FACTSHEET

Experiences with Carbon Pricing in Germany, the EU and Japan

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List of Abbreviations

CBAM	Carbon border adjustment mechanism
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EEA	European Economic Area
EITE	Emissions-intensive and trade-exposed
ETS	Emissions trading system
EU	European Union
EUA	EU allowance
EU ETS	European Emission Trading System
EUR	Euro
ESR	Effort Sharing Regulation
FY	Fiscal year
GDP	Gross domestic product
GHG	Greenhouse gas
ICAP	International Carbon Action Partnership
JCM	Joint Crediting Mechanism
JI	Joint Implementation
JPY	Japanese yen
JVETS	Japan Voluntary Emissions Trading System
LPG	Liquefied petroleum gas
LRF	Linear reduction factor
METI	Ministry of Economy, Trade and Industry
MoEJ	Ministry of Environment Japan
MRV	Monitoring, reporting and verification
MSR	Market stability reserve
nEHS	Nationales Emissionshandelssystem (German national ETS)
RGGI	Regional Greenhouse Gas Initiative
SME	Small and medium enterprises
TMG	Tokyo Metropolitan Government
TPE	Third-party entities
UN	United Nations
USD	US dollar
VRE	Variable renewable energy

1 Introduction

Climate change is the largest global threat of the 21st century. Increases in the concentration of greenhouse gas (GHG) in the world's atmosphere have caused average global surface temperature to rise by about one degree Celsius. Most of the warming has occurred in the last 40 years, with 2016 and 2020 the warmest years on record (NASA, 2021b, 2021a).

This accelerating change in global surface temperature has severe environmental consequences that threaten the world's populations and economies. Partly irreversible physical changes can already be seen, such as the disruption of seasonal events, sea-level rise, extreme weather, glacier retreat, and decreases in Arctic sea ice. Climate variability has also triggered forced migrations, conflicts, pressure on freshwater supplies, negative consequences on human health, and food security risks. This phenomenon has also increased the gap between the rich and poor (Diffenbaugh & Burke, 2019).

To halt temperature increases, net emissions must ultimately fall to zero such that any remaining emissions are balanced by removals of carbon dioxide from the atmosphere. There is scientific and emerging political consensus that this must take place by 2050 to have a realistic chance of maintaining temperature increases to 1.5 degrees Celsius (IPCC, 2018). Reflecting this urgency, the Paris Agreement was adopted by 196 countries in 2015, with the goal to keep global average temperatures to "well below" 2 degrees Celsius, preferably to 1.5 degrees Celsius, above pre-industrial levels. On top of this, 127 countries, including both Japan and Germany, have committed to net zero emissions targets by 2050 (CAT, 2020).

While the goal is clear, the pathway towards net zero is not. Various pathways have differing environmental and economic tradeoffs that also diverge across regions and sectors (IPCC, 2018). Carbon pricing, which harnesses the power of private actors in changing their production, consumption, and investment decisions, is therefore an essential component of a broader strategy in coordinating mitigation efforts in a way that ensures least cost.

Experience with carbon pricing is growing. Carbon prices have proven effective in driving both mitigation (Burke et al. 2020; Marcu et al. 2020; Abrell et al. 2020) as well as contributing to low carbon innovation (Grub et al., 2021; Calel & Dehezlepretre, 2016; Aghion et al., 2016). However, a challenge confronting all jurisdictions that consider carbon pricing is how to ensure a level playing field for carbon-intensive commodities that compete in international markets (Acworth et al., 2020). In response to this challenge, there is growing interest in, for example in the European Union and United States, the role of carbon border adjustment mechanisms (CBAM) to level carbon costs at national borders.

The Japanese government has begun to review domestic carbon pricing and, in parallel, examine Japan's border carbon adjustment strategies (Nakayabashi, 2021). Decarbonization of the power and industrial sectors will be a key component of any carbon pricing policy for the country given its emissions profile.

This factsheet aims to support the discussion on carbon pricing for the German-Japanese Environmental and Energy Dialogue Forum (EEDF). It reviews the experience to date with carbon pricing in Germany and Japan and places a spotlight on emerging trends in the industrial and power generation sectors. The timing for such a discussion is opportune as Japan considers the important role of a carbon price in the policy mix and in the transition towards its net zero target.

The factsheet proceeds as follows: the first two sections outline the rationale for global carbon pricing, lay out how jurisdictions have pioneered such policy approaches, and describe how these have recently proliferated around the world. The third and fourth sections cover the main experiences with carbon pricing mechanisms in Europe, Germany, and Japan. Conclusions follow.

2 Carbon pricing design and diffusion

2.1 Why price carbon?

In its essence, carbon pricing aims to correct a market failure in that existing economic systems do not value the climate damages associated with the release of GHG emissions. Through this lens, damages from climate change are not properly reflected in production and investment decisions or consumer choices.

For producers, carbon pricing creates an incentive to incorporate the cost of GHG emissions into operational decisions. GHG emissions are treated as an input with an associated cost and are therefore managed accordingly. Companies are forced to restrict emissions in their processes, make their goods less emissions-intensive, or make low-carbon investments. If declining emissions caps are set for future periods, carbon pricing also gives visibility to future obligations that may be relevant in decision-making about long-lived assets (Acworth et al., 2017).

For consumers, carbon pricing makes carbon-intensive goods and services more expensive, thereby reducing their consumption. For investors, carbon pricing provides a financial incentive to invest in low-carbon assets, including new products, processes, and technologies. High-carbon assets are less attractive as they are less competitive, and risk being decommissioned before capital costs have been recovered (standard assets). For innovators, a financial incentive is created to develop new products, processes, and less emissions-intensive technologies.[1]

The cost of combating climate change differs considerably across emission sources. By harnessing the power of individual decision makers, carbon pricing ensures emission reductions are cost effective. A carbon price does not tell people what steps they need to take to minimize emissions. Instead, people and firms decide how best to respond to this price. This means that carbon pricing can accomplish further reductions at the same expense as other climate policies. Flexibility is also provided surrounding *when* emission reductions take place, such that mitigation can happen when it is cheapest.

Jurisdictions can choose the carbon pricing instrument that best suits their needs. In the first part of this section, we discuss the types of carbon pricing, address their similarities and differences, and see how these influence instrument design. The global diffusion of carbon pricing is then discussed.

2.2 Types of carbon pricing

It is possible to create an explicit carbon price directly through emissions trading or a carbon tax. Regulations and standards produce an implicit carbon price. However, explicit pricing has typically been found to be more cost-effective (IPCC, 2014). An emissions trading system (ETS)

[1] This is consistent with the Hicksian theory of induced innovation, which suggests that changes in relative factor prices should lead to innovations that reduce the need for the relatively expensive factor (Hicks, 1932).

is based on the principle of cap and trade. This instrument sets a cap on overall emissions in the sectors covered by the system. To generate a unit of GHG, emitters must surrender an emission allowance. Regulated companies can obtain, buy, or trade these, with the emerging allowance price reflecting the underlying scarcity of allowances.

A carbon tax levies a price per ton of GHG emitted. Businesses covered by the tax are obliged to pay this amount for every ton they emit. Governments consider how the tax will fit into the general environment of the jurisdiction, as well as the context of energy and fiscal policy. Increasingly, policymakers are implementing hybrid instruments that combine elements of each instrument, as discussed below.

ETSs and carbon taxes share common ground: Both an ETS and a carbon tax impose a carbon price, are cost-effective, and generate revenue (through allowance auctions under an ETS). Carbon pricing revenues may be used to invest in environment and energy policy, fund tax changes, repay government debt, sustain social services, or reimburse domestic customers (Haug et al., 2015).

Two roads, one destination: ETSs and carbon taxes are different in their treatment of uncertainty, simplicity, and the flexibility they offer. An ETS determines the total amount of emissions by setting a cap, ensuring the mitigation outcome. As a result, the price of carbon fluctuates according to the demand for allowances. A carbon tax offers price stability but provides less certainty over the level of mitigation achieved.[2] To the extent that a carbon tax can be integrated into the existing fiscal infrastructure, it is considered to be administratively easier to implement than an ETS, which requires additional market infrastructure (Goulder & Parry, 2008). However, an ETS provides more versatility. Provisions such as offsets and banking give covered entities options for when and where to mitigate emissions. Finally, there is the ability to expand the ETS by linking it with other programs across boundaries. Cooperating on carbon taxes is possible, but more complex (Kreibich & Wang-Helmreich, 2017)

Tailor-made carbon pricing: The choice between an ETS and a carbon tax depends on the context and needs of a particular jurisdiction. These two instruments are not mutually exclusive. Several jurisdictions have complementary ETS and carbon taxes covering different sectors. As a first step towards creating an ETS, some have introduced a carbon tax. Over time, hybrid approaches have evolved that aim to combine the advantages of both instruments for a more effective and efficient outcome. For example, it is common for an ETS to also include price floors that provide certainty regarding the lower bound of the carbon price, as well as an overall emissions constraint (Acworth et al., 2020). Further, carbon taxes can be designed to adjust periodically based on an assessment of the mitigation achieved (Metcalf, 2017). Conversely, offsets can provide flexibility for covered entities under both a carbon tax and ETS and therefore offer a potential indirect link.

[2] See Weitzman (1998) on policy choice under uncertainty.

Regardless of its nature, carbon pricing is a crucial mechanism for governments to minimize the emissions in their jurisdictions cost-effectively, with various design options.

2.3 Global diffusion of carbon pricing

As of 2019, 46 countries and 35 subnational jurisdictions on five continents directly price carbon, covering over 12 $GtCO_2e$ and representing 22.3% of global GHG emissions (World bank, 2020a). There are 63 initiatives implemented, of which 33 are ETSs, and 30 are carbon taxes (Doda & Ortiz Rivera, 2020). Carbon prices range from less than USD 1/tCO_2e to USD 119/tCO_2e, with almost half of the regulated emissions priced below USD 10/tCO_2e (see Appendix 1) (World Bank, 2020b). The cumulative value of carbon pricing initiatives alone was USD 45 billion in 2019 (World Bank, 2020b). Systems work in a wide variety of jurisdictions, from mega-cities such as Tokyo, to US states and Canadian provinces, as well as in supranational jurisdictions such as the European Union (See Figure 1). The number of initiatives using carbon pricing has been increasing, going from 37 in 2015 to 63 in 2019 (Table 1).

Year	Carbon Markets	Carbon Tax	Carbon Pricing
2019	30	33	63
2018	23	24	47
2017	22	23	45
2016	22	20	42
2015	17	20	37

Table 1: Carbon pricing initiatives. Count by year.
(Source: Global Carbon Pricing Initiatives Database, ICAP.)

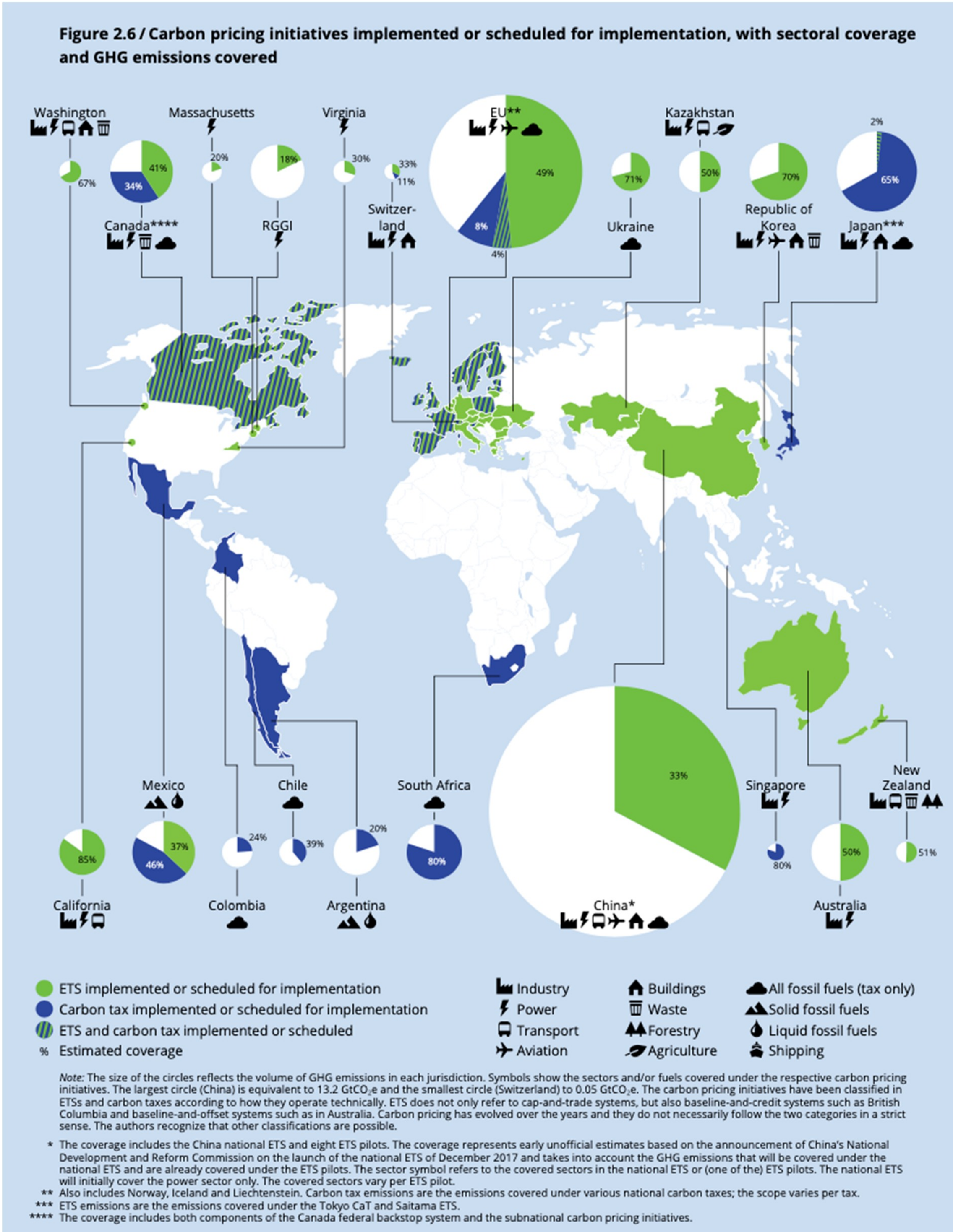

Figure 1: Carbon pricing initiatives implemented or scheduled for implementation, with sectoral coverage and GHG emissions covered
Source: World Bank

Each system implemented to date illustrates the flexibility of carbon pricing: Each program implemented to date reflects its own carbon pricing approach, with design characteristics varying depending on the different contexts. This means that the GHG and economic sectors covered vary between different initiatives (Figure 1). Carbon pricing instruments can be built to accommodate several political and economic conditions and go hand in hand with sustainable economic growth.

Carbon pricing is most common in the power and industrial sectors, although it has been implemented or is under consideration in all sectors (ICAP, 2021). Several jurisdictions have expanded the scope of their existing carbon pricing initiatives to include a higher number of facilities, sectors, and gases (World Bank, 2020b). Other modifications include the refinement of allocation methodologies and linkage with other jurisdictions with ETSs in place. Cooperation between jurisdictions, at all levels, continues to increase around the world (see Section 5.3).

New systems are emerging: Recently, Asia has become a hotspot for new ETS development. After Kazakhstan in 2013, Korea and China introduced their national ETSs in 2015 and 2021 respectively. The instrument is also under development or consideration in for example Thailand, Vietnam, Indonesia, and the Philippines. Elsewhere, interest in emissions trading has continued at the state level in the US, with New Jersey, Virginia, and possibly other states preparing to enter the RGGI market and others considering their own systems, such as Oregon. In Latin America, the start of the pilot phase of Mexico's ETS marked the beginning of emissions trading in the region (ICAP, 2021).

3 Experience with carbon pricing mechanisms in Germany and the EU

3.1 The EU ETS

In 1997, the Kyoto Protocol created, for the first time, legally binding goals for industrialized countries to reduce emissions (UNFCCC, 1997). After the Protocol was signed by all EU Member States, a period began aimed at exploring how to fulfill the commitment. The EU's job was to find an efficient way to set up a framework for enforcing the agreements signed on climate change and reducing GHG emissions. The European Commission published a green paper on GHG emissions trading within the EU in March 2000 with some initial thoughts on the European Union Emissions Trading System (EU ETS) design. This served as the basis for various stakeholder discussions, which helped form the basis of the EU ETS Directive and ultimately the start of the EU ETS in 2005 (European Parliament, 2018).[3]

The EU ETS is a central pillar of the EU's climate change strategy and a crucial mechanism for cost-effectively reducing GHG emissions from the regulated sectors. The system covers approximately 45% of emissions from energy, manufacturing, and intra-EEA aviation (flights within the European Economic Area). The EU ETS has been linked to the Swiss ETS since January

[3] The provisions of the EU ETS Directive have been kept under review and changed since then.

2020, the first such link for both parties. The revision of the system's architecture, completed in 2018, was introduced in January 2021 with the start of the fourth trading phase. The European Commission is currently proposing to update and likely extend the EU ETS's reach to achieve a climate-neutral EU by 2050 and the goal of a net reduction of at least 55% in GHG emissions by 2030.

The first phase of the EU ETS took place between 2005 and 2007 and was the pilot phase. This phase was primarily focused on data gathering, learning, and built the appropriate infrastructure for emissions monitoring, reporting, and verification (MRV).

The second phase ran from 2008 to 2012. This phase coincided with the first commitment period of the Kyoto Protocol, where emissions reduction goals had to be met by the Member States. Consistent with the flexibility provisions envisaged in the Kyoto Protocol, covered entities could draw upon a fixed number of units generated through the Joint Implementation (JI) mechanism as well as the Clean Development Mechanism (CDM), although in practice few credits were used. A major learning from the second phase surrounded allocation. Allowances were predominately granted free of charge, which resulted in large windfall profits to fossil fuel power generators that were able to pass on the opportunity cost of the allowances to electricity prices.

The third phase ran from 2013 to 2020, with several adjustments based on the lessons of the first two phases. These included:

- The creation, through a single Union Registry, of a centralized system;
- A single EU-wide emissions cap in place of the previous framework of national caps;
- Auctioning as the default method for allocating allowances;
- The inclusion of installations for carbon capture, transport, and storage. The production of petrochemicals, ammonia, nonferrous and ferrous metals, gypsum, aluminum, as well as nitric, adipic, and glyoxylic acid (various thresholds) was also included;
- The establishment of a carbon leakage list that enabled installations in sectors considered to be exposed to a risk of carbon leakage to obtain a higher proportion of the free allowances; and
- 300 million allowances set aside to support innovative renewable energy and carbon capture and storage (CCS) technologies through the NER 300 initiative.

While from an operational perspective, the EU ETS performed well in its third phase, from a mitigation perspective it was plagued by an oversupply of allowances that resulted from the economic crisis and the rapid inflow of credits. This surplus weighed heavily on the allowance price that remained low for much of the eight-year period. Hence, policy discussions focused on future reform options that would make the EU ETS more resilient to unforeseen exogenous shocks. Ultimately a Market Stability Reserve (MSR) was implemented in 2019 that automatically adjusts auction volumes based on a measure of allowance surplus.

The fourth phase of the EU ETS will run from 2021 until 2030. Phase IV aims to increase the pace of emission reductions, create better-targeted rules on carbon leakage, and finance low-carbon innovation and modernization of the energy sector. An additional reform to the system in Phase IV is also under development. As governments around the world aim to keep pace with the required emission reductions of the Paris Agreement, the European Commission is currently preparing a proposal for further adjustments to the EU ETS. Known as the "Fit for 55% Package" the European Commission is considering changes to the emissions cap and associated Linear Reduction Factor (LRF); sectoral scope; rules around carbon leakage; and the parameters of the MSR.

The EU Allowance (EUA) price has varied. As discussed above, Phase III saw a sustained period of low prices associated with an imbalance between allowances supply and demand. However, as the rules for Phase IV were adopted and the MSR began operation, prices have steadily risen.

Figure 2: EU ETS allowance price over time.
Source: ICAP Allowance Price Explorer

The EU ETS has proved to be a successful instrument for cost-effectively guiding emissions reduction. Between 2005 and 2019, emissions from installations regulated by the ETS declined by about 35% (European Commission, 2020). Higher allowance prices have converged with lower gas prices to ensure that the EU ETS has contributed significantly to fuel switching in recent years (Abrell et al., 2020; Marcu et al., 2019). Since 2009, the EU ETS has cumulatively raised over USD 80 billion (ICAP, 2020). These revenues have been funneled back into projects related to energy efficiency, renewable energies, low-carbon innovation, research into carbon storage and capture technologies, and GHG reduction programs. The EU ETS has also had a modest effect on investments and innovation (Lilliestam et al., 2021), although this mitigation lever is expected to play a stronger role with higher and more stable allowance prices in Phase IV. For an overview of key policy changes, see Annex 2.

3.2 The German Fuels ETS

In 2021, Germany launched its National Emissions Trading System (in German: Nationales Emissionshandelssystem, or nEHS) for heating and transportation fuels. This measure complements the EU ETS and forms a key part of Germany's 'Climate Action Programme 2030', which sets out the steps necessary to meet Germany's 2030 climate goals and achieve climate neutrality by 2050. The implementing legislation for the nEHS is the 'Fuel Emissions Trading Act' that was adopted in December 2019 and amended in November 2020. Combined with the EU ETS for the power, industry and aviation sectors, the nEHS ensures that most of Germany's emissions will face a carbon price from 2021 onwards (ICAP, 2021).

The nEHS will be phased in from 2021 to 2025, with an annually increasing fixed price per tCO_2. In 2026, a price corridor will apply, and in 2025, it will be determined if a price corridor will be introduced from 2027 onwards as well. Fuel coverage will also be gradually extended between 2021 and 2023.

The nEHS and the EU ETS have different approaches to reducing GHG emissions (DEHSt, 2020). The EU ETS requires emissions reporting and surrendering of allowances at the source where emissions are produced in installations such as power plants (downstream). The nEHS on the other hand covers emissions at a much earlier stage when the fuels enter the market and before they reach the plant (upstream). That means that the emissions that arise from the fuels' subsequent combustion are traced back to the distributor.

The nEHS includes all fuel distributors and suppliers and applies to all fuels used in the transport sector and for heat production (e.g., fuel oil, LPG, natural gas, coal, gasoline, and diesel). In general, biomass used as fuel in the transport sector and for heating purposes is also covered. However, biogenic fuel emissions that meet the sustainability requirements set out in the national regulations transposing the European Renewable Energy Directives 2029/28/EC and 2018/2001 are not subject to compliance obligations. In 2021 and 2022, the system will begin with a restricted scope, including fuel oil, LPG, natural gas, gasoline, and diesel. Other fuels such as coal will be covered from 2023 onwards.

The cap will be set annually based on a Cap Setting Regulation to be implemented in 2021. In essence, the cap will be calculated in line with Germany's reduction targets for non-EU ETS sectors as specified in the European Effort Sharing Regulation (ESR). However, if emissions and thus demand for allowances within the nEHS exceed its cap, additional allowances would be made available , drawing from the flexibility mechanisms provided for in the ESR, , including the transfer of additional emission reductions under sectors not covered by the nEHS to the system, or the acquisition of annual emission allocations from the other EU Member States. The flexibility described above leads to a flexible cap, which will be implemented during the fixed price phase and as long as a price cap is considered necessary. As soon as the fixed prices are lifted and price-setting is left to the market alone, the cap will be absolute.

All allowances will be sold between 2021 and 2025 for a fixed price that starts at EUR 25 per tCO_2 in 2021 and increases annually to EUR 55 per tCO_2 by 2025. The steady rise in the price of CO_2 strengthens the incentive to minimize or eradicate the combustion of fossil fuels over time. The price will not be paid by those who use the fuel and generate CO_2 emissions but rather by the fuel suppliers. However, it is anticipated that the suppliers will pass the carbon costs on to their customers so that, at the end of the supply chain, the consumers of the fuels will be paying for their emissions. Figure 4 provides an estimate for how fuel costs are expected to evolve. The auctioning of allowances begins in 2026, and there will be a price corridor with a minimum price of EUR 55 and a maximum price of EUR 65 per tCO_2. Based on a system review in 2025, it will be determined if a price corridor will continue to be implemented from 2027 onwards.

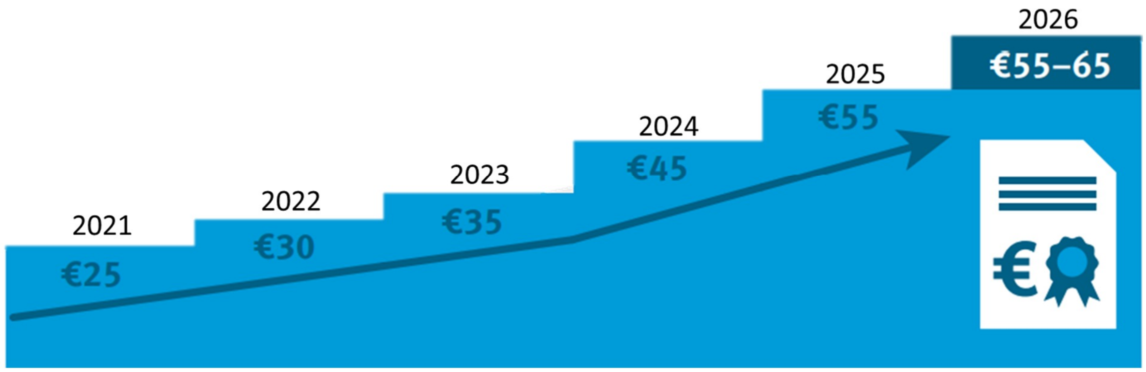

Figure 3: 2021-2026 Price trend
Source: DEHSt (2020)

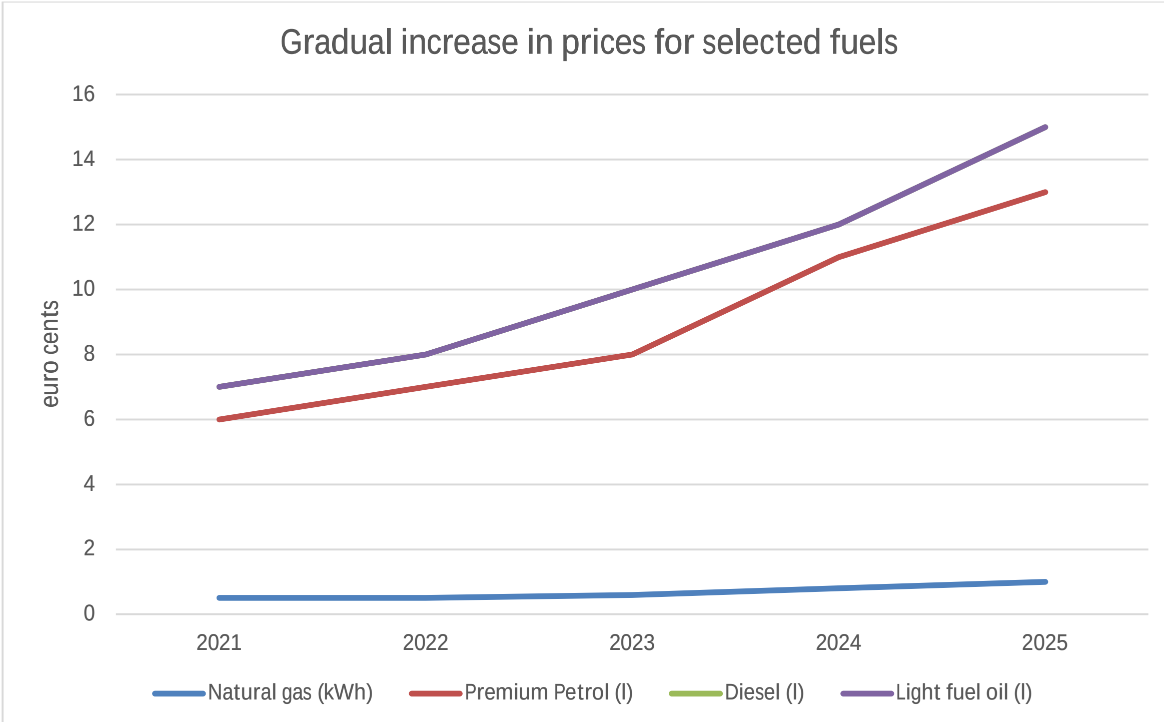

Figure 4: Gradual increase in prices for selected fuels
Source: DEHSt (2020)

To ensure the competitiveness of entities covered by the nEHS a financial compensation mechanism will be established to avoid the relocation of companies and their emissions abroad as a result of the additional fuel costs (carbon leakage). The mechanism will apply to companies from emissions-intensive and trade-exposed (EITE) sectors that operate internationally and will come into effect as early as 1 January 2021. Respective regulations will be released by mid-2021 and will have retroactive effect.

4 Experiences with carbon pricing mechanisms in Japan

4.1 National level: JVETS, JCM, and recent developments

Discussions on the introduction of carbon pricing mechanisms on a national level have been ongoing in Japan for more than ten years. The Ministry of the Environment, Japan (MoEJ) was the first authority to launch a national carbon pricing mechanism in 2005 (Voluntary Emission Trading Scheme (JVETS), see Section 4.1.1), with the aim to accumulate knowledge and experience in cap and trade. In his "Fukuda Vision" in 2008, former Prime Minister Takeo Fukuda mentioned the experimental introduction of an integrated domestic market for emissions trading, although this was not initially intended as a precursor to the future introduction of a mandatory ETS. He also gave the instruction to relevant ministries to proceed with concrete discussions on this matter (Nikkei Newspaper, 2019; The Japan Research Institute 2008). After the change of government, former Prime Minister Yukio Hatoyama declared in a speech at the 2009 UN Summit on Climate Change in New York that Japan would introduce a domestic emissions trading mechanism (Asahi Newspaper, 2009).

The Japan Business Federation *Keidanren* soon raised objections regarding the introduction of a mandatory ETS by pointing out that strengthening carbon pricing measures would lead to a depression of economic activities and a decrease in international competitiveness due to rising energy costs. Moreover, they insisted that private sector innovation – necessary for long-term climate mitigation – would be inhibited (Keidanren, 2019). *Keidanren* established its own Voluntary Action Plan, Plan in 1997, where each industrial sector sets its own reduction target (Keidanren, 2014). For small- and medium-sized enterprises (SMEs) not covered by the Action Plan, the government established a Domestic Credit Scheme in 2008. *Keidanren* also stated in 2012 that the government should support the Low-Carbon Society Implementation Plan by Industry and that it is necessary to accelerate negotiations with developing countries for bilateral offset mechanisms to promote overseas contributions through Japanese technology (Keidanren, 2014). Under pressure from these domestic voices, the MoEJ was not in the position to introduce a nation-wide mandatory ETS.

However, political framework conditions have changed since newly elected Prime Minister Yoshihide Suga pledged to bring Japan to net zero emissions by 2050 in his policy speech in October 2020 (Nikkei Asia, 2020); this breathed life into a debate that has lain relatively dormant for many years (see Section 4.1.3).

The steps and milestones regarding the development of a domestic ETS in Japan are outlined below and described in the following sections.

Apr 2005 - Mar 2013	Japan Voluntary Emission Trading Scheme (JVETS) introduced by MoEJ designed to gain experience in cap and trade and voluntary GHG reductions
Jan 2008	Advisory Committee on the Emissions Trading Scheme established by MoEJ - Published an interim report in May 2008, with discussion points and four scheme options for cap and trade
Jun 2008	Declaration of "Fukuda Vision"
Oct 2008	Experimental introduction of an integrated domestic market for emissions trading and Domestic Credit Scheme
Nov 2008	Offset Credits (J-VER), MoEJ - Verify emissions reductions and removals by SMEs, agriculture, and forestry as reliable credits for market transactions
Sep 2009	PM Hatoyama's Declaration at the UN Summit on Climate Change, New York
Mar 2010	Bill for the Basic Act on Climate Change Countermeasures (cabinet decision 12 Mar 2010, passed by the Lower House 18 May)

Apr - Dec 2010	Domestic Emission Trading Subcommittee, Central Environment Council - Based on the Bill for the Basic Act, contributing to the scheme design by analyzing various discussion points
Dec 2010	Discussion on three major policies (carbon tax, ETS and feed-in-tariff for renewable energy) to counter climate change, ministerial meeting on the issue of global warming - Request for careful consideration on emissions trading
Oct 2012	Introduction of Tax for Global Warming Countermeasures
2013	Launch of J-Credit scheme
2016	Japan's official General Plan for Global Warming Prevention released
2019	Long-Term Strategy under the Paris Agreement as growth strategy
Feb 2021	Working group for discussion on carbon pricing is planned to be established

Table 2: Progress of ETS related measures in Japan
(Source: ECOS based on MoEJ, April 2012, "Consideration of Emissions Trading Scheme in Japan" UNFCCC, 24 June 2019" Japan's current progress of GHG reduction" and MoEJ, 2012, "Details on the Carbon Tax")

4.1.1 JVETS

The Voluntary Emission Trading Scheme (JVETS) was introduced by the MoEJ in 2005 with the aim to accumulate knowledge and experience in cap and trade. The basic scheme and infrastructure were similar to the operational system of the ETS in the EU. The scheme was in operation from 2005 to 2013 for seven phases with 389 participating entities (MoEJ, 2014). The initial pledged estimated amount of CO_2 reductions was 1.25 Mt; final results of the program showed 2.22 Mt of reductions (MoEJ, 2014).

The JVETS provided valuable learnings with regards to MRV. A lack of clear guidance in the initial phase resulted in a diversity of procedures and calculation methods across installations and verifiers, which created some confusion. To address this, the MoEJ released a guideline for monitoring and reporting in the second phase. In the third phase, the verification line was revised in accordance with ISO 14064-3, an international standard for validation and verification (MoEJ, 2014).

For promoting further emissions reduction, the MoEJ additionally established the J-VER Scheme in 2008, a verification scheme for credits generated through GHG reductions carried out by domestic projects. Participants in the JVETS constituted a part of Experimental Integrated ETS which began in 2008 (MoEJ, 2011; see Section 4.1).

In 2013, the J-Credit scheme was created by integrating the Domestic Credit Scheme and the J-VER. Under this scheme, the central government certifies the amount of GHG reductions by energy-saving devices and managing forests, as credit. The scheme is still running today with 832 projects in total (J-Credit, 2020). The benefits of the scheme include not only achieving CO_2 emission reductions and energy savings, but also saving running costs and making profit from selling credits. Being able to signal sustainability is another attractive aspect for businesses. For large-scale enterprises that consume more energy and emit more CO_2 in general, the scheme can be used to achieve Voluntary Action Plan targets by reporting adjusted emission amounts. There is no limitation for project participants under the J-Credit scheme (J-Credit, 2020).

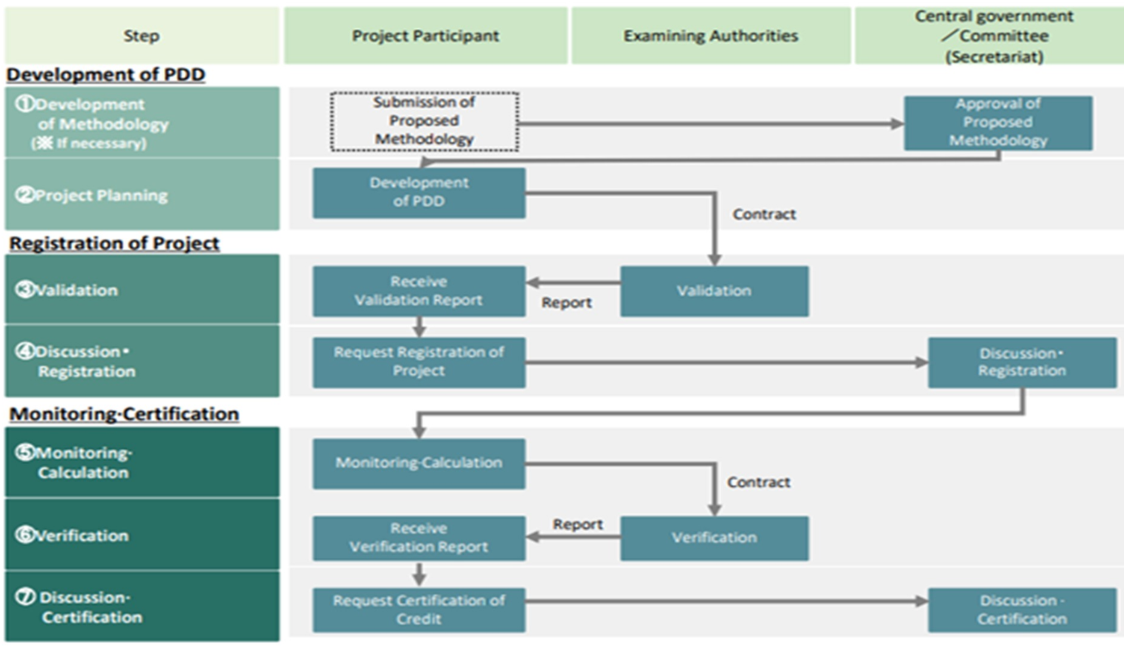

Figure 5: Process of J-Credit
(Source: J-Credit Scheme, June 2020 "Outline of J-Credit Scheme": https://japancredit.go.jp/english/)

4.1.2 Joint Crediting Mechanism (JCM)

To contribute to the sustainable development of developing countries, the Japanese government set up the Joint Crediting Mechanism (JCM) in 2011. The JCM implements mitigation actions in developing countries to help achieve Japan's own targets. A Joint Committee consisting of representatives of both the Japanese and the implementing country's governments develops rules and guidelines necessary for the implementation of the scheme, approves the proposed methodologies, and designates third-party entities (TPE) (Government of Japan, 2019). The Committee then decides on whether to register JCM projects validated by the TPEs. Based on notification for issuance of credits by the Joint Committee, each government issues the notified number of credits to its registry.

Partnership documents have been signed with 17 countries, including countries in Asia, Africa, Small Island Developing States (SIDS), Latin America and the Middle East (Ministry of Foreign Affairs, 2019). As of December 2020, 174 projects with those countries are in operation (MoEJ, 2020). The estimated emission reductions by 2030 through JCM programs range from 50 to 100 Mt CO_2 (Government of Japan, 2019).

Funding for the JCM is currently provided mostly by the Japanese government. Each partner country develops its own methodology, and this complicated system can hinder the active participation and efforts on business development of private entities in this scheme. The long-term prospect of the scheme is also uncertain.

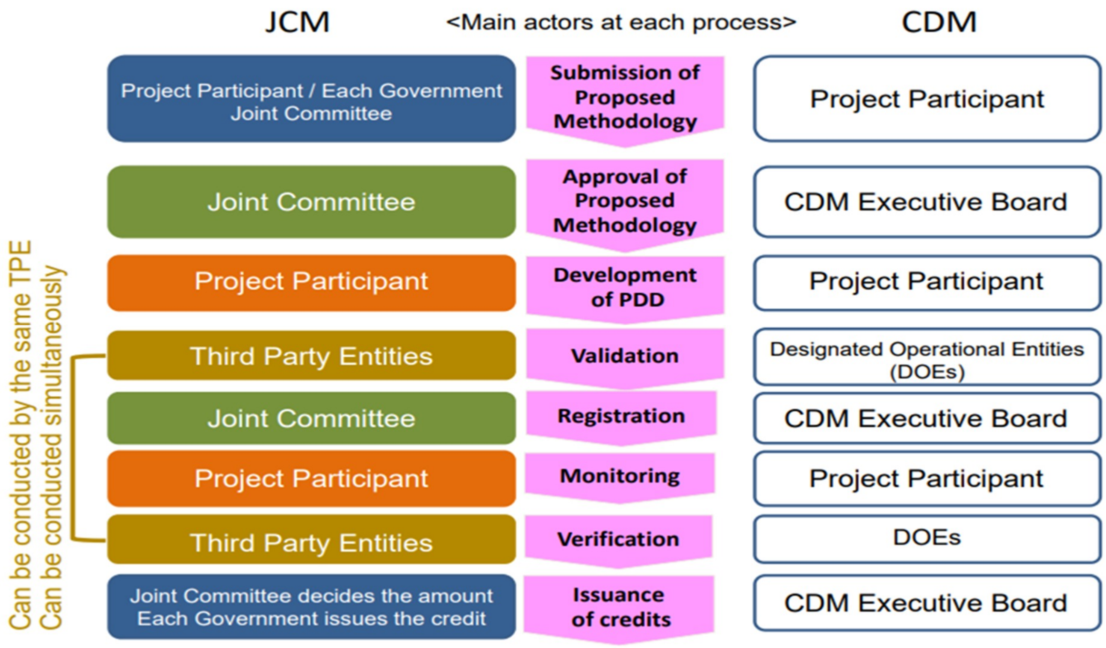

Figure 6: JCM Procedures
(Source: The Joint Crediting Mechanism, 2021, "Overview of the Joint Crediting Mechanism": http://gec.jp/jcm/about/)

4.1.3 Tax for Global Warming Countermeasures

A tax for Global Warming Countermeasures was implemented gradually in Japan from October 2012 and reached the originally planned tax rate in April 2016. It covers the use of all the fossil fuels such as oil, natural gas, and coal. The tax rate per unit quantity (kL or tonne) is set in order that the tax burden is equal to JPY 289 (USD 2.75) per tCO_2 emissions and added above to the petroleum and coal tax. Compared with other countries, the rate is still very low. Revenues from this tax are channeled to renewable energy, low-carbon technologies, and energy-saving measures and equipment. In 2021, working groups on carbon pricing will continue discussions on the future shape of this tax (Government of Japan, 2021; World Bank, 2020).

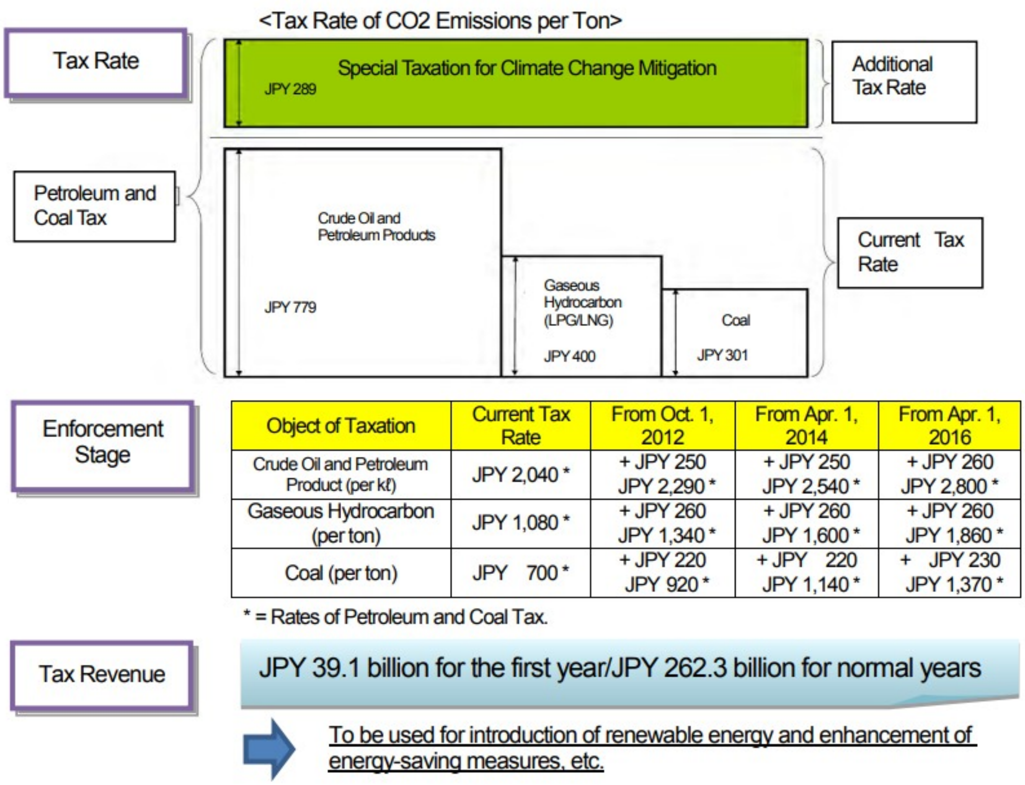

Figure 7: Tax for Climate Change Mitigation (Source: MoEJ, 2012, "Details on the Carbon Tax": https://www.env.go.jp/en/policy/tax/env-tax/20121001a_dct.pdf)

4.1.4 Recent developments

Some momentum has come into the discussion on a nation-wide carbon pricing policy after Prime Minister Suga announced a 2050 net zero pledge in October 2020. Already in December 2020, Prime Minister Suga instructed the Ministry of Environment, Trade and Industry (METI) and the MoEJ to begin coordinating on carbon pricing. METI has announced that it is now starting the process for the potential introduction of carbon pricing (Nikkei Newspaper, 2021). A related working group is planned to be established in mid-February 2021; MoEJ will join as observer. It is expected that various political options including a carbon tax or ETS will be discussed here.

In the beginning of February 2021, the MoEJ resumed a talk on carbon pricing with experts after a one-and-a- half year hiatus (NHK, 2020). The panel discussed the characteristics and problems of establishing an ETS and hopes to conclude its opinions by end of the year. The chairperson of Keidanren also showed his intention to discuss the issue positively and will consider and propose a "realistic" plan (NHK, 2021).

4.2 Subnational level: Tokyo and Saitama

4.2.1 Tokyo Metropolitan Government

Almost 14 million people (as of November 2020) are living (TMG, 2020) in the capital city of Japan, and it generates approximately one fifth of Japan's GDP. The metropolis emitted 63.9 Mt CO_2 in 2018, which is approximately 5% of Japans total GHGs (TMG, 2020). In 2008, the Tokyo Metropolitan Government (TMG) announced the new Environmental Master Plan, which includes the goal of reducing emissions by 25% compared to 2000 by 2020 (TMG, 2008). The revised regulations for the enforcement of the Tokyo Metropolitan Environmental Security Ordinance in March 2020 include a decision on the cap for the third compliance period (FY2020-FY2024) of the Tokyo Cap-and-Trade Program and set the more ambitious goal to reduce energy consumption by 38% and GHG reduction by 30% in 2030 (TMG, 2020).

Against this backdrop, Japan's first subnational mandatory ETS was launched by the Tokyo Metropolitan Government in 2010, following related government measures as outlined below.

2000	Launch of the Carbon Emissions Reduction Programme
2002	Launch of Green Building Programme
2005	Revision of the Carbon Emissions Reduction Programme and launch of Phase II
2006	Announcement of GHG emission reduction target of 25% by 2020 relative to 2000 levels
2007	Approval of Tokyo Climate Change Strategy and Tokyo Metropolitan Environmental Master Plan
2008	Tokyo Metropolitan Environment Security Ordinance amended to officially establish the Tokyo ETS
2010	Official launch of Tokyo ETS

Table 3: Brief history of ETS development by the Tokyo Metropolitan Government
(Source: CDC Climate Research, EDF and IETA, May 2015, "Tokyo The World's Carbon Markets: A Case Study Guide to Emissions Trading": http://www.edf.org/sites/default/files/tokyo-case-study-may2015

The Tokyo ETS covers large-scale facilities from the industrial and commercial sectors that consume fuel and heating equivalent to at least 1,500kL per year. These accounts for almost 40% of the total emissions of the city. The first compliance period ran from 2010 to 2014, and the second from 2015 to 2019 (TMG, 2010). In FY2018, emissions from participating facilities amounted to 12.11 Mt CO_2, achieving a 27% reduction from baseline emissions (16.5 Mt).

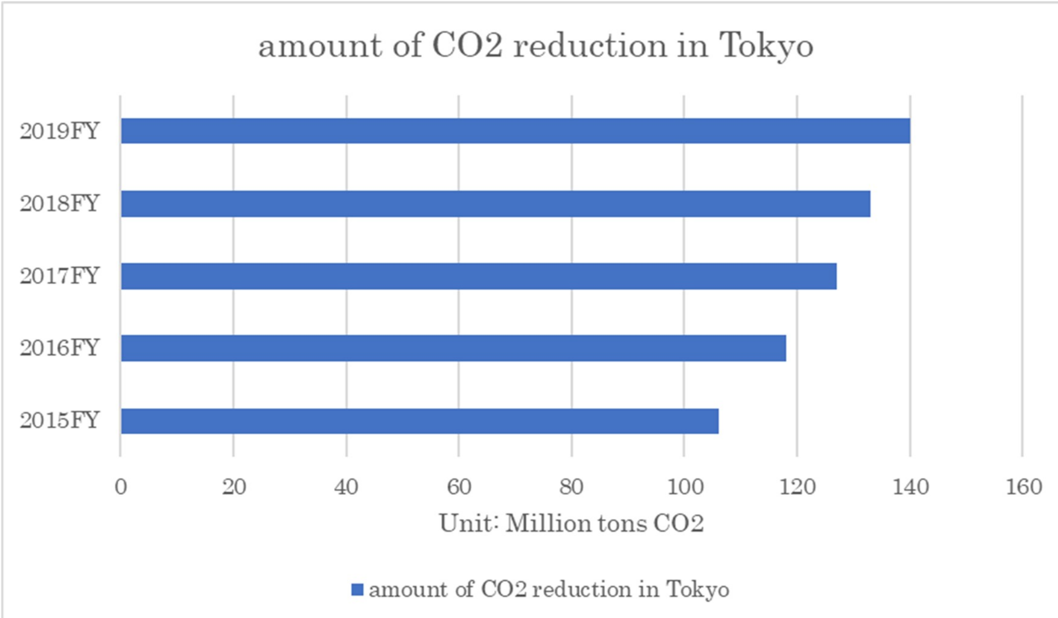

Figure 8: Amount of CO_2 reduction from 2015FY to 2019FY
(Source: Based on TMG press release on 26. March 2020, "Tokyo Cap and Trade, the result of the fourth year of the second phase":
https://www.kankyo.metro.tokyo.lg.jp/climate/large_scale/data/index.files/CapandTrade2018result_J.pdf)

When the Tokyo ETS was first introduced, it was met with opposition from several industries. 15 industry federations including *Keidanren* submitted a request document to the TMG, in which five problems were listed as serious concerns: 1) the regulatory measure was too strong, 2) it prevented competition between companies, 3) it went against national and global climate policy, 4) it hindered innovation, and 5) it inhibited the vitality of the city (REI, 2017). Keidanren stated in a public comment in 2018 that (Keidanren, 2018):

- The Tokyo ETS creates a managerial burden on businesses and large-scale office owners;
- Despite the work of the "Study Group on Specialized Matters for Implementation of Reduction Obligations", it is unlikely that a system was in place that could fully reflect the opinions of the participating businesses; and
- The opinions of the participating businesses should be taken into consideration as much as possible in the making of important decisions regarding the ETS.

Despite the concerns of the industry, Tokyo's economy has grown continuously after the introduction of the ETS. According to a survey for participating entities, more than 70% were willing to install high performance equipment. Moreover, 7% of entities were nominated as "top-level facilities", a label awarded to facilities (including buildings and factories) with high energy-saving performance (TMG, 2015).

4.2.2 Saitama Prefecture

Saitama Prefecture began its efforts on climate policy with the 'Eco-Up System' in 2002: the prefecture grants certification to business entities contributing voluntarily to emission reductions. The targeted group includes private enterprises consuming more than 1,500kL energy equivalent and with an area exceeding 10,000m^2. In this scheme, however, the compliance deadlines as well as the targeted reduction amounts are decided by the entities themselves. Therefore, participating entities accounted only for one quarter of the total emissions in the prefecture (Hamamoto, 2020). Against this backdrop, Saitama's ETS was established in April 2011 as part of the 'Saitama Prefecture Global Warming Strategy Promotion Ordinance', consisting of three compliance periods (FY2011-FY2014, FY2015-FY2019, and FY2020-FY2024).

Based on the amount of 42.96 Mt CO_2 emissions in FY2005, the prefecture aimed to reach a total CO_2 reduction of 21% by 2020. Under the ETS, large buildings and factories in Saitama were required to reduce emissions by 15% or 13% in its second compliance period as compared to the baseline.[4] Tokyo and Saitama have since signed a linking agreement, allowing credits to be traded across the systems of the two jurisdictions.

In FY2018, the Saitama ETS achieved a reduction of 29% below base-year emissions (Nikkei Newspaper, 2020) of large facilities. In August 2019, the prefecture announced targets for the third compliance period (FY2020-FY2024), which requires facilities to reduce emissions by 22% or 20% depending on their category (ICAP, 2020).

5 Current carbon pricing debates

5.1 Industrial decarbonization

The industrial sector makes up a large share of many economies around the world and emits significant amounts of GHGs. In 2016, the production of basic materials alone made up approximately 22% of total global CO_2 emissions (Bataille, 2019). Unless the sector can decarbonize swiftly and significantly, achieving targets of net zero or the 1.5-2 degrees of the Paris Agreement by 2050 will be difficult.

The industrial sector has been included in the EU ETS since its inception but has seen fewer reductions in emissions intensity compared to the power sector (Neuhoff et al., 2018; Le Quere et al., 2018; Marcu et al., 2019; Marcu et al., 2020). There are numerous challenges when it comes to industrial decarbonization. Growing global demand stands in contrast to the higher costs of abatement of basic materials (such as iron and steel, cement, ammonia, and plastics), carbon leakage concerns, and a lack of attention and funding directed to R&D strategies (IEA,

[4] Basic level is calculated from average emission of three consecutive years from FY2002 to FY2007. For new participants, average rate from 4 FY in advance to the last FY before the beginning of the program or calculating rate by using emission standard intensity.

2019). Moreover, abatement options are limited compared to other sectors, given the very high heat requirements for the production of basic materials; the large amount of process emissions that result from the chemical transformations that take place when raw minerals are converted to materials; and the emissions that are embedded within the materials themselves (Material Economics, 2019). These factors, among others, have resulted in less decarbonization progress than in other sectors.

Deep decarbonization in the industrial sectors will require pushes from both the supply and demand side. Opportunities for mitigation include, for supply: fuel switching, increased efficiency, and technological innovation in production; and for demand: substitution to low-carbon materials and products as well as improved product design (Acworth et al., 2020; Neuhoff et al., 2018; Material Economics, 2018; ETC, 2018). Carbon pricing in the industrial sectors can function across the aforementioned levers: changing production and consumption behaviors and spurring innovation and investment, channeling these into less carbon-intensive alternatives.

However, many industrial sectors are emissions-intensive and trade-exposed (EITE). A carbon price increases the cost of production for firms. Limited abatement options for many sectors combine with the inability to pass costs down the value chain to consumers due to risks of a loss of competitiveness, as producers in regions without a carbon pricing policy in place continue operation without these increased costs (Berger, 2008). This results in the risk of carbon leakage or deindustrialization, whereby EITE firms may choose to shift production and investment outside of the covered jurisdiction to keep costs down or lose market share domestically to competitors that face fewer constraints on emissions (Arlinghaus, 2015).

Currently, the free allocation of allowances is one approach to leakage protection being used by many ETSs around the world (ICAP, 2020). Sectors assessed as being EITE can be eligible for free allocation, which is useful in protecting their competitiveness but limits incentives for mitigation beyond incremental production efficiency (e.g., through the use of benchmarks). However, as ETSs become more ambitious on the pathway to net zero, with declining allowance caps and greater auctioning, allowances available to be handed out for free will also decline, especially in systems with narrower sectoral scopes (Acworth et al., 2020). EITE sectors will face increasing carbon costs and leakage risk unless their mitigation keeps pace with the phase-out of free allocation (ibid).

Various reforms and companion policies are currently under discussion to ensure carbon pricing can drive deep industrial decarbonization. The first of these, of particular prominence in the EU context, are carbon border adjustment mechanisms (CBAM). To level the playing field between firms covered by a carbon price and competitors operating from beyond the borders of the covered jurisdiction, tariffs or other fiscal measures can be applied to imported goods based on their embedded GHG emissions (Mehling et al., 2017). Similarly, rebates can be applied to domestic exports headed to markets without a comparably stringent carbon price. Talks on CBAM, however, suffer several obstacles. Legal questions of compatibility with World Trade Organization rules; administrative feasibility such as the availability of and access to emissions data especially from trade partners; and political sensitivities all play a role in the current debate (Marcu et al., 2020).

Another lever through which carbon pricing can spur decarbonization is innovation, whereby the carbon price serves as a financial incentive to invest in the development and deployment of less carbon-intensive industrial products and processes to replace currently high-emitting goods and practices. However, as outlined in Section 1, without a sufficiently high level and stable forward trajectory, carbon pricing alone cannot be the only driver of industrial innovation. Innovation itself suffers from multiple market failures, including the spillover effects from when positive externalities from technological advances are not included in the rewards for eco-innovators, leading to under-investment in R&D. Underinvestment in deployment may arise due to high capital costs, limited demand for low-carbon industrial goods, uncertain carbon price trajectories, and the lock-in of incumbent technologies. These challenges must therefore be addressed by a comprehensive package of companion policies (Neuhoff et al., 2017; Chiappinelli et al., 2018).

Dedicated funding programs are one such policy that work in tandem with carbon pricing (Fischer et al., 2014). Under the EU Innovation Fund, for example, revenues from the EU ETS are funneled directly back into piloting innovative technologies, with the aim to bring low-carbon industrial solutions to a stage of readiness for deployment. Other instruments include subsidies for abatement technologies either via direct transfers or expenditure refunding to compensate companies' costs as they work to mitigate emissions. Carbon contracts for difference (CCfD) are another supporting policy that can help to alleviate the risk that innovative technologies become unprofitable in the future due to low carbon prices (Richstein, 2017). In essence, these are contracts between a government and a firm developing a low-carbon project. Carbon costs are guaranteed for the duration of the contract and are based on a reference price, such as the allowance price. If the reference price is lower than the agreed contract price, the difference is paid by the government, and vice versa. CCfDs stabilize future cost-saving environments, can create lead markets for low-carbon processes and materials, and help bridge the gap between R&D/piloting and deployment and commercialization.

5.2 Electricity sector decarbonization

Experience with carbon pricing to date demonstrates that it can be a powerful tool to decarbonize competitive electricity sectors. By including the cost of GHG emissions into the variable costs of electricity production, a carbon price has a number affects. First, it encourages fossil fuel-based electricity producers to increase their efficiency or switch to low carbon generation technologies. Second, it makes high carbon generation less competitive in wholesale markets, meaning they operate less and earn lower margins. The opposite is true for low carbon generators that enjoy a higher market share and increased margins. Finally, allowance costs are reflected in electricity prices paid by consumers, encouraging them to conserve electricity through energy efficiency investments and behavioral change (Acworth et al., 2019).

CO_2 emissions from the European power sector have decreased by an estimated 36.6% since 2005, driving down the carbon intensity of power production by 35% (Marcu et al., 2020). The decrease in the sector's verified emissions in recent years results from significant improvements in the fuel mix (EEA, 2020b). The EU-28[5] production of electricity from hard coal, lignite, and nuclear power decreased by 47%, 15%, and 17%, respectively, between 2005 and 2018 (Figure 11). These decreases in electricity production were accommodated by an increase over the same period in the gross generation of electricity from renewables such as wind, solar, and biomass.

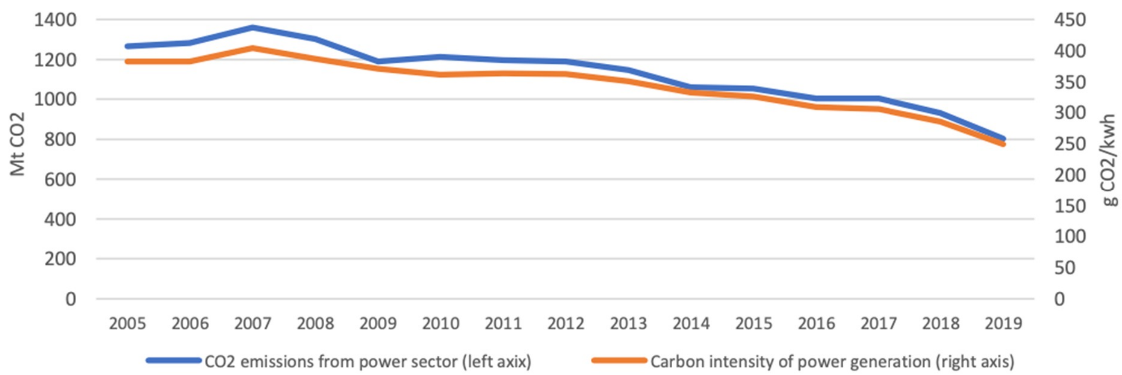

Figure 9. CO2 emissions from the power sector and carbon intensity of power generation (2005-2019)
Source: Marcu et al. (2020); ERCST and BloombergNEF, data from Eurostat (2020) and EUTL (2020)

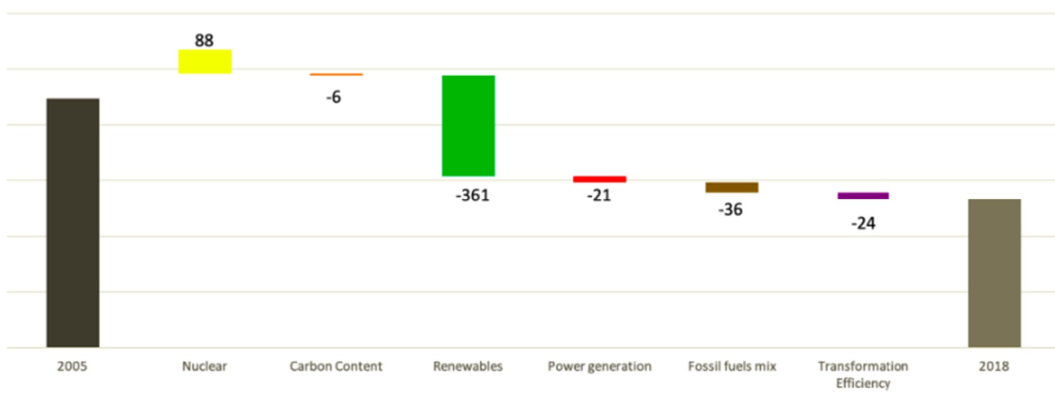

Figure 10: Drivers of GHG emissions variations in the power sector in the EU (2005-2018)
Source: Marcu et al. (2020); I4CE, data from Eurostat (2020)

There is little doubt the EU ETS has contributed to declining emissions from the European power sector. However, given the complex interaction of supporting policies such as support for renewable energy through the Renewable Energy Directive and national coal phase out policies, the precise effect is difficult to assess. Quantitative analysis of the contribution of the various factors to the variance in energy sector emissions reveals that the introduction of renewable

[5] Now EU-27 after the departure of the UK from the EU post-Brexit in 2020.

energy sources was the most significant factor in reducing CO_2 emissions from the power sector over the period 2005-2018, equivalent to a 361 Mt reduction in CO_2 emissions (Marcu et al., 2020). That said, with increasing allowance prices and favorable gas prices, the EU ETS is also becoming an increasingly important factor in driving fuel switching from coal to gas. Examining the German and UK contexts, Gugler et al. (2021) show that in the power sector, even a modest carbon price can trigger substantial abatement at low cost so long as gas plants are available as an alternative to coal. Their study also points to the greater impact of carbon pricing on inducing abatement as compared to subsidizing wind or solar (ibid).

The EU ETS is also considered to have played a key role in the decarbonization of the UK power sector, where since 2013 the allowance price has been supported by a top up fee that guarantees a minimum carbon price for UK power generators (ICAP & PMR, 2020).[6] The resulting carbon price was identified as the main driver for the shift in generation away from coal, reducing its share in UK electricity generation from about 35% in 2013 to about 5% in 2018 (DUKES, 2019).

EU ETS and power sector companion policies

The degree to which the reduction in emissions and the decrease in carbon intensity have been induced by the EU ETS, by improvements in output and investment levels, or by other policies' incentives is uncertain (Marcu et al., 2020). Indeed, there are other initiatives, some directly aimed at reducing GHG emissions, others aimed at achieving other objectives (such as the implementation of renewable energy sources and energy efficiency improvements) that can contribute to emission reductions in the EU ETS sectors. National policies may also influence the functioning of the EU ETS at the level of the Member States. Figure 11 provides an overview of EU-level policies that influence the functioning of the EU ETS.

[6] The price floor was reached through the introduction of a Carbon Price Support (CPS). The CPS is an additional carbon tax levied on all companies that use gas (supplied by a gas utility), LPG or coal, and other solid fossil fuels to produce electricity. Instead of functioning as a reserve price at auction, the CPS is paid on top of EU ETS allowance rates to ensure that the carbon price hits the minimum national target. The CPS shall be paid by organizations for each emissions unit and added to any allowance costs. When allowances are surrendered, the obligation to pay the CPS applies.

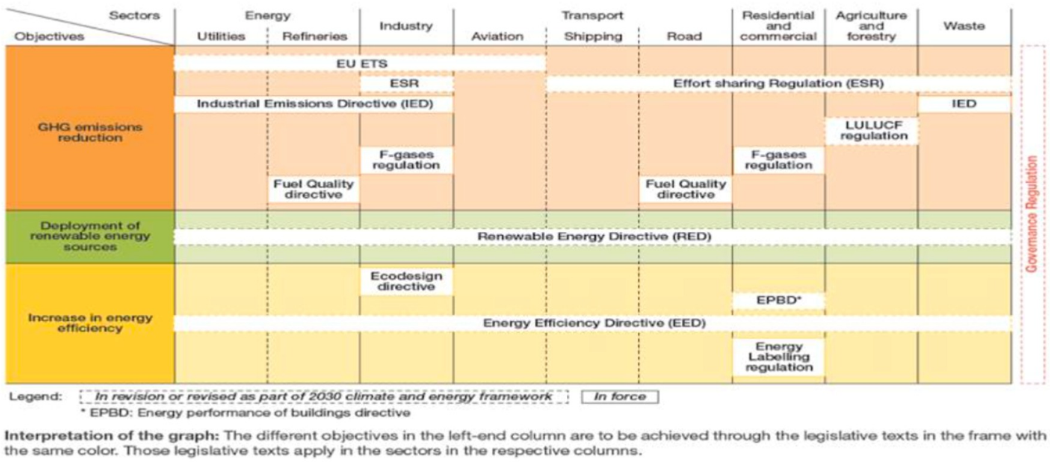

Figure 11: Landscape of climate and energy policies
Source: Marcu et al. (2020); I4CE and Enerdata (2018) based on a visual concept of Ecologic

Given the uncertain impact of companion policies on emission levels and therefore the market for allowances, it is now common place for ETSs to include measures for market stability that automatically adjust the market in response to quantity or price triggers (PMR & ICAP, 2020). As discussed above, since 2019 a MSR has been operating in the EU ETS. Other systems notable in North America have opted for a reserve price at auction (Acworth et al. 2019). The design and function of the MSR considering coal phase out policies and broader European climate objectives as set out in the European Green Deal are to be an important aspect of the upcoming reforms.

Emerging challenges

Renewable energies are transforming the economics of the power industry (Egenhofer & Gazzoletti, 2019). Electrification is recognized as a least-cost decarbonization option. The low-carbon transition will begin to expand deeper into the mobility, energy-intensive, and gas markets. This will require reliable and inexpensive low-carbon electricity at huge volumes. It is estimated that around 65-70% of electricity generation, from renewables and nuclear combined, will have zero marginal costs by 2030 (Egenhofer & Gazzoletti, 2019). The EU will draw on its 2020 strategy achievements, but there will be new and more significant obstacles in the period from 2020 to 2030.

There are growing concerns that the electricity market architecture will not reward the required flexibility to operate a system with large shares of variable renewable energy (VRE) or sufficiently remunerate investments where prices are likely to remain low for prolonged periods of time (Egenhofer & Gazzoletti, 2019). With regard to the role of carbon pricing, even with increasing allowances prices, the impact on electricity prices will be muted when zero carbon generators are setting the marginal cost of electricity. To deliver a safe, low-carbon generation mix at reasonable cost, it is crucial to ensure efficient investment market signals (Egenhofer & Gazzoletti, 2019). Reforms that seek to reward flexible electricity supply, harness the responsiveness of demand, and send long term remuneration signals, will likely be discussed in the coming years. This could require new thinking surrounding what role the carbon price will play in continuing the push towards a net zero electricity system.

Finally, the diffusion of carbon pricing into regions outside of Europe that operate with various types of market structure and regulations will face different opportunities and challenges. The structure of the electricity system in terms of the power mix, availability and cost of renewables and the age and ownership of the existing fossil based assets will impact the role of a carbon price in the low carbon transition (Acworth et al., 2019).

5.3 Cooperation and linking

The effects of climate change are not demarcated by jurisdictional borders; neither do carbon pricing instruments have to be constrained in this way. By cooperating internationally, jurisdictions can work towards harmonizing carbon prices thereby reducing the risk of carbon leakage and allow for greater climate ambition (Haug et al., 2015).

A key advantage of ETSs is that they can be linked to form larger, more liquid carbon markets. Under linked systems, covered entities in one system have the option to use allowances from the other ETS to meet their compliance obligations, and to trade across the two (or more) (ICAP, 2018). Linking can take various shapes, as shown in Figure 12 below. Unilateral linking allows covered entities in System A to buy allowances from System B, but not vice versa. Bilateral linking allows the two-way flow of allowances. Indirect linking can occur via other market mechanisms if two systems are both linked to, for example, the CDM, but not each other (ibid).

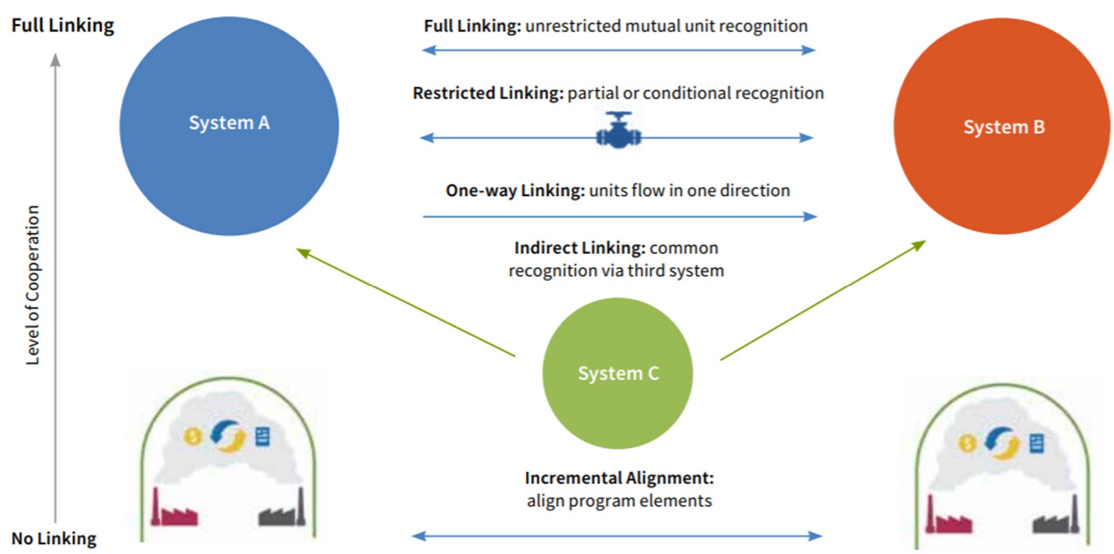

Figure 12: Different types of linking
Source: ICAP (2018)

Although there are of course challenges involved when establishing a link between systems, such as ensuring the compatibility of ETS design features and policymaker sensitivities regarding the sovereignty of managing a joint market (Green et al., 2014), cooperation in this way has many benefits. Linking increases access to more and potentially cheaper emissions reduction options, making room for more cost-effective and greater climate ambition (Edenhofer et al., 2007). Linking also reduces concerns of competitiveness (Burtraw et al., 2013). As prices in linked systems converge, covered entities are all subject to the same carbon price. Furthermore, linking increases the number of market participants, improving trading efficiency and making the market more resilient to external shocks (Flachsland et al., 2009). Finally, linking is a concrete example of international cooperation and is an opportunity for jurisdictions to exercise climate diplomacy and leadership (ICAP, 2018).

In Japan, the Tokyo Cap-and-Trade Program has been linked to the Saitama Prefecture ETS since 2011. Other prominent examples of linkages around the world include California and Quebec (since 2014), Switzerland and the EU (since 2020), and the currently eleven states that make up the Regional Greenhouse Gas Initiative (RGGI) in the US (since 2008).

Cooperation is also possible in the context of a carbon tax. Unlike when ETSs are linked with each other and carbon prices converge through a market alone, connecting a fixed price carbon tax with a flexible price ETS requires political coordination (Haug et al., 2015). This kind of linking can take several forms: jurisdictions can exchange units directly, indirectly via offsets, one-way, or two-way (Bodansky et al., 2014; Metcalf & Weißbach, 2010). For instance, tradable units can be incorporated into a carbon tax design, where entities can pay above their compliance obligation and receive carbon tax credits in return. These could then be traded within the tax regime or across system boundaries, such as with an ETS (although quantitative limits may have to be imposed to safeguard the system's emissions cap), or across borders (Haug et al., 2015). Ultimately, linking between carbon taxes or across heterogeneous carbon pricing instruments requires sustained political engagement in order to achieve comparable carbon prices (ibid).

6 Conclusions

Given Japan's emissions profile, recently announced net zero targets, and economic and political standing on the world stage, climate ambition and reducing emissions are matters of increasingly high priority. In this regard, carbon pricing has proven to be an effective tool in steering cost-optimal decarbonization pathways in Europe. By pricing emissions and aligning profits with low carbon production, investments and consumption, a well-designed carbon price can significantly contribute to Japan's net zero goal. However, carbon pricing alone cannot drive deep decarbonization across the board. Cumulative experience from around the world suggests that a price on carbon must be embedded in a longer term, low-carbon policy framework in order to successfully achieve its purpose of mitigation. In particular, Europe and Germany's experience provides excellent lessons on the crucial influence of the energy and industrial sectors on their emissions and, therefore, the importance of understanding and designing carbon pricing policies that take the characteristics of these sectors and national contexts into account.

In the Japanese context, whether for the industrial, energy, or other sectors, carbon pricing must therefore also be coupled with broader companion policies that support research and development, bridge the gaps between innovation and deployment, and encourage investment in less carbon-intensive alternatives. As climate ambition around the world ramps up and questions of carbon leakage and competitiveness continue to arise, talks on CBAM are also progressing. As part of the EU, Germany is squarely in the debate. CBAM is quickly gaining momentum on Japan's agenda too.

These in particular are areas where Germany and Japan can greatly benefit from shared experience. By fostering a continued and symbiotic dialogue on carbon pricing and broader climate policy, Germany and Japan are presented the opportunity to increase their ambition and demonstrate that international cooperation on climate action is greater than the sum of its parts.

Appendix

Appendix 1: The EU ETS at a glance

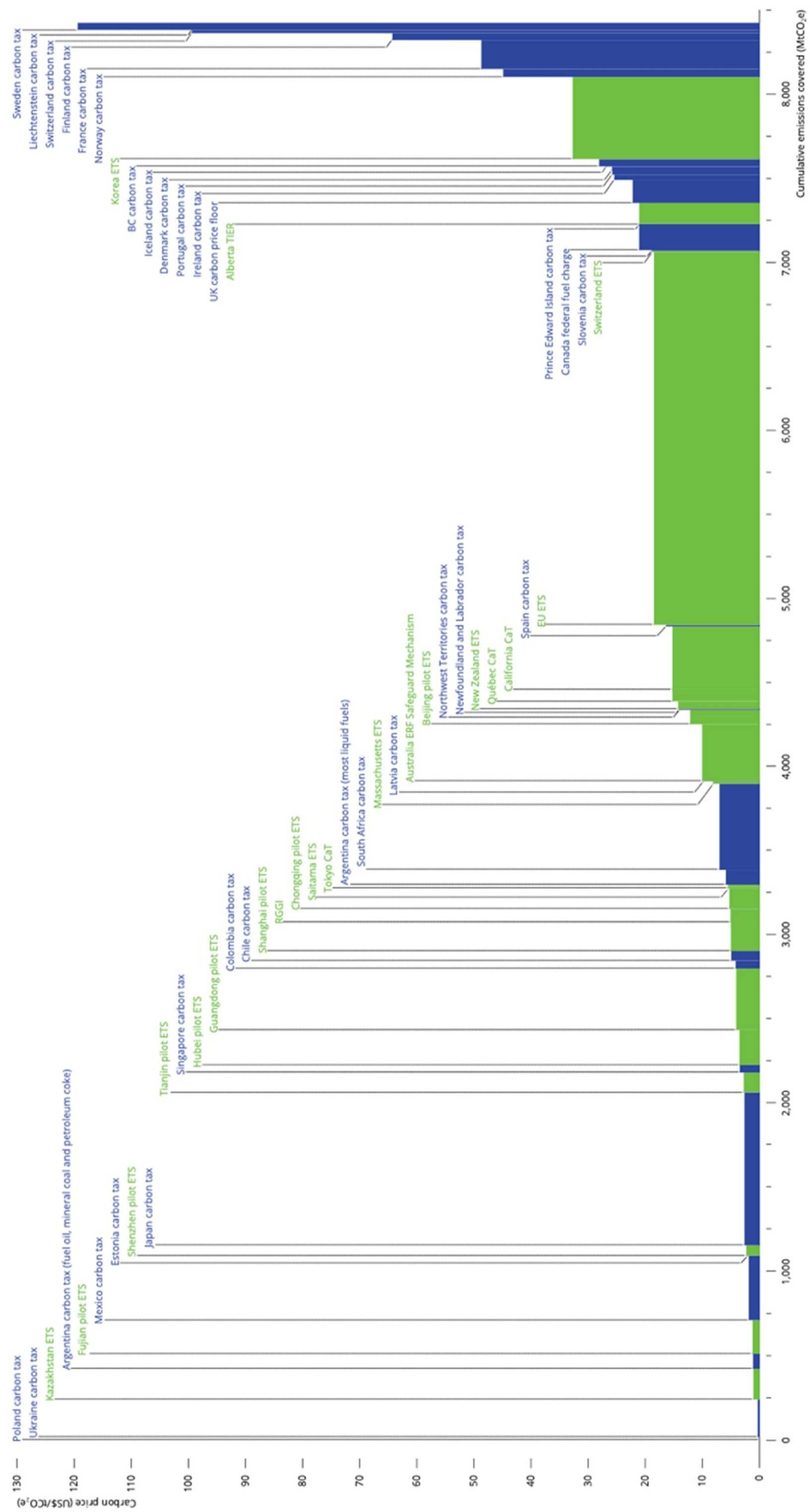

Figure: Carbon price and emissions coverage of implemented carbon pricing initiatives
Source: World Bank

Appendix 2: The EU ETS at a glance

The EU ETS at a Glance	
Jurisdictions:	Member states: 28 EU Member States and three European Economic Area-European Free Trade Association (EEA-EFTA) states: Iceland, Liechtenstein, and Norway
Overall GHG emissions (excluding LULUCF)	4391.9 $MtCO_2e$ in 2018 (3893.1 $MtCO_2e$ excluding the UK)
Overall GHG emissions by sector	Energy 2907.1 $MtCO_2e$; Industrial processes 343.5 $MtCO_2e$; Agriculture 394.4 $MtCO_2e$; Waste 117.2 $MtCO_2e$
GHG covered	CO_2, N_2O, PFCs
Sectors covered and thresholds	Phase I: Power generation and other combustion plants and industrial facilities (oil refineries, coke ovens, iron and steel plants and facilities producing cement, glass, lime, blocks, ceramics, pulp, paper, and cardboard). Phase II: Sectors covered during Phase I, plus intra-European flights (since 2012). Phase III: Carbon capture and storage installations, production of petrochemicals, ammonia, nonferrous and ferrous metals, gypsum, aluminum, as well as nitric, adipic, and glyoxylic acid (various thresholds) were included. Phase IV: Based on the current legislation, no changes to the scope have been agreed on for Phase 4. Changes are being considered as part of the review of the ETS foreseen under the 2030 Climate Target Plan (please see "Year in review").
Cap	Phase I and II: The cap was established bottom-up, based on the aggregation of each member state's national allocation plans. Phase 1 started with a cap of 2,096 $MtCO_2e$ in 2005, Phase 2with a cap of 2,049 $MtCO_2e$ in 2009. Phase III: A single EU-wide cap for stationary sources: 2,084 $MtCO_2e$ in 2013, which is annually reduced by a linear reduction factor (currently 1.74% or ~38.3 million allowances). This amounts to a cap of 1,816 $MtCO_2e$ in 2020. Phase IV: A single EU-wide cap for stationary installations set for 2021 at 1,572 $MtCO_2e$. A linear cap reduction factor of 2.2% applies to both stationary and aviation sectors each year. This translates into a year-on-year reduction of the cap by 43 million allowances. The linear reduction factor does not have a sunset clause, and the cap will continue to decline beyond 2030. Starting 2021, emissions from UK entities previously covered by the EU ETS are no longer considered in the cap. However, under Article 9 and Annex 4 of the Protocol on Ireland/Northern Ireland, the cap trajectory in Phase 4 accounts for emissions from electricity generators in Northern Ireland.
Trading period	Phase I: 3 years (2005-2007) Phase II:5 years (2008-2012) Phase III: 8 years (2013-2020)

	Phase IV:10 years (2021-2030)
Allocation	Phase I: Free distribution mostly based on historical criteria ('grandfathering'). Phase II: Similar to Phase I, with some benchmarking on free allocation and certain auctions and sales (e.g., Germany). Phase III: Auctions as primary allocation method (especially for the power generation sector) and free allocation to industry based on benchmarking and gradual increase in auctions' use. Special rules for sectors confronted with the risk of carbon leakage (a temporary exception to the general policy of increasing auctions) Phase IV: Benchmark values are updated twice to reflect technological progress in different sectors. The first set of benchmark values applies to the period 2021-2025; the second set of values will cover the period from 2026 to 2030. Member States submitted lists of incumbent installations and updated emissions data by 30 September 2019 and must do so again by 30 September 2024. Based on this data, the European Commission will update Phase 3 benchmarks.
MRV	Each facility needs a monitoring plan approved by the competent authority. Annual report Verification by an accredited independent verifier
Banking	Unlimited (since 2008)
Borrowing	Borrowing is not allowed. However, implicit borrowing within trading periods is allowed —i.e., the use of allowances allocated in the current year for compliance of the previous year.
Offset credits	Phase I: Unlimited use of CDM credits (in practice, there is neither demand nor supply). Phase II: Almost all categories of CDM/JI credits are allowed, varying by country to some extent. LULUCF credits and nuclear plants are not allowed, additional requirements for large hydropower projects. Phase III: Similar to Phase II, but with additional quantitative and qualitative restrictions - new CDM credit only for LDCS projects, no credits for new JI projects, no credits for specific industrial gas destruction projects (e.g., HFC23). The total amount of international credits is limited by the principle of "supplementarity" (no more than 50% emission reductions). Phase IV: Based on the current legislation, the use of offsets is not envisaged.
Allowances auctioning (Use of earnings)	$80,737 million since 2009 2020: 21,769.6 2019: 16,413.5 2018: 16,747.3 Used for: Energy efficiency; Clean/renewable energy; Low-carbon innovation; Research and demonstration of carbon capture and storage technologies; GHG reduction programs.

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