Chapter 5

Catalysing Regional Cooperation for Seizing the Opportunities

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Asia's economic performance through its open regionalism policies is remarkable. The Association of Southeast Asian Nations (ASEAN) Member States (AMS), China, and India – along with the advanced economies of Japan, the Republic of Korea (henceforth, Korea), Australia, and New Zealand – are in the midst of historic transformation into a low-carbon economic system that has the potential to dramatically improve the resilience and living standards of the region's 3 billion people.

Addressing global issues such as climate change requires urgent policy actions at the national level. Many countries are implementing core policies that support low-carbon green growth: regulatory interventions, market-based instruments (e.g. carbon pricing and targeted support to low-carbon technology), diffusion innovation, and sustainable consumption. Several obstacles stand in the way of effective implementation of such policies. One of the most important is the continued prioritisation of carbon-intensive activities by existing policy frameworks due to economic interests. Inadvertently or not, this creates misalignment between existing regional policy frameworks such as the ASEAN Economic Community (AEC), the Regional Comprehensive Economic Partnership (RCEP), and the ASEAN Comprehensive Recovery Framework (ACRF), hindering the progress towards global targets such as the Paris Agreement and the Sustainable Development Goals (SDGs).

There is consensus on the need to achieve a net zero economy as quickly as possible. However, it is equally clear that transformational integrated policy changes and structural changes in key economic sectors are not happening at the required speed. The coronavirus disease (COVID-19) pandemic has its own impact on the economy, but has also created new once-in-a-generation opportunities for implementing hard policy reforms through economic recovery and stimulus packages. The need to accelerate the low-carbon transition as part of the pandemic recovery is unquestionable, but the question is how to do it in a cost-effective way.

This chapter presents a broad diagnosis of new regional cooperation opportunities in areas essential to complete the transition to a low-carbon economy by 2030 and a net zero economy by 2050. It highlights where regional cooperation and coordination can have the greatest impact, by bringing together frontier knowledge of how regional cooperation has succeeded in the past. It points to a number of policy areas – trade, finance, taxation, carbon markets, innovation, and capacity building – where regional cooperation reduces the cost of implementing national actions and complements global pacts.

1. Emerging Regional Cooperation Architecture in Support of Low-Carbon Green Growth

Figure 5.1 provides an overview of selected regional cooperation initiatives that have been introduced in Asia during the past 20 years, which have an economic, environmental, and low-carbon development component.

Of these, two are singled out here for additional discussion given their strong relevance to post-COVID-19 recovery strategies in the region at large but especially in Southeast Asia. The first is the ASEAN Smart Cities Network (ASCN), a collaborative platform established in 2018 to support smart and sustainable development.

Figure 5.1 Regional Cooperation Initiatives in Asia

Source: ERIA Study Team.

At a high level, its approach seeks to encourage inclusive development strategies that are respectful of human rights and fundamental freedoms, as inscribed in the ASEAN Charter. Moreover, its networking aspects – connecting leaders and specialists from different countries – are designed to enhance mutual understanding across cultures. Currently, the ASCN has 26 pilot cities as members and has established partnerships with 33 external partners, including from Japan, Korea, and the United States (US).

The second is the ACRF, a cooperative framework designed to support countries from across Southeast Asia to respond to and recover from the COVID-19 pandemic collectively. It is designed as a consolidated framework – one that brings together all new and existing sector and thematic initiatives that fall under the umbrella of ASEAN. Its

focus covers both specific near-term recovery needs and an overall crisis exit strategy. A key consideration for the development of the consolidated framework is to promote consistent and coordinated measures and ensure long-term sustainability and social inclusion. As this framework was developed at the 36th ASEAN Summit in June 2020, it remains to be seen how effectively countries will be in aligning their national recovery strategies with the ACRF priorities.

As both initiatives suggest, ASEAN has sought to characterise some of the benefits of regional cooperation in terms of greater sharing of ideas, resources, experiences, and perspectives. Beyond this, though, both efforts also hint at an important leadership role for a diverse range of subnational actors in driving economic and social transformation, and the importance of their inclusion at the table. To that end, while national and central governments design and formulate broad strategic plans, it is cities and subnational authorities that will adapt and implement such plans at the local level, with people's participation. Further, if well executed, these measures could help to propel these communities to greater economic competitiveness as Asia's economies increasingly find themselves on a global stage.

2. Role of Capacity Building – Knowledge Sharing and Policy Networks

2.1 Reconciling Global and National Priorities

Many countries with a net zero target (NZT)[1] have started to incorporate it directly into their near-term nationally determined contributions (NDCs). Achieving a global transition to NZT by 2050 without effective regional and international cooperation will be a major challenge. Strong regional cooperation is of immense importance for innovating and disseminating cost-effective technologies to achieve the NZT. More regionally coordinated actions are essential amidst the COVID-19 pandemic to seize opportunities across borders that lead to reducing the cost of implementing the stimulus agenda and maintaining competitiveness. Recent literature (e.g. Li and Zhang, 2018; Mo, Zhai, and Lu, 2017) has argued strongly that regional economic cooperation – through liberalised trade and investment, carbon markets integration, and increasing investment in innovation on low-carbon products and services – could contribute not only to lowering emissions, but also to raising long-term economic growth prospects.

Figure 5.2 illustrates the evolution of formalised institutions in support of economic cooperation and integration, which started in 1967 with the formation of ASEAN. Accelerated liberalisation of trade, investment, infrastructure connectivity, and technology transfer in the 1980s and 1990s was made possible through this institution, which served as a platform for networked economies. Individual countries continued to benefit from public and private investment in innovations, financing, and institutional reform, such as eliminating domestic content rules, which made the transition to a low-carbon economy less expensive. Regional cooperation, drawing on the experience and comparative advantage of Asian economies, will further amplify more locally focused programmes.

[1] Net zero refers to the balance between the amount of greenhouse gases produced and the amount removed from the atmosphere. Net zero is achieved if the amount added is no more than the amount taken away.

Figure 5.2 Evolution of Institutions Supporting Regional

Source: ERIA Study Team.

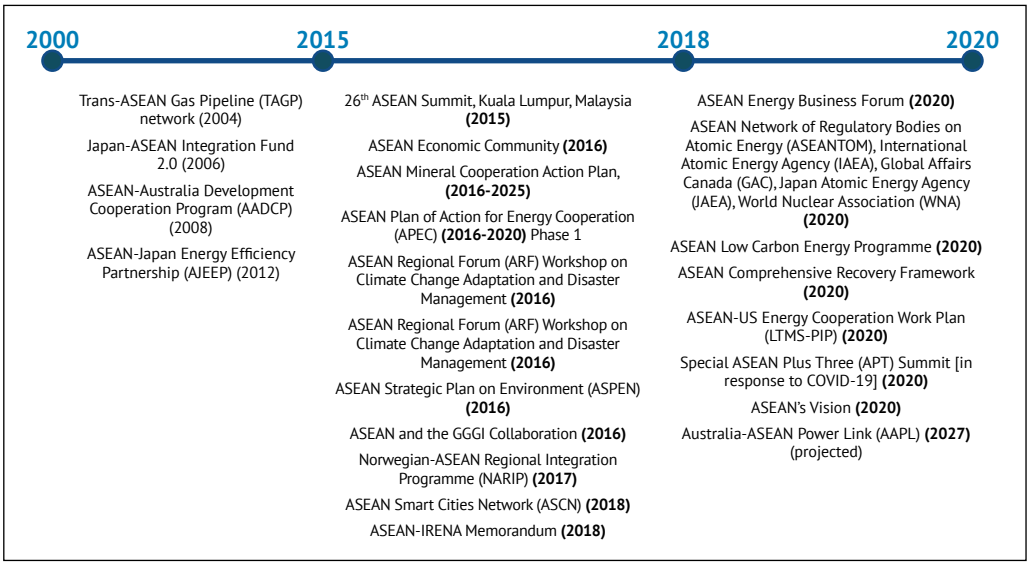
The foundations for regional cooperation are based on the endowment mix of individual economies – notably, their respective endowments of natural, manufactured, human, and social capital. Opportunities for collaboration emerge from the heterogeneity across economies. These are the foundations for the five pillars on which regional cooperation can be built by strengthening (i) regional innovation systems; (ii) collective learning and capacity building; (iii) free trade in all goods and services, including low-carbon goods and services; (iv) integration of carbon markets; and (v) pooling of regional public and private financial resources (Anbumozhi and Yao, 2016). Drawing on Anbumozhi and Yao (2016), this chapter discusses the following issues on climate change: ways to seize non-market opportunities, such as joint research and policy networking; capacity building through regional cooperation; ways to seize market-based opportunities, such as knowledge, and trade in low-carbon goods and services; and boosting investment flows in low-carbon goods and services. Following an evidence-based approach to transforming Asia into a low-carbon green Asia with net zero emissions, this chapter will highlight a few good examples of policy initiatives taken across the region for other countries to emulate.

2.2 ASEAN's Regional Framework on Climate Change

Climate change has long been addressed by the ASEAN Ministerial Meeting on Environment (AMME), with the ASEAN Senior Officials' Meeting on Environment reporting to the ministerial body. The ASEAN Socio Cultural Community (ASCC) Blueprint 2025 discussed environmental and climate change issues in four key areas – biodiversity and natural resources, environmentally sustainable cities, sustainable climate, and sustainable consumption and production – which were articulated into seven strategic priorities. The ASEAN Working Group on Climate Change (AWGCC), formed in 2009, has three mandates: (i) enhance regional cooperation in climate change via its action plan; (ii) promote collaboration amongst ASEAN sectoral bodies; and (iii) articulate ASEAN's concerns and

priorities at international fora. The AWGCC held the first ASEAN Climate Change Partnership Conference in 2018 in Manila to introduce and build awareness of the need for coordination in addressing climate change issues. The second conference, held in Singapore in 2019, provided a platform to share experiences and identify potential cooperation in addressing climate change. Although the AWGCC has delivered a number of collaborative projects involving ASEAN Dialogue Partners in recent years, it is clear that the AWGCC lacks a clear mandate to coordinate beyond the AMME working groups. Unfortunately, with the passing of time, dialogues on climate change have appeared beyond the domain of the AMME and ASCC blueprint.

Figure 5.3 Key ASEAN Cooperation Initiatives on the Economy, Energy, Environment, and Climate Change



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, GGGI = Global Green Growth Institute, IRENA = International Renewable Energy Agency, LTMS-PIP = Lao PDR–Thailand–Malaysia–Singapore Power Integration Project.

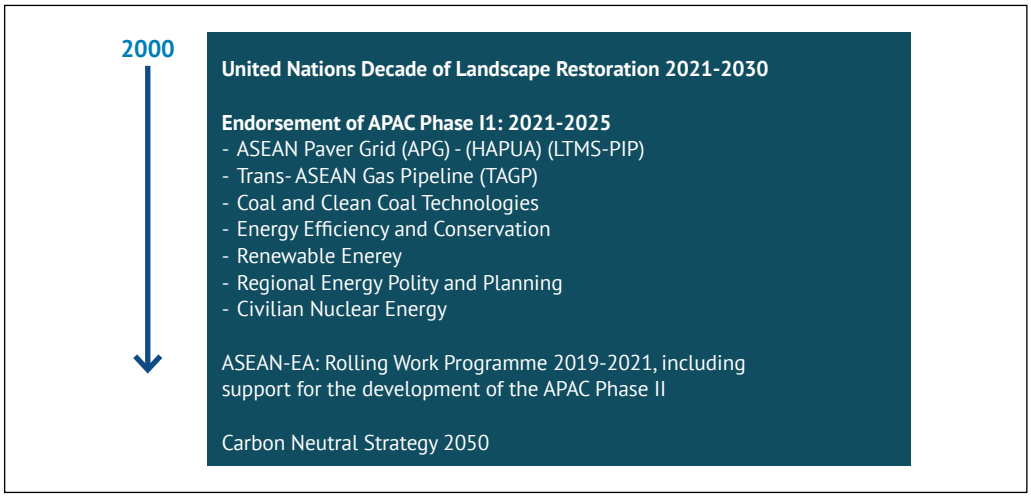
Source: ERIA Study Team.

For example, the ASEAN Plan of Action for Energy Cooperation (APAEC), which is the blueprint for energy cooperation in the region, plays a vital role in setting a sustainable future for the ASEAN energy landscape. The APAEC sets the work plan for the ASEAN Ministers on Energy Meeting (AMEM), which has consistently promoted renewable energy transition not only to fuel the region's energy security, but also to control carbon emissions. The ASEAN Ministerial Meeting on Agriculture and Forestry has increasingly promoted collaboration in protecting agriculture, forestry, and food security amid the climate crisis. The ASEAN Health Ministerial Meeting has acknowledged the challenge posed by climate change on public health. As the region is prone to natural disasters and is increasingly experiencing the impacts of climate change, ASEAN could see increasing cases of climate-triggered diseases such as dengue, malaria, and respiratory diseases. Prakash (2018: 22) cautioned that 'Long coastlines and heavily populated

low-lying areas make the region of more than 640 million people one of the world's most vulnerable to weather extremes and rising sea levels associated with global warming'. There is an urgent need for effective regional cooperation to assist with building both physical and human capital to mitigate this challenge.

The future planned under the APAEC phase II – regional cooperation projects – is listed in Figure 5.4, including institutional propositions to achieve carbon neutrality in 2059.

Figure 5.4 Proposed Regional Cooperation Projects in Energy and Environment



ASEAN = Association of Southeast Asian Nations, HAPUA = Heads of ASEAN Power Utilities/Authorities, IEA = International Energy Agency, LTMS-PIP = LTMS-PIP = Lao PDR–Thailand–Malaysia–Singapore Power Integration Project.

Source: ERIA Study Team.

Several weaknesses in the regional governance structure limit the region's ability to tackle cross-cutting issues such as climate change. Most importantly, information sharing is limited amongst the different ASEAN sectoral bodies, ASEAN entities, and the ASEAN Secretariat. Ironically, the ASEAN Joint Statement on Climate Change to the 25th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCC COP 25) in November 2019 reaffirmed 'the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC)' in light of climate challenges and differences in national circumstances (ASEAN, 2019b).

As a regional organisation invested in meeting transboundary challenges together, ASEAN is an institution that has the convening power to convince Dialogue Partners to prioritise climate action, channel public financing, and provide capacity building.

The time frame for meeting the objective of a temperature rise well below 2°C has been shortened significantly with the COVID-19 pandemic. A business-as-usual scenario for the global economy will not bring any changes or benefits to countries trying to meet their international obligations. COVID-19 may be the crisis of a generation, but it is also a critical opportunity for governments, regional groupings, and

businesses to make changes to the conduct of business that addresses the new challenges head on. Recognising the urgent need for coordinated actions for the COVID-19 pandemic exit strategy for the region, the 37th ASEAN Summit promulgated the ACRF. The five strategic areas of the ACRF are intended to address both the region's immediate needs during the reopening stage for a successful transition to the new normal as well as medium- and long-term needs through the stages of COVID-19 recovery and for longer-term sustainability with net zero emissions. The framework rests on commitments to create jobs, accelerate economic growth, and achieve environmental sustainability.

2.3 Regional Collaboration: Learning from Country Experiences

It is well documented that Japan, Korea, and China have been at the forefront of controlling carbon emissions by instituting appropriate policy measures at the sectoral and national levels (Kharecha and Sato, 2019; Winchester and Reilly, 2019; and Duan et al., 2018). Drawing on the experiences of Japan and China, Asia's big emerging economies, such as India, Viet Nam, and Indonesia, have begun taking actions in the form of voluntary targets and policy commitments to improve carbon efficiency. Nevertheless, the realisation of these commitments in Asian emerging economies has varied and is constrained by barriers including a lack of technological innovation and dissemination, and financial deficiencies for promoting innovation (Durmusoglu et al., 2018). Thus, regional/international funding and technology innovation and transfer are imperative for effective functioning of low-carbon energy systems to achieve the NZT by 2050 in Asia. The region should enhance its capacity to make better use of existing institutions, human capital, and funding sources. An interesting question is what the developed and emerging economies of Asia can demonstrate to other Asian economies in terms of instituting policy frameworks for transforming Asia into a net zero economy.

The similarities amongst some Asian countries, such as urbanisation (measured by the annual percentage change in the urban population) and air pollution in cities, enhance the opportunity to learn from each other. Hence, discussion in this subsection is focused on what developing Asian countries can learn from developed and emerging Asian economies in sectors that have common characteristics. Creditable efforts by China have included energy-saving laws and regulations; carrying out annual assessment evaluations; increased public budgets to encourage energy savings; and respective adjustments in tax, price, and financial policies. Research on improving the carbon sink capacity of forests has been encouraged through financial support. These emission reduction methods seem to be cost-effective: 'What once seemed unattainable targets to Chinese economic authorities are now viewed with confidence. Officials have been pleasantly surprised at the rate of decrease in costs and are now talking confidently of reaching the high point of the emissions intensity reduction' (Garnaut, 2011: 56).

China's afforestation programme could be a good source of learning for Indonesia, which has serious deforestation problems. Land use, land use change, and forestry are

central to climate change discussions in Indonesia. Changes in these sectors are strongly correlated with the country's emission trajectory. Better forest management will be critical for reaping the highest social and environmental benefits from the Reducing Emissions from Deforestation and forest Degradation plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks (REDD+) programme. The potential for achieving such benefits is very high if the management of forests is placed in the hands of those who push for sustainable practices, which is exemplified in India. In this context, it may be useful to observe India's forest management initiatives, which aim to strengthen community participation in the sustainable use of forests. To achieve the active participation of communities, capacity building programmes to increase local communities' awareness of forest conservation have been implemented at the subnational level, which can also be applied in Indonesia. The development of community-based forest management in Indonesia has gained momentum since 2014. The Indonesian government committed to allocate 12.7 million hectares of forestland to local communities through various schemes of the Social Forestry Programme. By early 2019, the total forest area managed by the local community through the Social Forestry Programme was only 2.7 million hectares, involving more than 0.5 million households (Suharjito and Wulandari, 2019). Thus, local communities administered only about 21% of the committed forestland 5 years since its announcement, which indicates that government regulations to constrain deforestation are still relatively ineffective. Hence, the Indonesian government's target of making its forests a major carbon sink by 2030 may be difficult to achieve as long as there are economic gains from carrying out unsustainable forestry practices, mainly due to the prevailing poverty in the local community.

Strict regulation is in place in East Asian countries for new vehicles to comply with airborne emission standards. Further, countries such as China and India have significantly promoted the use of mixed-fuel motor vehicles and have popularised the use of liquefied petroleum gas in auto-rickshaws and taxis in cities. China has increased resources for coal liquefaction projects and encouraged research into alternative fuels.[2] In developed countries, such as Japan, electric vehicle (EV) market shares have remained at a low level. By 2017, China accounted for more than half of all EV sales globally (IEA, 2018) (Box 5.1).

India has concentrated its efforts on improving and promoting public transportation, with long-term plans to ensure the availability of efficient and convenient public transport. Like China, India is supporting research and development (R&D) programmes on the cellulosic extraction of ethanol and butanol from agricultural waste and crop residues. As in the case of China, India has introduced compressed natural gas operated public transport, including three-wheelers in big cities, which has significantly reduced

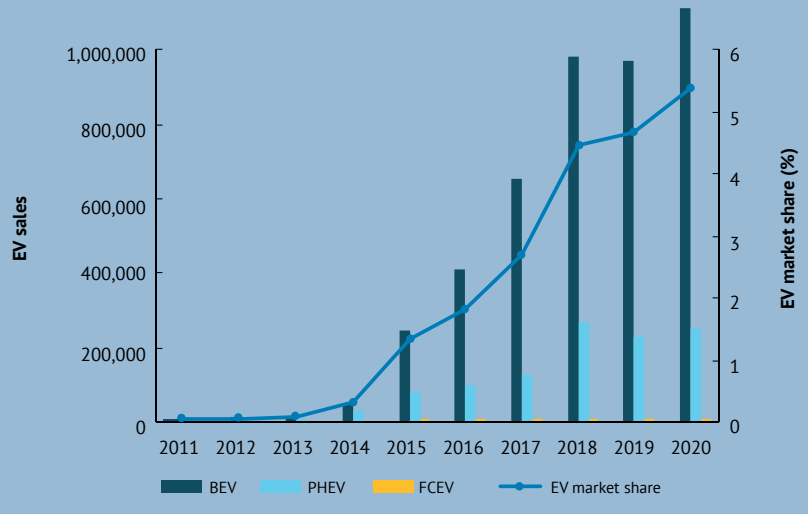
[2] Coal to liquids 'results in a fuel with appreciably less (5-12%) life cycle GHG emissions than the average US petroleum-derived diesel…Coal and Biomass to Liquids can produce fuels, which are economically competitive when crude prices are equal to or above USUS$93/bbl and which have 20% lower life cycle GHG emissions than petroleum-derived diesel' (National Energy Technology Laboratory, 2009: vi).

Box 5.1 China's Electric Vehicle Market – The Success Story

The Chinese government introduced a package of electric vehicle (EV) promotion policies at the launch of the 'Ten Cities, Thousands of EVs' project in January 2009. The project was initially implemented in 13 pilot cities and focused on subsidies for purchasing EVs for public transport, taxis, public affairs, sanitation, and postal services (Ministry of Finance, China, 2009). In May 2010, purchase subsidies were extended to cover private purchases of EVs in six cities – Beijing, Shenzhen, Shanghai, Hangzhou, Hefei, and Changchun (Ministry of Finance, China, 2010). The number of cities in which purchase subsidies for private EVs were given gradually increased to 88 in 2013 and was extended nationwide in 2016 (Ministry of Finance, China, 2015).

Incentives for EV manufacturers in China have been in the form of model development awards, manufacturing awards, and monetary rewards for achieving a given sales target. Consumer EV incentives have been in the form of monetary and non-monetary incentives, including purchase subsidies, purchase tax exemptions, and exemptions from purchase restrictions. EV drivers have also been exempted from driving restrictions, vehicle and vessel tax, parking fees, bridge and road tolls, insurance fees, and public charging fees; and have had preferential access to bus lanes (Wang et al., 2019). To promote the transformation of the EV industry from a subsidy-driven model towards market-oriented development, China has begun to phase out its subsidies for purchasing EVs in a step-by-step way.

Sales of battery EVs have seen particularly strong growth, at least partly because of policies favouring battery EVs (Hao et al., 2020). Fuel cell EV technology is still relatively underdeveloped and there is a shortage of hydrogen refuelling stations (Matsumoto, 2019).



BEV = battery electric vehicle, EV = electric vehicle, FCEV = fuel cell electric vehicle, PHEV = plug-in hybrid electric vehicle.

Note: EV market share is as a share (%) of total car sales.

Source: CAAM (2021), ERIA Study Team.

air pollution.[3] With the objective of promoting eco-friendly vehicles, the Government of India launched the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme in 2015. Many carmakers in India have been working on EVs, and the penetration of battery EVs has increased significantly in the last 5 years. Several start-ups have emerged, and their respective products and technologies are competing with conventional car manufacturers. Nevertheless, there is still a long way to go for the industry to reach

[3] The California Energy Commission found that compressed natural gas reduces emissions by 30% in cars and 23% in buses compared with gasoline and diesel (Wang and Huang, 2000).

a parity point with conventional internal combustion engines vehicles. Passenger vehicle demand has been very low, so only a few original equipment manufacturers have brought their products to market. However, the two-wheeler and three-wheeler EV segments have increased significantly in India (Morder Intelligence, 2020). Each state government across India has announced its own EV policies. As in the case of China, some of them incentivise the supply side, while others promote the demand side. Some EV policies promote both the supply and demand sides through incentives, discounts, and other benefits (Transport Policy.net, n.d.). These policies are driving the growth of EVs in India in a slow but steady manner (National Automotive Board, India, 2021).

Amongst the six major ASEAN economies, Indonesia, Malaysia, and Thailand have shown a keen interest in promoting EV production and consumption by instituting appropriate macroeconomic policies. For example, in March 2017, the Thai government launched EV promotions for cars and other vehicles, covering three types: hybrid EVs, plug-in hybrid EVs, and battery EVs. Thailand's Board of Investment has offered promotional privileges, such as tax holidays of 5–8 years and import duty exemptions for cars and machinery. The promotions include passenger cars, pickups, and buses with different rates of privileges based on production technology (Maikaew, 2017). Eight more important EV parts have been added to the corporate income tax exemption for 8 years by the Thai government, including batteries, traction motors, battery management services, DC/DC converters, inverters, portable electric vehicle chargers, electrical circuit breakers, and EV smart charging systems. Four Japanese carmakers – Toyota, Nissan, Honda, and Mazda – have been granted privileges for hybrid EVs, while Mercedes-Benz, BMW, and SAIC Motor-CP all acquired privileges to build plug-in hybrid EVs. Thus, the EV policies are tailored to support assembly and component production, which will exert an impact on technological upgrading of the EV supply chain. Under the 2014 National Automotive Policy, the Malaysian government introduced reforms to boost the production of energy-efficient vehicles in the country's automotive industry (Zulkifli et al., 2016). In November 2020, Thailand's Board of Investment introduced a new EV package to focus on battery electric vehicles (BEVs), local production of critical parts, and the inclusion of commercial vehicles of all sizes as well as ships (Thailand Board of Investment, n.d.).

Viet Nam and the Philippines appear to have the same objective as Indonesia, Malaysia, and Thailand of joining in the EV supply chain through component production and assembly lines. However, government policies are not yet well articulated to attract private sector involvement in the EV supply chain. Singapore does not seem to be promoting EVs enthusiastically, as the public transport system in Singapore has been well developed to limit the number of private vehicles on the road (Schröder, Iwasaki, and Kobayashi, 2021a).

People living in major cities in ASEAN emerging economies like Thailand, Viet Nam, Indonesia, the Philippines, and Malaysia suffer from poor access to, and availability of, timely socio-economic services. The concept of

a smart city has been used in other parts of the world to eliminate such constraints to promote good living conditions with efficient resource allocation.[4] Rapid urbanisation within ASEAN has led to the formation of the ASCN, with the selection of 26 pilot cities in 2018. The ASCN's aim is to help AMS harness technological and digital solutions and thus improve the lives of people across the urban–rural continuum. Those technologies are expected to bring sustainability benefits to cities and subregions. Although regional cooperation amongst cities exists in different forms, their potential is often overlooked. The ASEAN Sustainable Urbanisation Strategy and the ACRF offer these cities a framework for working together. In this context, reduced costs and net benefits are worth mentioning. In March 2018, Australia announced an AU$30 million fund to support smart city development in ASEAN (Straits Times, 2018). In July 2018, five agreements were signed during the opening ceremony of the Inaugural ASCN Meeting. Amongst them, the most notable was an agreement between the United Nations Development Programme (UNDP) and the Japan External Trade Organization (JETRO), which expressed support for the ASCN in the context of promoting sustainable development in the Asia-Pacific (JETRO, 2018). An agreement was also signed in 2018 between Thailand's Amata Smart City Corporation in the province of Chonburi and the Yokohama Urban Solutions Alliance to set up a Smart Grid Project and build a new waste-to-energy power plant, amongst other measures (Tang, 2018).

2.4 Market-Based Instruments

Market-based instruments (MBIs) have the potential to become a major mechanism for managing a wide range of environmental concerns (Whitten, van Bueren, and Collins, 2003). In some countries, a variety of MBIs is being tested and applied to environmental problems. As MBIs aim to achieve emission reductions where marginal reductions are cheapest, they have greater potential to achieve efficiency gains compared with command-and-control (CAC) regulatory instruments. Many countries in the region have started introducing a carbon trading market and carbon pricing schemes to boost a low-carbon economy. Congestion charging and tradable renewable energy certificates are other examples. MBIs are more difficult to use when the impact of the relevant externality is difficult to assess or varies significantly (e.g. weather or time of day).

There has been a noticeable shift in favour of tradable permit programmes in the Asia-Pacific region in recent years. For example, the Korea emission trading scheme (K-ETS) was launched on 1 January 2015, becoming East Asia's first nationwide mandatory emission trading scheme and, at the time, the second-largest carbon market after the EU ETS. The K-ETS covers 685 of the country's largest emitters, accounting for about 73.5% of national greenhouse gas (GHG) emissions. It covers direct

[4] A smart city is a city area that uses different types of electronic methods and sensors to collect data. Insights gained from the data are used to manage assets, resources, and services efficiently; in return, the data are used to improve operations across the city. This includes data collected from citizens, devices, buildings, and assets, which are processed and analysed to monitor and manage traffic and transportation systems, power plants, utilities, water supply networks, waste, crime detection, information systems, schools, libraries, hospitals, and other community services (McLaren and Agyeman, 2015).

emissions of six GHGs, as well as indirect emissions from electricity consumption. The K-ETS is meant to play an essential role in meeting South Korea's 2030 updated NDC target of a 24.4% reduction from 2017 emissions (ICAP, 2021d: 1).

In 2011, China approved a pilot emission trading scheme (ETS) in seven provincial regions – Beijing, Tianjin, Shanghai, Chongqing, Shenzhen, Hubei, and Guangdong – with a view to a national scheme in 2017. These have been operative, and progress has been made. The results have differed across regions, with the scheme performing quite well in the Hubei and Guangdong regions while Tianjin did not record a significant reduction in carbon emissions. In February 2021, after 3 years of preparation, China launched its national ETS – the world's largest – estimated to cover about 40% of national carbon emissions (ICAP, 2021a). The impacts of the nationwide scheme were recently studied by Mo et al. (2021). It is important to examine how the carbon pricing policy can fulfil the objective of phasing out China's coal power. Using a full-sample data set of China's 4,540 operating coal plant units, with the assumption that all plants are covered by the ETS, Mo et al. (2021) assessed the financial sustainability of the plants' operations. Their empirical results revealed that with a carbon price of US$7.70 per ton of carbon dioxide (CO_2) growing at 4% annually, the average residual lifetime of all the plants will be reduced by 5.43 years. Hence, the cumulative CO_2 emissions from 2020 to 2050 will be reduced by 22.73 billion tons. Due to different demand and supply conditions across regions, the impact of carbon pricing varies significantly by geography in China. The analysis indicated that the western regions are more vulnerable to the carbon pricing risk than the eastern regions (Mo et al., 2021).

Tokyo Metropolitan Government started the Mandatory CO_2 Reduction and Emissions Trading Programme in April 2010. The programme required the mandatory reduction of absolute CO_2 emissions and implemented a cap-and-trade programme under the amended Tokyo Metropolitan Environmental Security Ordinance. Under the Tokyo ETS, large offices and factories were required to reduce emissions by 8% (businesses) and 6% (industries) in the first period (FY2010– FY2014), which increased to 17% (businesses) and 15% (industries) in the second period (FY2015–FY2019) (Tokyo Metropolitan Government, n.d.). The introduction of high-efficiency heat sources and light fittings were key activities in generating emission reductions. Emission reductions have continued alongside increases to gross floor space, indicating a decrease in the emission intensity of Tokyo's building sector (OECD, 2019). The programme differs from that of the European Union (EU) ETS since it also includes large-scale office buildings within its scope (ICAP, 2021c). One year after Tokyo, Saitama Prefecture launched the Target-Setting Emissions Trading Program, in which the prefecture set reduction targets for covered facilities and allowed them to trade allowances, in accordance with the Saitama Prefecture Global Warming Strategy Promoting Ordinance of April 2011 (ICAP, 2021b). In April 2021, Prime Minister Yoshihide Suga announced a 46% carbon reduction target from 2013 levels by 2030. However, this target has been critiqued by some commercial entities and environmental experts for being 'unrealistic' (Harding, 2021).

New Zealand now operates a capped ETS covering all sectors except for agriculture, since there are no technological options, other than reducing livestock numbers, to reduce biogenic methane emissions. The first tranche of the New Zealand emission permits was auctioned in March 2021. A Fixed Price Option of NZ$25 per ton, which acted as a form of price ceiling, was introduced in 2009 and was later raised to NZ$35 per ton for emissions produced in 2020. In June 2020, the government passed the Climate Change Response (Emissions Trading Reform) Amendment Act, 2020, which strengthened New Zealand's ETS and aligned it with the goals of the Paris Agreement and the new 2050 NZT. The government also introduced regulatory settings for 2021–2025 within the legislative framework, establishing a cap on emissions for the first time under New Zealand's ETS. The price containment measures, which include Cost Containment Reserve (CCR) and auction floor price, were introduced via auctioning. Under the CCR, a specified number of allowances from the CCR will be released for auction if a predetermined trigger price is reached, currently set at NZ $50 per ton in 2021 and rising by 2% per year in line with projected inflation. Moreover, the government set a floor price of NZ$20 per ton for 2020–2025, which will operate through a reserve price and below which New Zealand Units will not be sold at auction (ICAP, 2021e).

In 2011, as a market-based emission reduction policy measure, India launched the Renewable Energy Certification (REC) scheme and in 2012 implemented the Perform, Achieve, and Trade (PAT) scheme to improve energy efficiency. In the former scheme, which concerns promoting renewable power generation through renewable purchase obligations on the energy distributor, the renewable energy certificates can be sold and purchased through the energy exchanges. In the latter scheme, the Bureau of Energy Efficiency in India sets energy efficiency benchmarks for India's largest energy users with trade occurring between participants that exceed their allowable targets and those that fail to meet them (Bureau of Energy Efficiency (n.d.). PAT has increased awareness around energy efficiency, and has provided a platform that could help generate exchange of knowledge leading to the adoption of technologies in the future.

A carbon tax, levied on fossil fuels, has been advocated as a cost-effective instrument to boost energy security, stimulate economic growth, and tackle climate change (Howes and Wyrwoll, 2012). Carbon taxes may generate indirect benefits, as the revenues can be used to reduce income or corporate taxes, or can be used to support environmental programmes and provide finance for compensation measures to lower-income households affected by the tax. Asian countries have addressed these issues in their carbon tax strategies, and some have planned to recycle carbon tax fiscal revenue to support environmental and pro-poor projects. India became the first Asian country to confirm the introduction of a carbon tax on coal in 2010, as part of its green growth strategy. However, none of the AMS has implemented a carbon tax – except Singapore, which implemented a carbon tax in January 2019. Nevertheless, an ETS has been under consideration in Indonesia, the Philippines, Thailand, and Viet Nam.

Carbon capture and storage (CCS) and carbon capture and utilisation (CCU)

technologies have been acknowledged as important technical supports for coal power plants to maintain the existing production structure while achieving near-zero carbon emissions. Of these, CCU – unlike CCS – does not store the CO_2 permanently underground, but utilises it as a raw material to produce other goods and services. Thus, CCU can add additional income streams to the reduction in CO_2 emissions (Baena-Moreno et al., 2019). Hence, CCU technologies can act as substitutes for fossil resources. Experts recommend that Southeast Asia harness CCS capabilities, which are estimated to allow countries to keep pace with economic growth and facilitate the transition towards hydrogen carbon economies. This could happen as blending of hydrogen with natural gas could provide a smooth transition from the current hydrocarbon-based economy to a hydrogen carbon economy. The main issues are that growth and innovation in the sector are highly uneven and regulatory frameworks are lacking in some contexts. The Asian Development Bank (ADB) has been incentivising and promoting the growth of carbon capture, utilisation, and storage (CCUS) activities in ASEAN (Nepal, Han, and Khatri, 2021).

Investment in CCUS technologies has been particularly promoted by Japan and Australia (Cuéllar-Franca and Azapagic, 2015). Japan highlights the importance of decarbonisation of the fossil fuel industry through the adoption of CCUS, carbon recycling, and the green transition fund on the pattern of the EU as important tools to meet low-carbon transition goals.

2.5 CAC Instruments

CAC instruments are the most common form of environmental policy used in both developed and developing countries. The CAC approach consists of a 'command', which sets a standard, and a 'control', which monitors and enforces the compliance with the regulation. Those who do not meet the standard are penalised. Emission standards can be either performance-based (specifying the acceptable emission limit) or technology-based (specifying emission limits and the technology that must be used). The advantages of CAC approaches are that they are more widely understood, and effective in emission reductions, provided that they are enforced. However, it is not always possible to set 'optimum' standards, especially with non-marketable goods (e.g. water and air); regulated agencies have no incentives to reduce pollution beyond the set standards; penalties for violating standards tend to be generally too low; and enforcement also tends to be weak. For CAC approaches to be effective, standards need to be reviewed and revised frequently, but in practice these measures are not keeping up with changing market environments (Howes and Wyrwoll, 2012). For example, UK climate agreements with firms in lieu of paying the Climate Change Levy seem not to have stimulated extra emission reductions. In contrast, carbon taxes are easily understood and more economically efficient.

Viet Nam, Cambodia, Malaysia, Thailand, and the Philippines all have stipulated standards on sulphur concentration in diesel. For Viet Nam, the standard reduced from 10,000 in 1996 to 500 in 2005, while it decreased

tenfold for the Philippines during the same period. Some AMS, such as Indonesia, Malaysia, Singapore, and the Philippines, also impose exhaust emission regulations on certain types of vehicles. Other popular types of environmental CAC regulations in the region include fuel quality regulations and specifications like those for unleaded gasoline in Malaysia, the Philippines, and Thailand; and blending requirements for fuels with ethanol and biodiesel (Timilsina and Dulal, 2009). Some other policy examples include the 'reduced cut' policy by Brunei to protect forests, Singapore's requirement that plans for new buildings and existing buildings which undergo major retrofitting should be cleared by the Ministry of Environment, Malaysia's mandated catalytic converters for cars brought after 1993, and Indonesia's 'liquid organic fertilizer rich in biological sources' (PORKASHI) programme. A few experts (e.g. Catelo, Francisco and Darvin, 2016) have argued that implementing MBIs in Southeast Asian countries would produce more impactful environmental policy than using CAC regulations. As discussed previously, MBIs are already used in certain national sectors, e.g. Viet Nam charges taxes in the transport sector and provides subsidies in the domestic cooking and heating sector, while Indonesia, Malaysia, and Thailand use information provision and voluntary agreement-based MBI strategies in the energy production and industrial pollution sector (Coria, Köhlin, and Xu, 2019).

As discussed in previous chapters, countries in the region are also learning from each other in bringing a green growth element to their green stimulus programmes and other fiscal measures.

2.6 Environmental Information Disclosure

Environmental information disclosure in capital markets is important for promoting investment in green businesses and technologies. Capital markets may, in specific circumstances, provide appropriate financial incentives for investment. Information about the pollution efficiency of a firm, and its environmental performance, may act as a signal of its expected long-term profitability (Horvathova, 2012). A firm's performance information, if provided on a regular basis, is valuable for the market to evaluate its worth. Therefore, governments can harness the forces of capital markets by introducing structured programmes requiring the regular release of information about environmental performance. The information will help reduce the risk of investments, protect the interests of investors, promote environmental transparency, encourage environmentally responsible investments, and enhance pollution control. Another example of a public disclosure mechanism is the Global Reporting Initiative (GRI and SASB, n.d.). The initiative facilitates voluntary participation from stakeholders, e.g. private sector agencies and non-governmental organisations, to undertake independent evaluation of the environmental performance of a firm. Environmental performance ratings appear to have a positive impact on regulatory compliance in several Asian countries. This positive impact is demonstrated by increases in compliance rates of 24% in Indonesia; 50% in the Philippines; 14% in Viet Nam; 10% in Zhenjiang, China; and 39% in Hohhot, China (Hongo, 2012). Environmental information disclosure has been associated with positive

performance outcomes for Malaysian firms (Abdullah et al., 2020).

Although countries can learn from each other in identifying appropriate institutions and policies to promote green growth, the pace of adoption depends on each country's resources, including human capital, and political will. Developing countries have specific problems with infrastructure development, initiatives for poverty reduction and sustainable development, training, and capacity development. Given the diversity of countries in the Asian region, regional cooperation can be a powerful instrument by which the leading countries can lift the lagging countries towards greater technological innovation and diffusion, which depends on the supply of sufficient human and physical capital. Official development assistance (ODA) can be another important mechanism for international cooperation, especially where there is a shortage of private investment. Traditionally, ODA has been used by countries for socio-economic development, but in recent times environmental protection has been included. For example, in February 2021, ADB and Japan's Ministry of Economy, Trade and Industry signed a memorandum of cooperation to enhance their joint efforts to promote clean energy in Southeast Asia under the Cleaner Energy Future Initiative for ASEAN (CEFIA).[5] The cooperation will focus on the areas of renewable energy, energy conservation and efficiency, and other technologies that will facilitate the transition to low-carbon energy (ADB, 2021a). Care needs to be taken that ODA funds being used for socio-economic development are not shared with the funds going into environmental protection. ODA needs to be increased from its present level to accommodate developing countries' environmental protection strategies. Further, the large foreign reserves in Asia could be leveraged for green research and investment through regional cooperation (Kalirajan, Venkatachalam, and Singh, 2010).

2.7 Seizing Market- and Non-Market-Based Opportunities Across Borders

2.7.1 Market-Based Opportunities

Besides the market-based opportunities that arise from improved trade and investment through ASEAN FTAs, regional cooperation can bring other win-win opportunities. For example, regional energy collaboration, which provides great opportunities, is important for energy security. Nevertheless, the success of collaboration depends on having strong carbon policies in place, particularly carbon pricing. Several studies have suggested how energy connectivity and cooperation can take place in East Asia. Kimura and Shi (2011) and Thukral, Wijayatunga, and Yoneoka (2017) identified areas of cooperation related to the energy sector that Southeast and Northeast Asian countries can focus on, such as multilateral cooperation, to attain energy security. The only current

[5] CEFIA, established in 2019, facilitates the collaboration of the public and private sectors in accelerating the deployment of sustainable energy and low-carbon technology in the region. The memorandum of cooperation was signed at the 2nd CEFIA Forum held online in February 2021 and hosted by the Ministry of Energy of the Government of Thailand, in cooperation with the Ministry of Economy, Trade and Industry and supported by the ASEAN Centre for Energy (ADB, 2021a).

example of multilateral power trading in the ASEAN region is the Lao People's Democratic Republic (Lao PDR)–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) (IEA, 2019). The LTMS-PIP is part of a broader strategy to develop a multilateral power market across ASEAN. Wu, Shi, and Kimura (2011) and Anbumozhi et al. (2016) in Investing in Low-Carbon Energy Systems: Implications for Regional Economic Cooperation suggested developing interconnected gas pipeline and electricity grids and creating regional energy markets. For example, underwater cables have connected the electricity grids of Singapore and Peninsular Malaysia since the mid-1980s. Their purpose is not commercial, but rather to help each country manage grid stability and supply security. Anbumozhi et al. (2016) and Kutani and Anbumozhi (2015) argued for adopting common efficiency standards as potential solutions for sustainable energy development in the region.

Concerning South Asia, India does not have the capacity to meet its burgeoning energy demand from domestic sources. However, it could solve its energy shortage by collaborating with Nepal on hydroelectricity, with Bangladesh and Myanmar on natural gas-generated electricity, and with Iran and Turkmenistan (through Pakistan) on gas. Experts project a significant increase in liquefied natural gas (LNG)-to-power asset class investments in Indonesia in the coming years (Mallo, 2020). Thailand and Myanmar have been cooperating on natural gas exports. There are other opportunities for the region in trading natural gas, as Asia is the centre of the global LNG trade. Overall, the natural gas market in Asia is projected to grow by 2.5 times in 10 years (Kobayashi and Li, 2018). Although LNG is not climate-friendly in the long run, its exports from the US to Asia increased by a record 67%, with China, Japan, and Korea being the primary recipients during 2019–2020 (US EIA, 2021).

A few energy collaboration programmes in Asia have already been working reasonably well. For example, Japan has established energy collaborative projects such as the Energy Silk Road project involving China, Turkmenistan, and the Cross-Country Pipeline network (Len, Tomohiko, and Tetsuya, 2008). The Trans-ASEAN Gas Pipeline and the ASEAN Power Grid projects have been set up to ensure regional access to gas reserves and greater stability and security of energy supply. That could also reduce emissions within ASEAN if coal is substituted by gas. Developing a network connecting all AMS with high-voltage transmission lines could not only resolve energy shortages, but also bring revenues from cross-border sales of electricity. For example, the Lao PDR has the potential to increase its renewable energy capacity and export the excess power to its neighbours, Thailand and Cambodia. Viet Nam's hydropower potential, which is huge, could also be sold to neighbouring countries (Thavasi and Ramakrishna, 2009). Although power grid interconnection in ASEAN is technically possible, it is challenging. Nevertheless, such projects have the potential to integrate the energy markets of East Asia–ASEAN–South Asia.

Malaysia and Japan have contributed US$308 million on a biofuel joint venture, with a target of producing about 0.2 million tons per year. Within ASEAN, some countries have

further potential to increase energy exports. For example, the Lao PDR and Thailand have already implemented several cross-border hydropower trade projects. Amongst them, the most notable is the US$1.2 billion Nam Theun 2, the biggest hydropower plant project in the Lao PDR. The Nam Theun 2 is the result of a private–public and multilateral organisation partnership. It started full generation in early 2010, exporting electricity to Thailand. From 2010 to 2017, the Nam Theun 2 recorded US$170 million in revenue and exported 1,000 megawatts (MW) of power to Thailand. Since 2017, the Nam Theun 2 has broadened its focus and acknowledged that its objectives are generational; therefore, it has started working closely with regional administrations, development agencies, and village partners (World Bank, 2019). In addition, Xekaman 3, commissioned in 2010 with 250 MW capacity, is supplying electricity to the Lao PDR and exporting 90% of the electricity generated to Viet Nam. The Theun-Hinboun Power Company operates the Theun-Hinboun hydropower plant in Bolikhamxay and Khammouane provinces of the Lao PDR. An extension to the original power project was completed in 2012 and was inaugurated in January 2013. The Theun-Hinboun expansion project, with an installed capacity of 60 MW, after some technical upgrades in 2016, now generates 520 MW. The Nam Ngum 2, which began operations in 2010, generates 2,220 gigawatt-hours of energy annually. The project has also helped Thailand gain access to a long-term source of renewable energy (Pöyry, n.d.). Coal is the primary export good in Indonesia, but faces challenges from the country's own growing domestic demand. In 2018, the region's fossil fuel trade balance deficit was US$57 billion, and this is projected to worsen over the next decade. Southeast Asian annual import bills are projected to exceed US$300 billion by 2040. In terms of renewables, trading tends to be mostly confined to bilateral agreements (IEA, 2019).

Sun Cable, a Singaporean consortium, has proposed the US$26 billion Australia–ASEAN Power Link (AAPL). The project is expected to supply power to the Darwin region of Australia and to Singapore via a 4,500-kilometre high-voltage direct current transmission network, including a 750-kilometre overhead transmission line from the solar farm to Darwin and a 3,800-kilometre submarine cable from Darwin to Singapore through Indonesia. The project is expected to generate enough renewable electricity to power more than 3 million homes a year, with commercial operations to commence in 2027.

As global carbon markets grew to more than US$20 trillion by 2020 (World Bank, 2021), Asian countries can benefit from such growth. There are variations across countries concerning the effective functioning of carbon markets, as there is no universally acceptable formula for carbon pricing.[6] As of 2019, carbon taxes have been implemented or scheduled for implementation in 25 countries, while 46 countries have put some form of price on carbon, either through carbon taxes or some form of ETS (World Bank, 2019). The Carbon Pricing Leadership Report 2020/21 (World Bank, 2021) strongly encouraged governments,

[6] Lu, Zhu, and Cui (2012) compared carbon tax, emission trading, and CAC regulation at the industry level, concluding that market-based mechanisms would perform better than emission standards in achieving emission targets without affecting industrial production.

business leaders, and other relevant stakeholders from around the world to use carbon pricing as a tool for effective climate action in support of sustainable development.

Although carbon credits have been in use for many years, the voluntary market for carbon credits has gained growth momentum in recent years. Blaufelder et al. (2021) estimated that buyers discharged carbon credits for some 95 million tons of CO_2 equivalent in 2020 – more than twice as much as in 2017. The need for scaling voluntary carbon markets to meet the NZT cannot be overemphasised here. Although Asian countries have addressed emission issues with different carbon tax strategies, it is imperative for countries to work together in a regional cooperation framework to make carbon market integration a reality rather than a myth in Asia.

Japan and Korea are keen to promote hydrogen technology as an important power source. Korea has intensified its efforts to move to green hydrogen, and the private sector is taking a lead role in transitioning to a green hydrogen future. The move comes as Korea is pushing to boost the supply of power from clean and renewable energy sources. Korean companies have also made commitments to invest in building a wide range of hydrogen infrastructure, such as the production and storage of hydrogen, by 2030 – which is a step in the right direction for achieving a green hydrogen economy. In 2019, hydrogen accounted for about 4% of final energy demand globally, of which more than 95% is generated from fossil fuels. So, hydrogen is not fully green yet (IRENA, 2019). The Global Green Growth Institute (GGGI) is well positioned to support countries to embrace hydrogen. Green hydrogen can be produced in GGGI member countries such as Indonesia, Viet Nam, and the Lao PDR (GGGI, 2021).

2.7.2 Non-Market-Based Opportunities

Many countries in Asia do not have enough resources to spend on R&D; and have a chronic shortage of scientists, engineers, and managers with the necessary skills. The shortage of R&D capacity and skilled workforces capable of low-carbon innovations in developing Asia emphasises the importance of regional cooperation in pooling human capital resources. Japan, China, Korea, and India have a pool of technical expertise, hence knowledge sharing can take place with other regional partners so that the best practice techniques of low-carbon energy systems can be disseminated in other Asian countries. Such a sharing of human capital could be formalised through an institutional framework involving regional institutions such as the South Asian Association for Regional Cooperation (SAARC) Secretariat, ASEAN Secretariat, and Central Asia Regional Economic Cooperation (CAREC) Secretariat. The role of institutions such as ADB, the Asian Development Bank Institute (ADBI), the Climate and Development Knowledge Network, and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) is crucial to bring these institutions together through the proposed virtual university/research institute/secretariat to achieve the common goal of low-carbon energy systems.

For instance, Japan and Korea's national hydrogen strategies are backed by massive investments in the research, development, and

commercialisation of clean hydrogen-related technologies. Japan and Korea have also been investing heavily in developing international clean hydrogen supply chains. Japan and Korea have recently emerged as major supporters of Australia's emergent renewable hydrogen industry. Australia's abundant wind and solar resources, technological know-how, R&D, and established record as a trusted energy exporter have made effective collaboration with Japan and Korea a reality. The dissemination of R&D results and technology transfer could be done through a virtual university, research institute, or secretariat for low-carbon research and knowledge sharing, with the help of regional development organisations such as ADB, ADBI, and UNESCAP. The private sector should be looked to for services such as training programmes for technicians and training for government personnel (World Bank, 2008).

Aus4Innovation, an AU$11 million development assistance programme that aims to strengthen Viet Nam's innovation system, is another regional cooperation initiative between Australia and Viet Nam. The Aus4Innovation programme facilitates and embraces opportunities emanating from Industry 4.0, and helps strengthen Viet Nam's innovation agenda in science and technology (S&T). The objective of the Aus4Innovation programme is to work together in exploring new areas of technology and digitalisation – devising new models for public–private partnership to improve Vietnamese capability in digital foresight, scenario planning, commercialisation, and innovation policy (CSIRO, 2021a).

Australia is undertaking an energy transition on a scale and complexity never before witnessed in its history. Record numbers of rooftop solar photovoltaic (PV) units, residential battery storage, and other new energy technologies (collectively referred to as distributed energy resources) are supplying energy to the electricity grid, bringing new challenges and opportunities. The Distributed Energy Resources Laboratory (DER Lab) is a state-of-the-art facility that mirrors the electricity grid. The lab will provide a fail-safe environment in which one can rapidly, efficiently, and securely develop and test technologies and systems before deploying them in the live grid. The DER Lab represents an important national facility for Australia's collaborative development and testing of new capabilities to support the operation of 21st century electricity systems.

2.7.3 International Intellectual Property Rights Regime

The intellectual property rights (IPR) regime is crucial in assisting technological innovation by developing countries from the basic R&D done in developed countries. At times, it may be necessary to combine technologies developed in different countries, which may pose problems due to the different IPR regimes in those countries. These problems may inhibit or slow down technological innovation and the adaptation of low-carbon technology by developing countries. A possible solution is regional cooperation in harmonising the IPR regimes across countries. UNESCAP, through its Renewable Energy Cooperation Mechanism for Asia and the Pacific, has been helping developing countries to overcome IPR issues in energy.

Concerning the smooth transfer of technology, an important factor is how closely the national IPR regime is integrated with the global IPR regime. The experiences of two major emerging economies in Asia – China and India – are worth noting. China has striven to conform to the World Trade Organization Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) and has managed its enforcement issues with administrative and judicial policies to assure foreign investors and a growing number of local IPR holders of the security of their intellectual property. How effectively the central government is in enforcing IPR policy at every level of government is an important benchmark for China's success in integrating its national IPR regime with the global regime. Signing the TRIPS Agreement in 1994 triggered significant changes in the IPR related legal framework in India. Since then, several legislative and institutional adjustments have been made to protect IPR.

Table 5.1 describes the IPR regimes and low-carbon industry policies in selected Asian countries. IPR has often been considered a constraint to international cooperation on low-carbon technology and a barrier to sharing technical know-how. However, success stories suggest that joint ventures between collaborators could provide a solution.[7] Nevertheless, more effort needs to be made to adapt R&D to local circumstances in developing countries. Hence, the importance of promoting more location-specific research cannot be overemphasised. Foreign universities and research institutions may be able to help through regional cooperation concerning capacity building agreements.

3. Regional Cooperation in Trade and Technological Innovations in Low-Carbon Energy Systems

3.1. Search for Anchors and Common Denominators for Enhanced Regional Cooperation

Consumption and production decisions drive economic systems, assisted by private and public sector investments, to achieve the desired objectives. International trade facilitates the smoothening of these consumption and production decisions. The platform through which this facilitation process predominantly occurs takes many forms/arrangements and is mainly recognised in the form of preferential trade agreements and free trade agreements (FTAs) at the bilateral, regional, and multilateral levels.

Production and consumption decisions to fulfil individual and societal needs are carriers of our perceptions about the environment, resources, level of development, and technological advancement. For example, the US decision in 2017 to cease its participation in the 2015 Paris Agreement on climate change mitigation, and its withdrawal from the agreement on 4 November 2020, and the US pulling out of the Trans-Pacific Partnership in January 2017

[7] Through patent citation analysis, Dechezleprêtre, Martin, and Mohne (2017) argued that the knowledge spillover from clean technologies would be larger than from dirty technologies. They also emphasised that higher R&D subsidies for clean technologies, in addition to implicit support for clean R&D through climate policies such as carbon tax, can lead to higher economic growth in the short and medium term.

Table 5.1 IPR Regimes and Low-Carbon Industry Policies in Selected Asian Countries

Type of economy based on carbon-intensiveness	Trade in low-carbon goods and services	FDI	Trade in knowledge (licensing)	IPR	Low-carbon industrial policies
Domestic policies					
Low carbon-intensive: Lao PDR and Cambodia	Liberal access	Non-discriminatory investment promotion	Improve information flows about public domain and mature technologies	Basic protection and minimum standards only	Basic education; improve infrastructure; reduce entry barriers
Low–medium carbon-intensive: Indonesia, Thailand, Viet Nam	Liberal access	Non-discriminatory investment promotion	Improve information; limited incentives for licensing	Wider scope of IPR protection; employ flexibilities	R&D support policies; improve infrastructure; reduce entry barriers
High carbon-intensive: China and India	Liberal access	Upstream supplier support programmes	Improve information; limited incentives for licensing	Apply full TRIPS	R&D support policies; improve infrastructure; reduce entry barriers
Developed-country policies towards emerging Asia					
Low-carbon intensive: Lao PDR and Cambodia	Subsidise public good type imports; free trade	Incentives for outward flows exceeding those for FDI	Subsidise transfer of public domain and mature technologies	Forbearance in disputes; differential pricing for exports of IPR products; competition policy assistance	Support for general low-carbon technology policies; public and public–private research facilities
Low–medium carbon-intensive: Indonesia, Thailand, Viet Nam	Free trade; no controls	Incentives equal to those granted for own disadvantaged regions	Assistance in establishing joint venture partnerships; matching grants	Differential pricing of public good type IPR protected goods; competition policy assistance	Support for general low- carbon technology policies; fiscal incentives for R&D performed in developed countries
High carbon-intensive: China and India	Free trade; no controls	Incentives equal to those granted for own disadvantaged regions	Assistance in establishment of joint venture partnerships; matching	Differential pricing of public-good type IPR protected goods; competition policy assistance	Support for general low- carbon technology policies; fiscal incentives for R&D

FDI = foreign direct investment, IPR = intellectual property rights, R&D = research and development, TRIPS = Trade-Related Aspects of Intellectual Property Rights.

Source: ADB and ADBI (2013).

and many others are reflective of such perceptions. On the other hand, these perceptions are not singular in character, and it is worth noting that regional groupings such as the EU have taken the lead in positive regional initiatives in the form of the European Green Deal and the promotion of activities such as the concept of a circular economy in an effort to strengthen the global response to the climate change threat (European Commission, 2021).

Multilateralism experienced challenges in 2020 in the spheres of climate mitigation and adaptation actions, international trade, economic growth, health outcomes, and actions required to meet the SDGs. The strains in the frameworks at the multilateral level started long before 2020, and the effects became exacerbated due to the spread of the COVID-19 pandemic. In this context, it is rational to argue that the increased emissions and delayed climate actions, consistent with the

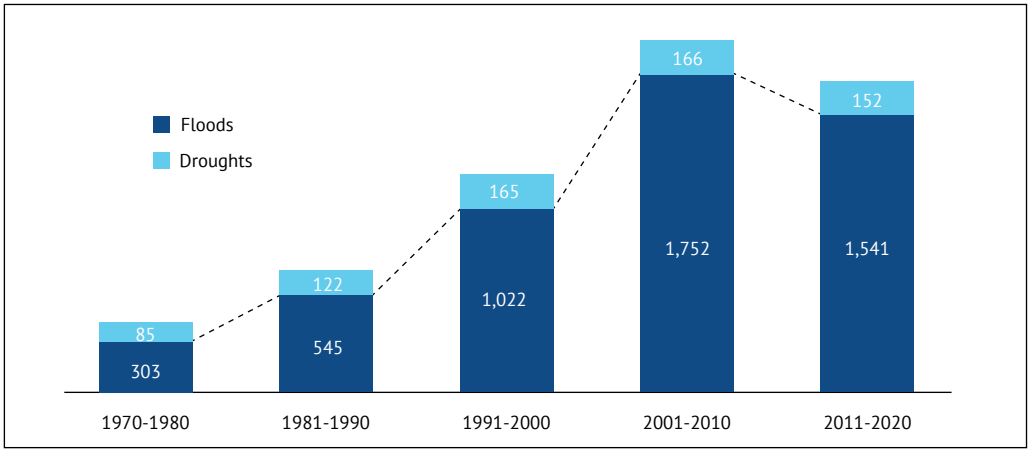
Paris Agreement long-term goal, indicate the need for more platforms to be used to overcome the challenges experienced at the multilateral level and due to considerations of political economy and domestic policy considerations. A regional approach to climate action has the potential to be effective in achieving its objectives because the issues of monitoring and enforcement can be tackled successfully by designing specific targets and programmes to achieve the climate targets due to the manageable geographical area of coverage at the regional level. For example, the EU's experience in collectively adopting a climate action response to the climate mitigation and adaptation measures has yielded results in the form of creating innovative solutions that impact both production and consumption decisions. The EU 27 has made climate mitigation one of the three main priorities in its COVID-19 recovery; and in July 2020, its leaders agreed to spend at least 30% of its multiannual financial framework budget for 2021–2027 and the Next Generation Recovery fund on achieving the EU's NZT by 2050 and meeting its increased 2030 emission reduction goal (Council of the European Union, 2020). In this context, the ASEAN experience within the 'open regionalism' framework deserves a closer look. It is important to identify and document the experience of the past decade, as the lagging countries can learn lessons from the experience of some of the leading countries towards closing the gap between their NDC objectives and achievements. It is argued that regional cooperation (e.g. the RCEP) and subregional cooperation (e.g. the Greater Mekong Subregion (GMS) involving China, Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam) would facilitate accomplishing the long-term goals of strengthening low-carbon energy systems and NZT (ADB and ADBI, 2013). Most importantly, the ACRF emphasises that the 'RCEP is expected to be a catalyst for the regional post-COVID-19 economic and social recovery' (ASEAN, 2020a: 33). In addition, ASEAN has identified 19 priority infrastructure projects under the Master Plan on ASEAN Connectivity 2025 to enhance regional connectivity and mobilise investments, of which nine greenfield and six brownfield investments are in the GMS (ASEAN, 2019a). However, the events over the last 3 years (2017–2020), such as intensified and frequent typhoons and floods, have also exposed the fragility of the regional drive towards climate action (Figure 5.5).

'Governments are under pressure to act quickly or risk giving up improvements in living standards achieved through decades of export-driven growth' (Prakash, 2018: 22). Therefore, the political economy has a role to play in the coming years. In light of this, the objective of achieving the goal of NZT by 2050 is also a challenge, if viewed through the sustainability prism.

Acknowledging this reality, the ACRF has been built on recognition of the fact that the business-as-usual scenario will not return to the global economy and a paradigm shift will lead to a 'new normal' situation in the post-COVID-19 world.[8] An inclusive economy, which

[8] The ACRF is structured into five broad strategies: (i) enhancing health systems, (ii) strengthening human security, (iii) maximising the potential of the intra-ASEAN market and broader economic integration, (iv) accelerating inclusive digital transformation, and (v) advancing towards a more sustainable and resilient future. Each of the broad strategies will be implemented by adopting key priorities, which are discussed in chapter 3 of the ACRF (ASEAN, 2020a).

Figure 5.5 Number of Flood and Drought Events in Asia



Source: Data from Centre for Research on the Epidemiology of Disasters (CRED), Université catholique de Louvain (n.d.), EM-DAT: The International Disaster Database. www.emdat.be. Cited in Kumse, Sonobe, and Rahut (2021).

provides opportunities to underserved people and communities, is at the core of building a 'new normal' after the COVID-19 crisis. Building an inclusive economy has never been more critical, and the time to embark on the objective is now. In line with the ASEAN Community Vision 2025 and beyond, the ACRF highlights five broad strategies for building an inclusive economy in the post-pandemic era. How to make it happen depends crucially on the will and commitment of ASEAN. The implementation should not lead to widening of gaps and inequalities across ASEAN during these challenging times.

Despite the challenges that have arisen in the global economy over the past 3 years due to the political economy and domestic considerations at the national level, regional cooperation arrangements such as the AEC and the RCEP have been crucial in strengthening the low-carbon energy systems across the region. A number of cooperation frameworks, such as the Agreement on ASEAN Energy Cooperation and ASEAN transport facilitation agreements, could also promote low-carbon energy systems. Apart from the GMS arrangement, the Mekong River Commission, Brunei Darussalam–Indonesia–Malaysia–Philippines–East ASEAN Growth Area (BIMP-EAGA), and Indonesia–Malaysia–Thailand Growth Triangle (IMT-GT) could also contribute to strengthening and enhancing the role of low-carbon energy systems at the national and regional levels (ASEAN, 2016).

There is no doubt that COVID-19 has reduced the financial space to initiate actions at every level. However, despite the reduced budgets, cities, businesses, and others have continued to maintain a stable climate and clean energy rather than making green energy progress in many Asian countries. For example, Australia initiated a clean energy recovery in May 2020 in the form of natural gas-led recovery rather than a green recovery, and is continuously signalling its support for the clean coal industry. At the national level, the government does not intend to update its Paris Agreement target or adopt a net zero emission

target by a specified timeframe, such as 2050 like most other countries, and plans to adopt a 'technology neutral' approach which focuses on outcomes rather than technology-based process. An outcomes-focused, technology-neutral approach increases flexibility for business, enabling it to find the most efficient way to comply. It also encourages innovation, since businesses have the scope to experiment with different approaches to reaching the outcome (Maxwell, 2021). However, it should be noted that the Australian government's intended approach is contrary to its focus on natural gas.[9] The federal government published the 'Technology Investment Roadmap Discussion Paper' in May 2020, advocating natural gas and CCS technology, without ruling out support for clean coal and nuclear energy (DISER, 2020). Despite the limited action at the federal government level, all states and territories have committed to both renewable energy as well as carbon reduction targets. Most targets are in line with the Paris Agreement, implying that all states and territories plan to achieve the net zero emission target by 2050 (Table 5.2).

It is interesting to learn that the Australian Capital Territory plans to achieve the net zero emission target much earlier, by 2045 (100% Renewables, 2020). Indonesia, which is the largest economy within ASEAN having vast renewable energy potential, is struggling to create a cleaner energy landscape for its economy and is unable to provide options for sourcing clean energy. For example, unlike the other major AMS – Malaysia, Thailand, and Viet Nam – Indonesia's energy policy has yet to include the direct power purchase agreement scheme, which allows companies to purchase electricity directly from renewable independent power producers instead of buying from state utility companies (Nugraha and Yusgiantoro, 2021). The Indonesian government has backed two recent energy investment decisions, which appear to be neglecting investments in green energy.

The first concerns the political push for promoting coal down-streaming technology. The main argument for the political push is to reduce the burden on Indonesia's trade deficit, created by liquefied petroleum gas imports. The latter can be replaced by its substitute, dimethyl ether, which can be produced through a sequence of processing domestic low-rank coal. However, only very few power producers have ever applied the coal gasification technology because of its poor economic returns. The second concerns promoting biodiesel production. Since the inception of the mandatory biodiesel programme in 2015, Indonesia's biodiesel development has relied heavily on subsidies funded by a levy on palm oil exports, provided through the controversial Oil Palm Plantation Fund Management Agency (BPDPKS). In 2020, additional stimulus of US$192 million was allocated in the state budget to cover the increasing price difference between biodiesel, which is costlier, and regular diesel. Biodiesel production is likely to

[9] The Australian government appointed key fossil fuel and mining stakeholders to its National COVID-19 Commission Advisory Board, including a member of the Saudi Aramco board. The commission has supported a gas-led recovery strategy by recommending the government to underwrite gas pipelines, and increase both domestic gas supply and subsidies for gas-fired power generation. The government has ignored the opportunities for a green recovery in the form of an accelerated transition to renewable energy.

Table 5.2 Australia's States and Territories' Climate Change Commitments

State/territory	Net zero emissions by	Current status of renewable energy	GHG reduction pathway
ACT	2045	100% by 2020	40% reduction by 2020 50%–60% reduction by 2025 65%–75% reduction by 2030 90%–95% reduction by 2040
NSW	2050	21% (target to reach 60% renewable energy penetration by 2030)	NSW electricity infrastructure roadmap: 12 GW wind + solar and 2 GW energy storage
Queensland	2050	16.6% (50% renewable energy by 2030 target)	30% reduction from 2005 levels by 2030
Northern Territory	2050	4%* (50% renewable energy by 2030 target)	
South Australia	2050	59.7% (target for 100% renewables by 2030)	More than 50% below 2005 levels by 2030
Western Australia	2050	24.2%	Has stated that the Western Australia government supports the federal government reducing emissions by 28%**
Tasmania	2050	100% by 2020 (target of 200% renewable energy by 2040)	Reduce GHGs by 60% below 1990 levels by 2050
Victoria	2050	27.7% (50% renewable energy target by 2030)	28%–33% reductions from 2005 levels by 2025 45%–50% by 2030

ACT = Australian Capital Territory, GHG = greenhouse gas, GW = gigawatt, NSW = New South Wales.

Source: ERIA Study Team based on various sources.

continue to be a huge financial burden on the Indonesian economy.

Nevertheless, the evidence-based research indicates that despite the challenges to the climate actions at different intensities across different countries within regional cooperation arrangements, subregional and non-state actors in the region have played an important role in the climate mitigation and adaptation measures. Therefore, strategies need to be evolved to make the climate action goal of NZT by 2050 sustainable, inclusive, orthogonal, and achievable through regional cooperation, particularly in the context of slowing down of the multilateral process. Trade, technology (including digitalisation), and R&D are instruments that could provide a flexible and sustainable path to NZT by 2050. Besides removing tariff and non-tariff trade barriers, technology and R&D, which would be environmentally, socially, and economically sustainable, are at the core of the innovative solutions to achieve net zero emissions.

Here, it is important to note from the policy perspective that regional (international) cooperation helps to reduce the cost of national level actions in the post-COVID-19 era. The benefits of simultaneous and concerted policy actions by the countries within the regional cooperation framework would generate economies of scale in climate solutions, and would amplify the gains from learning and quicken the decline in technology costs by increasing the penetration of new technologies through unrestricted and harmonized trade policies. Simultaneous action can also reduce externalities in the form of addressing the concerns of firms whose competitors in countries not facing carbon pricing or regulation would be at an advantage.

3.2. Catalysing Regional Cooperation: Seizing the Opportunities in Trade

It is acknowledged that the implementation of NDCs by Asian countries is not only their contribution to fulfilling global commitments, but an opportunity to make decisive, inclusive, and coordinated actions for reshaping the national and regional energy systems to achieve NZT by the middle of the century. NDCs in the context of the COVID-19 recovery can and must change the current paradigms of energy supply and use, which are patently unsustainable, and low-carbon renewable energy technologies will have a crucial role to play. In this context, the LTMS-PIP, which was initiated during the Lao PDR's leadership of the ASEAN energy track, is a milestone in electricity trading beyond borders. At the 38th AMEM held virtually from 19 to 20 November 2020, the Lao PDR, Thailand, Malaysia, and Singapore announced their commitment to initiate cross-border power trade of up to 100 MW under the LTMS-PIP. This is a significant step towards promoting greater infrastructural connectivity in the ASEAN region and is expected to contribute to ASEAN's sustainable energy goals. During the meeting, Singapore's Second Minister for Trade & Industry and Manpower, Dr Tan See Leng, emphasised that 'ASEAN must continue to work closely together to realise our shared energy goals and co-create innovative solutions that will contribute positively to our energy future' (Ministry of Trade and Industry, Singapore, 2020: 1).

Figure 5.6 shows the degree to which CO_2 emissions are embedded in the exports and imports of RCEP member countries and India.[10] It is interesting to note that except for Australia, Japan, the Philippines, and New Zealand, the rest of the countries' exports are more CO_2 intensive. China is at the top of the list of countries exporting CO_2-intensive exports, while Japan has the least CO_2 embedded exports. This international trade scenario has led to an initiative, particularly by the EU, to seek approval from the WTO to introduce carbon tariffs on carbon-intensive imports.

Gallagher (2014) argued that although energy-related goods account for more than 10% of international trade, policymakers and the business community perceive several constraints to the diffusion of these renewable technologies at not only the national but also the regional level. Hence, it is important to identify the market and non-market instruments to seize the opportunities for and eliminate the barriers to low-carbon renewable energy technology diffusion at the local, national, and regional levels (Kalirajan, 2012).

One of the important market channels through which to facilitate low-carbon renewable technology transfer is trade in renewable energy goods, and regional cooperation is crucial for maintaining unconstrained trade flows across countries.

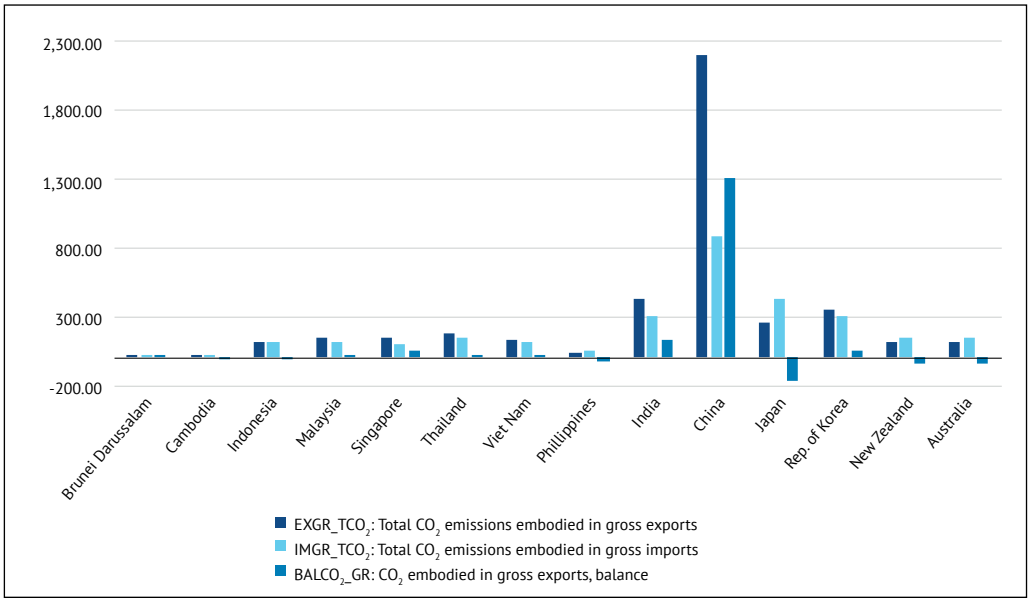
In this context, the RCEP – the regional grouping that includes ASEAN and its five FTA partners – can play an important role in facilitating the

[10] Organisation for Economic Co-operation and Development (OECD) indicators on CO_2 emissions embodied in international trade ($TECO_2$) are derived by combining the 2018 editions of the OECD Inter-Country Input–Output (ICIO) Database and the International Energy Agency (IEA) statistics on CO_2 emissions from fuel combustion.

RCEP member countries to achieve their NDC targets. As the RCEP is a comprehensive economic partnership arrangement, it is also expected to improve the functioning of non-market channels in transferring renewable energy technologies across countries. Trade flows are generally negatively influenced by 'behind the border' constraints, which are mainly the nontariff barriers that emanate from institutional rigidities; and 'beyond the border' constraints, most importantly tariff rates (Kalirajan and Anbumozhi, 2014). It is imperative to demonstrate the negative impacts of these constraints on the export potential of RCEP member countries to policymakers, so that they can be eliminated. This has implications for fulfilling NDCs across the RCEP region.

Based on the low-carbon renewable energy goods export performance, Kalirajan and Liu (2017) classified the RCEP member countries into two groups for empirical analysis: (i) group A, comprising countries with larger export values of renewable energy goods to RCEP members – China, Japan, Korea, Malaysia, and Singapore; and (ii) group B, including the rest of the

Figure 5.6 CO_2 Emissions Embedded in the International Trade of RCEP Countries and India, 2015



Note: CO_2 = carbon dioxide, RCEP = Regional Comprehensive Economic Partnership.

Source: OECD (n.d.), Carbon Dioxide Emissions Embodied in International Trade, Embodied CO_2 Emissions in Trade: Principal Indicators. https://stats.oecd.org/index.aspx?queryid=92932# (accessed 27 May 2021).

RCEP member countries – Australia, Indonesia, New Zealand, Philippines, Thailand, and Viet Nam. Drawing on the meta-frontier approach, Battese, Rao, and O'Donnell (2004) discussed how far the export potential of each member country is from their group's potential and how far each group's potential is from the regional potential frontier.

The results shown in Table 5.3 indicate a considerable gap between the realised export potential of the

group A and group B countries. The performance of the group A countries, in terms of realised export potential when measured from the regional meta-frontier, is higher than that of the group B countries.

Nevertheless, the results imply a significant gap in the overall renewable energy technology during the sample period in both groups, although group A showed a smaller gap than group B. Thus, there is an urgent need for technology transfer from group A to group B, although group A could improve its export potential by eliminating institutional and infrastructural rigidities to help group B countries in improving their export potential. These results also suggest that group A countries were better able to tackle the non-tariff barriers of their importing counties than the countries in group B, which warrants a detailed analysis for which data are not consistently available for all the selected RCEP members. Within group A and group B, there are wide variations in realising the export potential of renewable energy goods.

Some conjectures can be made drawing on the nexus between the non-market channels and export potential. Although currently there is a huge potential market for renewable energy goods due to NDCs, new entrants and existing players from emerging Asian countries have constraints that need to be addressed.

In this context, the interesting policy questions are whether renewable energy goods exports have been flowing without constraint in the Asian region and whether the RCEP regional cooperation mooted by ASEAN can facilitate minimising those constraints at the regional level. The short answers to those questions are no and yes, respectively. The answer is no, mainly due to the existing institutional rigidities, especially non-tariff measures. The answer is yes, mainly due to the possibility of improving technical cooperation in producing renewable energy goods and consultations in removing non-tariff barriers through the effective functioning of the RCEP.

Table 5.3 Realised Export Potential with Respect to the Meta-Frontier Countries

Country	Realised potential (%)
Group A	
China	70
Japan	68
Singapore	64
Malaysia	57
Republic of Korea	55
Group B	
Indonesia	56
Philippines	54
Australia	54
Thailand	46
New Zealand	44
Viet Nam	43

Source: Kalirajan and Liu (2017).

3.3. Catalysing Regional Cooperation: Seizing the Opportunities in Technological Innovations

Technology, including digitalisation and R&D, provide common denominators to innovate and thereby facilitate low-carbon production and consumption processes to achieve climate mitigation and adaptation goals in energy, transport, construction, food, and land use. However, there could be incentives down this path to deviate from achieving the climate action goals if technological developments cannot cope with expected and feasible innovations. The product and process inventions must ensure that the production and consumption of low-cost, low-carbon products are manufactured conditionally under economies of scale.

Delaying emission reductions without appropriate technological innovations has cost implications. In addition, countries would be tempted to delay the emission reductions due to the long-term nature of the climate threat and political resistance based on the perceived short-term risk of the economic, distributional, or competitiveness impacts of climate policies. Such delays would increase transaction costs if an abrupt action is required in this regard. For example, if more strict policies were introduced later, they would affect a larger stock of high-carbon infrastructure built in the intervening years, which could lead to higher levels of stranded assets across the economy. In a scenario with delayed action on climate change that hastens only after 2025, GDP losses are estimated to be 2% greater on average across the G20 after 10 years relative to the decisive transition with immediate action on climate change, and would be greater for net fossil fuel exporting countries. The losses could emerge as soon as the delayed transition starts and could be aggravated by financial market instability, as the main uncertainty would be the number of assets that might be stranded (OECD, 2017).

Thus, drawing on the European Green Deal, the RCEP would require investing more in environmentally friendly technologies; supporting agriculture and land use, and industry to innovate; rolling out cleaner, cheaper, and healthier forms of private and public transport; decarbonising the energy sector; ensuring that buildings are more energy-efficient; and working with international partners to improve global environmental standards. The R&D focus areas would be biodiversity (involving measures to protect our fragile ecosystem); the Farm to Fork Strategy (involving ways to ensure more sustainable food systems – European Commission, 2020); sustainable agriculture; clean energy; sustainable industry (entailing ways to ensure more sustainable and environmentally friendly production cycles); building and renovating (considering the need for a cleaner construction sector); sustainable mobility (aiming to promote more sustainable means of transport); and eliminating pollution. Inventions in the above areas would require investment from both the public and private sectors, with public finance providing the leadership role and the private sector facilitating in the form of scale. The circular economy concept envisages new initiatives along the entire life cycle of products to make the economy modern and sustainable. Products would be sustainable as they would last long and would ensure greater participation of citizens in the circular economy.

Regional platforms can be used to promote the climate mitigation and adaptation measures discussed above. The RCEP agreement, signed on 15 November 2020, opens health, education, water, energy, telecommunications, finance, and digital trade to foreign investors. Although the agreement does not mention climate change, the platform could be used to facilitate climate action through the consumption of technology-embedded low-carbon products. Moreover, foreign investors in infrastructure projects (water, energy, telecommunications, and others) could be encouraged on green growth trajectories after taking into consideration the national treatment principles.

Providing a bigger platform through regional rather than bilateral agreements, and subjecting low-carbon products to common standards at a larger geographical level, would help to facilitate new inventions and generate economies of scale, resulting in lower costs for consumers. Therefore, even if a trade agreement does not specifically deal with climate action, it can help in achieving climate goals through consumption-based decisions. A consumption-based approach to target the Paris Agreement goals through regional platforms – by facilitating decisions in the areas of the circular economy, renewables, transport, sustainable agriculture, and industry – would not only affect the fossil fuel-based production decisions, but would also lead to new low-carbon innovative inventions. This would result in investment diversification and has the potential to put the economy on a green growth path. The facilitation of low-carbon innovative products in the form of price-based (tariffs and taxes) and market-based measures has important implications for the market structure, where incumbents are well entrenched. Therefore, consumers guide production decisions, which are facilitated by capital, through investment decisions. Hence, technology and R&D provide the lead in innovating low-carbon products, which if facilitated at a larger level in the form of a regional agreement through trade, would have implications on the market structure of the product and thus on production decisions. In terms of technology transfer, Japan appears to disseminate its approach to carbon neutrality to developing and emerging economies, while Korea's approach seems to be attracting more support from developed countries. For example, Japan's vision highlights the importance of decarbonisation of the fossil fuel industry by adopting CCUS, carbon recycling, and a green transition fund as important tools to meet low-carbon transition goals. At the latest June 2021 ministerial meeting between ASEAN and Japan, the parties agreed to establish CCUS, which is a feasible path to decarbonisation; and to create a knowledge system and a networking platform for relevant CCUS stakeholders such as policymakers, financiers, researchers, and project implementers. CCUS represents a dominant part of the prevailing energy mix in several developing and emerging economies of ASEAN and East Asia. On the other hand, Korea intends to collaborate with Australia in promoting green hydrogen energy.

The 2-year Hydrogen RD&D International Collaboration Program in Australia is a key milestone in the Hydrogen Industry Mission of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), launched in May 2021. The engagement program will support

collaboration between Australia's research institutions and leading international research organisations for the benefit of the domestic hydrogen research, development, and demonstration (RD&D) community, as well as enabling RD&D linkages with partner countries. The Hydrogen RD&D International Collaboration Program is funded by the Australian government, and follows partnerships signed with Germany, Singapore, and Japan to accelerate the development of low-emission technologies, including hydrogen, which will drive investment and job creation in Australia. Box 5.2 describes the ascending importance of digital technologies in the region.

With respect to Australia's regional cooperation contribution to boost green growth through technological innovations that include digitalisation of services, Sun Cable has been developing the US$22 billion AAPL, which has been awarded 'major project status' by the Australian government.[11]

The AAPL involves the world's largest battery, with about 22 gigawatt-hours of battery storage, the world's largest solar farm (12,000 hectares of solar arrays), and 4,500 kilometres of high-voltage direct current submarine cable producing 10 gigawatts of dispatchable electricity.[12] The project will provide dispatchable renewable electricity to the Northern Territory and will supply up to 20% of Singapore's electricity demand. Eventually, it will supply Indonesia too. It is expected that the AAPL will export about US$2 billion of solar energy per year to Singapore by the end of 2027, connecting Australia to the ASEAN Power Grid (Straits Times, 2020). Sun Cable could profit from letting other projects export electricity to Asia through shared-cost use of its infrastructure. This would encourage future renewable energy exports, especially to ASEAN, and strengthen Australia's economic relationships with its ASEAN neighbours.

A pre-feasibility project report commissioned by the Pilbara Development Commission and authored by Australian and Indonesian researchers looked into the potential of exporting electricity generated by PV solar in the Pilbara to Asia (Mella, James, and Chalmers, 2017). The study found that it was feasible to deliver energy generated from a Pilbara solar facility and send it via a high-voltage direct current cable under the sea to Indonesia. A pilot project has been planned to involve the development of a 3-gigawatt solar farm and a subsea transmission cable by 2030. The Queensland government announced its support for the construction of Australia's largest solar farm, near Chinchilla.

In terms of regional cooperation on green growth, the hydrogen energy supply chain is provided as an example of Australia and Japan cooperating on a pilot project in 2020–2021. The project will make use of the world's first liquefied hydrogen carrier, the Suiso Frontier. Liquefied hydrogen will be transported from Latrobe Valley in Victoria to Kobe in Japan.

[11] 'Major project status' is the government's recognition of the strategic significance of a project to Australia. It provides projects with support from the Major Projects Facilitation Agency, which acts as a single-entry point for government approvals, project support, and coordination.

[12] Construction is expected to start in late 2023, with solar energy to reach Darwin in 2026 and Singapore in 2027.

Box 5.2 Ascending Importance of Digitisation – A Gift from COVID-19

One of the recent technological innovations before COVID-19, which is becoming popular in the post-COVID-19 situation, is the increasing presence of digitisation in socio-economic activities across countries. Currently, for example, just over half of the potential economic value of digital ID could accrue to individuals, making it a powerful key to inclusive growth, while the rest could flow to private sector and government institutions (White et al., 2019). Beyond quantifiable economic benefits, digital ID can offer non-economic value to individuals through social and political inclusion, rights protection, and transparency. Capturing the value of good digital ID is by no means certain or automatic. Careful system design and well-considered government policies are needed to promote uptake, mitigate risks like those associated with large-scale capture of personal data or systematic exclusion, and guard against the challenges of digital ID as a potential dual use technology (White et al., 2019). The World Economic Forum's Global Risks Report 2021 (World Economic Forum, 2021) identified cyberattacks as the top global tech-related danger (Figure). Business, government, and household cybersecurity infrastructure is outstripped or rendered obsolete by increasingly sophisticated and frequent cybercrimes, resulting in economic disruption, financial loss, geopolitical tensions, and/or social instability (Holleyman, 2021). Hence, digitalisation is a double-edged sword and needs to be handled carefully to avoid major disasters to individuals' privacy

COVID-19 = coronavirus disease, ID = identity.

Source: ERIA Study Team. based on World Econoic Forum (2021).

The Suiso Frontier vessel had originally been due to make the journey from Australia to Japan in March 2021, but the project team admits that it might not now happen until March 2022 (Recharge, 2021).

3.4. Fostering Policies in Support of New Regionalism for Low-Carbon Green Growth

Drawing on the above empirical results, a series of crucial questions needs to be addressed: How can regional cooperation help break these 'national' constraints? How should countries organise themselves collectively to overcome the skills barriers in any individual country? What will it take to make such a collective effort? How should leader–follower incentives be structured to make this happen?

The following policy implications can be drawn as answers to the above important questions, using the empirical results of this study. First, technology-focused alliances such as the International Solar Alliance (ISA), Global Geothermal Alliance, Mission Innovation, and others will play an important role in enabling countries to harness the full potential of the low-carbon renewable energy resources at their disposal. For example, the ISA, which is an alliance of 121 countries initiated by India, is also seen as an alliance by developing countries to form a united front and to undertake R&D for making solar power equipment in developing countries (Hindu Business Line, 2015). In 2016, the alliance entered into an understanding with the World Bank for accelerating the mobilisation of more than US$1 trillion in investments, which will be needed by 2030, to meet the ISA's goals for the massive deployment of affordable solar energy across the alliance countries (Press Information Bureau, India, 2016).

Secondly, cooperation amongst RCEP members has the potential to help new and existing players in the renewable energy sector to invest in quality education, R&D, and training by harmonising education standards across the region. Thirdly, active involvement by governments in the promotion of R&D concerning renewable energy technologies has been more successful in countries such as Japan, China, India, and Singapore than other countries in the region. These developments help make these countries competitive in the export market. The private sector in these countries has contributed to the provision of basic infrastructure services and education. The collaborative role of government and the private sector in the emerging Asian countries can improve their competitiveness in renewable energy goods exports. Fourth, R&D activities and the enforcement of IPR are essential for the players in the renewable energy sector to move into high-end markets. Foreign direct investment (FDI) is an important source for emerging Asian economies to increase their competitiveness and R&D activities, which can be easily facilitated through the RCEP cooperation framework. Fifth, the renewable energy business environment in the emerging Asian countries can be improved by removing unwarranted government interventions, such as providing subsidies to fossil fuels, and inefficient regulations in which the costs exceed the benefits; and improving infrastructure, such as transportation for the renewable energy goods and services export industry. Existing players can expand

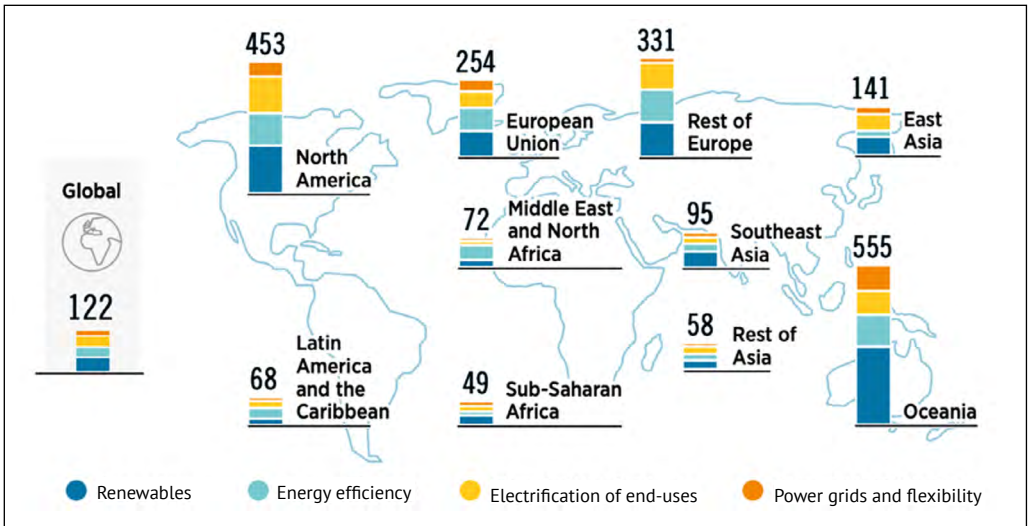
into high-end and new markets while new entrants may find their place in low-end products on the basis of cost advantage. Finally, with the increasing use of digitalisation in almost all socio-economic activities, maintaining cybersecurity at its best becomes imperative.

4. Addressing Green Financing Challenges Through Regional Cooperation

The discussion in section 3 on regional cooperation in trade and technology and its empirical evidence on developing renewable energy capacity and long-term sustainable development show that the role of capital investment and R&D are key to drive the low-carbon development path in the electricity market. Along the way, building labour capabilities via green jobs – focusing on human capital, skills, and talent – is critical as a regional cooperation agenda to accelerate the post-pandemic recovery plans. Removing tariff and non-tariff measures is critical. Taking the empirical evidence further than the renewable electricity market, which is equally important to discuss further, is regional cooperation in financing the green path – especially, financing with regards to infrastructure development, R&D, technology, research mobility, and innovation. Indeed, with the varying degree of clean energy per capita investment across regions, regional cooperation in finance is crucial in ensuring a more balanced clean energy development path (Figure 5.7).

Countries have put forward various amounts of stimulus packages for the road to recovery. While some focus on the immediate health impacts of the pandemic, others have gone beyond the immediate impacts and concentrated on the post-recovery plans. The evidence from the stimulus packages designed and implemented

Figure 5.7 Clean Energy per Capita Investment Across Regions, 2019–2050 (US$)



Based on IRENA analysis

Note: Per capita investment figures were calculated on basis of each region's average population during the period 2019-2050.

Disclaimer: The designations employed and the presentation of material herein do not imply the expression of any opinion on the part of IRENA concerning the legal status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Source: IRENA (2018).

by most of the developing countries, as shown in the earlier chapters, indicate that most countries lack adequate long-term recovery plans and strategies moving towards a greener path. This, in return, poses new challenges and opportunities for the long-term recovery plans to catalyse cross-border activities by firms and other service providers. Nevertheless, fiscal space to do that is limited in many countries, especially in the developing countries that have budget constraints. Indeed, without acknowledging structural deficiencies, it is unlikely that recovery is possible, especially for stimulus packages targeting green initiatives or green industries. For instance, it is estimated that between 2016 and 2030, ASEAN requires US$3 trillion in green investment in areas like infrastructure, renewable energy, energy efficiency and food, agriculture, and land use to realise its green transition (UNEP and DBS, 2017). Table 5.4 shows the amount for global trends in renewable energy investment in 2019. Within the new investment by value chain, asset financing and small distributed capacity financing is dominant. More investment is required in venture capital and private equity. Public and private R&D investments should be intensified.

Moreover, 90% of the infrastructure financing in Asia is almost driven by government financing while the global average of government financing is only around 40% (SIIA, 2020). Thus, major challenges and opportunities for many countries in Asia are tied to the financing needs of such activities and how to attract private financing to strengthen its recovery process. In this regard, the role of regional financial cooperation is critical. Similarly, aligning with the role of domestic capital markets is imperative. This section further discusses the need for regional financial cooperation and how it can play a role in the recovery and post-recovery periods. It also discusses the challenges and opportunities that countries have in the context of green and sustainability related financing as a strategy for recovery.

Table 5.4 Global Trends in Renewable Energy Investment, 2019

Category	Type	Amount ($ billion)
Total investment	New investment	**301.7**
	Total transactions	402.4
New investment by value chain	Venture capital	1.2
	Government R&D	5.7
	Corporate R&D	7.7
	Public markets	6.6
	Private equity expansion capital	1.8
	Asset finance	230.1
	Small, distributed capacity	52.1
M&A transactions	Private equity buy-outs	3.2
	Public markets investor exits (2018)	0.1
	Corporate M&A	13.7
	Project acquisition and refinancing	83.8

M&A = mergers and acquisitions, R&D = research and development.

Source: Frankfurt School-UNEP Centre (2020).

4.1. Seizing Financing Opportunities Through Regional Cooperation in the Post-COVID-19 Era

Regional cooperation focuses a great deal of effort on trade integration, while financial cooperation shows limited progress and mostly focuses on infrastructure financing. The launch of the Asian Financial Cooperation Association in 2017, a China-led initiative, marks another agenda that focuses specifically on financial cooperation. However, financial cooperation largely occurs in the form of bilateral arrangements. For instance, the Monetary Authority of Singapore announced initiatives with China, as post-recovery strategies, to expand financial cooperation in capital markets, digital finance, and green financing. Nonetheless, similar trends are not observed with other countries.

Charting low-carbon recovery plans must move towards international and regional systems of mutual aid and cooperation in finance. Trade coordination in health-related goods and services is a good example. The need for regional cooperation in finance takes a classical risk-pooling argument. Regional cooperation in finance serves as an opportunity to manage financial resources collectively so that large and unpredictable financial risk becomes more predictable and manageable, and is well distributed amongst the pooling members. It is even more critical in new forms of investment such as green investment.

Further, given the heterogeneity of financial infrastructure across countries, regional cooperation in public and private financing, best practices in financing green projects, and collective government risk sharing and instruments for lowering risk (such as risk insurance for the private sector) would have a complementary role in facilitating and mitigating the financial risk of cross-border financing – especially in new industries where information is lacking for financial institutions to assess such investment portfolios. Likewise, regional cooperation would help to reduce information asymmetry on financial practices and management across countries to facilitate new private investments. Similarly, the role of regional cooperation in helping the functioning of the financial markets to return to their normal state is imperative.

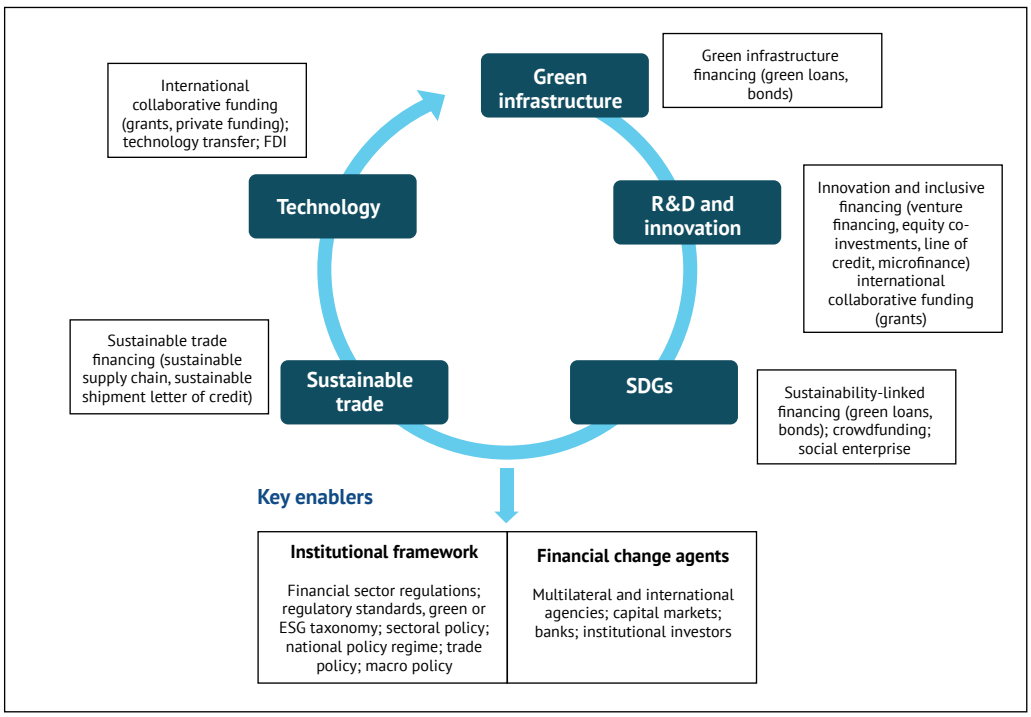
Regional cooperation in finance must quickly take the necessary measures to kick-start long-term recovery plans, especially in supporting banks and capital markets to finance green growth. This includes improving financial institutions' capabilities to fund green businesses and investments. Amongst others, new instruments like the bond and sukukmarket could facilitate green transitions as a recovery plan targeting new growth areas. From the regional perspective, the development of new financing instruments can be targeted. For instance, the global green bond and loan market has seen an upsurge of 50%, from US$171 billion in 2018 to US$258.9 billion in 2019. Within ASEAN, with regulatory support, issuance doubled from US$4.1 billion in 2018 to US$7.8 billion in 2019. (Climate Bonds Initiative, 2019). Using such an instrument offers huge potential, as ASEAN and the Asia-Pacific only represent 3% and 12% of the global total issuance, respectively. Policy development concerning green debt issuance, as well as the formation of an ASEAN+3 Bond Market Forum and

ASEAN Bond Market Initiative, have catalysed green financing (Climate Bonds Initiative, 2019).

What is important in regional financial cooperation is that financing the green growth path should be holistic and not limit finance to green infrastructure development. It should also encompass other activities that catalyse the transition to green growth. Figure 5.8 depicts how regional financing could be made more transformative in supporting the long-term recovery amongst countries and, at the same time, move towards the new engine of growth – i.e. making the green transition in various areas and activities. One critical area is infrastructure development financing to support the green transition.

Various efforts are already under way in the regional context for financing infrastructure development, with international development agencies such as ADB taking an active part in financing. For instance, ADB committed US$6.5 billion in climate financing in 2019, and targets cumulative climate financing of US$80 billion by 2030 (ADB, 2020). Within ASEAN, the only regionally owned green financing for upscaling climate change initiatives is the ASEAN Catalytic Green Finance Facility, which was established in 2019 under the ASEAN Infrastructure Fund (AIF). From 2019 to 2020, three projects were financed by the AIF (US$40 million), ADB (US$820 million), and co-financing partners (US$410

Figure 5.8 Regional Cooperation Agenda and Financing Opportunities for the Long-Term Green Recovery



ESG = environment, social, and governance; FDI = foreign direct investment; R&D = research and development; SDG = Sustainable Development Goal.

Source: ERIA Study Team.

million). These projects will bring together private project financing in the targeted countries. There are also initiatives to create national green de-risking finance facilities by identifying bankability gaps and finding various financing instruments to close the project financing gaps.

Chinese investments have become critical to many developing countries in infrastructure development, with the Belt and Road Initiative (BRI), the Asian Infrastructure Investment Bank, and the Silk Road Fund supporting the financing gaps. For instance, one of the largest BRI investments is in the energy sector, totalling US$20 billion, of which 35% was for hydropower and 23% for solar in 2020 (Nedopil, 2021). The shift to renewable energy is encouraging, and if other investments follow the same trend, this regional cooperation could bring significant changes in green infrastructure financing. Further, the signing of the RCEP could expand access to BRI financing by providing market access and by financing areas such as e-commerce, financial services, and services trade.

Other than financing infrastructure development, financing technology, innovation, and R&D activities is critical. This could include financing technological adoption costs, and capacity building by providing technical assistance as well as technological policy support. For instance, the heavy reliance on public grants and public funding mechanisms to support renewable energy is not sustainable, and guarantees for renewable energy specific risks with private funding systems should be established at all stages – early stage, demonstration, deployment, diffusion, and commercialisation. A vibrant private financing system that includes venture capital, equity, debt, and insurance could shape the nature of green technology, R&D, and innovation. Regional cooperation in driving the next generation of technologies and R&D activities, e.g. hydrogen could allow countries to leap technologically. A specific financing support system is required to provide for more focus on climate change related technologies based on regional needs. Box 5.3 illustrates the European Bank for Reconstruction and Development's Finance and Technology Transfer Centre for Climate Change programme, which is a global initiative to promote the transfer of technology for developing countries and countries in transition through networks.

Energy-efficient investment for Southeast Asia, China, and India totalled US$20 billion in 2015 and is projected to increase to US$2.62 trillion over 2017–2030,[13] with 72% in renewable energy and 28% in energy efficiency (Treco, Stephens, and Marten, 2018). Such investment would allow countries to take an active part in the global value chain of these new technologies, which would have various positive spillovers. Importantly, technology transfer and FDI play a critical role. Malaysia's experience in building a solar industry ecosystem through multinational corporations and active state intervention in completing the entire industrial ecosystem by driving foreign and domestic investment is a key lesson on how cooperation can work to accelerate a green industrial policy (Chandran, 2019). Industrialisation that comes with urbanisation should be transformed to move towards

[13] The estimated figure is the total investment for China, India, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam.

Box 5.3 Technology Transfer Financing

The EBRD's Finance and Technology Transfer Centre for Climate Change programme focuses and assists countries to implement climate technologies to reduce their carbon footprint and mitigate climate change challenges. In doing so, it provides grants as well as technical support to assist the transfer of technology with the participating regions. The collaborative networks established by the EBRD allow information and knowledge sharing, which is crucial given that various stakeholders are involved in financing technology transfers. Indeed, the programme helps to facilitate technology support requests by participating countries so that technical know-how and other support can be provided.

An outstanding case study is the technology transfer financing awarded to Elemental Holding S.A., a Polish company involved in the recycling of platinum-group metals and electrical waste. A loan of € 25 million from the ERBD was instrumental in financing the construction of a recycling facility to treat lithium-ion batteries for electric vehicles and other waste-containing metals in realising Poland's move towards a low-carbon economy. The deployment of the facility is also co-financed by the Polish National Centre for Research and Development, while technical cooperation support is provided by the Taiwan Business–EBRD Technical Cooperation Fund and Spain. As of April 2021, the EBRD has invested € 10.8 billion in 456 projects in Poland.

GEF = Global Environment Facility, Gov't = government, UNDP = United Nations Development Programme.

Source: ERIA study team based on UNDP (2021) and Lee (2021).

supporting low-carbon urban development. Box 5.4 shows these low-carbon urban development initiatives in Malaysia.

Regional cooperation in the international tax system is much needed to counter the challenges of the digital economy as well as to mobilise resources. A commitment on international exchange of information is also critical to have a more transparent system that could tackle tax evasion. The establishment of a Regional Hub on Domestic Resource Mobilisation and International Tax Cooperation in Asia could be a point of reference. This would allow international private financing to support the industrial development process.

Likewise, viewing society as an agent of green innovation would require regional cooperation to take a bold approach in catalysing green growth as well as creating jobs and inclusiveness. Social enterprise and community-based innovation, as well as social innovation, plays a critical role in solving and providing environment-related solutions. Regional cooperation in financing such activities could broaden the focus to reduce the carbon footprint at the community level – impacting the environment in many developing countries. For instance, the launch of the ASEAN Social

Box 5.4 Regional Financing for Low-Carbon Urban Development

Low-carbon urban development, especially in cities, is critical to the minimisation of carbon footprints. Malaysia launched the Low Carbon Cities Framework in 2011 and has worked with various local councils and agencies to promote low-carbon cities. The aim of the framework is to provide a guide for developers, local councils, town planners, and other stakeholders to achieve carbon reduction in cities. Various measures and initiatives – such as clean energy, integrated waste management, sustainable transportation, energy efficiency, pollution control, land use, and green buildings – are crucial in paving the way to low-carbon urban development. Malaysia uses various financing options in implementing low-carbon urban development. These include co-financing with private sector entities such as private banks, pension funds, insurance funds, and Islamic investors. Other financing entities and channels include social impact investors, corporations (via corporate social responsibility initiatives), and debt as well as equity financing as part of project financing and longer tenor funding. Credit enhancement options, such as partial loss guarantee and political risk guarantee options, are considered to attract foreign investors.

In 2015, the Green Technology Application for the Development of Low Carbon Cities was established with the support of the Global Environment Facility and the United Nations Development Programme to implement a low-carbon cities project. The aim of the project is to remove barriers to low-carbon urban planning and development by establishing policy support for promoting integrated urban planning, building awareness and institutional capacity, and investing in low-carbon technology. Consequently, many cities have set low-carbon action plans to help track low-carbon actions, with a number of urban areas having signed partnerships with various actors. Currently, 52 local authorities have been part of the Low Carbon Cities Framework to reduce their carbon footprint.

Institution	Amount ($)
GEF	4,354,794
Federal and local gov't	55,258,266
UNDP	354,000
Cost sharing	50,000
Leveraged co-finance – private sector	164,136,278

GEF = Global Environment Facility, Gov't = government, UNDP = United Nations Development Programme.

Source: ERIA study team based on UNDP (2021) and Lee (2021).

Enterprise Development Programme by the ASEAN Foundation, with the support of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), offers opportunities for social enterprises to build capacity, fund projects, and network to address environmental problems by promoting responsible consumption and production and supporting actions for climate change impacts. At the country level, in Malaysia, the AirAsia Foundation established a social enterprise hub to promote 30 social enterprises around ASEAN. The foundation provided 26 grants totalling US$20,000 each in seven countries. This can be regarded as financing social impact investment within the sustainable development goal framework that countries adopt. Regional development institutions can also play a critical role. Similarly, social impact investment can be established out of venture capital model that seeks to support social, environmental, and economic challenges. Indeed, intermediaries operating as accelerators, investment vehicles, and social investment wholesalers can be positioned to take a more regional approach. These financing models can be better positioned if there is harmonised regulatory framework and more transparency within regions. Likewise, Korea has positioned science, technology, and innovation (STI) policy and financing for social problem-solving R&D programmes in the areas of environment and energy. Regional R&D support and financing through the university network can be redirected towards financing academic research in these areas. ASEAN cooperation in S&T has made various efforts, but lacks resource mobilisation and funds for supporting S&T. A financial roadmap to leverage cooperation in S&T is critical, while financing a bottom–up low-carbon approach such as grassroots innovation is essential so that participation can be critically engaged directly with society. For example, community-based movements such as local exchange trading schemes, the Bollington Carbon Revolution, and Transition Towns are already making impacts. Having regional financing available for such innovative approaches would accelerate the green path transitions.

One positive development caused by the pandemic is the acceleration of digitalisation efforts amongst countries. Firms have quickened their efforts to use technology to stay competitive during the pandemic. This provides a critical juncture for regional cooperation in financing the digital value chain that would ultimately lead to sustainable trade. Regional supply chains and value chains can be transformed through financing digitalisation efforts to limit the impact of trade on the environment and support the low-carbon agenda. Nevertheless, the conception and the driver for financing a sustainable supply chain or even greener logistics are limited in Asia. Bancilhon, Karge, and Norton (2018) estimated that the global sustainable finance market was US$660 billion, with revenue opportunities of US$6 billion for a sustainable supply chain in 2017. New technological revolutions such as blockchain and fintech could revolutionise the management of the challenges of tracking green practices along the supply chain. The potential is limitless, but efforts are scarce regionally. Individual countries' financial stability overrides financial innovation in most cases, causing new types of financing to progress slowly. As a region, more can be done if collective action results in

risk-pooling collaboration amongst financial regulators, commercial banks, investment funds, retail investors, and other agents in the financial sector. Amongst the tasks to consider are adequate reporting of risk, a risk assessment system, and integrating green investment risks into financial sector prudential regulation. ASEAN as a region aspires to promote financial inclusion via digital financial services and regional payment connectivity as a strategy in its ACRF. However, it requires greater services liberalisation efforts, especially in the financial sector.

Trade financing has also been key in catalysing green development. Technology embedded in capital goods and the provision of green-related services facilitate the move to a green growth path. Indeed, efforts towards making trade sustainable could contribute significantly to global low-carbon and climate change initiatives. Globally, in goods trade, interfirm trade credit supports 60% of trade financing, while banks support the remainder. Letters of credit are the most common instrument, with other instruments including documentary collection and supply chain financing and guarantees. Nevertheless, financing gaps in trade are still a huge problem – and more so for sustainable trade financing. The global trade finance gap is projected to be US$1.5 trillion in 2019, and the Asia-Pacific accounts for half of the trade finance applications (ADB, 2019a). Instruments such as green supply chain financing and sustainable letters of credit are still in their infancy. Blockchain technology acts as a digital enabler that allows more effective management of the green supply chain and promotes transparency to support green financing. It facilitates sharing of critically needed information for green management, allowing traceability, which is difficult in conventional supply chain settings. Blockchain technology also facilitates better management of stakeholders, reviews returns in real time, and is transparent in managing the proceeds where risk can be minimised amongst investors. This technology also saves costs. For instance, issuing green bonds through the standard process costs around US$6.4 million, while the cost is reduced to US$692,000 with blockchain automation issuance (HSBC and Sustainable Digital Finance Alliance, 2019).

One of the key developments in financing, as a result of the pandemic, is the formulation of the ACRF, which emphasises, amongst others, the promotion of sustainable financing as one of the key strategies – with actionable plans on ASEAN sustainable capital markets; sustainable banking principles; and green, social, and sustainability bond standards. A critical aspect of financing the SDGs requires such a framework to leverage public and private financing institutions to play a major role.

4.2. Key Enablers of the Regional Financing Architecture

4.2.1.Facilitating an Institutional Framework

Key enablers of the financing ecosystem are the formulation of a clear institutional framework and the positioning of financial change agents within the ecosystem. While there are efforts to have regional institutional settings to facilitate progress, with the involvement of multidimensional agencies, progress has been slow in Asia and largely fragmented as it requires coordination efforts in many

other areas. In fact, financing needs for infrastructure development could not be met effectively given the lack of private financing participation. These new opportunities can be sized if, regionally and nationally, the policy regimes and a holistic framework of financing can be developed to support all areas of financing. The regional operational architecture should be developed with this perspective in mind. Therefore, the policy and institutional framework should not be based solely on infrastructure financing but also on other activities that support green infrastructure. For instance, financing infrastructure development could also bring opportunities in technology, R&D, sustainable trade, and meeting some of the SDGs. In addition, involving various stakeholders through consortium financing would be viable. In reducing the risk of financing, governments could set and commit to regional efforts to transfer risk effectively by engaging in risk-pooling instruments or contingent credit lines and funds to boost public–private investments. Moreover, government subsidies for insurance for green deals could be sponsored through publicly supported private schemes at the regional level if an adequate framework is available.

Table 5.5 Key Funding Mechanisms for Environmental Projects

Fund	Details
Climate Change Fund	The Climate Change Fund was established in 2008 to provide grant funding for climate-related projects, research, and development, to assess causes and consequences. Funding is provided for projects that lead to the reduction of greenhouse gas emissions or adaptation to climate change.
Clean Energy Financing Partnership Facility	The Clean Energy Financing Partnership Facility was established in 2007 and provides grant funding to member countries in the region for improving energy security and transitioning to low-carbon economies, through cost-effective investments in technologies and practices.
Asia Pacific Carbon Fund	The Asia Pacific Carbon Fund was established in 2007 as part of the Carbon Market Initiative. It provides financial assistance for clean energy projects.
Future Carbon Fund	The Future Carbon Fund was established in 2008 and provides funding for projects that will generate carbon credits for greenhouse gas reductions after 2012, to improve energy efficiency and renewable energy.
Water Financing Partnership Facility	The Water Financing Partnership Facility provides financial resources and technical support for water services and river basin water management.
Poverty and Environment Fund	The Poverty and Environment Fund is a multi-donor trust fund which promotes the mainstreaming of environmental considerations into broader development strategies, programmes, and projects.
Global Environment Facility	The Global Environment Facility, established in 1992, provides opportunities for 'inclusive economic growth with local and global environmental benefits'. This is done through innovation testing, scaling investments, and mainstreaming sustainable technology and infrastructure.*
Urban Environment Infrastructure Fund	Established in 2009, the Urban Environment Infrastructure Fund supports the efforts to address the 'huge unmet needs of the region for both basic and economic infrastructure'. The fund focuses on climate change mitigation, urban environmental transport, water, and solid waste management services.**

Fund	Details
Investment Climate Facilitation Fund	Established in 2008 as a response to the challenges of 'promoting investment and tackling climate change through energy efficiency', the Investment Climate Facilitation Fund is focused on promoting sector development and regional investment.***
Green Climate Fund	Established under the Cancun Agreements by 194 countries in 2010, the Green Climate Fund focuses on promoting and financing sustainable climate change architecture in developing countries.****
ASEAN Catalytic Green Finance Facility	The ASEAN Catalytic Green Finance Facility – an initiative of the ASEAN Infrastructure Fund – was launched in April 2019 to accelerate green infrastructure investments in Southeast Asia.*****

ADB = Asian Development Bank, ASEAN = Association of Southeast Asian Nations.

* ADB (n.d.), Global Environment Facility (GEF). https://www.adb.org/what-we-do/funds/global-environment-facility (accessed day month year).

** ADB (n.d.), Urban Environmental Infrastructure Fund. https://www.adb.org/what-we-do/funds/urban-environmental-infrastructure-fund (accessed day month year).

*** ADB (n.d.), Investment Climate Facilitation Fund. https://www.adb.org/what-we-do/funds/investment-climate-facilitation-fund (accessed day month year).

**** Green Climate Fund (n.d.), Accredited Entities: ADB. https://www.greenclimate.fund/ae/adb (accessed day month year).

***** ADB (n.d.), ASEAN Catalytic Green Finance Facility (ACGF). https://www.adb.org/what-we-do/funds/asean-catalytic-green-finance-facility/overview (accessed day month year).

Source: ADB website.

At the national level, countries should clearly show what types of financing are needed to meet the mitigation targets. This would provide adequate information for regional financial cooperation – through regional initiatives or private arrangements. Information on policies and regulatory systems, including public procurement, international standards, and targets for low-carbon infrastructure, would allow investors to build trust and work towards financing the green targets. Political stability and information on incentives and other provisions would incentivise the private sector to show interest in such an environment. Domestic market reactions to this would also be positive. Currently, there is a vast difference in terms of transparency across countries in Asia, and removing the gaps via learning and sharing best practices through regional cooperation would position the countries to function effectively in financing. A framework could be established within the regional context.

4.2.2 Multilateral Development Banks and Agencies

In the context of regional cooperation in low-carbon initiatives, various activities have been undertaken. For instance, since its establishment in 2011, the AIF has committed US$520 million for regional energy, transport, water, and urban infrastructure projects.

In 2019, as part of the AIF, ASEAN partnered with ADB and other major financing institutions to launch a US$1 billion financing facility to accelerate green infrastructure investment across Southeast Asia. The financing comes from the AIF (US$75 million), ADB (US$300 million), KfW (US$336 million), the European Investment Bank (€150 million), and Agence Française de Développement (€150 million) (Reuters, 2019). The role of multilateral development finance institutions is critical in fostering the development of the low-carbon economy. For instance,

organisations such as ADB, the Asian Infrastructure Investment Bank, the Islamic Development Bank, the World Bank, the AIF, the Credit Guarantee and Investment Facility, and the New Development Bank facilitate green infrastructure financing. These institutions offer concessional and market rate loans; and support private participation in investments via long-term loans, equity, guarantees, and technical assistance. ADB's funding methods, for example, include loans, equity investments, guarantees, grants, and technical assistance. ADB provides funding for climate change and adaptation through different projects. A number of funding mechanisms have been devised, as shown in Table 5.5.

Multilateral financing should be clearly linked to existing initiatives undertaken in the region. Moreover, if new initiatives emerge as part of the long-term pandemic recovery plans, they could be facilitated across regional blocs. For instance, the NDC commitment provides an estimation of how much funding is needed to achieve the climate change initiatives. The estimated cost of achieving the NDCs in developing countries is US$3.5 trillion[14] (Carbon Brief, 2015). Indeed, US$420 billion is expected to come from international financing sources. An example of a recent pilot project on climate change that has an integrated approach engaging various stakeholders with adequate investment criteria framework is the Shandong Green Development Fund. The project leverages the private, public, and international institutions to restructure Shandong to transit towards low-carbon and climate-resilient development. Importantly, the project makes the financing bankable by evaluating the project risk up front, and promoting technologies through an integrated approach to achieve the climate change challenges. It consists of US$300 million of international institutional financing and US$1.2 billion of public and private sector capital financing. It also uses the Green Climate Fund investment criteria and framework.

4.2.3. Private Financing

Kalirajan and Chen (2018) indicated that there is a huge imbalance in private financing across regions in domestic markets. Indeed, the full potential of private financing of renewable energy is not fully realised across Asia. For instance, most Asian countries can only achieve 60% of their renewable energy investment potential. It is therefore critical to mobilise private financing through regional cooperation. Nevertheless, regional private financing cooperation is largely subject to regional trade and financial integration. This problem is exacerbated during crises if the financing is supplied in a procyclical manner that limits the financing from coping to cope with capital account shocks. Studies have shown that during the Asian financial crisis, countries suffered due to the sudden reversal in capital flows (Cavallo, 2019). This has also been true during the pandemic, as investment flows into green initiatives have slowed and declined significantly. Moreover, financial flows are limited due to the existence of a larger risk

[14] Only about two-thirds of 111 countries quantified the financial needs.

Table 5.6 Tools for Financing Renewable Energy, Southeast Asia

Tools	Descriptions
Concessional finance	Loans with below-market financial conditions (e.g. lower interest rates, longer grace periods, low or no collateral requirements)
Dedicated loan	Loans only dedicated to renewable energy investments (e.g. solar energy loan, energy efficiency tractor loan)
First-loss capital	Capital that is the last to be repaid in the event of default (e.g. junior equity or subordinated loans)
Mezzanine finance	Debt that can be converted into equity over a defined time period (e.g. convertible loans)
Patient capital	Long-term investment made to support the development of the SMEs
Carbon finance	Long-term and additional source of revenue received upon achievement of certified climate change outcomes
Co-investment	Capital provided alongside other investors to make larger investments
Fundraising platform	Large group of investors pooling resources to fund a project
Loan guarantee	Responsibility of the guarantor to repay the SME loans in the event of default
Output-based grant	Non-repayable money disbursed only upon achievement and verification of pre-agreed results
Project finance	Loans with specific financial terms and conditions adapted to capital-intensive investments (e.g. longer maturities, grace periods, repayment by cash flow generation, limited recourse loans)
Revolving credit facility	Loans that can be withdrawn, repaid, and redrawn
Syndicated loan	Pool of lenders investing together to provide larger loans under the same terms and conditions
Majority or significant minority shareholder position	Active involvement of the investors in the SME governance
Mobile phone payment	Loan payback facilitated by mobile phone payment for people living in remote areas
Technical assistance	Non-financial support provided to the SME (e.g. capacity building, training, pre/post-investment support on legal structure, financial reporting, business plan)

SMEs = small and medium-sized enterprises.

Source: Nexus for Development (2018).

(accessed 18 March 2021).

exposure associated with regional financial contagion. However, regional cooperation in facilitating financing during times of crisis can effectively facilitate and support member countries within the region.

Cross-border private financing through bank lending activities could be encouraged if the spread of financial risk or perception of such risks across economies could be reduced or mitigated.[15] There has also been a steady increase in the issuance of green loans and bonds globally and in ASEAN. However, ASEAN's share of the issuance was only 3% of the global total and 12% of the Asia-Pacific region total in 2019. Within the member countries, financing development is uneven, with Singapore, Malaysia, Thailand, the Philippines, and

[15] Refer to Chapter 4 for details on private financing.

Indonesia leading the pack. Issues such as credit ratings, capacities, and the lack of an enabling framework limit market growth – restricting private sector participation across borders. Likewise, financing challenges include rethinking and unveiling policy and institutional barriers to encouraging such investment and financing. Studies show that cross-border capital flows, especially short-term portfolio and banking flows, are significantly affected by economic and policy shocks. In scaling up green financing, for instance, various policy and regulatory barriers still limit the movement of capital and lines of credit to firms and green producers.

Such cooperation should also reconsider establishing innovative private fund systems that reduce the risk-bearing capacity of the private sector and the region at large. For instance, blended financing arrangements would have the potential to reduce the risk and narrow the investment gaps that exist during the pandemic. This could be established through public funding and private arrangements across borders – sharing the risk to encourage the potential of sustainable investment. Cross-border cooperation should emphasise the administration of such initiatives by linking the public and private sectors as well as various stakeholders, such as insurance, sovereign wealth funds, and development institutions. Such efforts would require establishing an adequate framework within the regional context, which is currently lacking. Table 5.6 shows some of the financing tools used by renewable energy entrepreneurs in Southeast Asia.

4.3. Way Forward: Improving Regional Financial Cooperation

The existing ecosystem can be reorganised via policy intervention and collective actions. Regional cooperation in money and finance, based on the Asia-Pacific Regional Cooperation and Integration Index, remains weak and regionally diverse. For instance, cross-border equality liabilities and interest rate dispersion contributed to the weak integration in 2017 (ADB, 2021b). Indeed, a recent study showed that the degree of financial integration varied across regions such as East Asia, South Asia, Southeast Asia, and Central Asia (Montanes and Schmukler, 2018). The proposed Asia-Pacific Regional Cooperation and Integration Index Enhanced Framework could be a good starting point to track the integration efforts. However, the regional integration of money and finance indicators could be aligned to support other critical aspects of the framework – such as technology and digital connectivity, environmental cooperation and regional public goods, regional value chains, infrastructure and connectivity, and trade and investment – to ensure that a green growth path is supported. We suggest a few broad critical areas that regional cooperation could focus on, given its limited presence in accelerating the financing for green growth path.

4.3.1. Green Financing Architecture and Capacity Development

A leadership role within regional blocs is required to facilitate regional initiatives. In other words, an integrated one-stop coordinating agency approach is needed. The agency should facilitate and support project identification and structuring as well as a financing and regulatory

framework that aligns with individual countries' public finance for green projects. Most successful regional green financing has been due to the central role of international financial institutions. These entities could play an intermediary role and coordinate efforts effectively at the regional level in investment and capital facilitation. Technical assistance is crucial in building such financing infrastructure. Regional blocs such as ASEAN could foster critical cooperation and link international institutions with their member countries, which could align their project needs with domestic capital mobility. Innovative financing instruments are critical for improving bankability – requiring member countries to work on co-financing agendas, financial harmonisation, technical assistance, and capital market access.

Sustainable financing and green financing are taking shape, with more financial institutions participating actively in supporting green projects. The current green financing framework comprises the Green Bond Principles, Social Bond Principles, Sustainability-Linked Bond Principles of the International Capital Market Association, Climate Bonds Standard and Certification Scheme, green taxonomy for the European Green Deal, Green Loan Principles of the Loan Market Association, and Asia Pacific Loan Market Association. In terms of recovery, stimulus packages that provide aid for the private sector could make the aid conditional on sustainability and green impacts. This would also help financing institutions to reorganise themselves to the new market opportunities that the recovery poses. As discussed, strengthening the regional framework for new financing instruments such as the loan, bond, and sukuk market could facilitate green transitions as a recovery plan, targeting new growth areas.

Similarly, the financing framework could also cover the larger regional cooperation agenda in green infrastructure development, R&D, innovation, technology, and others. Amongst the current missing mechanisms are policy coordination, harmonisation of regulations and standards, operational framework, and practicality, as well as capacity development. These mechanisms are required for ensuring long-term financing, and in managing project financing as well as uncertainty in project development cost, and equity financing. A financing framework and institutional cooperation should be established to minimise the risk related to politics, policy and regulatory uncertainty, grids and transmission, technology, currency, refinancing, liquidity, and resources.

The initiative to develop the financing architecture and capacity building could leverage some of the existing institutional settings, such as intergovernmental organisation, multilateral institutions, and other entities within the context of ASEAN. Action on streamlining regulatory requirements, negotiating a revenue and cost sharing model for cross-border investments, capital mobility arrangements, and resolving individual countries' procurement arrangements could accelerate the financing flows.

4.3.2. Incentivising the Shift from a Financial Institution-Based Compliance Model to a Cooperation-Based Approach and ESG Compliance Model

Reconciling corporate social responsibility objectives and the SDGs within the context of financing

allows us to move from thinking solely of the dominance of an institutional risk compliance-based model to a more sustainability-linked financing focus. At present, financial institutions are mostly risk averse and are targeted towards maximising shareholder returns, which in return perceive green financing as risky – especially if it involves unknown technologies. Potential transformation, by engaging in socially responsible activities with the idea of introducing progressive values that shape the way that financial institutions behave in the future, should be explored. The rapid proliferation of sustainable financing, specifically sustainability-linked financing, moves beyond the instrumental concern of individual corporations to a broader developmental approach. This landscape is changing fast, given the new initiatives such as environmental, social, and governance (ESG) reporting and taxonomy.

Nevertheless, acceptance of such ideas is still largely lacking in many developing countries. These efforts could be accelerated at the regional level through the formulation of an adequate framework that allows private sector participation. Many financial institutions are already gearing up to sustainable financing, and at least an adequate framework should allow better utilisation of such financing to benefit the larger environmental concerns. However, incentivising financial institutions to embark on such activities requires regional institutional efforts to minimise reputational risk.

For instance, the establishment of an ESG framework and taxonomy provides a clear direction for the Asian region on how to incentivise investors and firms to be more environmentally and socially responsible. Another way is, regionally, to engage in shared stakeholder responsibility. This requires innovative institutional arrangements that reward financial institutions for engaging in shared responsibility, such as sustainability financing. In addition, it is vital to establish and operationalise a new taxonomy with clear measures of the concept of sustainability, financing, and potential financing instruments. A risk mitigation framework is also required when cross-border financing is one of the options. Amongst others, institutional capacity in finance auditing and a sustainability financing assessment are crucial to ensure that financing meets its purpose. Regionally, more work on measurement and developing appropriate indicators for the evaluation and monitoring mechanism is unavoidable. All these must be institutionalised. In doing so, sectoral technology mapping – especially in the renewable energy sector or low-carbon energy technologies – is required. Sector- and technology-specific initiatives are required to execute and mitigate the financial needs gaps. Indeed, accelerating financing support requires identifying innovative fund systems with the private sector, as well as formulating a risk-bearing system and developing third-party risk assessment capacity. Current broad policy initiatives, such as financial integration as well as sustainable financing, should be expanded to include sectors, technologies, and key actors within the context of the region.

The call for clean energy investment must also mitigate the issues of stranded assets to facilitate firms to invest in clean energy. For instance, despite the potential of renewable

energy in Asia, many governments and the private sector are reluctant to move into renewable energy and continue to depend on high-carbon assets because of the inability to mitigate the risk of stranded assets, which could lead to significant non-performing loans. A regional cooperation framework for identifying stranded assets, assessing such risks, and gradually making the transition to clean energy should be considered. Financing institutions could play a role in helping to evaluate the risk and identify mitigation strategies for projects with stranded assets. Complex dynamics concerning reversibility and risk typologies are critical to understand if firms, especially state-dominated energy power companies, can be resilient to environment-related risks. Another option involves the financing of cross-border renewable projects, which could help provide financing opportunities to manage financial exposure due to the stranded assets risk. Regional cooperation in financing the transition plans is critical.

4.3.3. Organising and Building Regional Financing for a Green Innovation System

Revitalising the STI system means unlocking talent mobility and adopting technologies, as well as innovating to tackle the greatest challenges – net zero carbon emissions and other sustainability problems. Financing R&D and innovation activities is critical for the development of the green growth path. A regional science and innovation financing system for carbon and storage technologies, digital technologies, and other new emerging technologies is required to accelerate the green growth path. Nevertheless, the challenges in building a functional green innovation system remain as the existing policy frameworks within the countries differ greatly due to different development stages. Indeed, IPR are critical for developing countries to build a green STI ecosystem. Cooperation in areas of intellectual property law and IPR enforcement are not discussed in depth in most trade agreements, given their complexity. One important move is the ASEAN[16] Framework Agreement on Intellectual Property Cooperation, signed in 1995, which paved the way to the formation of the ASEAN IPR Action Plan, 2016–2025. However, challenges remain in the areas of intellectual property law, policy, and regulation, which require greater regulatory cooperation and coordination to link IPR to the building of a functioning STI ecosystem. Efforts towards regulatory harmonisation and, more importantly, a framework for regional competition policy are still far from complete (Jusoh, Ramli, and Damuri, 2019). More importantly, the financing needs for IPR engagement have not been adequately addressed. Issues like IPR as collateral (IPR-backed financing) within the ASEAN financial system could be one such priority area for cooperation. Likewise, best practices in financing as well as in creating adequate valuation models and intellectual property market platforms are important.

Capital markets play a critical role in financing innovation. For instance, utilising initial public offerings (IPOs) for financing innovation requires policymakers to look at the IPO process so that it can be aligned with the evolving structure of the financial markets. Financial market structure has evolved significantly, but not the

[16] ASEAN has embedded STI in its vision. It launched the ASEAN Plan of Action on Science, Technology and Innovation in 2016 after the launch of the ASEAN Economic Community.

IPO process. For instance, the existing regulatory obligations in the capital market should be reviewed and updated. IPOs are also reported to be less attractive because of the mismatch in valuations between the public and private markets (ICMR, 2021). Similarly, capital markets also lack variety, and should diversify and incorporate so-called 'new economy companies' (ICMR, 2021).

Alternative capital market mechanisms have emerged strongly, e.g. venture capital. Estimates indicate that US$3.6 billion was raised by Southeast Asia based venture capital firms in 2019 (DealStreetAsia, 2020). In ASEAN, Singapore leads the way with 59% of the ASEAN total. The potential of venture capital in the context of green and low-carbon development can be further reorganised by instituting a favourable venture capital ecosystem. However, the venture capital ecosystem is predominantly government-backed in developing countries, and it requires regional cooperation to facilitate cross-border funding. A cooperative framework for driving private and public funding would be mutually beneficial for the respective countries in the region. These efforts should also consider and align with incentive systems – such as financing schemes for SMEs, tax rebates, and loan and insurance schemes – to accelerate start-ups in the respective countries. Building the venture capital ecosystem regionally would also help finance green deals. In November 2019, the ASEAN Coordinating Committee on Micro, Small and Medium Enterprises noted the increasing importance of supporting the start-up ecosystem, especially to spur entrepreneurship, but specific venture capital financing industry strategies are largely missing. Variations in the regulatory and legal framework, financing infrastructure, and market conditions remain the key challenges for the venture capital industry. For instance, within the regulatory and legal framework, diverse tax treatment, licensing requirements, and compliance costs deter the progress of the venture capital markets. The de-risking efforts should consider public–private partnership schemes, risk mitigation instruments, sector liberalisation reforms, and the identification of priorities. Thus, potential areas of regional cooperation should focus on regulatory harmonisation, a shared policy response, and information exchange for the venture capital markets. Along the way, mapping the regional private equity firms, and accelerator and incubator programmes across the region, specifically in ASEAN, increases understanding of the ecosystem for an effective regional policy response. Specifically, the regional cooperation and policy response could focus on the creation of a single platform for market access, facilitate the expansion of the venture debt sector, and establish an information gateway and intergovernmental unit within the existing framework for participatory engagement.

The role of technology transfer and FDI is critical in supporting the national innovation system. The challenges of cross-border financing should be rectified regionally. Addressing the financial intermediaries' heterogeneity, risk profile management, and framework to mitigate the global asset price risk would allow better facilitation of capital flows into the region. Technology transfer should be seen in a broader context, considering tangible and intangible assets – from knowledge transfer

to that of physical technologies. For instance, licensing arrangements, the export and import of technologies, managerial resources (including production technology), managerial expertise, and marketing and logistics tools form some of the channels of technology transfer. Indeed, specific financing tools could focus on process technology transfer such as inventory management, quality control, schedule control, facility administration, and environmental management systems, which are critical to move forward to a greener path.

Regional initiatives that have a clear plan for technology transfer to benefit the region are recommended. For instance, in areas of human capital development, tapping and upscaling individual nations' support and financing of activities related to training and upskilling at the regional level – incorporating multinational corporations' commitment through cross-border investment – is one example. Facilitating forward and backward linkages through a financing mechanism could be another option to facilitate technology transfer. Public sector technology transfer also remains low. Collaboration between actors within a country ecosystem – such as universities, suppliers, firms, and research institutions – could be encouraged by establishing a matching financing mechanism. This could also be established regionally. International collaboration in Asia and the Pacific, measured by the intra-regional share of research outputs, has progressed since 2006 (ADB, 2021b), but important actors such as firms and businesses have not participated significantly. Private sector participation is critical.

5. Conclusions

It is necessary to reach collective and binding decisions on the NZT for global emissions and the time trajectory of emission reductions. Therefore, effective intra-regional and interregional cooperation are crucial to promote and sustain low-carbon energy systems growth. The focus of this chapter is on intra-regional cooperation in Asia. Given the strong regional blocs such as ASEAN, the RCEP, and Asia-Pacific Economic Cooperation (APEC), Asia is in an excellent position to work under a regional cooperation framework to maximise market-based and non-market-based opportunities.

Regional cooperation – not only through ODA, which is decreasing, but also through other means of communications and cooperation such as joint ventures – is important in creating the enabling conditions for carbon-neutral energy systems growth and sustainable development. The development of new technologies and the distribution of proven technologies are the twin engines to bring about a carbon-neutral society. International and regional cooperation is necessary for innovation, technology development, and distribution. Subregional incubation centres for technology development would help; though there is no need to create new centres, it is necessary to harmonise the mindset of the existing subregional institutions towards promoting low-carbon growth. The private sector should transfer proven technologies to developing countries at concessional rates, but should be compensated for the difference between the commercial and concessional rates. To implement this process, an important priority is to create specialised subregional funds to address key climate change

issues. Financing at the subregional level does not require new structures or institutions: it is possible to reform existing financial institutions, such as ADB, with a clear focus on subregional interests.

Development of capacity is needed, particularly in the banking sector, because staff attached to banks and capital markets need to have professional knowledge about low-carbon growth, carbon trading, and carbon tax. Capacity building is also needed to contribute to R&D in net zero emissions to improve the attitudes of consumers, producers, and policymakers towards carbon-neutral energy systems growth. In this context, what is needed is a virtual university/research institute/secretariat involving selected top universities/research institutions. Established regional institutions such as the ASEAN Secretariat, UNESCAP, and ADBI need to play a coordinating role. A rapid digitalisation shift creates vulnerabilities for people with low digital literacy to fall victim to scams and other crimes. Policymakers must not forget the importance of digital education as they increase service provision. In addition, although digital services such as fintech may provide promising solutions, risks regarding data protection and privacy should be taken into account when formulating an appropriate policy framework. In this context, the role of regional cooperation is crucial in strengthening the responsibility of developed countries in the region to help developing economies frame adequate policies related to data protection and digital services.

In a globalised world, international trade is central to reaching the objectives of the Paris Agreement as it facilitates the availability of climate-friendly technologies and products with lower levels of embedded carbon at competitive costs and on a larger scale. It facilitates the diffusion of low-carbon innovative products. Trade liberalisation stimulates the development of this market and enhances the spread and affordability of, for example, clean energy or energy efficiency technologies. However, the evidence-based empirical analysis of this study has revealed that renewable energy goods exports have not been flowing without constraints such as non-tariff measures in the Asian region. Nevertheless, the potential for improving technical cooperation in harmonising the production process of renewable energy goods and eliminating non-tariff measures is very high through effective functioning of the RCEP regional cooperation mooted by ASEAN. Drawing on the evidence-based research, as the exports of many countries are carbon intensive, it may be argued as fair to impose carbon tariffs on carbon-intensive imports to discourage such carbon-intensive exports.

Many Asian and Pacific countries do not have developed capital markets, so financing through capital markets for low-carbon industries is limited. Various innovative financial products and services, from private institutions, could be useful in the development of capital markets. To motivate strong private sector involvement in low-carbon growth, it is necessary to support the establishment of new and innovative regional private financing mechanisms – especially for risk transfer and insurance instruments. For this to occur, regional R&D efforts are necessary through the proposed regional virtual university/research institute/secretariat, and these

require regional funding with liberal assistance from countries enjoying large foreign reserves within Asia.

The carbon market in Asia is fragmented, which is not conducive to meeting the NZT within the regionally prescribed time frame. None of the AMS, except Singapore, has implemented a carbon tax, although ETSs have been under consideration in Indonesia, the Philippines, Thailand, and Viet Nam. Unification of the market under a grand regional coalition scenario could improve regional financing for low-carbon energy systems growth. Regional cooperation in this context should facilitate (i) eliminating risks and barriers to market entry, as low-carbon financial flows and stocks remain marginal; (ii) connecting the financial system (banks, institutional investors, and cross-border national institutions) to the long-term needs of the energy sector; and (iii) improving not only the national but also the regional understanding of the efficiency and effectiveness of meeting the NZT within the regionally agreed time frame.

The solid message of this chapter is that low-carbon energy systems growth cannot be handled by any single country effectively, but requires considerable cooperation across countries in the region and beyond. Efficient coordination is crucial for the success of cooperation amongst different policymaking sub-groups within the region. Many weaknesses can be observed in the regional governance structure that limit the region's ability to tackle cross-cutting issues such as climate change. For example, the AWGCC has delivered a number of collaborative projects on climate change involving Dialogue Partners in recent years. However, it is evident that the AWGCC lacks a clear mandate to coordinate beyond the AMME working groups. It appears that the possibility of dialogue on climate change in the long run disappearing from the responsibility of the AMME and the ASCC blueprint may not be ruled out.

Nevertheless, it is important to note that countries in this region have in the past been able to work on cooperative initiatives and programmes in areas such as cross-border energy exports through cooperative projects like the Theun–Hinboun expansion project, the Xekaman 3 hydropower plant, and the Nam Ngum 2. The diversity of countries in the region offers much greater opportunity and is imperative to advance cooperation beyond energy exports, specifically in areas such as smart city models, digitisation, and investing in the EV production network. Further, in terms of technological development, areas such as clean and green hydrogen need to be developed and implemented for strengthening regional cooperation to achieve the NZT soon.

The policy recommendations to strengthen regional cooperation to achieve the NZT by the middle of the century are (i) a regional low-carbon transition fund that could broaden and deepen the risk-bearing capacity of the private sector; (ii) the formulation of a finance performance warranty programme, which would target low-carbon technology providers, with insurance on the financial availability and guarantees for the performance; (iii) the recruitment of independent third parties to assess the effectiveness of low-carbon energy policies and AEC trade policies internationally and regionally to spur private finance

action domestically; (iv) voluntary carbon credits to direct private financing to climate action projects that would not otherwise materialise; (v) effective regional coordination to establish a quality energy infrastructure programme with net zero emissions aspects that also brings job growth in member countries; and (vi) strengthened implementation of economic and social policy strategies, which are developed with regional expertise and consensus, at each country level in the region with strong political will.