly delays in achieving global temperature goals. This subsection first identifies sources of major gaps and discusses key policies that can help close the gaps, drawing on the policy discussions with country authorities in bilateral surveillance,[8] the analysis of the country authority and public perception surveys of climate mitigation issues, and related studies. An important implication from the surveys is that country authorities should address distributional implications of the green transition, by providing targeted support to households and firms as needed.

Identifying Sources of Major Gaps

Carbon pricing has remained low, and its effectiveness limited so far. In order to contain global warming to the target levels of the Paris Agreement, substantial declines in CO_2 emissions are needed. As discussed in the previous section, momentum for introducing carbon pricing, particularly an ETS, is growing. However, the level of carbon prices in the region remains low, contributing to its limited effectiveness.

Structural factors limit the effectiveness of carbon pricing. For instance, generous allocation of free allowance, intensity-based permits (as opposed to absolute caps on emissions), and ex post adjustments on emissions are impediments to realizing the benefits of an ETS. In some countries, the ETS is limited to the power sector, reducing the effectiveness in controlling emissions. In other cases, state-owned enterprises are allowed to set administrative energy prices, thereby limiting incentives for the power sector to adopt renewables, and the scope for ETS-implied carbon prices to be passed on to downstream sectors and for consumers to internalize the cost of decarbonization. In other countries, the domestic electricity market is segmented, with limited output sold at market prices. Finally, existing fuel duties in many countries are fragmented.[9]

[8] Specifically, the section covers policy recommendations in recent IMF country reports, primarily of the large five emitters in Asia.

[9] Fuel excises, an implicit form of carbon pricing, are in place as an important revenue source for a number of countries in Asia-Pacific, although they are not necessarily formulated based on carbon content.

The region still lags behind the levels of technology penetration and green finance needed to achieve net zero by 2050. Some countries in the region possess sizable market shares in manufacturing green technologies and are at the global frontier of technology innovation (Annex 2). Nonetheless, progress toward mitigation targets appears slow, and the region as a whole is behind where it should be to achieve net zero by 2050. While costs of renewables (for example, solar photovoltaic and onshore wind) have come down, a price tag of replacing existing coal-fired power plants remains expensive when investment costs of infrastructure in grid networks and storage facilities are considered. Gaps in access to green finance at affordable prices are another critical factor making it difficult for EMDEs to make green transition needed to achieve mitigation goals. Limited data and climate disclosure exacerbate the gap, inhibiting investors from assessing risk-return trade-offs (Annex 3).

Pervasive gaps in public investments constrain benefits of clean technologies. The country climate surveys highlight limited reliability of renewables as a key impediment to expand its adoption (China, Japan, Malaysia, Thailand). While renewable electricity capacity has increased across the region, investments in distribution networks for connection and storage capability for improving reliability are lagging and will be needed to complement the investments in renewables (Box 3). Ensuring long-term energy security with renewables, while transitioning away from fossil fuel imports, will take time.

Seeking Policy Complementarity and Reform Durability

Making the Best Use of Carbon Pricing in a Tailored Approach

A holistic, multipronged approach is needed to make the best use of the carbon pricing tools. Carbon pricing remains one of the most efficient policy instruments to reduce emissions (Box 2). However, its effectiveness depends on the underlying market structure and its mechanism and must be enhanced over time. The policy mix should be tailored to the country context, seek complementarity, and maximize the policy's effectiveness for mitigation goals (Table 3).

The implementation of carbon pricing is not a panacea to GHG reduction and needs to ensure the effectiveness of the underlying market mechanisms. Consideration should be given to partial or full auctioning of allowances (IEA 2021c), which would enhance the ETS effectiveness while promoting low-carbon investments (for example, in China). Broadening coverage of carbon pricing can address existing market fragmentation and gain in efficiency and effectiveness. Deregulating electricity markets, however popular, needs to be pursued carefully since its cost may outweigh some of the benefits if it increases market concentration (MacKay and Mercadal 2022). Choosing appropriate pricing measures (carbon tax and ETS) is also critical. Political economy considerations would prefer ETS (with permits freely allocated to affected firms) to carbon tax, although the latter offers significant practical advantages as it covers broader emissions sources and helps promote investment and revenue recycling, with ease of administration (Parry, Black, and Zhunussova 2022).

A credible future trajectory of carbon prices must be communicated well to the public to provide incentives for decarbonization. There are concerns about the extent to which carbon prices must be raised to generate needed emission reductions. For example, the carbon price would have to be increased by more than $75 per ton on all fossil-based CO_2 emission from the current level of $18 per ton in Korea by 2030 in the absence of other measures (Parry 2021a). This implies that similar pricing or equivalent measures to other GHGs must be applied. In Singapore, the government has already announced that the carbon tax will increase to a S$50–80 (US$36.7–58.6) range by 2030 from the current price of S$5 (US$3.7) per ton. Clear communication of a carbon price trajectory can help maximize the policy's potential benefits by reducing uncertainty for businesses and consumers, although the path can be finetuned in response to economic conditions and technological progress for synergies with other key emitting countries. Likewise, countries in the Asia-Pacific

Table 3. Complementary Policies to Support the Efficacy of Carbon Pricing

1. Improving public awareness of carbon pricing efficacy: Introduction of carbon taxation initially at a low rate can help raise the public awareness of the government's policy intension for gaining public ownership, with reform durability needed over political cycles and reducing risks to derailment of pathways to net zero by 2050.
2. Designing comprehensive packages of policy reforms: Realizing opportunities from green transition can help address public concerns of its cost. Promoting productivity, employment, and green investment for inclusive growth can help pave the way for carbon-price increases. Policy reforms to support a green transition should be mainstreamed in the medium-term budget framework (MTBF).
3. Reforming energy subsidies: Gradually phasing out of fossil-fuel subsidies can support introduction of carbon pricing and helps navigate a predictable and increasing path forward for prices in the Big-5 emitters and EMDEs (Bangladesh, Lao PDR, Malaysia, Philippines, Thailand, Vietnam). Such reforms can improve the price signal effect of carbon pricing and support broadening of the ETS coverage to include industries with large GHG emissions. In addition, the subsidy reforms can mobilize additional revenues.
5. Carbon sinks: The forestry and land use (FOLU) measures offer lower abatement costs than carbon pricing used in isolation and help preserve the natural endowment in a targeted approach.
6. Revenue recycling: Revenues from carbon pricing offer options to influence the scope, speed, and durability of green transitions, including through targeted support to the vulnerable (both households and firms), and for R&D, investment in green technologies, and climate-resilient agriculture. In some cases, revenues can help finance income tax reforms.
7. Establishing a climate finance ecosystem consistent with international standards: Well-defined climate taxonomies and disclosure can help narrow data gaps for assessment of climate risks, which can offer market-based monitoring and discipline and improve the effectiveness of carbon pricing.

Sources: Dabla-Norris and others (2021); and IMF country reports of China, India, Indonesia, Japan, and Korea.
Note: EMDEs = emerging market and developing economies; ETS = emissions trading system; GHG = greenhouse gas; R&D = research and development.

region must assess and communicate long-term implications of the Carbon Border Adjustment Mechanism, established by the European Parliament in May 2023, with a carbon border tax on specific imports rolled out by the European Union in phases starting in October 2023.

IMF bilateral surveillance has noted the importance of sectoral policies as a complement to carbon pricing tools. Some examples include scaling up of existing coal taxes (for example, in China, India, and Korea), implementing feebates with better waste management, tightening vehicle emissions standards (for example, in India and Korea), and promoting EV use (for example, in China, India, and Korea). Complementary policies, such as development of charging infrastructures, are often emphasized in the region (Arregui and others 2020). India has a policy to rollout nationwide charging infrastructures and provides fiscal incentives to encourage the production and sale of EVs. Some ASEAN countries (Indonesia, Malaysia, Vietnam) can benefit from feebates on EVs, as they currently provide limited tax benefits for fuel-efficient vehicles (Chen, Yang, and Wappelhorst 2022). In the Philippines, reviewing tax treatment of vehicles is warranted to reduce emissions and mobilize revenues (Jahan and Swistak 2022), along with implementation of a carbon pricing scheme that benefits the economy (Black, Parry and Zhunussova 2022).

Growth-friendly mitigation policies can help make green transitions durable. Findings from the public perception surveys underscore the importance of public ownership to policies and reforms to address countries' climate goals. With political economy considerations, governments may confront policy trade-offs of energy transitions with Sustainable Development Goals. In particular, decommissioning coal-fired power plants for greening the economy can negatively affect growth and income distribution consequences in the short term, despite clear long-term green benefits enabling robust economic growth (Cohen and Tubb 2018; Metcalf and Stock 2020; IEA 2021a). Boosting agricultural productivity and decarbonizing entire supply chains, for example, can boost growth and promote green transition at the same time (Bengston

and others 2023). Well-designed fiscal policies ensuring a just transition can address the impacts while raising well-beings (OECD 2017a; World Bank 2019). However, policy trade-offs are particularly acute in India (Chateau and others 2023) and Indonesia (IMF 2023a) since these countries have been relying heavily on coals. For the latter, mitigation from forestry and land use could be a more efficient mitigation approach in the short term and limit economic costs,[10] considering constraints from existing long-term commodity supply contracts. In this context, external financing can play a pivotal role. The expected mobilization of $20 billion in external financing through the Just Energy Transition Partnership will allow for the early decommissioning of coal-powered electricity plants and accelerating of investment in renewable energy in Indonesia, supporting a roadmap to phase-out coal-fired power plants by 2050.

Active labor market policies and targeted support to firms in carbon-intensive industries can help lower transition costs for households and firms disproportionately impacted by green transition. A critical part of enabling the transition to a low-carbon economy is to manage potential side effects, such as rising energy costs for households and firms, labor displacement and increased unemployment, increased regional inequality, or a combination of these effects. Countries with a regressive carbon tax must support people—such as coal miners—whose livelihoods depend on energy sector jobs and may have difficulty transitioning to growing low-carbon sectors. EMDEs with a large informal sector must find ways to provide targeted support to the self-employed as carbon pricing can reduce their income (Kuralbayeva 2013). Due to existing leverage, some firms are financially vulnerable to increases in carbon pricing during green transitions.[11]

Securing the Nexus Between Green Investments and Technology

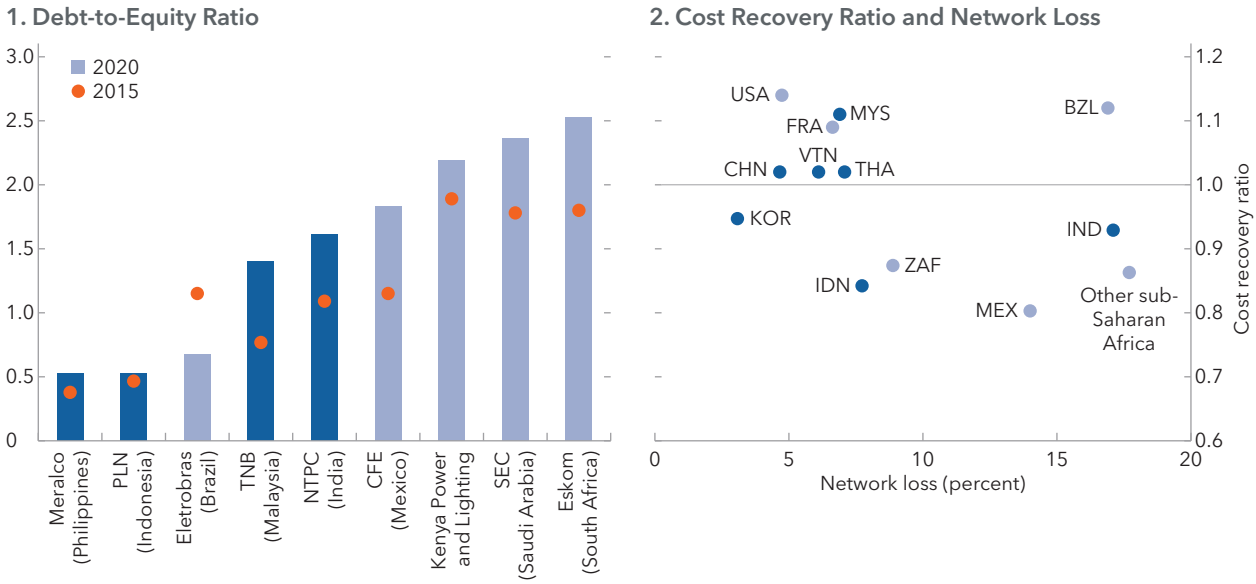
Green industrial policy can help galvanize the green transition, if implemented appropriately. Governments can embark on green industrial policy with a specific strategy to realize state-driven structural transformation needed for an optimal energy transition under NDCs, while promoting broader social and environmental goals. Green industrial policy, combined with carbon pricing and other complementary policies, can help accelerate decarbonization of hard-to-abate sectors with technology use. It also offers an integral approach to boosting economic growth by encouraging green investments in specific sectors and promoting job creation and long-term productivity gains (Altenburg and Assmann 2017). Despite its potential gains, the use of green industrial policy must follow a set of guiding principles to minimize its adverse implications and negative spillovers (Black and others 2023). In particular, tax incentives and subsidies to promote innovation and diffusion of green technologies (Table 2) need to ensure spending efficiency and minimize fiscal risks. Importantly, the use of green industrial policy should not introduce unfair competition in the global markets and create impediments to technology transfer.

Leveraging a technology-driven approach for climate mitigation requires both public investment and private financing. The region will need a physical infrastructure suitable for decarbonization, supported by renewable energy capacity, storage, and grid flexibility. Countries with limited fiscal space or access to capital markets should leverage direct private financing for such investment, including power grid system upgrades to accommodate renewable energy. Governments must pursue revenue mobilization and spending prioritization and efficiency to finance costs of maintaining infrastructures and technology adoption. Public investments can also serve as catalyst for private investment flows, including in hard-to-abate sectors. Countries with debt sustainability concerns must first restore sound macroeconomic footing to be able to attract private capital. In this context, the IMF and multilateral development banks (MDBs) can play catalytic roles (Lim and others, forthcoming).

[10] See Box 2 of the 2023 Article IV Consultation Staff Report by the IMF (2023a). The forestry and land use sector in Indonesia accounts for about half of the country's GHG emissions on average.

[11] Schmittmann (2023) underscores vulnerability of some corporates in Japan, resulting from increases in carbon prices, in particular those in energy, utility, and materials, as well as some downstream sectors.

Figure 13. Measuring the Financial Sustainability of State-Owned Utility Companies[1]



Source: IEA (2021b).
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1]Countries with dark blue represent Asian economies, including India, Indonesia, Korea, Malaysia, Philippines, Thailand, and Vietnam.

Investments in fossil fuel–based projects must consider the implications for green transition costs to avoid costly delays. Many EMDEs in the region continue to invest in coal-fired power plants, which have typical lifespans of multiple decades and significant fixed costs (Chateau and others 2023). If the country wishes to close these plants before their full lifespan, these fixed costs will be amortized over a shorter period, inducing high transition costs. Scaling up renewable alternatives will also be more challenging if the process is delayed. The cost of addressing intermittency problems, typically requiring a long-term horizon to address, must be assessed appropriately to pave the transition.

The long-term financial viability of state-owned utility companies must be well-maintained to attract private investments in renewables and electrification. State-owned enterprises (SOEs) often provide electricity and other energy in countries where electricity markets remain tightly regulated by governments. In these economies, the underlying market structure, tariff design, and a number of other structural factors determine operational efficiency and impact the financial sustainability of utility companies, thereby influencing financing cost of private investments (Figure 13). In India, many state electricity distribution companies charge subsidized or even zero prices for electricity to customers in certain sectors (for example, agriculture and residential), which has led to financial viability issues and dampening the effect of price signals. Structural impediments in China limit SOEs in the power sector to adopt renewables. For example, only about a third of electricity output is sold at market prices (Ho, Wang, and Yu 2017). With energy prices administratively set by SOEs, there is limited pass-through of ETS-implied carbon prices to downstream sectors and consumers, which would help reduce emissions. Improving governance and oversight, operational efficiency, tariff structures, and ensuring that policy mandates are fully funded are necessary for SOEs (Medas and Sy 2023).

Developing Sound Climate Finance Architecture for Green Transition

Countries in Asia and the Pacific must build a sound climate finance ecosystem conducive to attracting private financing. Data gaps, limited climate disclosure, and inadequate financial regulations for banks to assess exposures to transition risks identified in the country climate surveys point to the need to build a finance ecosystem in line with international standards. Cohesive institutional frameworks with a coordinating

body to oversee the progress of the climate financing strategy will also be essential in this regard (Lim and others, forthcoming), and the frameworks can prevent silos and build capacity to assess comprehensive financing needs and gaps at the country level.

The green transition requires stronger prudential policies of climate risks to safeguard financial stability. The Big Five and other economies have identified major transition risks, but they have not yet addressed them. Countries with a high level of GHG emissions and/or those subject to a higher probability of severe weather-related events are prone to face more elevated transition and physical risks, thereby requiring stronger prudential policies to address them. In particular, supervisors should require banks to establish comprehensive climate risk management practices with analytical capacity for stress testing, develop processes to evaluate the solvency impact of climate risk, and hold capital compatible with the evaluation. In this regard, Japan has published the Supervisory Guidance on Climate-related Risk Management and Client Engagement.[12] Likewise, China has issued Green Finance Guidelines for the Banking and Insurance Sector to guide the industries to improve climate-related financial risks management.

The region's economies must address transition risks on the path to a greener global economy. These transition risks include stranded assets (for example, in China and Indonesia) and loss from commodity-linked rents (for example, in Indonesia). Deforestation can be another source of transition risk. Marked financial vulnerabilities exist in some countries (China) since many firms in carbon-intensive sectors face liquidity risk. Tightening of credit conditions could raise defaults among the firms, and some state and local governments might be disproportionately exposed to such risks. Concentration of such a risk can be also found in high-emission sectors (energy, utilities, materials), and targeted support with clear carbon pricing pathways can minimize the risk of disorderly adjustment (Japan).

Monitoring and managing climate-related financial risks is essential to develop green financial markets. Developing and further enhancing the climate finance ecosystem is key to mobilizing green finance (Lim and others, forthcoming). A suite of policy options can be applied in a tailored way, including:

- **Better climate data and disclosures:** Setting mandatory minimum standards for financial institutions, corporates, and investment funds to disclose climate-related metrics (Japan) and bringing green finance disclosure requirements closer to international standards (China).
- **Green taxonomy:** Setting up an official ecosystem of climate-related activities to mitigate the risk of greenwashing and provide common grounds to market participants (China, Japan), with green taxonomy encompassing financial products.
- **Capacity development:** Building expertise on climate finance among financial institutions to promote green financial markets.
- **Stress testing:** Developing risk measurement and management by conducting scenario analyses to identify climate-related risks and take preemptive measures.
- **Supervisory guidance:** Guiding financial institutions to strengthen monitoring and managing of climate-related financial sector vulnerabilities, with due considerations to avoid overstretching the capacity of financial regulators for risks management.

[12] Schmittmann (2022) reports the importance of further policy efforts in the area of climate risk management guidelines for banks, insurers, and asset managers, which will promote common standards and plans to issue supervisory guidance for banks and insurers.

3. Adaptation and Resilience to Climate Change

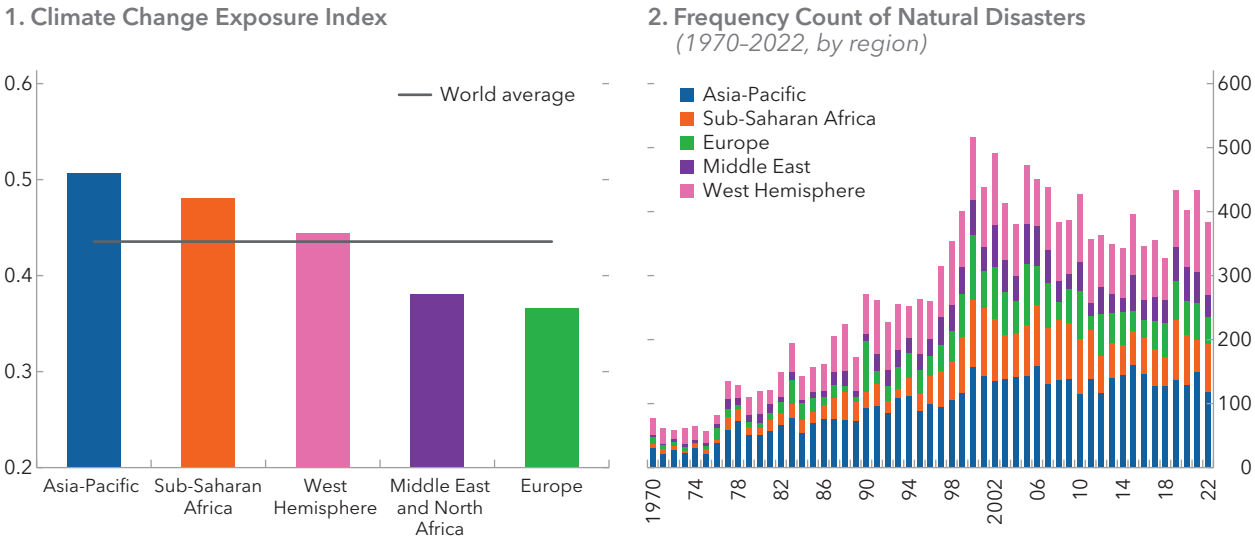
A. Institutional Frameworks to Cope with Natural Disasters

A Region Prone to Frequent and Costly Natural Disasters

Countries in Asia-Pacific are among the most vulnerable to climate change. The region is highly exposed to natural disasters and contains 8 out of the 10 countries most exposed to the adverse impact of natural hazards (Figure 14).[13] Over the last 50 years, the region has experienced about 100 natural disaster events per year, higher than other regions. Owing to its large land mass, Asia's temperatures have risen two times faster than the world average (Dabla-Norris, Daniel, and Nozaki 2021), leading to more frequent natural disasters.[14] In the next eight decades, the region's average temperature is expected to further increase by 1.4 to 3.7 degrees Celsius and sea levels by 120 to 200 centimeters (Fouad and others 2021), posing an existential threat to many megacities and small island economies. In China, overall productivity is affected by an increase in its annual average surface temperature as it induces more frequent and extreme weather events (IMF 2021b). Likewise, rising temperatures are affecting productivity and growth in India's most affected states (IMF 2022a).

Major weather-related natural disasters are growing in frequency and severity, affecting almost all countries in the region. The country climate surveys highlight floods, droughts, rainfall, storms, and rising sea levels as the main physical risks from climate change in the region (Figure 15). In addition, there are country specific risks such as greater frequency of bushfires in Australia, soil erosion in the Philippines, and coral

Figure 14. Exposures to Climate Change and Frequency of Natural Disasters

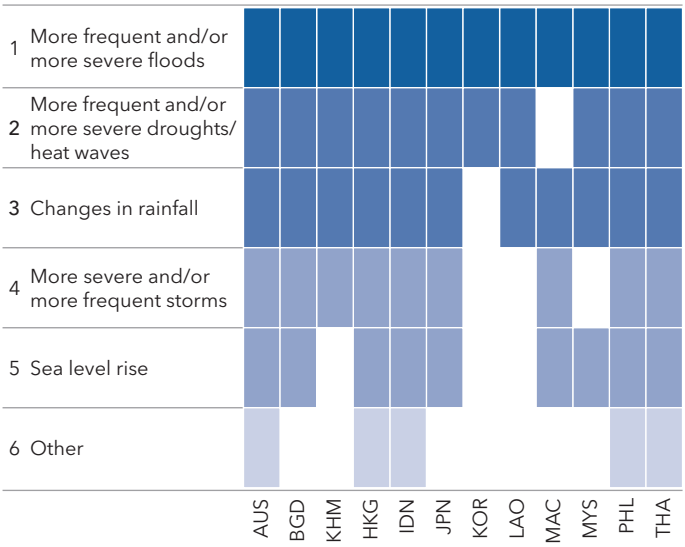


Sources: EM-DAT/CRED; Notre Dame Adaptation Index (2020); and IMF staff calculations.
Note: Simple averages are used, and Asia-Pacific is based on IMF's classification of regions.

[13] Based on the 2021 INFORM Global Natural Risk Index. The countries are, by order of exposure to natural disasters, Philippines, Bangladesh, Japan, Myanmar, India, Indonesia, China, and Vietnam.

[14] Warmer temperatures have increased the frequency and severity of weather-related natural disasters, with damage estimated at $50 billion annually over 2010–19 in the region (Dabla-Norris, Daniel, and Nozaki 2021). Warmer oceans have also caused tropical storms to gain in intensity and to deviate from their usual trajectories, making them harder to predict.

Figure 15. Asia-Pacific: Expected Main Drivers of Physical Risks from Climate Change



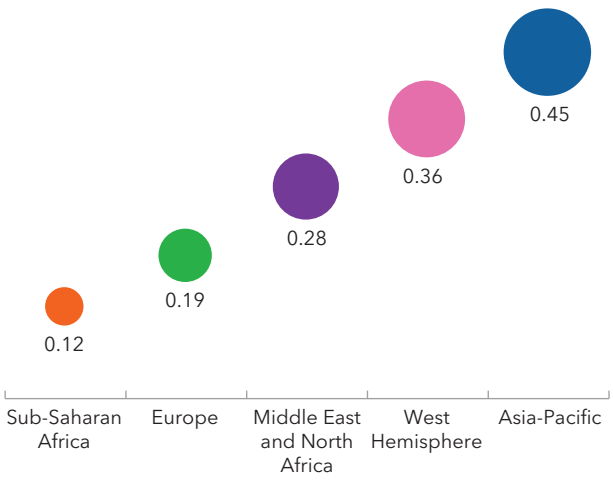
Sources: Country Climate Surveys 2022; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

reef breeching in Thailand. Flooding and wildfire due to extreme drought are major risks in Indonesia (IMF 2021a), impacting the agriculture and forestry sectors.

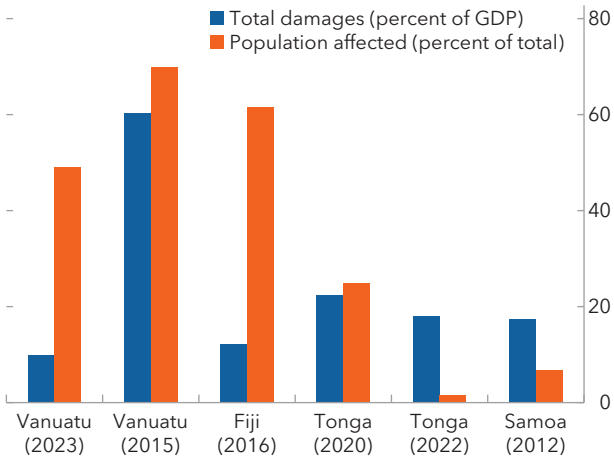
Large exposures to natural disasters are costly for the region and weigh disproportionately on small island economies. Between 1980 and 2022, the region recorded the largest cost of damages related to natural disasters, averaging 0.5 percent of GDP per year (Figure 16). Pacific Island countries (PICs) face more frequent natural disasters with a disproportionately high average cost of damages relative to the size of their economies. For example, four major natural disasters hit Tonga between 2014 and 2022, with the average cost of damage estimated at about 24 percent of GDP.[15] Going forward, the average damage from natural disasters is expected to increase by about 0.3 percent of GDP per year over the next decade based on the country climate surveys.[16] Beyond the direct costs, severe natural disasters negatively affect economic growth (Loayza and others 2012) and can exacerbate income inequality within countries (Budina, Chen, and Nowzohour 2023).

Figure 16. Costly Damages from Natural Disasters

1. Costs of Damages from Natural Disasters
(Average per year from 1980–2022 by region, percent of GDP)



2. PICs: Selected Impact of Tropical Cyclones

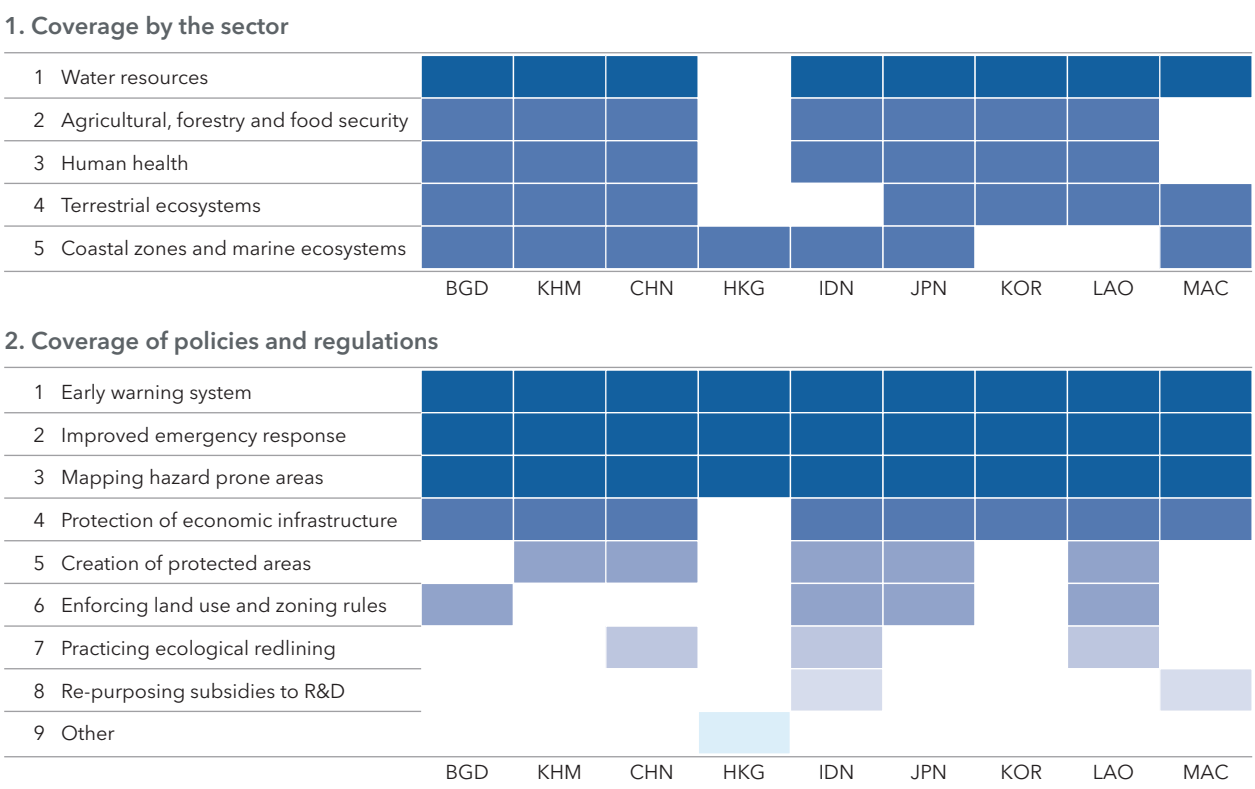


Sources: EM-DAT/CRED; IMF, April 2022 *World Economic Outlook*; World Bank; and IMF staff calculations.
Note: PICs = Pacific Island countries.

[15] Tonga was hit by four major natural disasters in the last eight years, with costs of the damages ranging from about 11 percent of GDP (the Cyclone Ian in January 2014) to 38 percent of GDP (the Cyclone Gita in February 2018).

[16] This number excludes the PICs since they are not included in the survey.

Figure 17. Landscape of National Adaptation Strategies in Asia-Pacific



Source: Country Climate Surveys 2022.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. R&D = research and development.

Institutional Frameworks for Adaptation

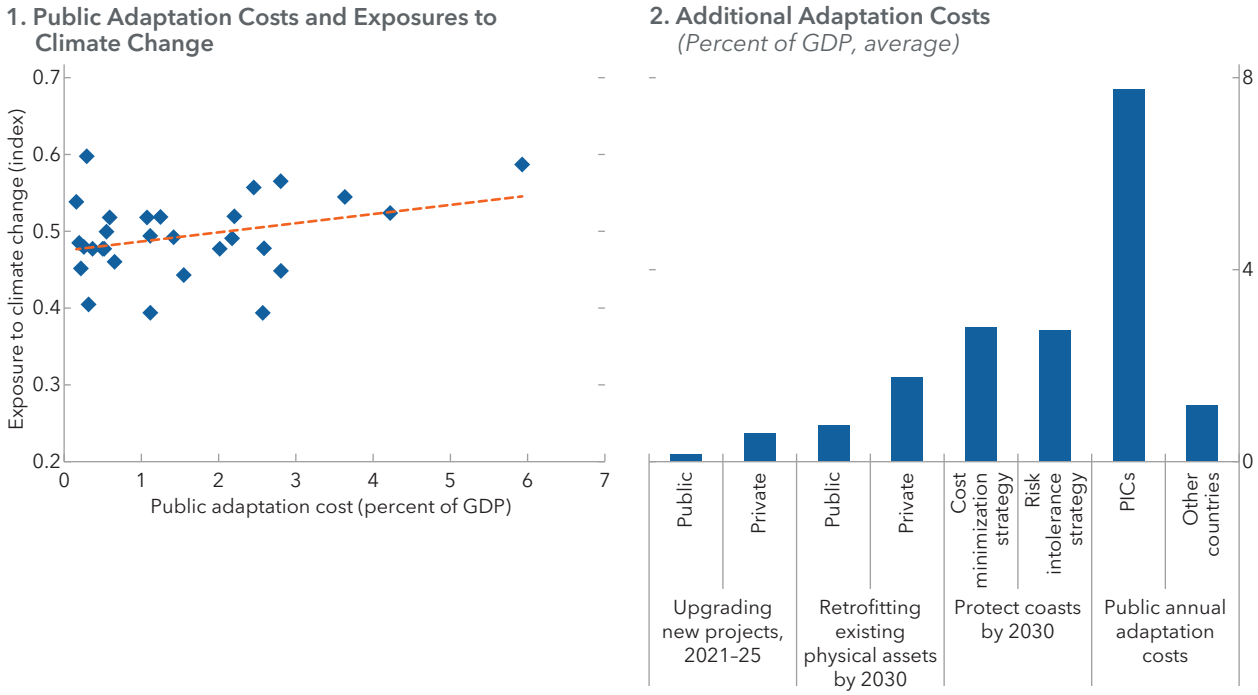
Many Asian countries have NAPs, documenting planned actions to address vulnerabilities to climate change. NAPs are a part of the climate Sustainable Development Goals and are often integrated into NDCs (for example, in Indonesia). They aim to reduce the impacts of climate change by building adaptive capacity and integrating adaptation into new and existing policies and programs, especially development strategies.[17] The country climate surveys identify a few countries without NAPs, citing limited capacity, expertise, and financing solutions as the main constraints.

Countries in the region have been at the forefront of adaptation efforts. Overall, countries in the region are aware of physical risks from climate change and are identifying sectoral approaches to adaptation (Figure 17). NAPs in the region incorporate both "hard" policies (for example, management of water resources) as well as "soft" policies and regulatory measures (mapping of hazard-prone areas and the development of early warning system). The region's AEs, Bhutan, and Thailand are best performers on adopting and implementing disaster risk reduction frameworks (Dabla-Norris, Daniel, and Nozaki 2021).[18] Restoring mangroves, protecting coral reefs, and adopting local adaptation plans are among the measures these countries are putting in place.

[17] Some countries in the region have included NAPs as part of their national climate change action plans (China, Indonesia, the Philippines, Samoa, Sri Lanka), whereas others have chosen to develop a separate, more comprehensive, and yet specific adaptation framework (Mongolia, Papua New Guinea, Thailand, Vietnam).

[18] Indonesia's disaster recovery agency set up after the 2004 tsunami has become a role model (GFDRR 2017). Japan imposes requirements and targets for companies to adopt a business continuity plan in case of disasters.

Figure 18. Asia-Pacific: National Adaptation Strategies



Sources: Dabla-Norris, Daniel, and Nozaki (2021); Notre Dame Global Adaptation Index (2020); and IMF staff calculations.
Note: PICs = Pacific Island countries.

B. Adaptation Challenges in Asia

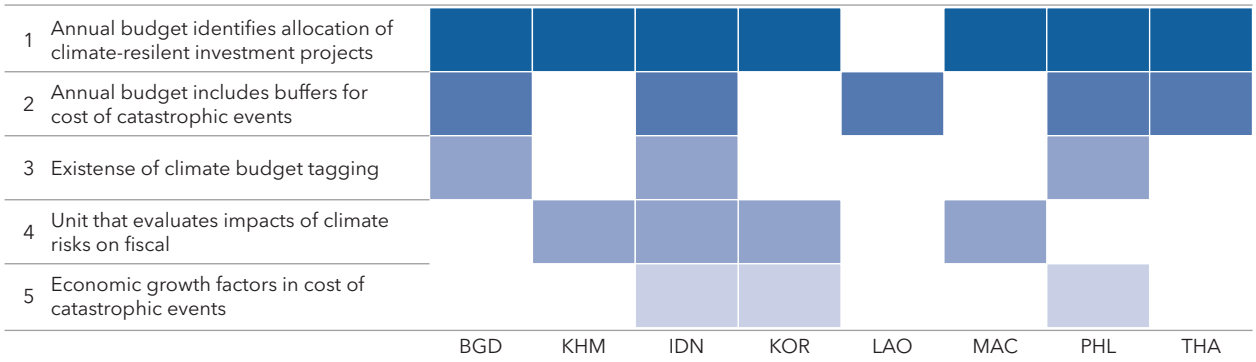
Despite the existence of institutional frameworks, major gaps in adaptation strategies remain. The country climate surveys point to a number of shortcomings, including (1) limited assessment of investment needs to achieve climate adaptation goals; (2) disconnect between adaptation strategies and budget and fiscal frameworks; (3) limited transfer of risks to primary insurers or reinsurers through, for example, catastrophe bonds and traditional private insurance; and (4) limited postdisaster responses through adequate social protection programs. In what follows, these challenges are discussed in greater detail.

Adaptation Strategies Are Often Not Based on Adequate Assessment of Investment Needs

Assessment of investment needs for climate adaptation is inadequate, hampering the ability to design appropriate adaptation policies and mobilize financing. The country climate surveys indicate that NAPs lack systematic estimates of the costs of increasing risks (frequency and severance) of natural hazards and assessment of investment needs under the adaptation strategy. There is an urgent need to cost and prioritize adaptation plans in the region, particularly for countries that are highly exposed to natural disasters given their large adaptation costs (Figure 18, panel 1). The lack of estimation of investment needs appears independent of income levels. For instance, developed countries, such as Australia and Japan, lack granular estimates of adaptation costs, while Bangladesh's NAP is regarded as exemplary, as its strategy identifies investment needs, financing gaps, and potential sources of financing.[19]

[19] Bangladesh released a new adaptation plan in October 2022 that covers the period of 2023–50 (https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202211020942---National Adaptation Plan of Bangladesh (2023-2050).pdf).

Figure 19. Integrating Adaptation Strategies into Macro-Fiscal Frameworks



Source: Country Climate Surveys 2022.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

Adaptation in the region is macro-critical, given large investment needs, particularly for the PICs. Estimated costs of public and private adaptation investment needs in the region are large (Dabla-Norris, Daniel, and Nozaki 2021; Figure 18, panel 2).[20] For example, the average annual cost of upgrading new investment projects is estimated to be about 0.7 percent of GDP, retrofitting existing assets around 2.3 percent of GDP, and developing coastal protection infrastructure about 2¾ percent of GDP. The average public sector investment cost for adaptation is estimated at around 3.3 percent of GDP, but the cost is significantly higher for the PICs (around 8 percent of GDP, on average). In Tonga, for example, climate-related investment needs (of which adaptation investment accounts for a major part) are estimated at 14 percent of GDP annually for 10 years (IMF 2020). Public investment needs are also sizable in Indonesia, Lao P.D.R., and the Philippines, because of their large existing stock of exposed assets. These high costs highlight the urgency of starting to build better to avoid further accumulation of vulnerable assets. There are material benefits to estimating adaptation investment needs and investing in adaptive infrastructure as it can yield high returns (Box 5).

Disconnect between Adaptation Strategies and Medium-Term Fiscal Planning and Budgeting

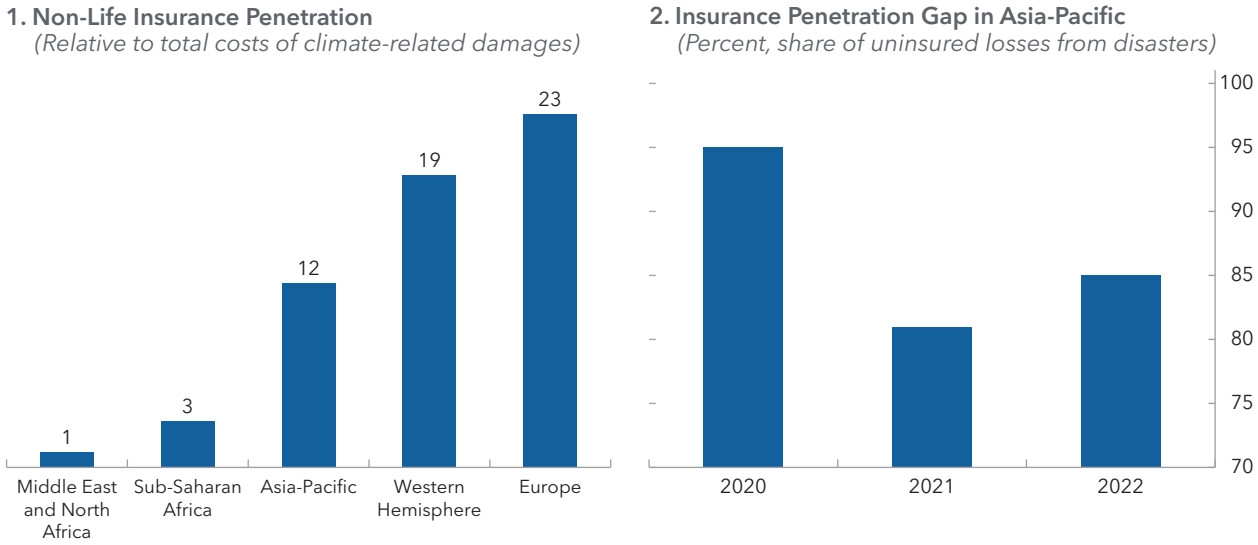
Adaptation polices are insufficiently integrated into fiscal frameworks. Another key gap in climate adaptation policies highlighted by the country climate surveys is the disconnect between adaptation strategies and budgetary and fiscal frameworks. Few countries in the region (Indonesia, Philippines, Thailand) reported developing a comprehensive climate budgeting framework. Bangladesh and Indonesia are good examples of how climate adaptation policies are progressively being mainstreamed into budgets and fiscal frameworks, with implementation of green budgeting by Indonesia (Box 6).

There is scope to further strengthen medium-term fiscal frameworks (MTFF). The country climate surveys indicate that the most common feature of countries that integrate adaptation needs in budgets is the identification of climate-resilient investment projects (Figure 19). Some countries (Bangladesh, Philippines) define climate-resilient investment projects for line ministries and agencies. Other countries (Korea, Philippines) have set up a dedicated unit or department for promoting climate resilient infrastructure investment. The inclusion of buffers (for example, budget provisions and dedicated funds), specifically for costs of catastrophic events, is also practiced by some countries in the region. Some disaster-prone countries, such as Bangladesh and Nepal, were among the first to adopt green public finance management (PFM) practices with the support of development partners.[21] A number of Asia's EMDEs have been the first in the world to

[20] See also Margulis and Narain (2010) and Hallegatte, Rentschler, and Rozenberg (2019).

[21] Green PFM integrates climate-friendly perspectives into PFM practices, systems, and frameworks, with the aim of promoting fiscal policies to address climate concerns (Gonguet and others 2021).

Figure 20. Non-Life Insurance Markets



Sources: EM-DAT/CRED; Munich Re; OECD.Stat; World Bank, Global Financial Development Database; and IMF staff calculations.

introduce climate budget tagging, a tool for tracking climate-related expenditures in the budget.[22] Bhutan's budget, for instance, includes estimates of explicit and implicit contingent liabilities in the fiscal risk assessment matrix (World Bank 2020). Indonesia, New Zealand, and the Philippines have also detailed fiscal risk statements that cover natural disasters. However, countries could better integrate plans into MTFFs.

Limited Risk-Sharing Mechanisms

Risk transfer options, such as catastrophe bonds, are in their infancy. Public resources can be limited when natural disasters are both frequent and severe as in Asia and the Pacific. The use of public resources in such circumstances can crowd out otherwise productive spending (for example, on health and education) or pose risks to fiscal sustainability. Therefore, it becomes necessary to transfer the risks to third parties when countries cope with large-scale natural disasters (Cevik and Huang 2018). Catastrophe bonds and traditional non-life insurance are the main risk-sharing instruments against natural disasters. However, the global market for catastrophe bonds is in its infancy compared to the market of non-life insurance, and the region is falling behind. For instance, the total catastrophe bonds issuance by the public sector from 2001 to 2021 was around $10 billion, of which the Asia-Pacific region accounted for only about 5 percent.[23,24]

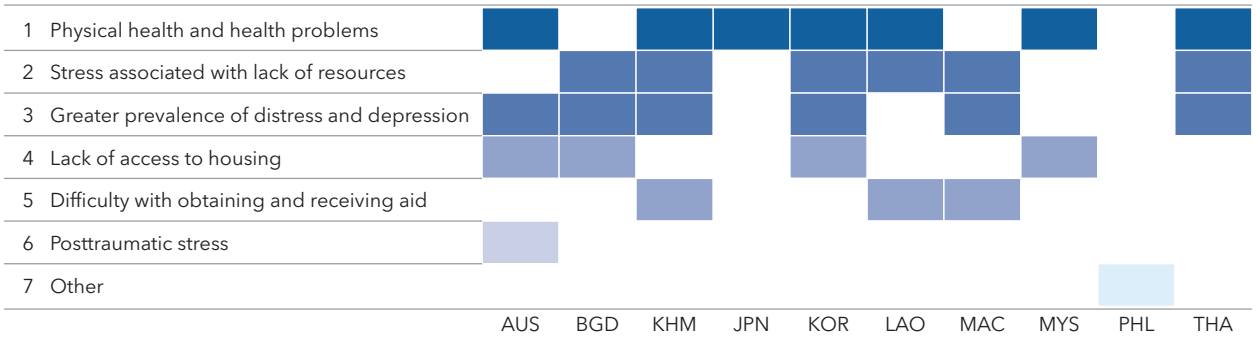
Despite increasing physical risks from natural disasters, traditional insurance coverage is limited. The size of the private insurance market is limited compared to other regions (Figure 20). The Asia-Pacific region accounts for around 28 percent of the global market for non-life insurance but around 40 percent of the world GDP. The relatively low insurance penetration leaves households and businesses increasingly vulnerable to climate, given rising risks. Traditional insurance remains one of the most used mechanisms to shift risks including disaster risks to primary insurers and reinsurers and mitigate fiscal costs. However, out of the

[22] Nepal (2012), Indonesia (2014), Philippines (2015), and Bangladesh (2018).

[23] The numbers are based on authors' calculations using Ando and others (2022).

[24] The paper focuses on risk-sharing instruments such as catastrophe bonds and insurance. In general, some instruments are suited for risk mitigation and preparedness, such as green bonds, debt-to-climate, and debt-to-environment swaps. Others come into play when a disaster has occurred, enhancing fiscal space, for example, through natural disaster clauses in sovereign debt. Lastly, there are instruments more suitable during the recovery phase, such as national stabilization and recovery funds and credit lines with international financial institutions. Countries can decide how to diversify their insurance portfolio given their risk profile and vulnerabilities.

Figure 21. Asia-Pacific: Multidimensional Social Issues



Source: Country Climate Surveys 2022.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

$50 to $70 billion of losses induced by natural disasters between 2020 to 2022 in the region, only $3 to $10 billion were insured (Lim and others, forthcoming). Therefore, the share of uninsured losses from natural disasters (the insurance gap) remains large in Asia.

Inadequate Social Protection System Weighs on the Vulnerable

The region underinvests in social protections, hindering the ability to provide effective coverage to vulnerable groups. The proportion of people with access to at least one form of social protection increased significantly in Asia-Pacific from 39 percent in 2015 to 44 percent in 2020 (ILO 2021). However, average coverage in region remains below the world average of 47 percent. Underinvestment in social protection systems remains the major driver of the large coverage gap in Asia compared to other regions. For example, the region spends on average about 7.5 percent of GDP on social protection (excluding health), far below the world average of about 13 percent of GDP. Beyond financial constraints, social issues concerning the vulnerable under climate change are multidimensional (Figure 21). Issues concerning health, dealing with stress due to lack of resources, and greater prevalence of distress and depression are among the most common issues, raised by responding authorities regardless of the level of economic development.

Lack of financing—particularly in developing Asia—remains the main constraint to scale adaptive social protection. Adaptive social protection systems can offer quick responses to beneficiaries affected by natural disasters (World Bank 2020).[25] For example, Fiji rapidly scaled up its Poverty Benefit Scheme following the Tropical Cyclone Winston in 2016. Many other countries (Australia, Hong Kong SAR, Korea, Malaysia, Thailand) indicated that social assistance for possible disaster events is already integrated with existing social safety measures. The country climate surveys indicate that lack of financing is the most commonly cited constraint to extend social protection to natural disasters, particularly in low-income countries in the region. In addition, a number of other constraints prevent development and scaling up of adaptive social protection systems, including challenges with developing and improving cash delivery infrastructure and collecting socioeconomic information for means testing, and limited capacity for spatial risk assessment.

[25] Adaptive social protection seeks to identify how existing social protection can be leveraged and enhanced to build household resilience to shocks such as natural disasters. See World Bank (2020b) for details.

C. Building Resilience to Climate Change with Adaptation Policies

Mainstreaming Adaptation Goals into Budget and Macro-Fiscal Frameworks

Mainstreaming adaptation policies into the budget process is critical for their implementation. A robust MTFF can help realistically incorporate adaptation priorities into medium-term fiscal planning. Well-integrated MTFFs ensure that annual budgets consider adaptation policies (Bellon and Massetti 2022), providing a multiyear perspective of climate expenditure planning and reporting. However, in many countries, national legal frameworks need to be strengthened to better integrate adaptation policies and PFM process. Some countries in the region (Vietnam) have integrated climate change policies into existing laws, while others (Japan) have adopted a separate dedicated climate law, but more could be done to integrate climate strategies into budget and multiyear fiscal frameworks.

Addressing weaknesses in public investment management should be a priority. It is important to improve the public investment management system prior to scaling up adaptation investments as climate-smart public investment management can enable governments to design, appraise, select, and implement projects to increase returns on infrastructure investments for adaptation (Kim, Le, and Glenday 2021). IMF staff analysis has shown that, across the world, over one-third of resources are lost in the process of managing public investment (IMF 2015; Baum, Mogues and Verdier 2020). These losses are linked to weak regulatory frameworks and organization, and ineffective planning, allocation, and implementation of public investment projects (IMF 2022b).[26]

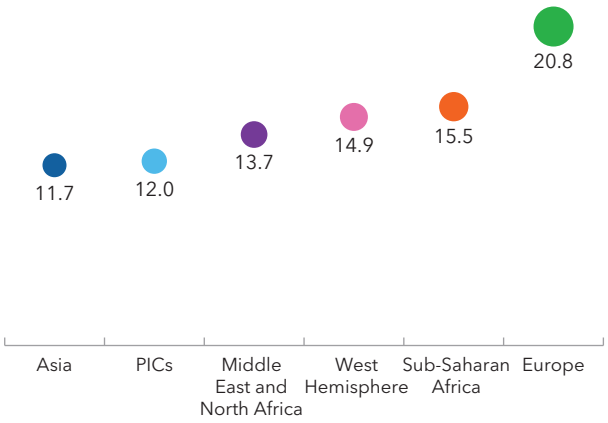
Fiscal risks related to climate change need to be assessed and budgeted. This entails identifying and estimating public physical assets that are exposed to climate change. Climate-related fiscal risks need to be included in the overall fiscal risk statement. Including contingent liabilities from natural disasters in the planning and budgeting process allows for inclusion of fiscal risks as part of the budget deliberation process (OECD and World Bank 2019). Publishing a fiscal risk statement that includes quantifications of risks from natural disasters is crucial for all countries that are prone to natural disasters. The fiscal risk statement should also discuss the government's strategies for preventing, mitigating, and managing fiscal risks from natural disasters (IMF 2018). Managing fiscal risks is particularly important given the significant investment needs for the green transition and adaptation amid of rising debt levels and shrinking fiscal space in the region.[27]

Building adequate fiscal buffers must also be part of the toolkit for adaptation. Budget provisioning is the appropriate instrument to manage small- and medium-scale natural disasters. Adequate fiscal buffers are necessary for disaster contingent planning. Adequacy of the buffers can be determined based on the expected frequency of natural disasters and fiscal costs, the country's borrowing capacity in case of emergency, opportunity costs of building up buffers, and postdisaster funding needs (Cevik and Huang 2018). Contingent reserves in the budget and natural disaster funds are the most used mechanisms to build fiscal buffers. Contingent reserves can cover frequent natural disasters with moderate costs, while natural disaster funds are often outside the budget and can help preserve fiscal sustainability. Natural disaster–prone countries also need to adopt safe debt anchors that are lower than the debt limits to accommodate more frequent and large natural disaster shocks (Caselli and others 2022; Akanbi, Gbohoui, and Lam 2023).

[26] The Climate Public Investment Management Assessment, a framework developed by the IMF, aims to help countries build low-carbon and climate-resilient infrastructure. It has five pillars: (1) climate-aware planning, (2) coordination between entities, (3) project appraisal and selection, (4) budgeting and portfolio management, and (5) risk management.

[27] About 50 percent of Poverty Reduction and Growth Trust–eligible countries with a debt sustainability analysis were at high risk of debt distress in the region as of the end of 2022 from 44 percent prior to the pandemic.

Figure 22. Standard Value-Added Tax Rates, by Region
(Average 2021, percent)



Sources: IMF, FAD Tax Policy Database; and IMF staff calculations.
Note: PICs = Pacific island countries.

Mobilizing and Scaling Public Resources

Domestic resources should be made available first to finance adaptation needs. Budget adequacy signals a country's commitment to use its own resources and offers options to leverage domestic resources for attracting private investment. Besides recycling of revenues from the introduction of carbon tax, improving efficiency of the taxation systems can help the region mobilize additional domestic resources for adaptation. For example, given the low value-added tax rates in Asia-Pacific compared to other regions, there is room to improve value-added tax collection (Figure 22). Prioritizing and making spending more efficient offers another avenue to create fiscal space for adaption projects. For example, reforming fossil fuel subsidies potentially provides sizable savings, as the region accounts for about 50 percent of the world's total (explicit and implicit) subsidies.[28] Full price reforms, targeting both forms of subsidies, could raise an additional revenue by about $1.8 trillion or 4.4 percent of GDP in East Asia and the Pacific (Black and others 2023; Lim and others, forthcoming).

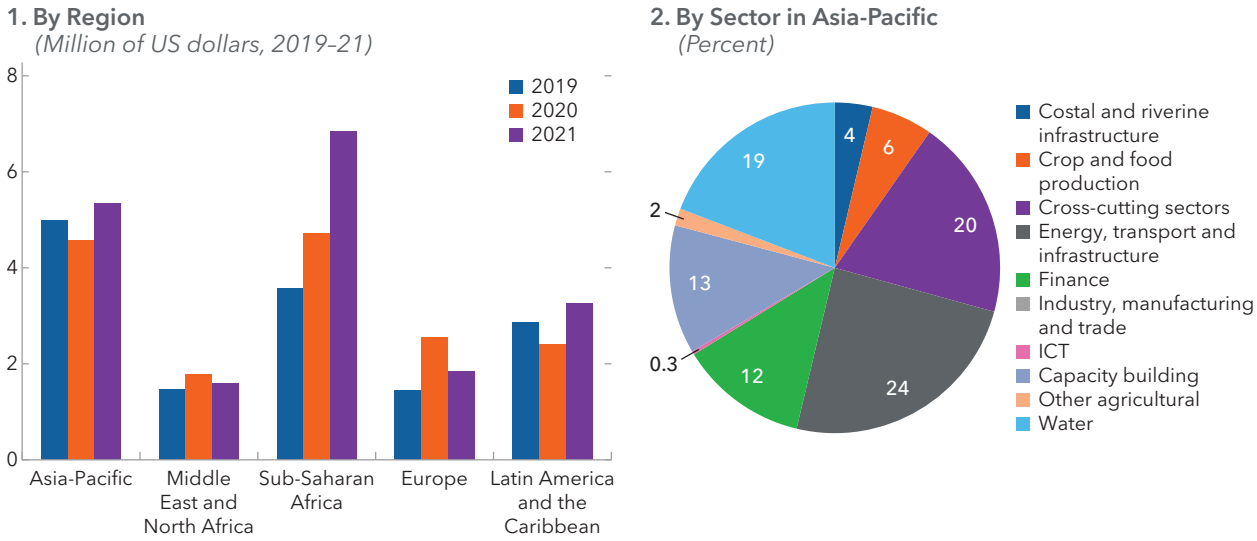
Streamlining and scaling up multilateral climate funds is urgently needed particularly for small island countries. Countries in the region can tap into various multilateral climate funds, which can be broadly categorized into two groups (NGN 2017). Those established under the UN Framework Convention on Climate Change, such as the well-known Green Climate Fund, support countries to fund adaptations projects. There are also multilateral funds outside the UN Framework Convention on Climate Change, such as the pilot program that focuses on achieving long-term climate resilience. In 2020, total climate funds approved to the region amounted to $5.7 billion, out of which 21 percent was for adaptation initiatives (Climate Funds Update 2021). However, access to climate funds remains challenging for many developing countries mainly due to lack of capacity (that is, absence of NAPs) and stringent requirements of PFM systems. Access to the Green Climate Fund is the most successful avenue for the PICs and is available to finance their adaptation needs. Nevertheless, there is an urgent need to streamline accreditation requirements of climate funds to boost the implementation of adaptation-related projects in the PICs (Fouad and others 2021).

The region's economies need to tap into finance made available by international financial institutions. Given the commitments of MDBs to further increase their climate finance at the COP27 in 2022, the region can expect more financing from MDBs going forward. Funding from MDBs has some advantage as it offers grants or concessional loans to eligible low-income countries. The region's economies have been already benefiting from MDBs for financing adaptation projects. From 2019 to 2021, the region received about 30 percent of MDB adaptation finance (Figure 23), which primarily financed energy, transport, and infrastructure projects. In this context, the IMF has launched a new lending facility—the Resilience and Sustainable Trust—that offers long-term and affordable concessional financing for countries to reduce their vulnerability to climate change while catalyzing other financing.[29] In-kind support provided by MDBs and the IMF remains important, including transfer of knowledge through capacity building and technical assistance.

[28] Explicit subsidies (about 3 percent of total subsidies in Asia-Pacific) reflect undercharging for supply cost, whereas implicit subsidies reflect for undercharging for environmental costs and forgone consumption taxes.

[29] Bangladesh is the first Asia-Pacific member to benefit from the Resilience and Sustainable Trust.

Figure 23. Multilateral Development Banks' Adaptation Finance



Sources: MDB Joint Report on Climate Finance; and IMF staff calculations.
Note: The IMF's classification of regions is used. Therefore, Central Asia is in the Middle East region. ICT = information and communications technology.

Donor funding is another pillar for the most vulnerable countries to finance adaptation investment and post-disaster reconstruction costs. Without additional resources, natural disasters could exacerbate the situation of vulnerable countries like Tonga (IMF 2020) that are already in debt distress. Frequency and severity of natural hazards are increasing, and countries vulnerable to natural disasters may face substantial and unanticipated fiscal financing gaps, further jeopardizing already weak growth and high debt vulnerabilities (Dabla-Norris, Daniel, and Nozaki 2021). The donor community can provide critical support for enhancing the economic resilience and debt sustainability of such vulnerable countries.

Catalyzing Private Finance

The contribution of the private sector to the financing of climate adaptation initiatives is limited. Indeed, out of $30 billion spent globally on adaptation in 2017 and 2018, only 1.6 percent came from the private sector, according to the Climate Policy Initiative. Lack of taxonomy, confidential requirements, and the large size of the informal sector are among the important factors explaining the private sector's limited involvement in financing adaptation projects (NGN 2017). Lack of country-level climate risk data, limited clarity on government financing gaps, and low perceived returns on adaptation investments are other impediments, hindering greater contributions from the private sector (World Bank 2021).

The public sector has an important role in catalyzing private finance for adaptation. The most important factor in attracting private finance remains a supportive business environment, including the ease of doing business, regulations, rule of law, and the quality of infrastructure. But there are conditions that are specific in attracting private finance into climate adaptation projects (NGN 2017; World Bank 2021). Some specificities include developing and raising awareness of the business case for financing climate change adaptation; providing nonfinancial incentives such as making localized climate risk data available; providing incentives through risk-sharing, tax incentives, and guarantees; and setting up effective institutional arrangements for multisector adaptation planning.

Public-private partnerships (PPPs) provide an opportunity to attract private finance into large-scale adaptation projects. PPPs focus on bankable, long-term projects and offer natural entry points for private sector participation into climate projects, including adaptation activities (Lu 2022). The public sector will need to

Table 4. Insurance Coverage in Selected Asian Countries

	Government		Households		Farmers		Businesses	
	Public	Private	Public	Private	Public	Private	Public	Private
Australia	√ ComCover, the Government's self-managed insurance fund			√		√		√
Japan				√	√ Agricultural Insurance Mechanism[1]			√ Corporate fire insurance has an optional coverage on floods.
Macao, SAR				√ Property insurance products protect certain class(es) of properties against catastrophic events.				√ Small and Medium-sized Enterprise (SME) Catastrophe Property Insurance Scheme
Philippines					√ The Philippine Crop Insurance Corporation[2]			

Source: Country Climate Surveys 2022.

[1]A national public insurance system consists of an "Agricultural Mutual Aid System" to cover losses incurred by farmers due to natural disasters and unforeseen accidents and an "Income Insurance System" to cover the decrease in income of each farmer due to fluctuations in supply and demand of agricultural products.

[2]Insurance covers different crops and livestock, including rice, corn, high-value crops, livestock, non-crop agricultural assets, and fisheries.

identify bankable pipelines of climate-smart projects to attract private finance through PPP financing (World Bank 2022). However, PPPs can induce fiscal risks since contingent liabilities through guaranteed debt or minimum revenue guarantees could materialize, thereby requiring careful design and risk assessment.

Developing Insurance Markets and Protecting the Vulnerable

Developing insurance markets is critical to address risks related to natural hazards. Developing insurance markets must be a priority given that it can be an effective tool to support households and businesses exposed to natural disasters (World Bank 2020). Investing in climate adaptation needs is important, but there will be always a residual risk that traditional insurance can cover. Governments can support the development of domestic insurance markets by leveraging their own resources. For example, the country climate surveys find examples of insurance coverage for farmers and small and medium enterprises in some Asian economies such as Japan, Macao SAR, and Philippines (Table 4). Lessons can also be learned from the experience of Caribbean countries, also prone to natural disasters, that are developing state-contingent instruments to strengthen their financial resilience.[30]

[30] This includes the issuance of catastrophe bonds and enrollment in the World Bank's CAT Deferred Drawdown Option, which provides contingent financing of immediate liquidity following a natural disaster. They also launched in 2007 the Caribbean Catastrophe Risk Insurance Facility, which offers insurance for natural catastrophes.

Strengthened social safety nets with better targeting can help ensure prompt postdisaster response by countries. Savings, borrowing, and insurance can be limited for vulnerable populations necessitating the development of social protection systems for the vulnerable groups. Cash transfers (conditional or unconditional) can help build resiliency to climate-related shocks (World Bank 2020), but it is necessary to build fiscal space and improve infrastructure for direct cash transfers in emergencies. Digital solutions can help identify and reach intended beneficiaries, including those in the informal labor market, and improve the targeting of cash transfers.

4. Conclusion and the Way Forward

Asia and the Pacific's green transition will have far-reaching implications for the global economy. Over the past decades, the region has become the engine of global economic growth. With relatively more energy-intensive growth and heavy reliance on coal, the region has become the largest contributor to growth in global GHG emissions, accounting for nearly 40 percent of the total emissions in 2020. Achieving net zero by 2050 requires an energy transition at an unprecedented scale and speed, even as the region must ensure energy security and affordability. If managed well, the green transformation in Asia and the Pacific will create opportunities for economies not only in the region, but also around the world.

A successful mitigation policy mix must entail a range of complementary policies to narrow implementation gaps. No single policy can achieve net zero emission targets. Green technologies, both currently available and coming into stream, are key for ensuring an energy transformation at speed and scale needed to achieve climate mitigation goals. Establishing and maintaining secure supply chains of green technologies can promote technology adoption and diffusion and reduce the costs of mitigation. Investments in clean public transportation, smart electricity grids to incorporate renewables into power generation, and retrofitting buildings to make them more energy efficient would complement these efforts. Other sectoral policies, including feebates, fossil fuel subsidy reforms, and carbon sink and nature conservation can lend support to net zero pathways. Carbon pricing should play a more central role in the policy mix as it contributes to synergy across policy instruments. To maximize the efficacy of carbon pricing, accompanying reforms are needed to ensure that price signals best align incentives of different economic agents. Managing potential side effects, such as rising energy costs for households and firms, labor displacement, and unbalanced regional impacts, will be equally important to ensure a just and durable transition.

Public ownership of ambitious reforms is needed to entrench a green transition. An economic transformation to achieve net zero emissions must be underpinned by ambitious policies and strong public support to avoid delays and derailments. Climate ambitions must be translated into specific actions that ensure government accountability and policy efficacy. Policymakers need to raise awareness of climate change impacts and how mitigation policies work. Educating the public about the costs of inaction, such as pollution, and the benefits of addressing these, like improvements in air quality, health, and protection of low-income households, can increase buy-in for climate mitigation policies.

Comprehensive financing needs to fully implement mitigation and adaptation strategies must be estimated and integrated into the MTFFs. Implementation of mitigation and adaptation strategies is often vested in multiple line ministries and agencies. Since what is not measured cannot be funded, Asia-Pacific economies must urgently quantify their financing needs consistent with net zero targets and adaptation strategies, assess financing gaps, and integrate viable and deliverable projects into their MTFFs. Strengthening capacity for green PFM, infrastructure governance, and PPPs can go a long way toward improving accountability to achieve climate objectives.

Building adaptive capacity calls for substantial investment, but it also comes with opportunities. EMDEs in the region have large infrastructure needs and growing urban areas. This means they can ensure new building and construction are more resilient and better able to withstand the heightened risks of climate change. For example, new roads could incorporate drainage to withstand heavier rainfall or be built on higher ground to reduce flood risk, a relatively inexpensive solution.

Mobilizing climate finance will pave the way to net zero and climate-change resilience. Moving to a new equilibrium to achieve mitigation targets, while ensuring energy security and affordability, requires unleashing substantial amounts of private capital to be invested in profitable projects. Financing adaptation measures

is equally important, given the sheer scale of infrastructure needs for many countries. Revenue mobilization and spending prioritization and efficiency will have to play a role in easing growth-debt trade-offs. For the most vulnerable low-income countries and PICs with limited fiscal space, meeting adaptation needs will require concessional financing. Tapping into all available financial resources, including through capital markets, specific climate funds, grants, and concessional loans made available by the international community, will be essential to achieve climate goals.

Establishing conducive business environments remains paramount to mobilizing climate finance. The region's economies must establish a sound climate ecosystem underpinned by taxonomies, disclosure, and regulations that meet international standards. A sound climate ecosystem maximizes opportunities for cross-border investment in the green transition, while minimizing risks of regulatory arbitrage and greenwashing. Broadly aligning the taxonomies in Asia-Pacific with the European Union, for example, can foster climate finance development in the region while also strengthening international cooperation.

International collaboration is indispensable to close gaps in achieving climate goals. While green industrial policy can promote innovation and diffusion of clean technologies, it could lead to a reconfiguration of the geopolitical landscape that potentially creates winners and losers (Allan, Lewis, and Oatley 2021). International collaboration will become ever more essential to ensure advancement of the global climate agenda. Here, the public perception surveys point to broad-based public support for multilateral action. The country climate surveys also emphasize the need for a wide-ranging collaboration, covering knowledge and experience sharing, technology transfer, and financial support.

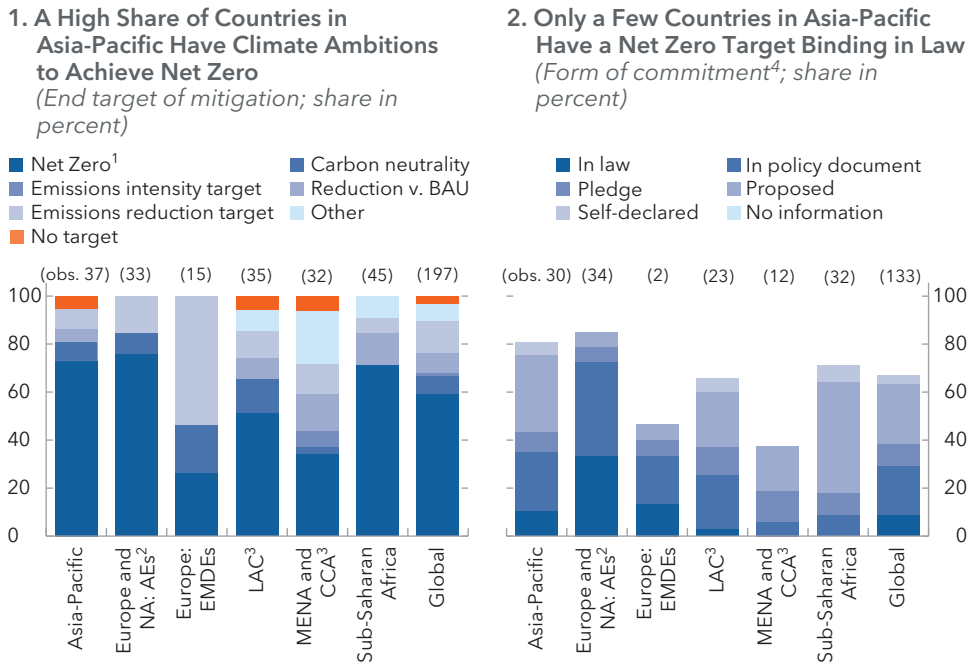
Asia and the Pacific should contribute to advancing the global climate agenda by example. The region remains at the forefront of innovation, production, and adoption of clean and low-emission technologies, supported by green industrial policy. In addition, access to critical minerals to manufacture green technologies (for example, renewables and EVs) is concentrated among a few Asian economies. Since climate change poses an existential threat to the global economy, Asia-Pacific should ensure access to green technologies by those most in need, through technology transfer and financial assistance.

Box 1. How Committed Are Countries for Action to Reducing GHG Emissions?

Many countries in Asia and the Pacific show a high level of ambition, with an end target of "net zero" emissions by 2050. Compared to other regions, Asia-Pacific has a high share of countries (80 percent) with an end target of net zero emissions or carbon neutrality (Box Figure 1.1). Many of these economies aim to achieve the target by 2050, in line with the Paris Agreement.

Climate ambition does not automatically translate to commitments for action which vary quite signifi-

Box Figure 1.1. Net Zero: Targets and Legislation



Sources: Country Climate Surveys 2022; The Net Zero Tracker; and IMF staff calculations.
Note: BAU = business as usual; EMDEs = emerging market and developing economies.
[1]Net zero includes end targets of greenhouse gas neutrality, 1.5 degrees Celsius target, climate neutral, and zero carbon.
[2]North America (NA) includes Canada and the United States.
[3]Latin America and the Caribbean (LAC) and Middle East and Northern Africa with the Caucasus and Central Asia (MENA and CCA).
[4]Observations account for the total number of countries with end targets of net zero or carbon neutrality in the respective regions.

cantly among the Big Five economies. China updated its nationally determined contributions (NDCs) in 2021 and anticipates a peak of greenhouse gas emissions before 2030, with backloaded carbon adjustments toward 2060, the target year for net zero emissions. India updated its NDCs in 2022 and sets its end target of net zero emissions by 2070, with an interim goal of reducing emissions intensity by 45 percent from 2005 levels by 2030. Indonesia announced the 2022 Enhanced NDC, which aims to reduce its emissions by 32 percent with respect to a business-as-usual scenario unconditionally and by 43 percent conditionally with international financial support. Japan and Korea both share the

Box 1. *(continued)*

same end target of net zero by 2050, which has been codified in law. Japan's NDC aims to reduce its emissions by 46 percent relative to 2013 levels for an interim target, while Korea aims to reduce emissions by 40 percent from its 2018 level by 2030.

However, only a few countries in the region have their end targets specified into laws. Climate ambition is a notional concept. Inherently, it does not contain deliverables needed to attain the Paris Agreement goals. Australia, Japan, and Korea share key elements of their ambition, grounded in law to navigate their pathways to net zero. China has recently upgraded its target, parameterized in policy documents. However, other large emitters (India, Indonesia) and some emerging markets have only announced their pledge or simply proposed the net zero target.

Raising ambition requires strong and credible commitments for actions to realize the Paris Agreement. Moving forward, narrowing the gaps in commitments and delivering ambitious actions are needed to achieve the net zero target, supported by national consensus in the respective economies.

Box 2. Implementation of Carbon Pricing Instruments: Examples from Asia-Pacific

Carbon pricing can incentivize changes needed to achieve emissions reduction in the most efficient way and provide social protection for the vulnerable (Parry, Black, and Zhunussova 2022). First, carbon pricing can lead to important behavioral responses in the economy (both at individual and corporate levels) for reducing energy use and shifting to low carbon fuels with market forces. Second, carbon pricing can also encourage innovation and adoption in green technologies by providing a credible, clear carbon pricing policy signal. Third, revenue recycling from carbon pricing can address economic and distributional impact of mitigation policies.

Japan was one of the first Asian countries to implement a carbon tax. In 2012, the Government of Japan announced the Tax for Climate Change Mitigation, legislating a carbon tax at the rate of JPY289 (US$2.65) per ton of carbon dioxide equivalent applied to all fossil fuels on top of the existing petroleum and coal tax. Estimated tax revenue was JPY262.3 billion (US$2.4 billion) per year, which was designed to be recycled for promoting transition to low-carbon technology-intensive industries, installation of energy-saving equipment by small and medium enterprises, and financial assistance for Green New Deal Funds used by local governments to implement energy saving and renewable energy in their respective jurisdictions. At its inception, the carbon tax was designed to reduce 80 percent of greenhouse gas (GHG) emissions by 2050. However, its rate has remained too low to reach the country's target (Gokhale 2021). The government is committed to expanding carbon pricing from current low levels beginning in fiscal year 2028.

Singapore implemented a carbon tax in 2019 and announced its scheduled path through 2030. The carbon tax level was initially set at S$5 (US$3.7) per ton of carbon dioxide equivalent for the first five years through 2023. This initial period of transition will be followed by subsequent, planned increases to S$25 (US$18.3) in 2024–25, S$45 (US$33) in 2026–27, and S$50–80 (US$36.7–58.6) per ton of carbon dioxide equivalent by 2030. The carbon tax covers 80 percent of total GHG emissions from selected facilities in the manufacturing, power, waste, and water sectors, consistent with the country's net zero target by 2050. Tax revenues are recycled to support decarbonization efforts for green transition, and for businesses and households to better cope with the transition.

New Zealand introduced an emissions trading system (ETS) in 2008, designed to cover all sectors of the economy for the first time in the world. Following the first-ever ETS introduced by European Union in 2005, New Zealand pushed the ETS frontier forward by covering all sectors of the economy (except agriculture for now), requiring businesses to measure and report on their emissions and make payments (or surrender one "emissions unit") to the government for each one ton of emissions they emit. The ETS covers nearly half of the country's GHG emissions (Box Figure 2.1) and is scheduled to limit the total number of available emissions unit overtime, with free allowable units provided to certain industries.

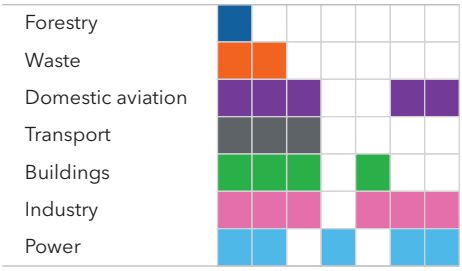
Korea launched a national ETS in 2015. A nationwide mandatory ETS is currently in Phase 3 (2021–25), applied to 684 companies covering 73 percent of national GHGs, up from 70 percent in Phase 2 (2018–20). The ETS cap was set based on the cumulative emissions during a three-year period in Phase 2 and has been reduced for Phase 3. Energy-intensive trade-exposed industries receive free allowance allocations. The ETS is playing a pivotal role in reducing GHG emissions at a measured pace, covering power generators and large firms, including hard-to-abate sectors.

Box 2. *(continued)*

In China, rolling out the national ETS in 2021 was one of the key policy milestones, and its success will play a pivotal role in the country's quest to achieve net zero. In December 2017, China announced its plan to implement a national ETS, initially targeting the power generation industry (that is, coal- and gas-fired power plants). Coal-fired power plants account for nearly half of China's carbon dioxide emissions from fossil fuel combustion (IEA 2020). Allowances to emit carbon dioxide are allocated based on each plant's generation output, with a formula to consider the use of fuel and technology against specific benchmarks. China's national ETS commenced in July 2021. Given the sheer size of carbon dioxide emissions in China, its ETS is the world's largest, with a plan to extend its coverage to other sectors.

Box Figure 2.1. ETSs: Sector and Emissions Coverage in Asia-Pacific

1. Sector Coverage



2. Emissions Coverage

Emissions coverage (percent in total emissions)	49	73	41	49	20	39	28
Country/State	NZL	KOR	CHN[1]	CHN[2]	JPN[3]	EU	UK

Sources: ADB (2021); and International Carbon Action Partnership (2022).
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. ETSs = emissions trading systems.
[1]Regional ETS pilots were introduced in some jurisdictions over the past years, including Beijing, Chongqing, Fujian, Guangdong, Hubei, Shanghai, Shenzhen, and Tianjin.
[2]It represents a national ETS operationalized in 2021, and the coverage reflects carbon dioxide emission only.
[3]ETSs have been introduced in Tokyo and Saitama prefectures.

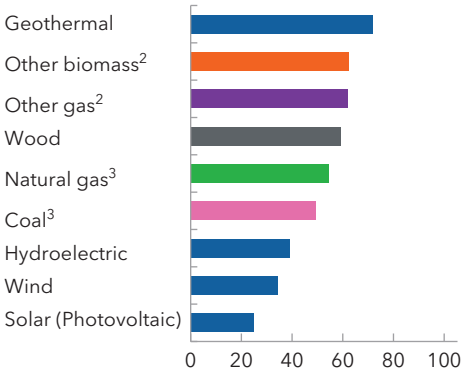
Box 3. Dependency and Penetration of Renewables: Existing Gaps

The country climate surveys indicate broad support for renewables as part of mitigation policy mix. Countries also indicated their plans to raise installed capacity of renewables in the future. Solar is ranked the top for renewable source, followed by hydropower, wind energy, and biomass, depending on available natural resources.

A few countries have specified a target dependency rate for renewable energy. For instance, Japan specified 36 to 38 percent for its target dependency rate on renewables by 2030. Likewise, Malaysia has set the dependency rate of around 40 percent in 2035. In Cambodia, the dependency rate is targeted at 65 percent in 2030 and 90 percent in 2050. In Vietnam, renewable energy, including hydroelectricity, wind power, solar power, and biomass, is targeted to account for 47 percent of electricity produced by 2030. By 2050, renewable energy in Vietnam is targeted to account for 67.5 to 71.5 percent of total electricity produced.

While declines in the cost of production should help incentivize investments in renewables, constraints to penetration remain. Some economies in the region indicated it is still expensive to install and maintain facilities for renewable energy, and limited access to affordable finance exacerbates the costs (Cambodia, China, Lao P.D.R.). Emerging market and developing economies still depend on advanced economies for technology transfers (China, Lao P.D.R.). Other factors, such as gaps in regulatory guidelines for a clean energy transition (Thailand) and labor market implications (Australia, Malaysia, Thailand), constrain increasing penetration of renewables.

Box Figure 3.1. Reliability for Producing Electricity
(Capacity factors in the United States, percent[1])



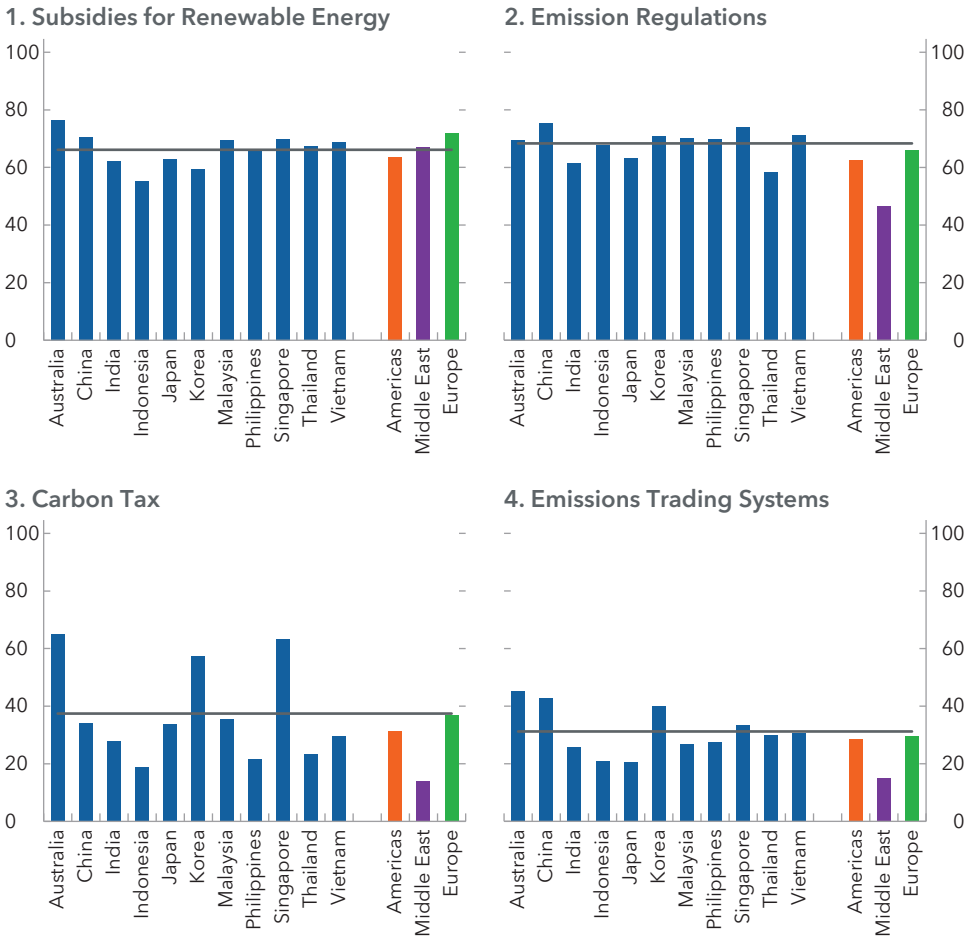
Source: US Energy Information Administration, Electric Power Monthly (2022).
[1]Capacity factor is a measure comparing net generation of electricity to available capacity over a specific duration of time. The data is based on the 2013–22 average where the data in 2022 is an estimate.
[2]Other gas includes blast furnace gas and other manufactured and waste gasses derived from fossil fuels. Other biomass includes biogenetic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, and other biomass.
[3]Based on 2021 data only (https://www.energy.gov/ne/articles/what-generation-capacity).

Raising dependency on and penetration of renewables will require supportive infrastructure and financing. The country climate surveys indicate that fluctuations in energy generation and supply are key impediments to increasing utilization of renewable energy sources (China, Japan, Malaysia, Thailand). Capacity factors, a measure of reliability for producing electricity, show low scores for solar photovoltaics in the United States (Box Figure 3.1), although global prices have come down significantly to more affordable levels over the past decade. Complementary policies to establish connectivity with a grid network and storage facilities are essential for raising dependency on and penetration of renewables, with adequate financing to install and maintain the entire ecosystem.

Box 4. IMF Public Perceptions Survey–Knowledge of Climate Mitigation Policies

Knowledge of mitigation policies is limited, especially in the case of carbon pricing (Box Figure 4.1). The public perception surveys show that about two-thirds of respondents in Asia-Pacific countries have heard of subsidies to renewable energy and laws and regulations limiting carbon emissions (including emission standards for power plants, vehicles, and buildings). While these survey results suggest that knowledge of these two policies is still far from universal, a more substantial information gap exists when it comes to carbon pricing. Only 37 percent of respondents in Asia-Pacific (a share similar to Europe's) have heard of carbon taxes, and even less–31 percent, similar to Europe and the Americas–are aware of emissions trading systems.

Box Figure 4.1. Knowledge of Climate Mitigation Policies
(Percentage of respondents)



Sources: Dabla-Norris and others (2023); and IMF staff calculations.
Note: See Figure 9 for details on the format of the figure and sample composition.

Knowledge is often limited even in countries that already adopted carbon pricing, and it is not directly correlated with such polices being already adopted (or under consideration) in the country. For instance, among surveyed countries where a carbon tax is in place, more than 60 percent of respondents in Singapore have heard of this policy, but the share is a mere 20 percent in Indonesia

Box 4. *(continued)*

where a tax was under consideration. Similarly in countries with emissions trading systems: 40 percent of respondents are aware of such a policy in China and Korea, and only about 20 percent in Japan.

Filling this information gap should be a priority for policymakers. Given the importance of carbon pricing in the policy mix to achieve climate goals (Parry, Black, and Zhunussova 2022), governments should make every effort to increase people's knowledge of this policy. Educating the public on policy costs as well as effectiveness and benefits in terms of revenue generation is key to garner the necessary support for this policy instrument.

Box 5. Catalyzing Adaptation Investments: What Economic Returns Do Adaptation Investments Provide?

Investing in adaptation projects offers large returns. Investing in adaptation not only yields societal benefits but also economic and financial returns. The Global Commission on Adaptation has shown that investing about $1.8 trillion into adaptation from 2020 to 2030 could yield about $7.1 trillion (Global Commission on Adaptation 2018).

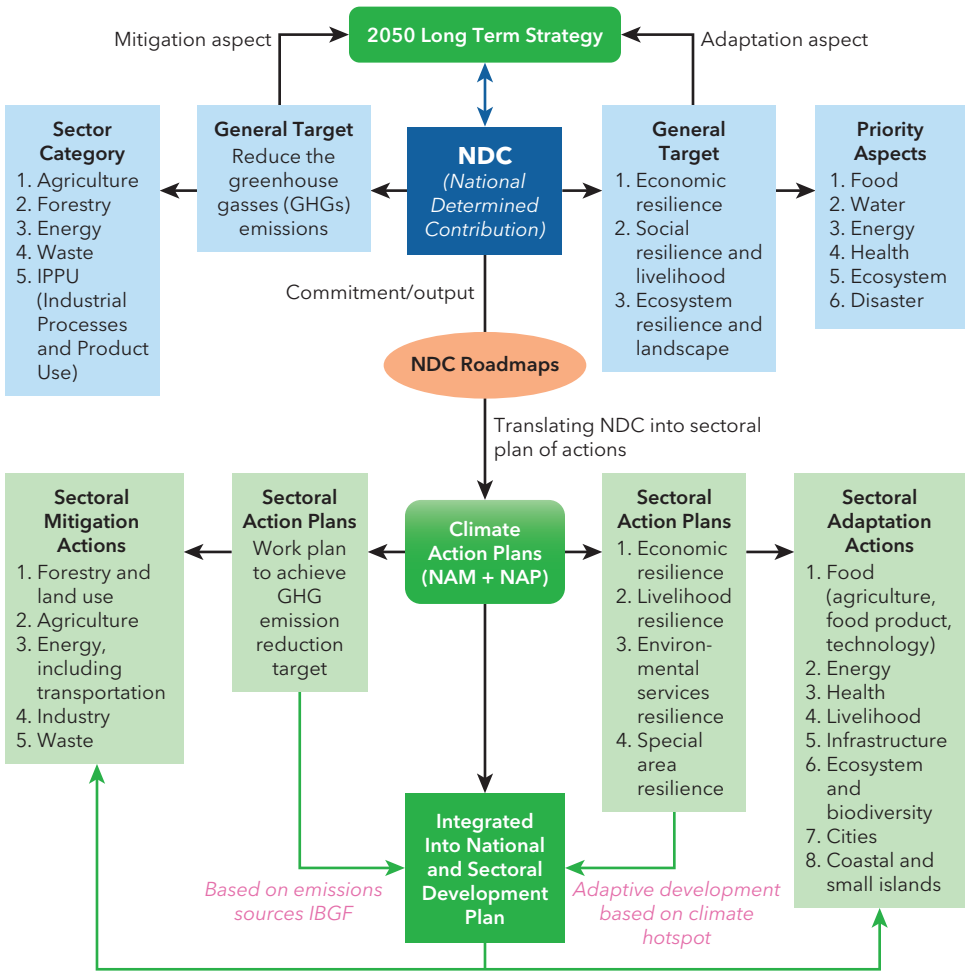
Major economic and social benefits explain large returns from adaptation investment. Reducing future losses is a key reason why investing into adaptation is beneficial. Policies to reduce losses include investing in early warning systems and making infrastructure more climate resilient. Second, adaption investment offers economic benefits, by reducing risks (for example, flood risks) and increasing productivity (for example, through irrigation technologies). Third, investing in adaptation yields social and environmental benefits, for example, by restoring and preserving mangroves, which can provide benefits that are 10 times the costs. Investing in adaptive infrastructure can also unlock private capital, including through reducing risk and damage from disasters; limit disaster recovery spending and debt distress; and ensure a quicker rebound in economic activity (Dabla-Norris and others 2021).

Key areas account for the high return for investing in adaptation. Investment in early warning systems, climate-resilient infrastructure, dryland agriculture crop production, mangrove protection, and making water resources more resilient can yield a triple dividend by avoiding economic losses and increasing economic, social, and environmental benefits.

Box 6. Mainstreaming Adaptation Policies into the Macro-Fiscal Framework: The Case of Indonesia[1]

Indonesia is very vulnerable to climate change–related risks, and the authorities have been proactively tackling climate change adaptation issues. The country is among the countries most exposed to high impact of natural hazards in the world based on the 2021 INFORM Global Natural Risk Index. All major physical risks such as rainfall, rising sea level, and severe floods and droughts affect the country. Indonesia has nationally determined contribution adaptation targets that are consistent with its national adaptation plan. In turn, the national adaptation plan has been mainstreamed into the national planning and covers issues related to the management of water resources, agriculture, forestry, and food security.

Box Figure 6.1. Connectivity between Mitigation and Adaptation, NDC, Climate Action Plans, and their Integration to National and Sectoral Development Plans



Sources: Indonesia authorities; and Indonesia's Long-Term Strategy for Low Carbon and Climate Resilience 2050.
Note: GHG = greenhouse gas; IBGF = index of biogeophysical; NAM = National Action on Mitigation; NAP = national adaptation plan; NDC = nationally determined contribution.

[1] Sources: Country Climate Surveys 2022; Indonesia authorities; and Indonesia's Long-Term Strategy for Low Carbon and Climate Resilience 2050.

Box 6. *(continued)*

The cost for adaptation to climate change is sizable. Indonesia has set an adaptation pathway to reduce the impact of climate change on GDP by 3.45 percent in 2050 by increasing resilience in four basic necessities (food, water, energy, and environment health). Adaptation cost for climate change is estimated at about 0.2 to 1.1 percent of GDP per year.

The budget covers part of the climate spending needs. Spending related to climate accounted, on average, about 4 percent of the central government budget (0.6 percent of GDP per year) from 2016 to 2022. Spending for mitigation activities accounted for about 62 percent of total spending, 34 percent for adaptation activities, and 4 percent for cross-cutting activities.

Indonesia is developing a comprehensive climate budget framework. The annual budget identifies allocation of climate-resilient investment projects for line ministries using the climate budget tagging mechanism. The climate budget tagging mechanism focused first on mitigation since 2016 and was extended to adaptation spending since 2018. The climate budget tagging mechanism also supported the issuance of green sukuks to finance climate investment projects. Expenditures monitored and tracked under the climate budget tagging mechanism are also published. Ministries and subnational governments are encouraged to integrate a green dimension into their budgeting and planning (Sakrak and others 2022). The country has also a dedicated unit focusing on climate resilience and a detailed fiscal risk statement that covers natural disasters.

Annex 1. IMF 2022 Climate Policy Surveys

The IMF Asia and Pacific Department conducted the country climate surveys during the second half of 2022. The surveys comprised 36 detailed multiple choice questions with an online interface developed by the IMF's Information Technology Department (see accompanying questionnaire). The mitigation and climate finance sections were sent to 18 economies, and the adaptation section to 26 economies, including the PICs. The country representatives preidentified by the IMF Resident Representative Offices or those designated to work on matters concerning international organizations responded to the surveys in coordination with relevant ministries, agencies, and central banks. The response rate across three sections was above 50 percent. Eight economies (Australia, Cambodia, China, Hong Kong SAR, Indonesia, Japan, Malaysia, Thailand) filled out all three sections. Other economies (Bangladesh, Korea, Lao P.D.R., Macao SAR, Mongolia, Philippines, Vietnam) submitted one or two out of the three sections.

Annex Table 1.1. Status of Survey Response by Country

	Mitigation	Adaptation	Climate Finance
Advanced Economies			
Australia	Responded	Responded	Responded
Hong Kong SAR	Responded	Responded	Responded
Japan	Responded	Responded	Responded
Korea	No	Responded	Responded
New Zealand	No	No	No
Singapore	No	No	No
Macao, SAR	Not applicable.	Responded	Not applicable.
Emerging Economies			
China	Responded	Responded	Responded
India	No	No	No
Indonesia	Responded	Responded	Responded
Malaysia	Responded	Responded	Responded
Mongolia	No	No	Responded
Philippines	No	Responded	Responded
Thailand	Responded	Responded	Responded
Vietnam	No	No	Responded
Major Low Income Countries			
Bangladesh	No	Responded	No
Cambodia	Responded	Responded	Responded
Lao PDR	Responded	Responded	No
Maldives	No	No	No
Pacific Island Countries: 7 countries[1,2]	Not applicable.	No	Not applicable.
Countries responded	**9**	**13**	**12**
Survey sent	**18**	**26**	**18**

[1] Include Federated States of Micronesia, Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu.
[2] The survey on the adaptation section was sent to those countries.

Annex 2. Use of Green Technologies in Asia

Some of the countries in Asia and the Pacific are at the frontier of green technology adoption and innovation. The region mostly contributes to four streams of green technology that sustain the global energy system, with potential to support energy transitions needed to reduce GHG emissions in the coming decades. In particular, clean and low-carbon technologies underpinned by renewables, energy efficiency, and electrification are penetrating fast in Asian economies. Innovation and applications of hydrogen use; carbon capture, utilization, and storage (CCUS); and bioenergy with CCU are also growing rapidly from infancy. Bringing down the cost of these technologies is key to adoption, supported by technology transfers and climate finance.

Renewables and Energy Efficiency

Electricity capacity of renewable energy has been expanding rapidly in the world, led by Asia and the Pacific (Annex Figure 2.1). The region accounted for nearly 60 percent of the global increase in renewable electricity capacity between 2010–20, led by China. Capacity in Korea and Vietnam has quadrupled over the period, and tripled in other large GHG emitters (Australia, India, Japan). Expansion in renewables also forms the backbone of low-carbon infrastructure, included in the policy mix for Cambodia, Japan, and Malaysia.

The capacity of solar-generated electricity has increased dramatically in the region, driven by substantial declines in prices of solar photovoltaics in the past decade. China is the global manufacturer of solar photovoltaics and batteries alongside the refinement and the production of rare earth elements, accounting for 60 percent and 90 percent of the respective totals which underpin its role as the global supplier of clean energy technologies (IEA 2023). India is also expanding its manufacturing capacity in this area. While Asia's larger emitters have invested heavily in expanding renewable capacity, developing economies and the PICs have also seen significant growth in renewables electricity capacity. In particular, solar-led growth in renewables capacity is the highest in the PICs, compared to other countries in the region. By 2027, solar photovoltaic–installed energy capacity in the world is projected to surpass that of coal, becoming the largest power capacity (IEA 2022b).

Electrification

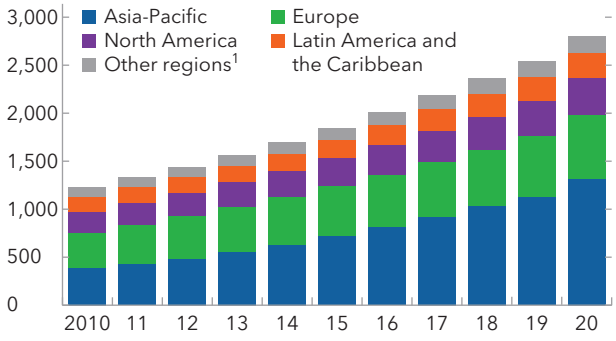
China dominated global sales volume of EVs in 2021, expanding electrification of road transport at a rapid pace (Annex Figure 2.2). Road transport accounts for 15 percent of global emissions, and EVs are the key technology to decarbonize (IEA 2022b). In 2021, the global sales of EVs more than doubled, reaching 6.6 million, with nearly half coming from China. Publicly available charging stations support EV use, and fast chargers as well as high energy-density batteries can accommodate owners for efficiency in driving, with China holding a large market share. For instance, the number of publicly available stations in China was around 0.5 million in 2021, accounting for 85 percent of the total number of charger stations across the world.

Hydrogen

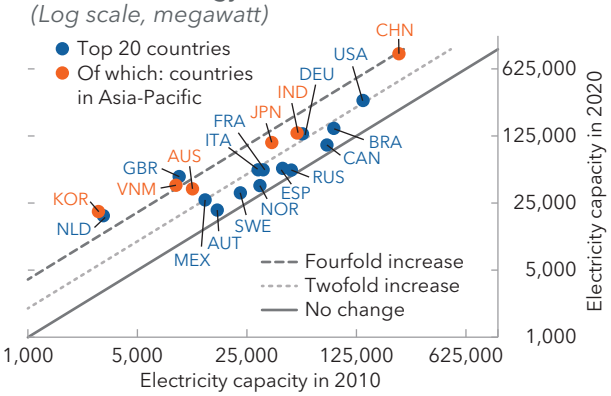
Green hydrogen projects are rapidly expanding globally, and Australia is among the global pioneers in the field. Hydrogen production using renewables ("green hydrogen") is increasing in Europe and some parts of Asia and the Pacific (Annex Figure 2.3; Annex Box 2.1). Hydrogen uses are typically found in hard-to-abate sectors, such as transportation and industries (power, iron, and steel), and other sectors by transforming hydrogen into ammonia for agriculture and synthetic fuels for broad aims. While the number of projects

Annex Figure 2.1. Growing Dependence on Renewables in Asia and the Pacific

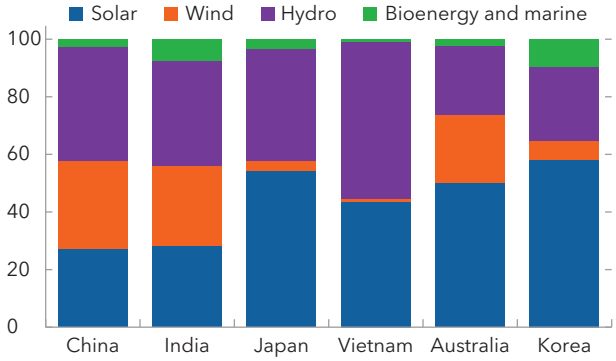
1. Electricity Capacity of Total Renewable Energy, 2010–20
(Gigawatt)



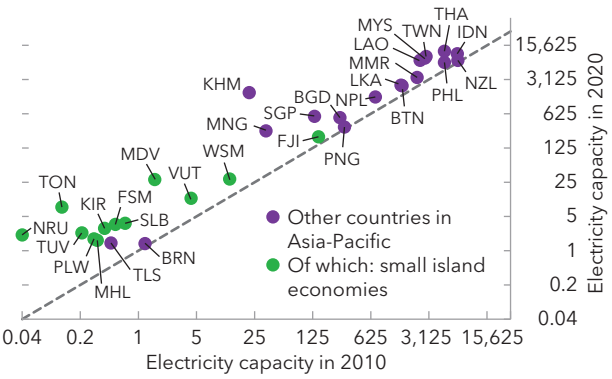
2. Top 20 Countries in Electricity Capacity of Total Renewable Energy in 2020
(Log scale, megawatt)



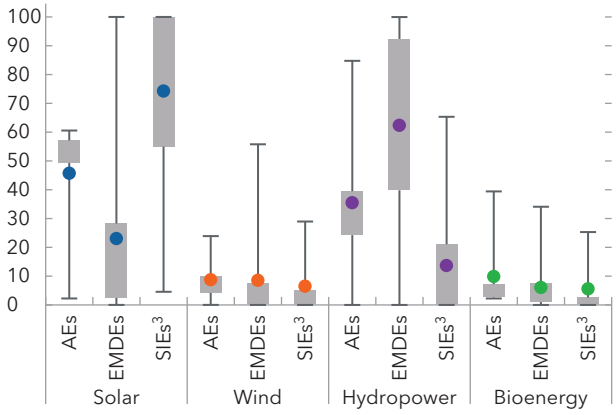
3. Diversifying the Source of Renewable Energy
(Percent, share of each renewable source in total renewable energy, 2020)



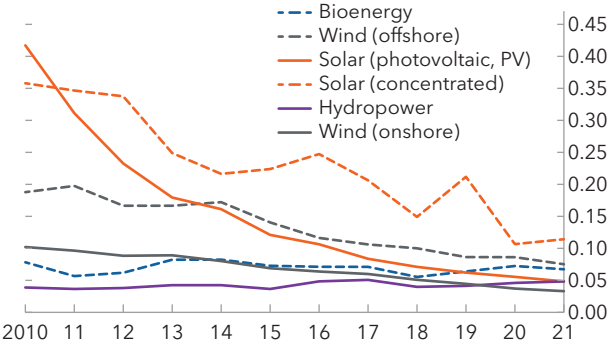
4. Expansion of Electricity Capacity in Renewables from a Low Base
(Log scale, megawatt, total renewable energy)



5. Varying Dependence in Asia-Pacific
(Percent, share of each renewable source in total renewable energy, 2020[2])

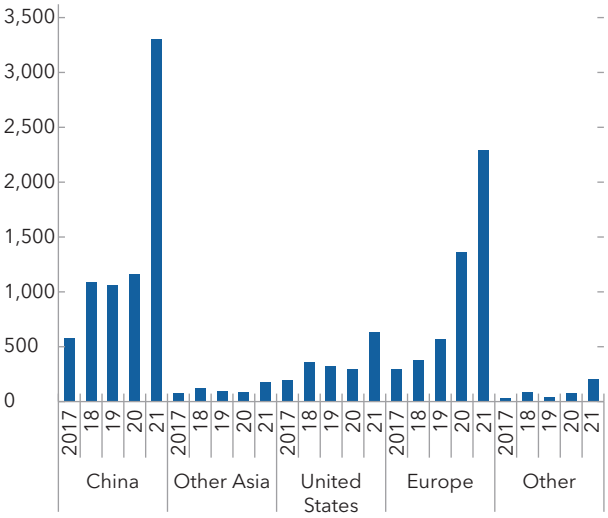


6. Declines in Levelized Cost of Energy by Renewable Technology
(2021 US dollar per kilowatt-hour)



Sources: IRENA, Renewable Capacity Statistics, 2022; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. AEs = advanced economies; EMDEs = emerging market and developing economies; SIEs = small island economies.
[1]"Other region" includes countries in Middle East and North Africa, the Caucasus and Central Asia, and sub-Saharan Africa.
[2] The figure shows maximum, minimum and average values, as well as the interquartile range of the share by source of renewable energy in electricity capacity for the respective economic groups.
[3]SIEs include 12 Pacific Island countries and the Maldives.

Annex Figure 2.2. Global Sales in Electric Vehicles, 2017–21
(Thousands[1])



Source: IEA (2022a).
[1]Includes both battery electric vehicles and plug-in hybrid electric vehicles.

is expanding, actual delivery of hydrogen will come into stream by 2030. Australia has recently revised its National Hydrogen Strategy in May 2023, updating its previous version in 2019 that focused more on the country's vision. Australia plans to conduct a review of the strategy to ensure that the country is on a path to be a global hydrogen leader by 2030.

Several countries in the region have a hydrogen strategy to achieve their mitigation goals (Annex Table 2.1). Nearly all AEs in the region have a hydrogen strategy in place. India has recently published a strategy to produce and export green hydrogen, and incorporate its use into the energy mix for reducing emissions intensity. Countries in the region are also in the process of creating a clean hydrogen supply chain (Annex Box Figure 2.1). India has set up the National Green Hydrogen Mission in 2022 with the intention of making the country a leading producer and supplier of green hydrogen globally, supported by the World Bank. These developments are consistent with the country climate survey results, as countries (Australia, Cambodia, Japan, Malaysia, Thailand) recognize the importance of emerging green technologies for emissions reduction in their pathways to net zero.

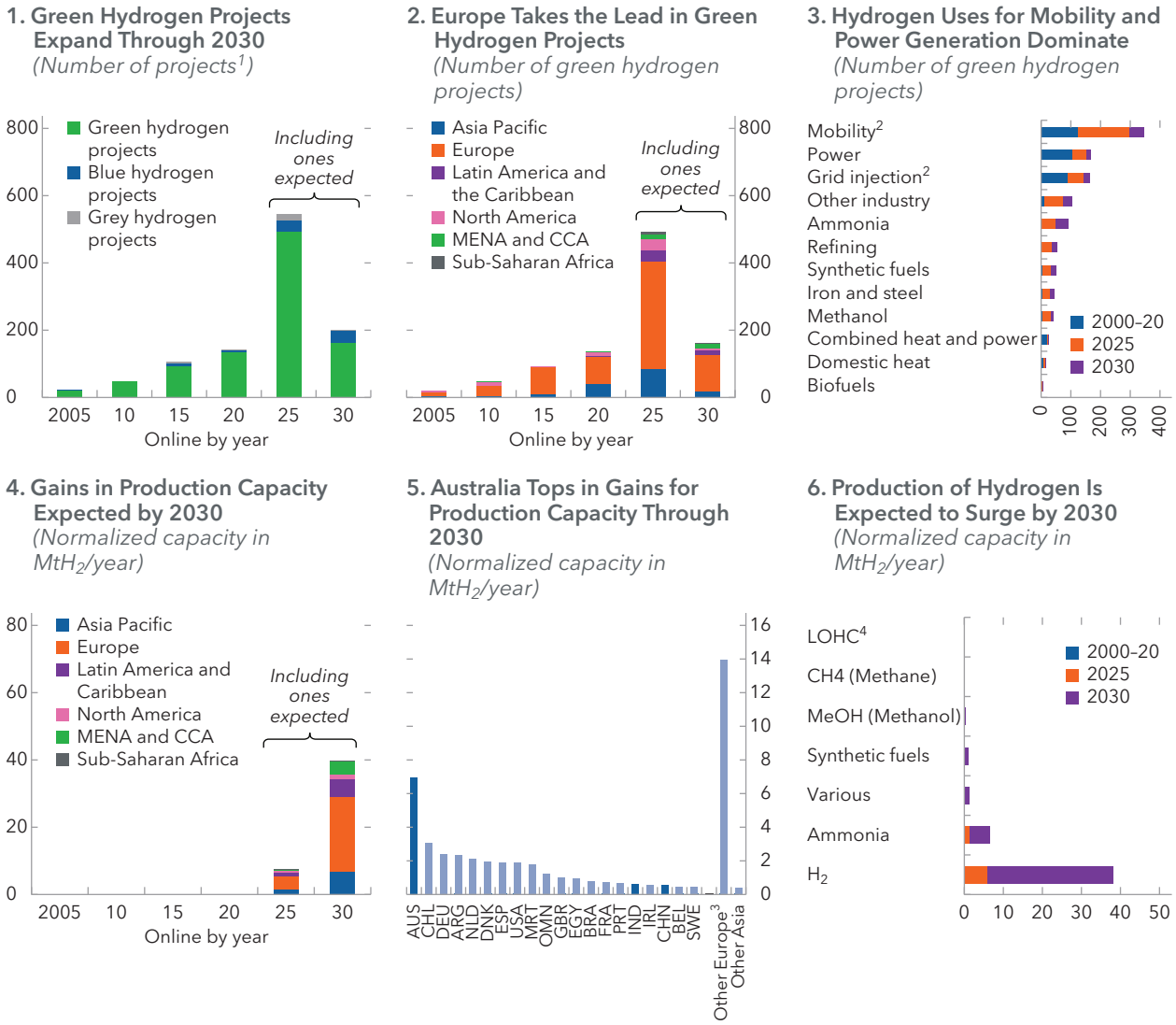
CCUS and Bioenergy with CCU

CCUS technologies for hard-to-abate sectors are increasingly in use in the region. CCUS refers to a suite of technologies, involving the capture of CO_2 released from industrial facilities and power generation. The number of facilities currently in operation is concentrated in the United States and Brazil. In Asia-Pacific, Australia and China have been increasing their capacity in recent years (Annex Figure 2.4). Most of the current use includes applications of CO_2 emissions for natural gas processing. A number of projects in the pipeline will raise the capacity of CCUS (or bioenergy CCUS) usage in the region for the coming decades. Besides Australia and China, other countries (for example, Indonesia, Korea, New Zealand, Thailand, and Timor-Leste) have projects at an advanced stage.

Nuclear Energy

Reliance on nuclear for ensuring clean energy and energy security is gaining momentum, but only in selected countries in the region (Annex Figure 2.5). Nuclear energy accounts for approximately 4 percent of the global energy mix in 2020. Europe, North America, and Asia and the Pacific are among the regions with the largest electrical capacity from nuclear energy, led by the United States, France, and China. Several Asian economies (China, India, Japan, Korea) have nuclear power plants under construction (IEA 2022b). China is set to become the leading nuclear power producer in the coming decade. With total capacity in the region expected to overtake North America in the future.

Annex Figure 2.3. Scaling Up of Green Hydrogen Projects Around the World and in Asia-Pacific
(Cumulative capture capacity, million tons per annum[1])



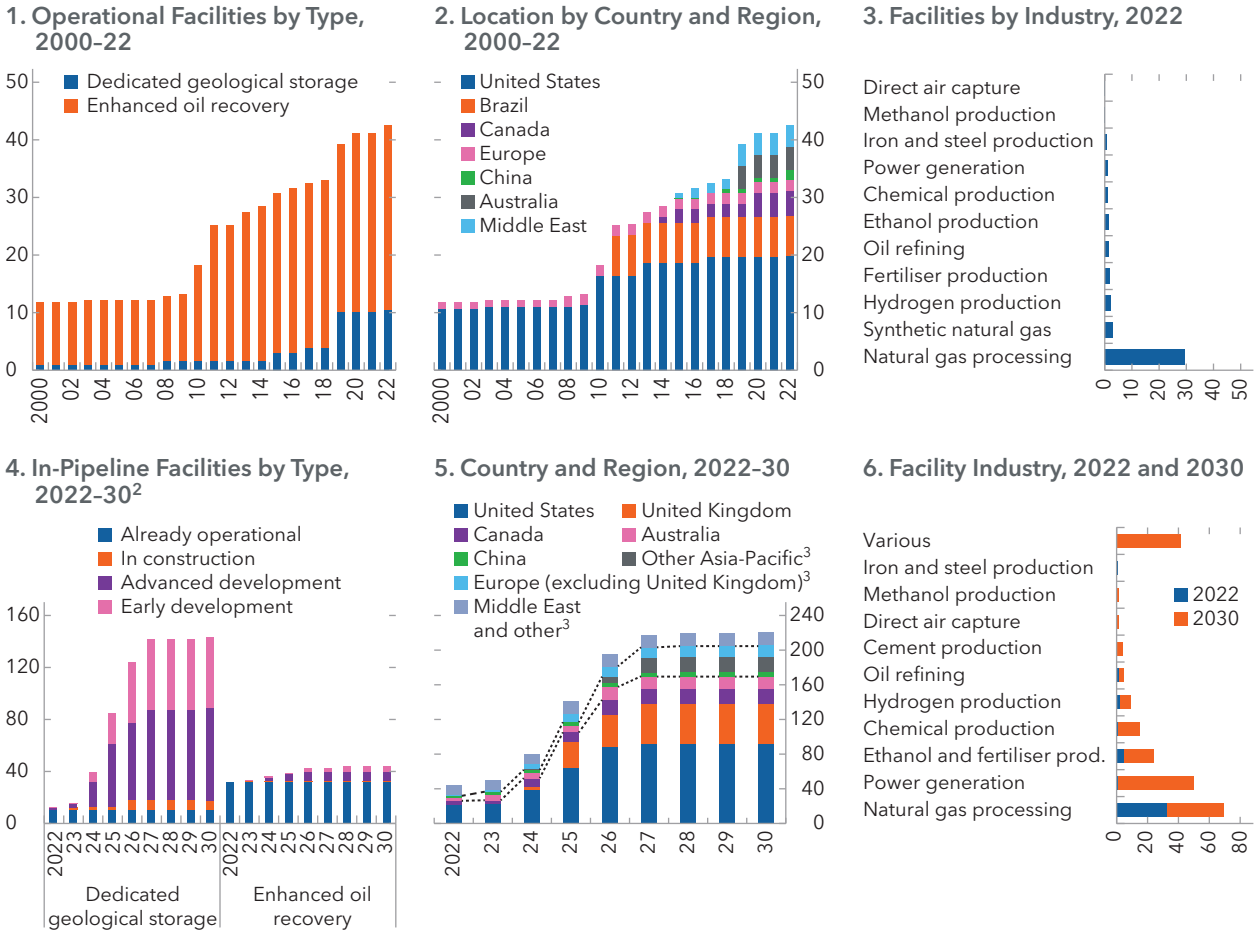
Sources: IEA, Hydrogen Projects Database (2021); and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. CCA = Caucasus and Central Asia; MENA = Middle East and North Africa.
[1]The number represents a sum of projects for each five-year period. Color represents the type of technology used. Broadly, green hydrogen projects refer to the ones relying on renewables, blue relying on fossil fuels with carbon capture and storage, and grey relying on biomass and other technology. The underlying projects are categorized by status, including the ones operational, under feasibility study, final investment decision, construction, at the concept stage, for demonstration, and other.
[2]Includes the use of methane for mobility and grid injection, respectively.
[3]The Hydrogen Projects Database identifies "HyDeal Ambition," launched by a consortium of 30 European companies from France, Germany, and Spain. It is expected to produce 11.6 million tons of H_2 annually and the largest giga-scale renewable hydrogen project globally, covering the entire green hydrogen value chain (upstream, midstream, downstream, and finance), with the initial phase of the project started in Spain in 2022.
[4]Liquid organic hydrogen carriers (LOHC) are organic compounds that can be used as storage for hydrogen.

Annex Table 2.1. Government Hydrogen-related Initiatives

Initiatives	AUS	CHN	*IND*	IDN[1]	JPN	KOR	NZL[1]	SGP
R&D programs		2020						
Vision document			2022				2019	
Roadmap		2022			2019	2019	2022	
Strategy	2019	2022	2023		2019	2020	2020	2022

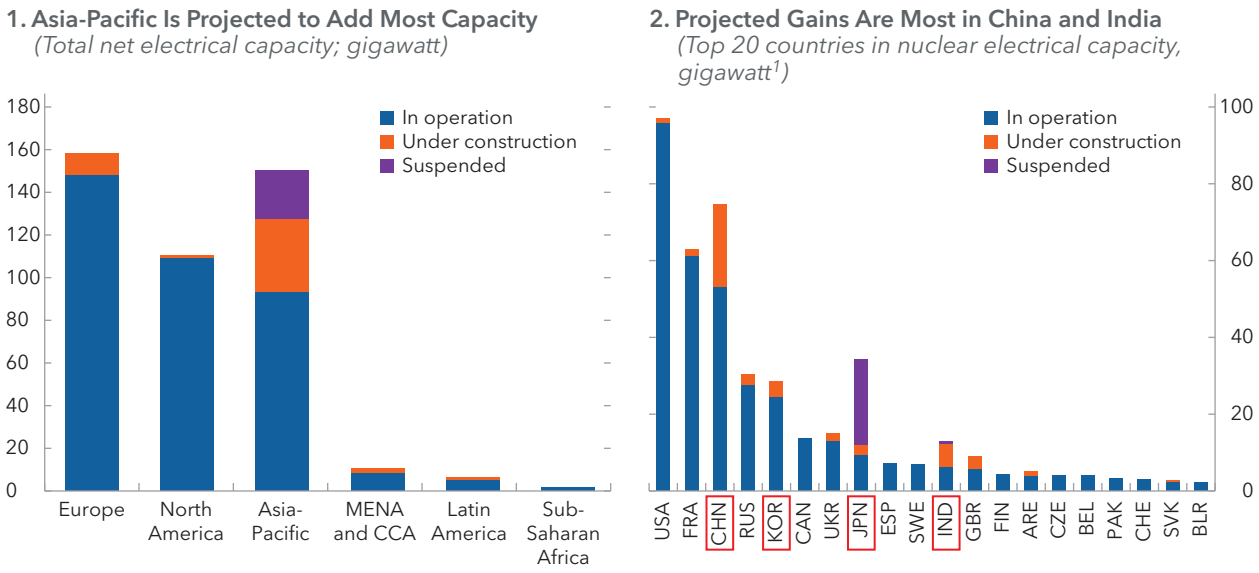
Sources: IRENA (2021a); and IMF staff.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. R&D = research and development.
[1]Indonesia and New Zealand are developing a hydrogen roadmap.

Annex Figure 2.4. Carbon Capture, Utilization, and Storage (CCUS): Australia Is Regional Leader
(Cumulative capture capacity, million tons per annum[1])



Sources: Global CCS Institute, Global CCS Facilities Database; and IMF staff calculations.
[1]The underlying data starts in 1972.
[2]Facilities already operational in 2022 are included in the underlying calculation.
[3]"Europe" includes Belgium, Denmark, Finland, France, Iceland, Ireland, Italy, The Netherlands, Norway, and Sweden; "Middle East and other" includes Brazil, Qatar, and the United Arab Emirates. "Other Asia-Pacific" includes Indonesia, Korea, New Zealand, Thailand, and Timor-Leste.

Annex Figure 2.5. Asia-Pacific, Particularly China and India, Will Lead the Expansion of Nuclear Electrical Capacity in the Coming Decade



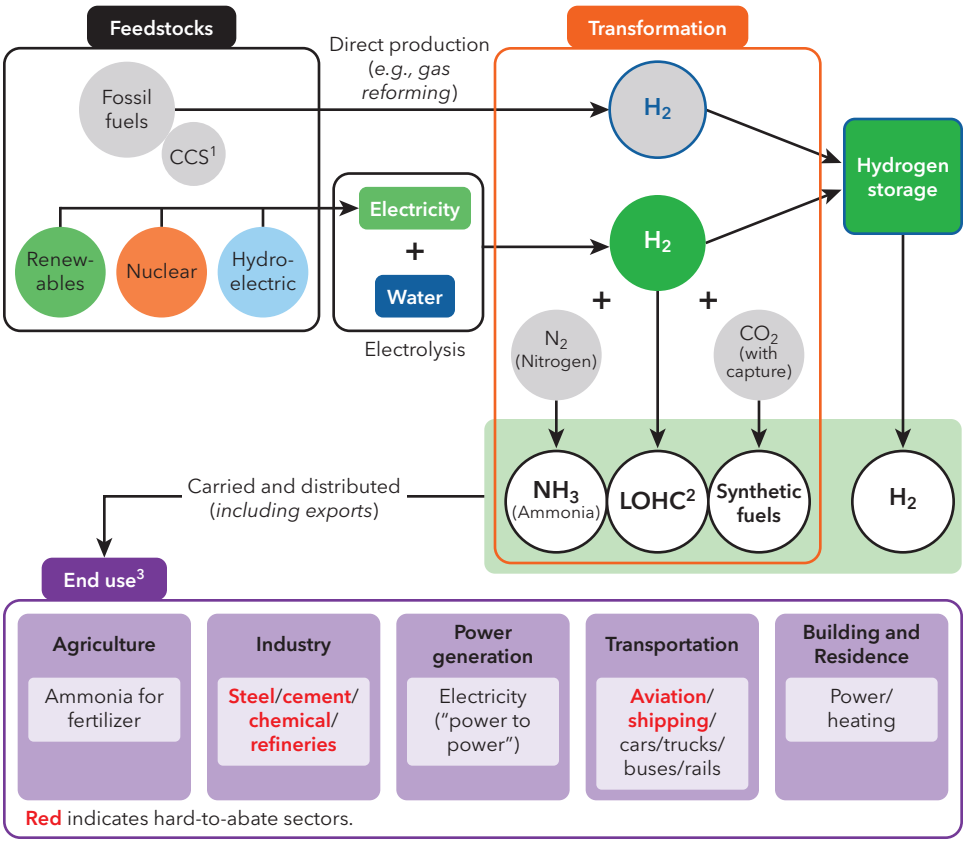
Sources: International Atomic Energy Agency, Power Reactor Information System (PRIS); and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes. CCA = Caucasus and Central Asia; MENA = Middle East and North Africa.
[1]Based on the data in 2022.

Annex Box 2.1. Emerging Hydrogen Supply Chains in Asia-Pacific

Some of the regional leaders in hydrogen projects are in the process of creating a clean hydrogen supply chain (Annex Box Figure 2.1). This has the potential to boost economic growth in the future, with expansion of supply chains contributing to lower prices of technologies (McNerney and others 2021). Some examples in the region include:

- Australia and Japan: A hydrogen supply chain is emerging between the two countries. Australia has signed a hydrogen export deal with Japan in January 2022 to advance Australian-based hydrogen supply chain projects. Following the agreement, a consortium of Japanese and Australian companies succeeded in a pilot project to transport hydrogen from Australia to Japan by the world's first liquified hydrogen tanker in April 2022. A hydrogen energy supply chain project was announced in March 2023 to produce hydrogen from brown coal.
- Malaysia: PETRONAS and ENEOS have teamed up to conduct a feasibility study in 2022–23 for a commercial hydrogen production and develop a clean hydrogen supply chain between Malaysia and Japan. A final investment decision is expected by the end of 2023.

Annex Box Figure 2.1. Emerging Hydrogen Supply Chains



Sources: Authors; and International Renewable Energy Agency (link: https://www.irena.org/Energy-Transition/Technology/Hydrogen).
[1]Carbon capture and storage (CCS).
[2]Liquid organic hydrogen carriers (LOHC) can be used as storage media for hydrogen.
[3]End use of hydrogen includes ammonia (NH_3), synthetic fuels, and LOHC that can be carried and distributed for commercial use.

Annex Box 2.1. *(continued)*

- New Zealand and Singapore have signed an arrangement in 2021 to team up on studies to establish a hydrogen-based carrier supply chain; shape global standards, regulations, and certifications of hydrogen product; and enable joint research and development.[1]
- Thailand: A memorandum of understanding has been signed by a Japanese company and the Electricity Generation Authority of Thailand, which will build a clean hydrogen and ammonia value chain in Southern Thailand.

[1] See https://www.mfat.govt.nz/en/trade/mfat-market-reports/market-reports-asia/new-zealand-and-singapore-link-up-on-hydrogen-august-2021/.

Annex 3. Gaps in Accessing Green Financing

Mobilizing climate finance to adopt green technologies for mitigation and climate-resilient infrastructure for adaptation is urgently needed to address threats of global warming. Many of the economies in the region face limited fiscal space, and country authorities face impediments to mobilizing domestic public resources. The region's economies must find ways to fill large financing needs and gaps. Tapping into private capital is a way forward, and innovative financing approaches must be explored. Identifying gaps and addressing them can improve access to private capital, which can go a long way to achieve mitigation targets.

Global financing needs range widely but are expected to be significant in Asia and the Pacific. Estimates of global financing span $120–130 trillion over the next three decades, which translates to an annual financing need of $4.0–4.5 trillion through 2050.[1] One estimate, which applied a net zero scenario from the Network for Greening the Financial System, shows cumulative financing needs of $275 trillion (MGI 2022).[2] The wide range of estimates makes it difficult to pin down financing needs for any specific region or countries, but some estimates show that cumulative financing needs in Asia and the Pacific could be around $50–120 trillion over 2021–50 (average annual cost of 4.8–11 percent of 2021 GDP).[3] Other estimates show financing needs in EMDEs of at least $1 trillion, with growing needs over time.

While global investments in clean energy have increased, large financing gaps remain particularly for EMDEs in the region. Global investment in clean technologies and grid networks reached $1.4 trillion in 2022, with renewables accounting for nearly a half of the total investment ($1.1 trillion) in clean energy (BloombergNEF 2023). Nearly half of the global investments in clean technologies took place in China, followed by the United States. Top 10 investment destinations include large emitters (India, Japan, Korea) in Asia-Pacific, amounting to around $60 billion in clean technologies alone. But investments in clean energy and technologies are lagging in many EMDEs in the region.[4] The country climate surveys suggest that country estimates for financing needs are not well aligned with NDC commitments. Many EMDEs in the region lack access to capital markets and will need to rely more on domestic financing and international financial support. Some countries face limited fiscal space to expand public investments needed for a green transition.

Asia has been a beneficiary of private climate finance but flows remain short of required needs. OECD (2022) finds that developed countries provided EMDEs $83 billion in total in 2020, with financing for mitigation accounting for two-thirds of the total and adaptation the rest. MDBs and multilateral climate funds have contributed to the bulk of public financing for developing countries, with equity only playing a limited role to date. Asia has received 42 percent of the total, and the region was the main beneficiary of private climate finance.

National climate strategies, encompassing development of green financial markets, require central banks and finance ministries to take integral roles. For instance, the People's Bank of China plays an integral role and has been working to refine the country's climate taxonomy and make green finance disclosure closely

[1] The *Financial Times* reported the world would need $125 trillion of climate investment by 2050 in an article titled "The World Bank Prepares for a New, Greener Mission" on February 21, 2023, sourced from "Net Zero Financing Roadmaps" prepared by the UNFCCC in 2021 (https://assets.bbhub.io/company/sites/63/2021/10/NZFRs-Key-Messages.pdf). Two of the leading international institutions indicate cumulative investment needs of around $130 trillion by 2050 (IEA 2021a; IRENA 2021).

[2] This figure translates to an average financing need of $9.2 trillion per annum, or 9½ percent of the world GDP in 2021, encompassing new capital allocations to acquire low-emissions assets (for example, passenger cars and heat pumps) and enabling infrastructure in agriculture, forestry, and other areas not previously accounted for.

[3] See UNFCCC (2021). An estimate of $120 trillion is based on the region's share of 43 percent applied to $275 trillion (estimated by MGI 2022).

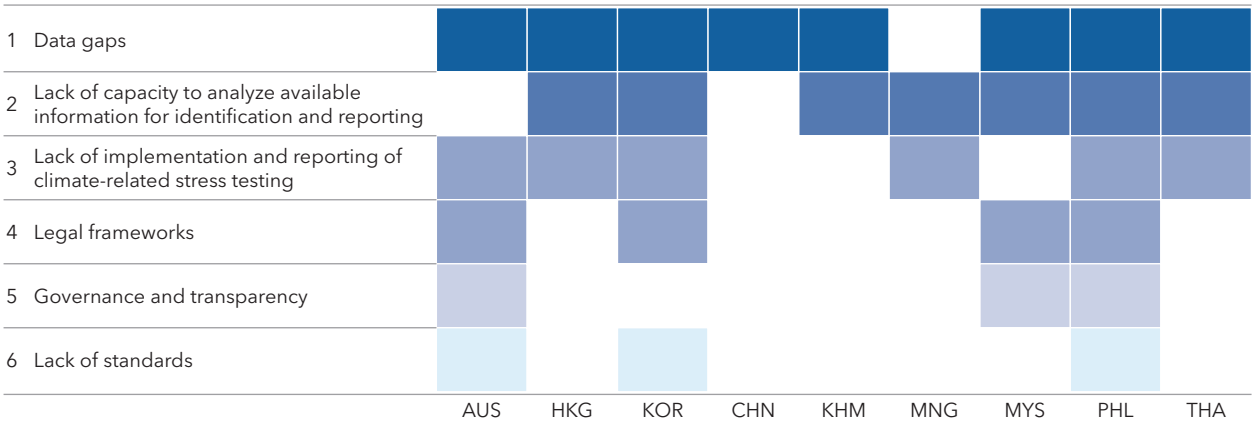
[4] On average, investment in Asia and Pacific was around $90 billion a year during 2016–20, nearly 80 percent of which was directed to the power sector and for building electricity networks. The remaining 20 percent covered investments in automotive, chemicals, construction materials, and home construction, among others (IEA 2021b).

aligned to international standards (Jeasakul and Xiao 2023). Similarly, the Bank of Japan has been implementing the national climate strategy to manage climate finance risks and support green financial markets. The Ministry of Finance in India issued its first sovereign green bonds in early 2023 to finance infrastructure and meet clean energy goals. In Indonesia, the authorities have been issuing green sukuks since 2018 and launched the first Green Taxonomy in January 2022. The Australian government announced in April 2023 its plan to launch sovereign green bond in mid-2024 to boost institutional investment for the green transition.

Despite these efforts, the country climate surveys point to a range of impediments to accessing green finance. The most widely cited challenges relate to the climate finance ecosystem (Annex Table 3.1), including data and capacity constraints to estimate climate-related risks (in both AEs and emerging markets) and lack of industry-wide standards and regulations on climate finance products (in emerging markets). Many AEs in the region (Hong Kong SAR, Japan, Korea) also noted the high cost of issuing green financial instruments consistent with other studies (OECD 2017b),[5] and several countries noted the lack of dedicated fiscal resources for climate action (Cambodia, Japan, Malaysia, Mongolia, Vietnam).

Data gaps in the region make it difficult to assess firms' exposure to climate change risk, amplifying transition risks. Financial markets need clear, comprehensive, high-quality information to assess their exposure to climate change, and disclosure by households, firms, and financial institutions is key for this assessment. However, while firms are accustomed to publishing financial statements, "sustainability reporting" of climate change risks and opportunities is still in its infancy in the region, and uptake is low (especially among smaller firms). Lack of disclosure requirements, coupled with data gaps (Annex Figure 3.1), makes it difficult for countries to comprehend total financing needs, amplifying transition risks as what is not estimated cannot be funded.

Annex Figure 3.1. Challenges with Introducing Disclosure Requirements



Source: Country Climate Surveys 2022.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

[5] High costs of issuing green bonds have been widely cited and documented as issuance requires upfront and ongoing transaction costs from labeling and associated administrative, certification, reporting, verification, and monitoring requirements.

Annex Table 3.1. Challenges to Accessing and Expanding Climate Finance

	HKG	JPN	KOR	KHM	MNG	MYS	PHL	THA	VTN
(A) Climate risks									
Lack of data and information to assess exposure of economy to climate risks	☑	☑	☑			☑		☑	☑
Lack of capacity or expertise to estimate climate-related risks in the economy	☑		☑			☑	☑	☑	
Lack of clear link between climate change and economic stability			☑		☑				☑
(B) Climate-related ecosytem									
Lack of industry-wide standards and regulations on climate finance products and market platforms					☑	☑	☑	☑	☑
A green taxonomy has not been established	☑			☑			☑		☑
No industry-wide standards for corporates have been set for climate-related disclosure	☑				☑		☑		
(C) Fiscal resources									
Lack of fiscal resources dedicated to climate action		☑		☑	☑	☑			☑
(D) Financial instruments and capital markets									
High cost of issuing green financial instruments	☑	☑	☑					☑	
Capital markets are not sufficiently deep or developed to mobilize and channel funds		☑	☑						
Limited economies of scale for investable green opportunities		☑					☑		
(E) Institutions and legal frameworks									
Lack of coordination and alignment of mandates of public institutions with climate objectives.				☑		☑			
Poor coordination between central and regional governments					☑				
Lack of legal and institutional frameworks to attract foreign participation in climate finance								☑	

Source: Country Climate Surveys 2022.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

References

African Development Bank, Asian Development Bank, Asian Infrastructure Investment Bank, Council of Europe Development Bank, European Bank for Reconstruction and Development, European Investment Bank, InterAmerican Development Bank Group, Islamic Development Bank, New Development Bank, and World Bank Group. 2022. "Joint Report on Multilateral Development Banks' Climate Finance."

Akanbi, Olusegun, William Gbohoui, and W. Raphael Lam. 2023. "Calibrating Fiscal Rules: A Consideration of Natural Disaster Risks." Technical Notes and Manuals 2023/002, International Monetary Fund, Washington, DC.

Allan, Bentley, Joanna I. Lewis, and Thomas Oatley. 2021. "Green Industrial Policy and the Global Transformation of Climate Politics." *Global Environmental Politics* 21 (4): 1–19.

Altenburg, Tilman, and Claudia Assmann. 2017. *Green Industrial Policy. Concept, Policies, Country Experiences*. Geneva: UN Environment Programme.

Ando, Sakai, Chenxu Fu, Francisco Roch, and Ursula Wiriadinata. 2022. "Sovereign Climate Debt Instruments: An Overview of the Green and Catastrophe Bond Markets." IMF Staff Climate Note 2022/004, International Monetary Fund, Washington, DC.

Andriansyah, Andriansyah, and Seung Hyun Hong. 2022. "Carbon Pricing in ASEAN+3 Economies: Progress and Challenges." Analytical Note, ASEAN+3 Macroeconomic Research Office, Singapore.

Arregui, Nicolas, Ruo Chen, Christian Ebeke, Jan Frie, Daniel Garcia-Macia, Dora Iakova, Andreas Jobst, and others. 2020. "Sectoral Policies for Climate Change Mitigation in the European Union." IMF Departmental Paper 20/14, International Monetary Fund, Washington, DC.

Asian Development Bank (ADB). 2021. "Carbon Pricing for Green Recovery and Growth." Manila.

Baum, Anja, Tewodaj Mogues, and Genevieve Verdier. 2020. "Getting the Most from Public Investment." In *Well Spent: How Strong Infrastructure Governance Can End Waste in Public Investment*, edited by Gerd Schwartz, Manal Fouad, Torben S. Hansen, and Genevieve Verdier, 30–49. Washington, DC: International Monetary Fund.

Bellon, Matthieu, and Emanuele Massetti. 2022. "Planning and Mainstreaming Adaptation to Climate Change in Fiscal Policy." IMF Staff Climate Note 2022/003, International Monetary Fund, Washington, DC.

Bengston, Onyx, Sherry Feng, Vasanth Ganesan, Joshua Katz, Hannah Kitchel, Pradeep Prabhala, Peter Mannion, and others. 2023. *The Agricultural Transition: Building a Sustainable Future*. New York: McKinsey & Company.

Black, Simon, Jean Chateau, Florence Jaumotte, Ian Parry, Gregor Schwerhoff, Sneha Thube, and Karlygash Zhunussova. 2022. "Getting on Track to Net Zero: Accelerating a Global Just Transition in This Decade." IMF Staff Climate Note 2022/010, International Monetary Fund, Washington, DC.

Black, Simon, Antung Liu, Ian Parry, and Nate Vernon. 2023. "IMF Fossil Fuel Subsidies Data: 2023 Update." IMF Working Paper 23/169, International Monetary Fund, Washington, DC.

Black, Simon, Ian Parry, James Roaf, and Karlygash Zhunussova. 2021. "Not Yet on Track to Net Zero: The Urgent Need for Greater Ambition and Policy Action to Achieve Paris Temperature Goals." IMF Staff Climate Note 2021/005, International Monetary Fund, Washington, DC.

Black, Simon, Ian Parry, and Karlygash Zhunussova. 2022. "Addressing Climate Change Mitigation in the Philippines: Role of Carbon Pricing." IMF Country Report 22/370, International Monetary Fund, Washington, DC.

Black, Simon, Tibor Hanappi, Samir Jahan, Pedro Juarros, Yuko Kinoshita, Thornton Matheson. 2023. "Green Industrial Policies." International Monetary Fund, Fiscal Affairs Department. April.

BloombergNEF. 2023. "Energy Transition Investment Trends 2023." London.

Bowen, Thomas, Carlo del Ninno, Colin Andrews, Sarah Coll-Black, Ugo Gentilini, Kelly Johnson, Yasuhiro Kawasoe, and others. 2020. *Adaptative Social Protection: Building Resilience to Shocks*. Washington, DC: The World Bank Group.

Budina, Nina, Lixue Chen, and Laura Nowzohour. 2023. "Why Some Don't Belong—The Distributional Effects of Natural Disasters." IMF Working Paper 23/2, International Monetary Fund, Washington, DC.

Caselli, Francesca, Hamid R. Davoodi, Carlos Goncalves, Gee Hee Hong, Andresa Lagerborg, Paulo A Medas, Anh D. M. Nguyen, and Jiae Yoo. 2022. "The Return to Fiscal Rules." IMF Staff Discussion Note 2022/0022, International Monetary Fund, Washington, DC.

Cevik, Serhan, and Guohua Huang. 2018. "How to Manage the Fiscal Costs of Natural Disasters." IMF How-To Note 18/03, International Monetary Fund, Washington, DC.

Chateau, Jean, Geetika Dang, Margaux MacDonald, John Spray, and Sneha Thube. 2023. "A Framework for Climate Change Mitigation in India." IMF Working Paper 23/218, International Monetary Fund, Washington DC.

Chen, Zhinan, Zifei Yang, and Sandra Wappelhorst. 2022. "Overview of Asian and Asia-Pacific Passenger Vehicle Taxation Policies and Their Potential to Drive Low-Emission Vehicle Purchases." White Paper, The International Council on Clean Transportation, Washington, DC.

Climate Funds Update. 2021. "Climate Finance Regional Briefing: Asia." Climate Finance Fundamentals 8, Washington, DC.

Cohen, Mark A., and Adeline Tubb. 2018. "The Impact of Environmental Regulation on Firm and Country Competitiveness: A Meta-analysis of the Porter Hypothesis." *Journal of the Association of Environmental and Resource Economists* 5 (2).

Dabla-Norris, Era, James Daniel, Masahiro Nozaki, Cristian Alonso, Vybhavi Balasundharam, Matthieu Bellon, Chuling Chen, and others. 2021. "Fiscal Policies to Address Climate Change in Asia and the Pacific." IMF Departmental Paper 2021/07, International Monetary Fund, Washington, DC.

Dabla-Norris, Era, Thomas Helbling, Salma Khalid, Hibah Khan, Giacomo Magistretti, Alexandre Sollaci, and Krishna Srinivasan. 2023. "Public Perceptions of Climate Mitigation Policies: Evidence from Cross-Country Surveys." IMF Staff Discussion Note 2023/2, International Monetary Fund, Washington, DC.

Fouad, Manal, Natalija Novta, Gemma Preston, Todd Schneider, and Sureni Weerathunga. 2021. "Unlocking Access to Climate Finance for Pacific Island Countries." IMF Departmental Paper 2021/020, International Monetary Fund, Washington, DC.

Global Commission on Adaptation (GCA). 2018. "Adapt Now: A Global Call for Leadership on Climate Resilience." World Resources Institute, Washington, DC.

Global Facility for Disaster Reduction and Recovery (GFDRR). 2017. *10: A Decade of Progress in Disaster Risk Management*. Washington, DC.

Gokhale, Hemangi. 2021. "Japan's Carbon Tax Policy: Limitations and Policy Suggestions." *Current Research in Environmental Sustainability* 3: 100082.

Gonguet, Fabien, Claude P. Wendling, Ozlem Aydin Sakrak, and Bryn Battersby. 2021. "Climate-Sensitive Management of Public Finances—'Green PFM.'" IMF Staff Climate Note 2021/002, International Monetary Fund, Washington, DC.

Hallegatte, Stephane, Jun Rentschler, and Julie Rozenberg. 2019. *Lifelines: The Resilient Infrastructure Opportunity*. Washington, DC: World Bank.

Hallegatte, Stephane, Jun Rentschler, and Julie Rozenberg. 2020. *The Adaptation Principles: A Guide for Designing Strategies for Climate Change Adaptation and Resilience*. Washington, DC: World Bank.

Ho, Mun S., Zhongmin Wang, and Zichao Yu. 2017. "China's Power Generation Dispatch." Report, Resources for the Future, Washington, DC.

International Carbon Action Partnership (ICAP). 2022. "Emissions Trading Worldwide: Status Report 2022." Berlin.

International Energy Agency (IEA). 2020. "China's Emissions Trading Scheme: Designing Efficient Allowance Allocation." Paris.

International Energy Agency (IEA). 2021a. "Net Zero by 2050." Paris.

International Energy Agency (IEA). 2021b. "Financing Clean Energy Transitions in Emerging and Developing Economies." Paris.

International Energy Agency (IEA). 2021c. "The Role of China's ETS in Power Sector Decarbonization." Paris.

International Energy Agency (IEA). 2022a. "Electric Vehicles." https://www.iea.org/reports/electric-vehicles

International Energy Agency (IEA). 2022b. "Nuclear Power and Secure Energy Transition: From Today's Challenges to Tomorrow's Clean Energy Systems." Paris.

International Energy Agency (IEA). 2023. "Energy Technology Perspectives 2023." Paris.

International Labor Organization (ILO). 2021. "World Social Protection Report 2020–22: Social Protection at the Crossroads—In Pursuit of a Better Future." Geneva.

International Monetary Fund (IMF). 2015. "Making Public Investment More Efficient." Policy Paper, Washington, DC.

International Monetary Fund (IMF). 2018. *Fiscal Transparency Handbook*. Washington, DC.

International Monetary Fund (IMF). 2020. "Tonga: Technical Assistance Report—Climate Change Policy Assessment." Country Report 20/212, Washington, DC.

International Monetary Fund (IMF). 2021a. "Indonesia and Climate Change: Recent Developments and Challenges." Country Report 21/47, Washington, DC.

International Monetary Fund (IMF). 2021b. "People's Republic of China: 2021 Article IV Consultation." Country Report 22/21, Washington, DC.

International Monetary Fund (IMF). 2022a. "India: 2022 Article IV Consultation." Country Report 22/386, Washington, DC.

International Monetary Fund (IMF). 2022b. *PIMA Handbook: Public Investment Management Assessment*, first edition. Washington, DC.

International Monetary Fund (IMF). 2023a. "Indonesia: 2023 Article IV Consultation." IMF Country Report No. 23/221. Washington DC.

International Monetary Fund (IMF). 2023b. *Data for a Greener World: A Guide for Practitioners and Policymakers*. Washington, DC.

International Monetary Fund (IMF). 2023c. "Climate Crossroads: Fiscal Policies in a Warming World." In Fiscal Monitor, Washington, DC, October.

Intergovernmental Panel on Climate Change (IPCC). 2022. "Climate Change 2022: Mitigation of Climate Change." Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

International Renewable Energy Agency (IRENA). 2021. "World Energy Transitions Outlook: 1.5°C Pathway." Abu Dhabi.

Jahan, Sarwat, and Artur Swistak. 2022. "Revenue Mobilization in the Philippines." IMF Country Report 22/370, International Monetary Fund, Washington, DC.

Jeasakul, Phakawa, and Hong Xiao. 2023. "Fostering the Development of Climate Finance." IMF Country Report 23/81, International Monetary Fund, Washington, DC.

Kim, Jay-Hyung, Tuan Minh Le, and Graham Glenday. 2021. "Stocktaking Survey on Climate-Smart Public Investment Management in Africa: What Did We Learn." The World Bank, Washington, DC.

Kuralbayeva, Karlygash. 2013. "Effects of Carbon Taxes in an Economy with Large Informal Sector and Rural-Urban Migration." Centre for Climate Change Economics and Policy Working Paper 156, Grantham Research Institute on Climate Change and the Environment, London.

Lim, Cheng Hoon, Ritu Basu, Yan Carrière-Swallow, Kenichiro Kashiwase, Mahmut Kutlukaya, Mike Li, Ehraz Refayet, and others. Forthcoming. "Unlocking Climate Finance in Asia Pacific: Transitioning to a Sustainable Future." IMF Departmental Paper, International Monetary Fund, Washington, DC.

Loayza, Norman V., Eduardo Olaberría, Jamele Rigolini, and Luc Christiaensen. 2012. "Natural Disasters and Growth: Going Beyond the Averages." *World Development* 40 (7): 1317–36.

Lu, Xianfu. 2022. "Accelerating Private Sector Engagement in Adaptation in Asia and the Pacific." ADB Sustainable Development Working Paper 84, Asian Development Bank, Manila.

MacKay, Alexander, and Ignacia Mercadal. 2022. "Deregulation, Market Power, and Prices: Evidence from the Electricity Sector." MIT Center for Energy and Environmental Policy Research Working Paper 2022-008, Massachusetts Institute of Technology, Cambridge.

Margulis, Sergio, and Urvashi Narain. 2010. "The Costs to Developing Countries of Adapting to Climate Change: New Methods and Estimates." World Bank, Washington, DC.

McKinsey Global Institute (MGI). 2022. "The Net-zero Transition: What It Would Cost, What It Could Bring." McKinsey & Company, New York.

McNerney, James, Charles Savoie, Francesco Caravelli, Vasco M. Carvalho, and J. Doyne Farmer. 2021. "How Production Networks Amplify Economic Growth." *Proceedings of the National Academy of Sciences of the United States of America* 119 (1).

Medas, Paulo, and Mouhamadou Sy. 2023. "State-owned Enterprises: Struggling to be Efficient." In *Handbook on Public Sector Efficiency*, edited by António Afonso, João Tovar Jalles, and Ana Venâncio, 219–49. London: Edward Elgar Publishing.

Metcalf, Gilbert E., and James H. Stock. 2020. "Measuring the Macroeconomic Impact of Carbon Taxes." *AEA Papers and Proceedings* 110: 101–06.

Meyfroidt, Patrick, and Eric F. Lambin. 2008. "The Causes of the Reforestation in Vietnam." *Land Use Policy* 25 (2): 182–97.

NAP Global Network. 2017. "Financing National Adaptation Plan (NAP) Process: Contributing to the Achievement of Nationally Determined Contribution (NDC) Adaptation Goals." Guidance Note, United Nations, New York.

NAP Global Network. 2017. ''Financing National Adaptation Plan (NAP) Process: Contributing to the achievement of nationally determined contribution (NDC) adaptation goals'', Guidance Note.

Organisation for Economic Co-operation and Development (OECD). 2017a. "Investing in Climate, Investing in Growth." Paris.

Organisation for Economic Co-operation and Development (OECD). 2017b. "Mobilizing Bond Markets for a Low-Carbon Transition." Paris.

Organisation for Economic Co-operation and Development (OECD). 2022. "Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action." Paris.

Organisation for Economic Co-operation and Development (OECD) and World Bank. 2019. "Fiscal Resilience to Natural Disasters: Lessons from Country Experiences." Paris.

Parry, Ian W. H. 2021a. "Fiscal Policies for Reinforcing Korea's Climate Mitigation Strategy." IMF Country Report 2021/065, International Monetary Fund, Washington, DC.

Parry, Ian W. H. 2021b. "Implementing the United States' Domestic and International Climate Mitigation Goals: A Supportive Fiscal Policy Approach." IMF Working Paper 21/57, International Monetary Fund, Washington, DC.

Parry Ian, Simon Black, and Nate Vernon. 2021. "Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies." IMF Working Paper 21/236, International Monetary Fund, Washington, DC.

Parry, Ian W. H., Simon Black, and Karlygash Zhunussova. 2022. "Carbon Taxes or Emissions Trading Systems? Instrument Choice and Design." IMF Staff Climate Note 2022/006, International Monetary Fund, Washington, DC.

Sakrak, Ozlem Aydin, Bryn Battersby, Fabien Gonguet, Claude P. Wendling, Jacques Charaoui, and Murray Petrie. 2022. "How to Make the Management of Public Finances Climate-Sensitive—'Green PFM.'" IMF How-To Note 2022/006, International Monetary Fund, Washington, DC.

Schmittmann, Jochen M. 2022. "Climate Finance in Japan." IMF Country Report 22/100, International Monetary Fund, Washington, DC.

Schmittmann, Jochen M. 2023. "The Financial Impact of Carbon Taxation on Corporates." IMF Country Report 23/128, International Monetary Fund, Washington, DC.

Una Gerardo, Richard Allen, Sailendra Pattanayak, and Gwenaelle Suc. 2020. "Digital Solutions for Direct Cash Transfers in Emergencies." Special Series on Fiscal Policies to Response to COVID-19, International Monetary Fund, Washington, DC.

UN Environment Programme (UNEP). 2022. "Emissions Gap Report 2022: The Closing Window—Climate Crisis Calls for Rapid Transformation of Societies." Nairobi.

UN Framework Convention on Climate Change (UNFCCC). 2021. "National Adaptation Plan 2021: Progress in the Formulation and Implementation of NAPs." Bonn.

World Bank. 2019. "Fiscal Policies for Development and Climate Action." Washington, DC.

World Bank. 2021. "Enabling Private Investment in Climate Adaptation & Resilience: Current Status, Barriers to Investment and Blueprint for Action." Washington, DC.

World Bank. 2022. "Climate Toolkits for Infrastructure PPPs." Washington, DC.

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DP/2023/008