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Carbon pricing for the transition toward net-zero of Asia

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Key messages

- This paper provides an overview of progress on carbon taxes, emissions trading schemes (ETS) and voluntary carbon crediting mechanisms in Asia, identifying relevant policy gaps and giving suggestions based on the lessons and experiences with pertinent policy practices in this region.
- Carbon pricing policy is already making headway in Asia. Countries with relatively developed economies have introduced carbon pricing in the last decade, such as the carbon tax in Japan and Singapore, and the national ETS in the Republic of Korea (hereinafter Korea) and China.
- Overall, carbon pricing practices in Asia are still at an early stage of development, and the resulting carbon prices are generally lower than USD 10 /t-CO_2. The prices in reality are much lower than the levels needed for achieving net-zero (i.e. starting from USD 30 /t-CO_2 immediately, rising to around USD 100 /t-CO_2 by 2030 and then going much higher by mid-century).
- Carbon pricing in Asia should be largely strengthened and pricing levels should become ambitious enough to catalyse a transition to net-zero. Carbon tax rates in Japan and Singapore should be raised significantly. The transparency and stringency of ETS in Korea and China needs to be enhanced for achieving the targets in NDCs and carbon neutrality.
- Developing countries in Asia with no carbon pricing are strongly recommended to adopt a pricing policy that is tailored to their national circumstances and context sooner rather than later. Political leadership and decision making at the highest level is indispensable in introducing such a policy. The practice of carbon pricing may start at acceptable levels for the policy targets and be gradually strengthened through a learning-by-doing process.
- The developed economies are suggested to provide technical assistance. Existing platforms like the forum on carbon pricing mechanism among Japan, China and Korea may be expanded to promote experience sharing and mutual learning in a wider scope of Asia.
- As a supplement to the mandatory carbon pricing, domestic voluntary carbon crediting mechanisms have been emerging in Asia although the scale is very limited due to the lack of demand for the credits. The domestic crediting mechanisms in voluntary should therefore be promoted. This approach may be scaled up by linking with mandatory carbon pricing, especially the ETS, to support a net-zero transition.

1. Introduction

A comprehensive mix of climate policies is necessary to achieve the carbon neutrality target that has been declared by many countries in Asia. Out of this mix, the setting of minimum efficiency performance standards (MEPS) is a regulative approach usually applied to overcome the non-economic barriers for realising the potential of cost-effective mitigation. Financial subsidies are often provided to promote the development and initial deployment of low and zero carbon technologies but these are only available for a narrow range of projects due to budget limitations. Functioning as a core element of climate policies by giving credible, stable and sustainable price signals, carbon pricing can enhance dynamic efficiency for long-term and economy-wide decarbonisation (Liu, 2017). In theory, carbon pricing may minimise the cost of achieving a specific mitigation target while also providing incentives for innovation and investment in low and zero carbon technologies. Experience with such policies in many developed countries has confirmed that carbon pricing is effective in improving the cost efficiency of mitigation and technology innovation, rather than hindering the economic growth (Ellis et al., 2019). Policy practices for carbon pricing have been expanding over the last decade from developed countries to some emerging economies in Asia. Along with the formal launch of China's national carbon emissions trading scheme (ETS) in 2021, the share of global greenhouse gas (GHG) emissions covered by carbon pricing has increased from 15.1% to 21.5% (The World Bank, 2021a).

Considering the great significance of carbon pricing for the transition of Asia toward net zero, this paper identifies the gap between the carbon price levels necessary for the achievement of the Paris Agreement goal, and looks at practices in reality through a review of literature and policy progress. Policy recommendations are proposed having gained an understanding of experiences and lessons from the policy introduction and implementation in countries with relatively developed economies in this region. In terms of the scope, a number of policies may implicitly put a price on carbon emissions. The most prominent examples are energy taxes based on the volume or the energy content of fuels rather than their carbon emissions. Nevertheless, the descriptions and discussions in this paper are mainly limited to explicit carbon pricing instruments, including carbon taxes and ETS, which set a price according to the volume of carbon emissions (OECD, 2013). Domestic voluntary crediting mechanisms are also covered since they make up a broader strategy for carbon pricing and may promote mitigate emissions through linkages with the mandatory ETS. The geographical coverage of this paper is restricted to major economies in northeast and southeast Asia, considering the actual policy progress of carbon pricing in this region.

This paper is arranged as follows. Section 2 gives a summary of the carbon price levels needed for the realisation of global climate targets referring to the available literature. Section 3 reviews the progress of carbon pricing policies in Asian countries, mainly carbon taxes in Japan and Singapore, and national ETS of the Republic of Korea (hereinafter Korea) and China. Policy design feature and effectiveness are discussed quantitatively and qualitatively based on the results of empirical studies. Section 4 outlines the progress of domestic carbon crediting initiatives in Asia and their future potential for emissions mitigation. Lastly, section 5 provides policy recommendations.

2. Carbon price levels needed for the decarbonisation

Based on a comprehensive literature review, Kojima & Asakawa (2021) conclude that the studies on explicit carbon pricing estimate the prices corresponding to the decarbonisation pathways at a range of USD 100 to 500 /t-CO_2. It is not appropriate to compare estimated carbon prices due to major inconsistencies when making assumptions on various analyses. Nevertheless, Figure 1 aims to show the rough trend in global carbon price levels that is required to achieve the 2°C and 1.5°C targets based on relevant literature.

Looking at this in more detail, the International Monetary Fund (2019) indicates that an immediate and uniform carbon price that would rise rapidly to USD 75 /t-CO_2 in 2030 could limit global warming to 2°C or less. Emissions are more responsive to carbon pricing in coal-reliant countries. For China and India, the two largest developing countries in Asia, this price might reduce their emissions by as much as 45%. Similarly, Stern & Stiglitz (2017) estimate global carbon prices consistent with 2°C target at a range of between USD 50 and 100 /t-CO_2 in 2030. Strefler et al. (2021) clarify how the optimal carbon price path would limit the demand of carbon direct removal (CDR) and identify the requirements for alternatives to be more easily implemented. All the scenarios in this study assume a uniform global carbon price from 2020 that has been adapted to achieve an accumulative emission budget of 1,070 Gt-CO_2 since 2018, which is consistent with a 66% chance of limiting the global mean temperature increase to 2°C. Their results show that the optimal scenario requires a global carbon price of around USD 36 /t-CO_2 in 2025 and USD 128 /t-CO_2 by 2050. The higher early carbon prices may lead to stronger emission reductions and an earlier upscaling of CDR in the period 2030 to 2050 (Strefler et al., 2021).

To keep global warming to 1.5°C, carbon prices have to be much higher. To illustrate, Wood Mackenzie (2021) finds that the price of carbon will need to reach USD 160 /t-CO_2 by 2030 to be on track for a 1.5°C pathway. Dietz et al. (2018) confirm that the median carbon price from a range of 1.5°C scenarios simulated by energy models is USD 85 /t-CO_2 in 2020 and USD 145 /t-CO_2 in 2030. All the scenarios have an over 50% probability of limiting warming to 1.5°C by 2100. These price numbers are for 2005 prices and they are approximately three times higher than the price levels for 2°C scenarios, which have more than 50% probability of limiting warming to a range between 1.75°C and 2°C by 2100. Rockström et al. (2017) suggest to eliminate all fossil fuel subsidies and introduce an explicit carbon price of USD 50 /t-CO_2 at least in the 2020s. This would aim to achieve a rapid reduction of global emissions by 2050 for a 50% chance of limiting warming to 1.5°C by the end of this century and an over 66% probability of meeting the 2°C target. The carbon price should then be gradually increased to go above USD 400 /t-CO_2 by 2050.

In summary, it would be necessary to set a global carbon price at around USD 30 /t-CO_2 immediately and raise it to a range of between USD 80 and 150 /t-CO_2 by 2030 to stay in line with the Paris Agreement target. The price level should be then further increased, i.e., to around USD 400 /t-CO_2, so as to achieve decarbonisation by mid-century and to limit warming to 1.5°C by 2100.

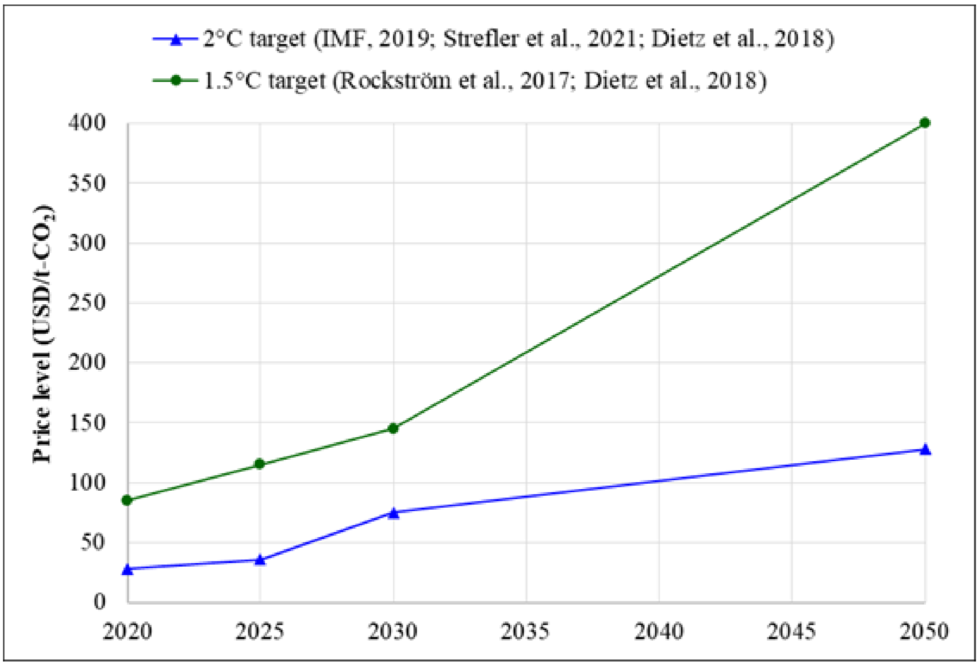

Figure 1: Global carbon price paths needed for the decarbonisation (Source: Prepared by the authors).

For major emitting countries in Asia, Kobayashi et al. (2019) estimate that a carbon tax of JPY 21,400 /t-CO_2 (Around USD 190 /t-CO_2) would be required for Japan to achieve net-zero emissions by 2050, assuming the application of carbon capture and storage (CCS) and maximum expansion of renewables through carbon pricing. Duan et al. (2021) indicate that the 1.5°C consistent goal would require China to reduce its emissions by more than 90% compared to a 'no policy' case, and the power sector should achieve a full decarbonisation by 2050. As for carbon prices, the global levels range from USD 119 to 650 /t-CO_2 in 2030, and such levels for China are USD 16 to 650 /t-CO_2. Jung & Park (2018) assess the feasibility for Korea to reduce its emissions in order to limit the global temperature increase to 1.5°C above pre-industrial levels. Their results show that, regardless of the scenarios of burden-sharing within the global carbon budget, the marginal cost for emissions reduction by Korea would range from USD 100 to 350 /t-CO_2 in 2050. Meeting Korea's NDC exclusively by carbon pricing would require raising the 2030 carbon price by more than USD 75 /t-CO_2 on all fossil fuel emissions from the current level, and applying similar prices to other GHG emissions. Korea has a relatively higher share of CO_2 emissions from coal. This implies that other countries would need even higher prices to achieve a comparable mitigation target (International Monetary Fund, 2021).

3. The latest progress of carbon pricing in Asia

3.1 Practices and effectiveness of carbon tax in Asia

Carbon taxes have been introduced and implemented in Japan and Singapore. The major attributes and mitigation effect of this policy in these two countries are summarised in Table 1 below.

Table 1: The major attributes and mitigation effect of carbon tax policy in Japan and Singapore

Items	Japan	Singapore
Starting time	1 October, 2012	1 January, 2019
Taxable target	Fossil fuels, including coal, crude oil and oil products, and gaseous hydrocarbon	Industrial facility with annual direct emissions of 25,000 t-CO_2 and above
Tax rate	About JPY 96 /t-CO_2 (0.85 USD/t-CO_2, from 1 October, 2012); About JPY 192 /t-CO_2 (USD 1.70 /t-CO_2, from 1 April, 2014); and, JPY 289 /t-CO_2 (2.56 USD/t-CO_2, from 1 April, 2016)	SGD 5 /t-CO_2 (USD 3.70 /t-CO_2, from 2019 to 2023)
Tax relief measures	Tax exemption and refund measures applicable for certain fields	Rebate to eligible households to mitigate possibly high energy costs
Tax revenue	About JPY 90 billion (USD 0.796 billion) in FY2013; JPY 170 billion (USD 1.504 billion) in FY2014 and FY2015; and, JPY 260 billion (USD 2.301 billion) since FY2016	About SGD 195 million (USD 144.3 million)
Utilisation of tax revenue	To utilise all the revenue for curbing energy-originated emissions	To encourage business efforts in energy efficiency via financing programmes
Mitigation effect	Expected to reduce 0.5%-2.2% of energy-related emissions by 2020 from the 1990 level, with an estimated reduction of 6.75 million t-CO_2 in FY2019	Quantitative estimation is not available, while the expected effect would be insignificant due to the low tax rate
Note: The currency exchange rates of December 2021 are applied for calculation (USD 1 = JPY 113; SGD 1 = USD 0.740).		

3.1.1 Global warming countermeasure tax in Japan and the effects of policy

A carbon tax had been under consideration within the Ministry of the Environment, Japan (MOEJ) since the early 1990s. Finally, after long discussions on possible proposals, the ‘global warming countermeasure tax’ was introduced in Japan on 1 October, 2012. Due to strong resistance from the business community and domestic political concerns about negative effects on economic growth and international competitiveness, Japan’s carbon tax features a low tax rate and earmarks all tax revenues solely for energy-related mitigation measures (Gokhale, 2021). All fossil fuels, including coal, crude oil and oil products, and gaseous hydrocarbon, are taxable targets. The tax rate is set at an equivalent of JPY 289 /t-CO_2 (Around USD 2.56 /t-CO_2) after three gradual increases. One third of this designated rate was applied from 1 October, 2012, then another one third was added from 1 April, 2014, and the tax was fully imposed from 1 April, 2016. Accordingly, the annual tax revenue has increased to about JPY 260 billion (Around USD 2.30 billion) since FY2016 (Ministry of the Environment, Japan, 2020). In practice, the incorporation of a double-dividend feature into the carbon tax requires significant inter-ministerial coordination, which might have hindered active discussions on double-dividend issues in Japan. There was also no further consideration given to the double-dividend potential offered by a higher tax rate (Gokhale, 2021).

The carbon tax in Japan was expected to reduce the country’s energy-related CO_2 emissions by 0.5% to 2.2% (About 6 to 24 million t-CO_2) by 2020 from 1990 levels. It is estimated that an overall reduction of

6.75 million t-CO_2 was achieved in FY2019 due to this policy. Out of this amount, 3.2 million t-CO_2 could be attributed to a decrease in energy demand in response to the tax-oriented energy price increase, namely the price effect. The other 3.55 million t-CO_2 is due to technology introduction supported by the specific fund from tax revenue, or what is known as the financial resource effect (Ministry of the Environment, Japan, 2021). After making a declaration in October 2020 to commit to carbon neutrality by 2050, Japan's prime minister requested the MOEJ and the Ministry of Economy, Trade and Industry (METI) to propose carbon pricing mechanisms that would contribute to the economic growth. Since February 2021, both ministries have been organising expert level discussions to figure out the direction for full-scale carbon pricing in Japan.

Obviously, the current carbon pricing schemes in Japan are modest and there is room to upgrade them in the context of decarbonisation transition. One key issue is how to set an adequate level for carbon pricing. As MOEJ's previous attempts to implement a national ETS were met with strong domestic resistance, raising the carbon price through the existing carbon tax mechanism may be a more time and cost-efficient solution. A much higher carbon tax rate, appropriate tax revenue treatment and compensation for the affected individuals and businesses would assist Japan in meeting both its economic growth objectives and its more ambitious emission reductions goals (Gokhale, 2021).

3.1.2 Carbon tax in Singapore

The 'Carbon Pricing Act' (CPA) in Singapore and its accompanying regulations came into effect on 1 January, 2019. As the first carbon pricing policy in Southeast Asia, any industrial facility with annual direct GHG emissions of 25,000 t-CO_2 and above is required to be registered as a taxable facility. These taxable facilities must pay a carbon tax from 1 January, 2019 for their countable emissions. Singapore is also implementing carbon tax in a gradual way to minimise the impact on business competitiveness. The tax is set at a low rate of SGD 5 /t-CO_2 (Around USD 3.70 /t-CO_2) between 2019 and 2023. The tax level and trajectory after 2023 will be reviewed and decided by 2022 (The National Environment Agency, 2021). Singapore's total GHG emissions amounted to 52.5 million t-CO_2 in 2017, with industry accounting for about 60% of these emissions. Carbon tax in Singapore covers about 80% of industrial emissions. The current tax revenue is around SGD 195 million (around USD 144.3 million) per year (The World Bank, 2021a). Tax revenue will be used to encourage business investment and innovation in energy efficiency via financing programmes.

Many members of parliament (MPs) in Singapore have expressed concerns that the current carbon tax would not reduce emissions due to the low rate. Some of them suggested to raise the tax rate to SGD 30-55 /t-CO_2 by 2030, SGD 50-90 /t-CO_2 by 2035 and SGD 75-120 /t-CO_2 by 2040 (Kurohi, 2021). To achieve net zero emissions by around mid-century, Singapore recently announced that it would raise its carbon tax levels progressively to SGD 25 /t-CO_2 in 2024 and 2025, and SGD 45 /t-CO_2 in 2026 and 2027, with a view to reach SGD 50 to 80 /t-CO_2 by 2030. The revised carbon tax trajectory is critical in enabling the pace of transformation and can provide certainty and impetus for companies to plan their business transition. The companies are allowed to surrender high quality international carbon credits to offset up to 5% of their taxable emissions from 2024. To maintain business competitiveness in the near term and mitigate the risk of carbon leakage, the existing emissions-intensive trade-exposed (EITE) companies will receive transitory allowances for part of their emissions (The National Climate Change Secretariat, 2022).

3.2 Practices and effectiveness of ETS in Asia

ETS at the national level have been introduced and implemented in Korea and China. The major attributes and mitigation effect of this policy in these two countries are summarised in Table 2.

Table 2: Major attributes and mitigation effect of national ETS in Korea and China

Items	Korean ETS	China's national ETS
Implementation period	1st phase: 2015-2017; 2nd phase: 2018-2020; 3rd phase: 2021-2025	Initial phase: 2021
Target	● Gases: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 ● Target: 1) Businesses with average emissions in the last 3 years: ≥125,000 t-CO_2; 2) Businesses with no less than one establishment whose average emissions in the last 3 years: ≥25,000 t-CO_2; and, 3) Businesses covered by the target management system and voluntarily participated ● No. of liable entities: 1st phase: 525 (2015); 2nd phase: 591 (2018); 3rd phase: 684 (2021)	● Gases: Only CO_2 from power generation sector ● Thresholds for target: 1) Belongs to the industry covered by the national ETS; and, 2) Annual emissions: ≥26,000 t-CO_2 ● No. of liable entities in 2021: 2,162 for power generation sector (Including industry-owned generators)
Coverage (By direct emissions)	1st phase: 67.3%; 2nd phase: 70.1%; 3rd phase: 73.5%	Around 40%
Allowance allocation	● No. of sectors by benchmarking: 1st phase: 4; 2nd phase: 7; 3rd phase: 12 ● 1st phase: Full for free; 2nd phase: 3% by auction; 3rd phase: 10% by auction	● Benchmarking for power generation sector ● Full for free initially, will apply non-gratuitous allocation later
Offsetting rate	1st phase: ≤10%; 2nd phase: ≤10% (≤5% for the credits from abroad); 3rd phase: ≤5%	≤5%
Utilisation of auction revenue	Mitigation equipment installation; energy-saving technology development; and support for SMEs, etc. (From the 2nd phase)	No revenue due to the allocation full for free
Market price	Average price: KRW 11,013 /t-CO_2 (USD 9.32 /t-CO_2, 2015); KRW 20,951 /t-CO_2 (USD 17.72 /t-CO_2, 2017); KRW 31,429 /t-CO_2 (USD 26.59 /t-CO_2, 2020)	Trading started on July 16, 2021 at about CNY 50 /t-CO_2 (USD 7.96 USD/t-CO_2)
Mitigation effect	The emissions of target entities continued to grow during 2016 and 2018, but started to decline by 2.3% in 2019 from the previous year	Too early to evaluate the scheme's mitigation effect as it was just launched
Note: The currency exchange rates of December, 2021 are applied for calculation (KRW 100 = USD 0.0846; CNY 1 = USD 0.159).		

3.2.1 National ETS of Korea and its effectiveness

The 'Basic Act on Low Carbon Green Growth' of Korea, which includes the introduction of an ETS, was passed in December 2009 and enacted in April 2010. Based on this law and guidelines set out by the government, a target management system (TMS) was introduced in January 2012. This system obliges large businesses from industry, building, transportation and waste sectors to set and achieve reduction targets of GHG emissions and energy consumption. The TMS played an important role in statistics and management of emissions of major emitters and paved the way for the ETS introduction in Korea (International Carbon Action Partnership, 2021). After the discussions and finalisation of management regulations on the scheme design and technical issues such as the emission allowance allocation plan, the Korean ETS was formally launched at the beginning of 2015. The 1st phase of this scheme was completed in 2017, the 2nd phase started in 2018 and ended in 2020, and the 3rd phase is scheduled to last for five years from 2021 until 2025 (Cho, 2020).

Korean ETS targets are categorised as follows: 1) businesses with average annual emissions of 125,000 t-CO_2 and above in the last three years; 2) businesses with one or more establishments having average annual emissions of 25,000 t-CO_2 and above in the last three years; and, 3) businesses covered by the TMS and to participate voluntarily. The number of covered sectors in the 1st phase was five — energy conversion, industry, building, aviation, and water, sewage and waste. These increased to six sectors in the 2nd phase, including energy conversion, industry, building, waste, public service, and others. From the 3rd phase, the transportation and construction sectors were also included. Accordingly, the number of targeted entities increased from 525 in 2015 to 591 in 2018, and then to 684 in 2021. Based on calculations of direct emissions, the targeted entities in the Korean ETS accounted for 67.3% and 70.1% of the country's total emissions in the 1st and 2nd phases, respectively. In the current 3rd phase, emission coverage has expanded to 73.5% (Cho, 2020).

Emission allowances are decided according to the national emissions reduction target. More and more sectors are applying a benchmarking approach when setting emission allowances. All allowances were allocated for free in the 1st phase. An auction was introduced in the 2nd phase, and the share of allowances allocated by auction increased from 3% in the 2nd phase to 10% in the 3rd phase. An auction was first held in January, 2019, and then once a month from then on. The auction revenue is used to install mitigation equipment as well as develop related technology and support for small and medium-sized enterprises (SMEs) (Korea Exchange, 2020).

The trading volume on the Korean carbon market increased from 5.8 million t-CO_2 in 2015 to 43.8 million t-CO_2 in 2020. The cumulative amount reached 173 million t-CO_2 by the end of 2020. The average market price has followed a rising trend. The price of Korean Allowance Unit (KAU) increased from around KRW 10,000 /t-CO_2 (Around USD 8.5 /t-CO_2) in 2015 to KRW 20,000 /t-CO_2 in 2016, and KRW 30,000 /t-CO_2 in August 2019. It further soared to around KRW 40,000 /t-CO_2 (monthly average, around USD 33.8 /t-CO_2) in December 2019. However, the price dropped from KRW 40,000 /t-CO_2 to KRW 20,000 /t-CO_2 or even less by May 2020, before starting to move up again in late summer of 2020 (Korea Exchange, 2020). The Korean government then started to review the allocation methodology and strengthen market liquidity for improving market performance. Currently, the Korean ETS permits the participation of some non-covered entities in the secondary market, i.e., banks, brokers and trading houses. In March 2021, three financial institutions were further appointed as market makers to boost market liquidity (The World Bank, 2021a).

Initially, businesses in Korea strongly resisted the introduction of ETS and indicated their opposition in terms of the cost. The government incorporated various business opinions into the design of the scheme to a large degree, aiming to overcome barriers to introducing the ETS (Suk, et al., 2014). With the implementation of the ETS, top managers at Korean companies have gradually increased their awareness on carbon management. Many large companies became proactive and even set internal carbon prices (Suk, et al., 2017). The obligation compliance rate of target entities was as high as 99% to 100% between 2015 and 2019. Emissions from target entities showed a growth rate of 2.2%, 3.2% and 5.2% individually in 2016, 2017 and 2018 from the previous year. It is encouraging that this number showed a decrease of 2.3% in 2019 from the previous year for the first time.

Korean ETS is currently the most developed scheme in Asia. Carbon market prices have strengthened to reach relatively high levels, and high allowance prices continued well into 2020 (Ritchie, 2022). Nevertheless, the Korean ETS has had negligible impact on electricity sector abatement due to lack of cost pass-through in wholesale electricity prices. Recent reforms to the retail tariff will support cost recovery and may pave the way for full carbon cost pass-through in the coming years (Kuneman et al., 2021). Aligned with the Korean 2050 carbon neutrality target announced in October 2020 and the 2030 NDC updated in December 2021, there will be some changes for enhancing Korean ETS in the near future, i.e., by increasing the share of auctioning and tightening the benchmarks for emission allowance allocation. This may lead to a further rise in carbon prices for Korea, enabling the ETS to play a central role in meeting the country’s climate targets (Ritchie, 2022).

3.2.2 Progress and initial effects of the national ETS in China

The implementation of ETS in China started from the development of seven pilot carbon markets at the local level since 2011. After about two years of preparation, carbon trading first kicked off in Shenzhen in June 2013. Other pilot markets in Beijing, Shanghai, Tianjin, Guangdong, Hubei and Chongqing were successively launched by June 2014. These local ETS pilots cover nearly 3,000 business entities from more than 20 industries such as power, iron & steel, cement and so on. By the end of August 2020, a total of 406 million t-CO_2 was traded in the pilot carbon markets and the transaction amount reached CNY 9.28 billion (around USD 1.48 billion) (Ministry of Ecology and Environment, China, 2020a).

The ‘Joint Statement on Climate Change between China and the United States’, released on 25 September, 2015, was the first declaration that China planned to launch a national ETS by applying the policy to key industries like iron & steel, electricity, chemicals, building materials, papermaking and non-ferrous metals (Xinhua News Agency, 2015). Aiming to introduce a national ETS, the government requested key emitting companies to prepare emissions measurement plans, and report their verified annual emissions from 2013. On 18 December, 2017, the National Development and Reform

Commission (NDRC), the ministry in charge of climate change policy in China at that time, published the 'National Carbon Emissions Trading Market Construction Plan (Power generation sector)'. This plan outlined the basic principles, goals, targets, emission allowance management, preparation works and rough timeline for the introduction of a national ETS (National Development and Reform Commission, 2017). In March 2018, the ministry in charge of climate change policy in China shifted from NDRC to the restructured Ministry of Ecology and Environment (MOEE). From then on, the development of the national ETS has been led by MOEE, including the establishment of related management rules, the development of emission allowance registry system and trading system, and emission data reporting. On 29 December, 2020, MOEE issued the 'Implementation Plan of Allowance Setting and Allocation in 2019-2020 for National Carbon Emissions Trading (Power generation sector)', and published a list of target companies from the power generation sector (Ministry of Ecology and Environment, China, 2020b). The 'Carbon Emissions Trading Management Measures (Trial version)', which applies to the management of related activities of the national ETS, was promulgated on 31 December, 2020, and came into effect on 1 February, 2021 (Ministry of Ecology and Environment, China, 2020c).

The compliance cycle of China's national ETS starts from 2021 and is obligatory for power generation entities (including self-owned generators by other industries), which had emitted no less than 26,000 t-CO_2 in any year between 2013 and 2019. At the initial stage, China's national ETS targets a total of 2,162 entities with annual emissions of around 4.5 billion t-CO_2 or around 40% of the country's total GHG emissions. This makes China's national ETS the largest scheme globally in terms of emissions coverage once it is fully implemented. The regulated entities have surrendered allowances to cover their 2019 and 2020 emissions by the end of 2021. For the thermal power generation sector, emission allowances are allocated by four types of carbon-intensity benchmarks: individually for conventional coal-fired power generators above 300 MW class (Rated power $\geq$ 400 MW); those below 300 MW class (Rated power $<$ 400 MW); unconventional coal-fired power generators; and gas turbines. Various adjustment coefficients are applied by the cooling method, heat supply ratio and the load factor to ensure that allowance setting remains fair for the same category of power units. All emission allowances in 2019-2020 were allocated free of charge. Non-gratuitous allocation will be adopted as appropriate in the future. Allowances were pre-allocated based on 70% of the entity's 2018 power generation amount. The remainder was allocated after the entity submitted its verified emissions for 2019 and 2020. In order to reduce the burden of targeted entities, gas turbines do not take compliance obligations at this stage, and coal-fired power plants are obligated to surrender extra allowances up to 20% of the verified emissions even when their allowance shortage is over 20% of the actual emissions (Ministry of Ecology and Environment, China, 2020b). In addition, up to 5% of the entity's allowance obligations can be offset by Chinese Certified Emission Reduction (CCER) (Ministry of Ecology and Environment, China, 2020c).

Trading on the national carbon market started on 16 July, 2021. A total of 4.1 million t-CO_2 was traded on the first day at an average price of around CNY 50 /t-CO_2 (Around USD 7.96 /t-CO_2) (Xinhua News Agency, 2021). By the end of 2021, the national carbon market was operated by 114 trading days. As the result, a total of 179 million t-CO_2 was traded and the transaction amount was CNY 7.661 billion

(Around USD 1.218 billion). The closure trading price on 31 December, 2021 was CNY 54.22 /t-CO_2, an increase of 13% from that on 16 July, the first day of trading (Ministry of Ecology and Environment, China, 2021).

China's national ETS has some unique features in design. Firstly, it covers direct emissions and indirect emissions due to electricity use. This is because electricity prices are largely regulated in China and currently, it is not feasible for to pass on carbon costs to consumers (Niizawa et al., 2020). Liu & Jin (2020) identified the interactions between electricity, fossil fuel and carbon prices in Guangdong province, China, where a pilot carbon market has been in operation since 2013. The price of electricity on the provincial monthly forward market indicates no significant relationship with the first differences of carbon prices. One suggestion has been to advance the liberalisation of the power industry to create conditions for carbon cost pass-through onto the electricity market. Secondly, benchmarks are used for allocating emission allowance in the power sector under China's national ETS, and this will be adopted for other target industries wherever possible. This may be attributed to China's tradition of using an intensity-based approach before the country's overall emissions peaked. Less efficient power plants have a disadvantage in the same benchmark category and China's national ETS is expected to induce earlier retirement of these inefficient plants. Nevertheless, over-segmented benchmarks may weaken the incentive for fuel switch and efficiency improvement. Overlapping command-and-control regulations may decrease the demand for emission allowances and reduce the liquidity of the national carbon market. Therefore, redundant regulations should be removed from the ETS target companies. China's experience with a national ETS may provide further reference for other Asian developing economies with strongly-regulated electricity markets (Niizawa et al., 2020).

China's national ETS is positioned to serve as an important policy for realising the country's commitment to peak its CO_2 emissions before 2030 and achieve carbon neutrality before 2060. Using the dataset of all 4,540 coal-fired power generators in China, Mo et al. (2021) suggest that the average residual lifetime of all units would be shorter with a low carbon price of CNY 50 /t-CO_2 but would grow at 4% annually with allowances fully auctioned. The cumulative emissions reduction by 2050 would be over 22 billion t-CO_2. In October 2021, the Chinese government published its national action plan to enable CO_2 emissions to peak out before 2030. Following a peak in emissions in the near future, a cap should be set so that the national ETS can ensure absolute mitigation targets are achieved.

The initial effect of ETS practices in China has been confirmed by empirical studies. Liu & Fan (2018) conducted a questionnaire survey of cement companies and confirmed that their carbon management has improved during the preparation for the national ETS, i.e., the measurement, reporting and verification of annual emissions. Deng, et al. (2018) carried out a survey of companies covered by the pilot ETS in China, and indicated that many of them have accounted for carbon prices in their investment decisions, although the trading was mostly motivated by achieving compliance rather than to manage the carbon assets in a market-oriented manner. Applying the difference-in-difference approach, Zhu, et al. (2019) showed that ETS practices in China have been effective in encouraging companies to invest in low carbon innovations.

3.2.3 Local ETS in Japan

ETS can be absolutely introduced at the local level. There are two local ETS in Japan. One is the Tokyo cap-and-trade programme that started in FY2010. This scheme is the first ETS at the local level in Asia and targets around 1,200 facilities with annual energy consumption of 1,500 kl crude oil equivalent and above; out of this total, about 1,000 facilities are office and commercial buildings, and 200 are factories. During the third phase from FY2020 to FY2024, the reduction liability is 27% for buildings and 25% for factories from base year emissions (average emissions of the selected three consecutive years between FY2002 and FY2007). Similar to the Tokyo cap-and-trade programme, Saitama Prefecture launched a target-setting type ETS in FY2011. Due to the difference in industrial structure, Saitama ETS targets about 600 facilities and most of them are factories. The two local ETS in Japan have been effective and the reduction targets were achieved much earlier than the required timeline. The facilities under these schemes also indicated relatively faster reductions than the average of industrial and commercial sectors (Ministry of the Environment, Japan, 2020).

4. Domestic voluntary carbon crediting mechanisms in Asia

4.1 Role of carbon crediting for decarbonisation in Asia

Moving toward a net-zero society, global discussions on the role of carbon crediting and offsetting mechanisms have started under new initiatives such as the 'Taskforce on Scaling the Voluntary Carbon Markets (TSVCM)' and the 'Voluntary Carbon Markets Global Dialogue' (The World Bank, 2021a). To achieve net-zero GHG emission targets in Asia, drastic reductions and removals of emissions in all sectors are needed, which requires a huge amount of financial support in the region. Voluntary crediting mechanisms can bring financial investment from the private sector and reduce the cost of low-carbon and zero-emission technologies (The World Bank, 2021a). The European Bank for Reconstruction and Development (2020) states that carbon markets can motivate countries to set more ambitious targets by unlocking private finance for further reductions.

A consensus on the role of carbon crediting mechanisms is that it is likely to be supplementary to mandatory carbon pricing like ETS and carbon tax. The design of a domestic crediting mechanism and linking this voluntary mechanism with mandatory carbon pricing tools are key to maximising its impact on a net-zero transition. The development of the domestic carbon crediting mechanism depends on a country's needs and priorities in target sectors and applicable technologies. As described earlier, China and Korea have integrated carbon crediting mechanisms with their domestic ETS, meaning that covered entities can offset a part of their emissions liabilities through carbon credits.

When designing of a carbon pricing instrument, the environmental integrity of carbon credits for offsetting needs to be ensured. The environmental integrity of credits is often related to real, quantifiable, verifiable, additional[1] and permanent[2] GHG emissions reductions and/or removals, avoidance of double

[1] A proposed project is considered additional if it would not be developed in the absence of crediting mechanisms.

[2] Carbon credits need to represent GHG emissions reductions and/or removals that are effectively permanent.

counting, and no environmental and social harm (World Wildlife Fund, Environmental Defense Fund, Oeko-Institut, 2020; Broekhoff et al., 2019; TSVCM, 2021; Murun & Takahashi, 2021). This can be associated with the quality and credibility of offset credits, which would have an impact on the potential of the crediting mechanism to contribute to net-zero targets. Therefore, ensuring environmental integrity is critical since poorly designed crediting mechanisms may give weak price signals and undermine the government's climate strategy (The World Bank, 2021a).

4.2 Brief summary of domestic crediting mechanisms in Asia

Domestic voluntary crediting mechanisms have been developed and implemented in China, Korea, Japan and Thailand. Table 3 summarises these domestic mechanisms.

4.2.1 Chinese Certified Emission Reduction (CCER)

CCER was developed based on the 'Interim Measures on the Management of the GHG Voluntary Emission Reduction Program' issued in June 2012. The national registry platform of voluntary carbon emission reductions was started in 2015, making CCERs tradable. However, CCER has been suspended since March 2017, due to a lack of standardisation in verification and validation processes, and a low volume of certified emission trading (Xue, 2022). Until the suspension, a total of 2,891 CCER projects had been developed, 1,047 projects were registered, and about 52 million t-CO_2 CCERs of 247 projects were issued. Among the registered projects, wind power (39%), solar PV (20%), household biogas utilisation (11%) and hydropower (8%) account for the largest share of projects. CCERs issued from the projects focusing on energy conservation, renewable energy and forestry (carbon sink) are permitted to be offset on local carbon markets, while emission reductions from hydropower projects are not eligible (Environmental Defense Fund & SinoCarbon Innovation & Investment Co., Ltd., 2020). CCERs are also allowed for compliance purposes of national ETS. Regulated entities covered by the national ETS can use CCERs to offset up to 5% of their verified emissions (Ministry of Ecology and Environment, China, 2020c). In addition, CCERs may be used as voluntary emission reductions by the private sector for achieving their own corporate social responsibility targets. In 2019, guidelines for carbon neutrality of large-scale events were published to promote the offsetting of event emissions by carbon credits from forestry carbon sink projects (Ministry of Ecology and Environment, China, 2019).

4.2.2 Korea Offset Credit Mechanism

The Korean Offset Credit Mechanism (KOCM) was established to support voluntary emission reductions and to increase financial flows for achieving the country's emission targets. Korean Offset Credits (KOCs) are allowed to be used to offset Korean ETS. The credits are issued from mitigation projects outside of the ETS coverage. During the second phase of the ETS between 2018 and 2019, the price of KOC remained between KRW 20,000 to 25,000 /t-CO_2. In September 2019, KOC was traded at the highest price of KRW 39,000 /t-CO_2. In the third quarter of 2019, a total of 1,498,000 t-CO_2 of KOC were traded in the domestic carbon market (Ministry of Environment, Korea, 2020). In 2020, a total of 308 activities were registered under this mechanism, 17.61 million t-CO_2 credits were issued and the price ranged between USD 20.31 and 36.02 /t-CO_2 (The World Bank, 2021a). In order to be used for the

ETS, KOCs should be converted into Korean Credit Units (KCUs), which is developed to limit the use of offset credits in the ETS. In the third phase of Korean ETS between 2021 and 2025, the share of offset credits, including domestic and international credits, rose to 5% of the covered entity's compliance obligation (The World Bank, 2021a).

Table 3: A summary of voluntary carbon crediting mechanisms in Asia

Country	China	Korea	Japan	Thailand
Mechanism name	Chinese Certified Emission Reduction	Korea Offset Credit Mechanism	Japan GHG Emission Reduction/Removal Certification Scheme	Thailand Voluntary Emission Reduction Program
Starting year	2015	NA	2013	2013
Sector coverage	Energy efficiency; Renewable energy; Fuel switch; Forestry; Waste	Energy efficiency; Renewable energy; Industry; Transportation; Waste	Energy efficiency; Renewable energy; Fuel switch; Forestry; Waste	Energy efficiency; Renewable energy; Waste; Transportation; Afforestation; Reforestation; Agriculture; Others
Registered projects	1,047 (As so far)	308 (In 2020)	387 (As of January, 2022)	228 (As of January, 2020)
Issued credits (Mt-CO_2)	Around 52 (As so far)	17.61 (In 2020)	5.25 (As of January, 2022)	7.9 (As of January, 2020)
Average price (USD/t-CO_2)	1.52-3.04 (In 2020)	20.31-36.02 (In 2020)	Renewable projects: 25.36; Energy efficiency projects: 15.18 (In April, 2021)	0.64-9.46

4.2.3 Japan GHG Emission Reduction/Removal Certification Scheme (J-Credit)

The J-Credit scheme has been implemented since 2013 to promote GHG emission reductions and removals, and to enhance voluntary carbon offsetting in Japan. The credits are mainly used by businesses when they report emissions under the 'Mandatory GHG Emission Accounting and Reporting System', or for reporting on energy efficiency under the 'Act on the Rational Use of Energy', as well as to achieve targets set out in Keidanren's commitment on a Low Carbon Society. J-Credits cover seven GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3). The project methodology types include energy (energy saving and renewable energy), industrial processes, agriculture (livestock and farmland), waste management and forest (forest management and afforestation) (J-Credit Secretariat, 2021a). By January 2022, the number of registered projects under J-Credit was 387 and the total amount of issued credits reached 5.25 million t-CO_2 (J-Credit Secretariat, 2021b). The estimated emission reduction of these projects by 2030 is scheduled to reach more than 13 million t-CO_2. Out of a total of 0.72 million t-CO_2 of credits issued to the standalone registered projects, fuel switch from fossil fuel to biomass projects count for the largest amount of more than 0.42 million t-CO_2, followed by energy efficiency projects, with around 0.1 million t-CO_2. Within a total of 4.50 million t-CO_2 issued to the aggregative registered projects, solar power generation projects have the largest share of nearly 80% (Around 3.55 million t-CO_2) (J-Credit Secretariat, 2021b). The credits can be traded through auctions or bilateral negotiations between buyers and sellers. From January 2018 to April 2021, the average price of credits of renewable energy projects increased from JPY 1,716 /t-CO_2 to JPY 2,536 /t-CO_2. For credits from energy efficiency projects, the average price fluctuated between JPY 1,148 /t-CO_2 and JPY 1,602 /t-CO_2 (J-Credit Secretariat, 2021b).

4.2.4 Thailand Voluntary Emission Reduction Program (T-VER)

The T-VER was started in 2013 as a domestic voluntary carbon crediting mechanism to support the involvement of public and private entities in GHG mitigation activities in Thailand. The credits are used for voluntary offsetting by businesses to fulfil their corporate responsibility to reduce emissions. There are seven types of T-VER methodologies, including alternative energy, energy efficiency, waste management, transportation, afforestation and reforestation, and agriculture and others as specified by Thailand Greenhouse Gas Organisation (TGO), the programme secretariat. As of May 2021, TGO has developed 43 T-VER methodologies for six sectors. In total, 239 projects are registered under T-VER and the expected emission reductions from these registered projects will be more than 6.5 million t-CO_2 per year (Thailand Voluntary Emission Reduction Program, 2021a). Credits from 196 projects have been issued, amounting to around 7.9 million t-CO_2 (Thailand Voluntary Emission Reduction Program, 2021b).

4.3 Increase in private finance and assurance of environmental integrity

Carbon crediting mechanisms could reduce GHG emissions at a lower cost and bring private finance to accelerate climate mitigation actions where they are not covered by mandatory instruments, such as carbon tax and ETS (The World Bank, 2021b). CCER in China is planned to be relaunched later and is considered to be a significant contributor to achieve China's net-zero GHG emissions target by 2060 (Xue, 2022). This implies that domestic crediting mechanisms in China have a significant potential to mobilise private finance and increase the involvement of business and the public in voluntary emissions reductions. In Japan, METI is providing support to achieve the net-zero target by 2050, and has announced the Green Transformation League[3] (hereinafter GX League) to bring transformational change to the economy and society as a whole. The private sector would participate voluntarily in the GX League to develop rules and guidelines to use high quality offset credits from international and domestic carbon mechanisms (e.g., J-Credit) (METI, 2022). This would generate the momentum to increase cost-effectiveness when aiming for a reduction in emissions. Nevertheless, an important point of the net-zero target is to mitigate its own emissions dramatically.

To secure high environmental integrity, crediting mechanisms have to develop rigorous and robust guidelines and procedures in all aspects, such as permanence and avoidance of double usage of carbon

[3] Green Transformation League, https://gx-league.go.jp/

credits. To avoid double usage, most domestic crediting mechanisms (e.g., J-Credit, TVER, and CCER) have developed a registry system within the public availability (J-Credit, 2022a; Thailand Voluntary Emission Reduction Program, 2021b). This system records, monitors and tracks all carbon credit transaction in the mechanism, thus buyers and sellers are able to see and check their credit usage. In terms of permanence, which is mostly related to forest and agriculture projects, crediting mechanisms have established robust monitoring guidelines and specified monitoring period of projects. For instance, J-Credit in Japan requires all projects in the forest sector to be monitored for 10 years even after the crediting period is completed (J-Credit, 2022b).

5. Discussions and suggestions for carbon pricing toward net-zero in Asia

Over the last decade, there has been a growing interest in carbon pricing and countries with relatively developed economies in Asia have started to implement related policies, i.e., carbon tax in Japan and Singapore, and the national ETS in Korea and China. However, these efforts resulted in only low to moderate carbon prices in reality. Nonetheless, there remains a significant gap between current prices, generally lower than USD 10 /t-CO_2, and the price levels needed for maintaining emission pathways aligned with the net-zero target, i.e., starting from USD 30 /t-CO_2 immediately to USD 80-150 /t-CO_2 by 2030 and then much higher by mid-century. In spite of the slow progress and obvious gaps in carbon pricing, Asian countries can certainly learn from the experiences of ongoing practices when implementing related policies.

5.1 Experiences and lessons learnt from the ongoing carbon pricing practices

Resistance from industry is the biggest barrier when trying to introduce carbon pricing, especially in export-oriented economies like Japan and Korea. Policymakers may have concerns about the negative impact of carbon pricing on production costs and international competitiveness in their industries (Liu et al., 2014). To overcome this barrier to carbon pricing, it is important to raise awareness about the necessity and usefulness of these policy tools. In Korea, the government was able to introduce ETS by gradually shifting the principle of climate policies from voluntary activities to a negotiated agreement, and then to the full-fledged application of a market mechanism. Through efforts in energy saving and by expanding renewables using administrative measures and financial subsidies, the Chinese government ensured that market mechanisms were effective in optimising the efficiency of resource allocations. Experiences of Korea and China also suggest that political leadership and decision-making at the highest level are indispensable for the launch of carbon pricing. For instance, the introduction of ETS in Korea is clearly stipulated in the ‘Basic Act on Low Carbon Green Growth’ enacted in April 2010 (Suk et al., 2017). The political decision to introduce a national ETS, which was announced in a Sino-U.S. joint statement on climate change in September 2015, was the critical starting point for development of the scheme in China (Liu et al., 2021).

The design and implementation of a carbon pricing policy is complex and as such, it is a process of learning by doing. It is politically feasible to start from a pricing level that is acceptable to the entities targeted by this policy. In practice, Japan and Singapore launched their carbon tax policy with very low rates. Appropriate tax relief measures and effective utilisation of tax revenues helped to gain the understanding of businesses. Similarly, the design of Korean ETS tried to reflect opinions from industry as much as possible, and allocated emission allowances for free in the initial phase. China's national ETS is based on the experience of operating pilot schemes at the local level, and started by solely targeting the power generation sector. This is because the power sector has better quality data and emission reporting compared to the other energy-intensive industries. Along with system improvement, China's national ETS will progressively expand to other key sectors in the near future. Liu (2017) confirms that even a moderate carbon price could bring about much faster diffusion of many low-carbon technologies. In addition, the practices of carbon pricing policies, particularly an ETS, could be improved through a process of capacity building for the targeted companies, industrial associations and government officials. The Korean government has been making efforts for greater business understanding through continuous and effective communications. To prepare for a national ETS in China, large-scale training has been arranged to build capacity of related stakeholders for carbon management and ETS implementation.

5.2 Recommendations for better carbon pricing practices in Asia

As an overall recommendation, this paper suggests that carbon pricing in Asia should be largely strengthened, and price levels should be ambitious enough to motivate a rapid and substantial reduction in emissions. It is encouraging that Japan has started to discuss how it would go about implementing full-scale carbon pricing. Singapore has decided to raise its carbon tax rate to achieve the country's enhanced NDC in line with the net-zero goal. The ETS of Korea and China are likely to become more stringent and transparent, and will play a key role in achieving their NDCs and carbon neutrality targets.

A major concern for the implementation of ambitious carbon pricing is how to protect domestic industrial competitiveness and avoid carbon leakage. Free allocation to energy-intensive and trade-intensive (EITI) sectors has been generally applied for an ETS to address this concern. As an alternative approach, the EU proposed a carbon border adjustment mechanism (CBAM) to put a carbon price on the import of target goods, thus ensuring that ambitious climate action in the EU would not lead to carbon leakage. The initial phase of the EU CBAM extends up to 2026 and will target five sectors, namely cement, iron & steel, aluminum, fertilizer and electricity. From 2026, the EU CBAM will be phased in gradually along with the phase-out of the free allowances under the EU-ETS (European Commission, 2021). The CBAM is likely to have a limited impact on Japan since there are only a few exports to the EU in the target industries for the initial phase and Japan is aligned with the EU in its ambition to decarbonise its economy by 2050 (Tanabe, 2021). Although some uncertainties remain, the EU CBAM proposal serves as a motivation for the Korean government to adopt a more ambitious climate target and create an enabling environment for businesses to pursue 2050 carbon neutrality (Choi, 2021). In 2019, China's exports of steel and aluminum products to the EU accounted for about 8% and 9% of EU's total imports, respectively. China is likely to be greatly affected by the CBAM, and the extent of this impact depends on the design of the mechanism, including what sectors are covered and the scope of emissions. Chinese policy experts are suggesting that the country should speed up the expansion of its national ETS to the CBAM target sectors, and ensure a higher carbon price to reduce export losses for the most exposed sectors (Kardish et al., 2021).

Other countries in Asia are strongly recommended to introduce carbon pricing as soon as possible to enrich their policy mixes, on the way to achieving their respective decarbonisation targets. Carbon tax and ETS each have their own advantages and disadvantages in theory. These two policy tools are not mutually exclusive and may be implemented individually (i.e., in some Asian countries as described in earlier) or simultaneously (i.e., in some European countries). Rather than the selection of a policy based on its theoretical merits, it is essential for a country to design a policy that is tailored to its own national circumstances and context (The World Bank, 2021a). The ETS usually targets large emitting entities due to the complexity of setting and allocating emission allowances, as well as the measurement, reporting and verification (MRV) of actual emissions. At this stage, a lack of quantitative analysis means that most developing countries in Asia still do not have a clear trajectory for carbon prices necessary to achieve net zero. Generally, policy practices start from a level acceptable to the targeted companies, especially those from the EITI industries, with policies then becoming ever more stringent. Several developing countries in southeast Asia have been moving forward with carbon pricing policies recently. Targeting coal-fired power plants, Indonesia launched a trial ETS in March 2021 despite having no date set for a national ETS, and the country decided to impose a tax of Rp 30 /kg-CO_2 (roughly USD 2 /t-CO_2) from 2022. In September 2021, Malaysia announced the inclusion of a carbon tax in the country's 12th Plan (2021-2025). However, there has been no decision as yet on how to design the carbon tax framework and little is known about the tax base, tax rate and use of revenues. The Malaysian government also approved a proposal to develop an ETS with voluntary participation from businesses. This may be attributed to pressure on Malaysia to achieve its NDC commitment and the possible introduction of the EU CBAM (Muhammad, 2021). Thailand is planning a pilot ETS in the country's eastern economic corridor. Viet Nam's National Assembly approved a revised 'Environmental Protection Law' in November 2020, aiming to develop a carbon market (The World Bank, 2021a). It may be also possible for Asian developing countries to consider developing an ETS in large metropolitan and industrial areas in preparation for more widespread, national-level adoption.

As a supplement to the mandatory carbon pricing, domestic voluntary carbon crediting mechanisms have been emerging in Asia albeit at a very limited scale due to the lack of demand for credits. Globally, the issuance of credits in domestic crediting mechanisms increased by 25% between 2019 and 2020, led by the California Compliance Offset Program and the Australia Emissions Reduction Fund (The World Bank, 2021a). As of now, China, Korea, Japan and Thailand have developed domestic crediting mechanisms at the national level. Nevertheless, the domestic crediting mechanisms in Asia can be promoted further to accelerate GHG emission reduction and expand financial flows from the private sector into climate change mitigation and adaptation actions. In addition, the environmental integrity of carbon credits should be ensured by developing robust rules and guidelines to maintain the quality of credits, which are used by the private sector to achieve their voluntary commitments. The domestic offset mechanisms may be scaled up by linking them with mandatory carbon pricing, especially the ETS, thereby maximising their full potential for achieving a net-zero transition. Integrating domestic carbon crediting mechanisms with the ETS has already been carried out in China (i.e., CCER) and Korea (i.e., KOCM). In addition, Indonesia has been discussing the development of a domestic crediting mechanism. To develop domestic offset mechanisms, one of the important factors is to avoid overlap with the scope covered by other carbon pricing instruments. Another important aspect to consider when designing domestic crediting mechanisms is to involve multi-stakeholders at the early stages of planning in order to gain political acceptance and increase public and private support, seeing as participation in crediting mechanisms is voluntary (The World Bank, 2021b).

Many developing countries in Asia lack capacity to design and implement carbon pricing policies and carbon crediting mechanisms. To help fill capacity gaps, developed economies with relevant experience can provide technical assistance. Experience-sharing and mutual learning is very useful and may be promoted through the expansion of existing platforms, i.e., the forum on carbon pricing mechanism among Japan, China and Korea. Other useful platforms that can provide support to developing Asian countries when designing carbon pricing instruments include the Partnership for Market Readiness, implemented by the World Bank.

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