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Different approaches, similar effects?

A comparative study of the Chinese and European Union Emissions Trading Systems

Prepared as part of the bilateral Energy Partnership on behalf of the German Federal Ministry for Economic Affairs and Energy

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1 Introduction

Every year, the World Meteorological Organization (WMO) publishes a report on the state of the climate. The year 2024 surpassed 2023 as the warmest on record, with global average temperatures 1.45°C above pre-industrial levels. Moreover, the past decade was the warmest ten-year period since records began. The socio-economic impact of extreme weather and climate events is immense and leads to economic and human losses. Food insecurity is rising, displacement due to the climate crisis is an increasingly pressing concern and vulnerable people in particular are suffering from the impact of rising temperatures (WMO 2025).

Looking more closely at Europe, the impact of climate change is obvious. Since 2020, Europe has dealt with the three warmest years on record. The negative societal impacts from extreme heatwaves, large wildfires, flooding and droughts are immense. In 2024, 335 people lost their lives due to storms and flooding, with a total of 435,000 people affected by such events; an additional 42,000 people were affected by wildfires. The resulting financial damage is estimated at 13.4 billion euros (EUR) (104.35 billion Chinese yuan (CNY))[1] (C3S 2025). In Asia, the mean temperature in 2023 was the second highest on record with temperatures in some regions – eastern China among them – markedly above average. The south-west of China suffered from drought in 2023, with precipitation levels below normal almost every month. Across Asia, extreme weather events led to over 2,000 fatalities in 2023, mostly due to flooding, with more than nine million people directly affected (WMO 2024a).

These changes in the global climate, from extreme weather events to rising global temperatures, have severe impacts including death, displacement, famine and economic losses. Climate protection and, consequently, greenhouse gas (GHG) reduction is therefore one of the most important current global tasks. While many different climate protection measures are possible, emissions trading systems (ETSs) are growing in importance. Countries, federal states and other jurisdictions using an ETS now account for 58 per cent of global GDP; one third of the world's population lives in locations with an ETS in place. In total, 38 ETSs are in operation worldwide, while another 11 are under development and nine are under consideration (ICAP 2025a). These ETSs and other carbon pricing mechanisms, such as carbon taxes and carbon offset mechanisms, cover about 24 per cent of global emissions (World Bank 2024). This reflects the expert consensus that such pricing mechanisms represent an effective and efficient instrument to achieve climate protection goals (Stechemesser et al. 2024). A key advantage of ETSs is that they can generate an additional revenue stream for the implementing jurisdiction. In 2024, the global revenue from ETSs reached almost EUR 65 billion[2] (CNY 504.75 billion). Between 2007 and 2024, they raised over EUR 345 billion (CNY 2,689.57 billion). Half of this revenue was allocated to fund climate and nature-related projects (ICAP 2025a).

Alongside the United States of America and the Republic of India, the European Union (EU) and the People's Republic of China (hereinafter referred to as China) are two of the biggest emitters of greenhouse gases. Since both jurisdictions have ETSs in place, a comparison of the two trading systems can provide key insights on their distinct design features and potential options for the future development of the Chinese national ETS. The EU ETS is the world's most mature emissions trading system, having been introduced in 2005. Since then, it has evolved through different phases and undergone several adjustments. This comparison refers to the EU ETS as it exists today while taking into account that both ETSs continue to evolve. It is important to bear in mind that the findings are limited by differences in policy design, political systems and different stages of evolution. The Chinese national ETS was implemented in 2021. Several regional pilots that had been operating in China since 2013 provided experience on how best to set up the national ETS. However, a comparison with the EU ETS can provide further useful indications on potential options for future development of the Chinese national ETS to increase its emissions reduction impact.

This report begins with a brief introduction to the function of emissions trading systems. It also outlines the climate data framework within which the EU and Chinese ETSs operate. Next, it analyses policy development and the design features of both ETSs. Building on this analysis, it then compares the two systems, which leads to potential options for the future development of the relatively new national ETS in China.

[1] All currency conversions in this paper are based on a fixed average EUR/CNY exchange rate of 7.7875, calculated for the year 2024 (ECB 2025). This rate has been consistently applied throughout the analysis to ensure comparability.
[2] The source refers to USD 70 billion; the average exchange rate in 2024 was around USD 1.08 for EUR 1.00 (Statista 2025). This rate has been consistently applied throughout the analysis to ensure comparability.

2 The function of Emissions Trading Systems

An ETS is a market-based policy instrument to incentivise emission reduction. Like other carbon pricing instruments, it alters the prices of goods and services in accordance with the polluter-pays principle (Baranzini et al. 2017). ETSs thereby ensure that producers adjust their decisions by internalising external costs. In contrast to carbon taxes, which set a fixed price for emissions, an ETS creates incentives to reduce emissions where it is most cost-effective (IEA 2020a) and, in case of a cap-and-trade system, provides certainty about the emission levels that are achieved.

ETSs can either operate under a baseline-and-credit system, like the Chinese national ETS, or under a cap-and-trade system (Wiesweg 2011). The most common variant is the cap-and-trade (C&T) system; examples include the ETSs in the EU and in California. In these systems, a limit (cap) is set on the total amount of emissions allowed within the system or in clearly defined sectors of the economy. This amount of emissions is then translated into property rights in the form of emission allowances. These allowances are then allocated to the ETS participants. In a cap-and-trade system, the emissions cap is lowered in regular intervals to ensure the gradual reduction of emissions in line with the respective climate targets. Allowances are initially allocated to emitting entities using one of two mechanisms: allowances can either be allocated free of charge (known as "grandparenting") or auctioned off – with the latter option raising revenue for the regulator (Neuhoff, Martinez, Sato 2008). In the baseline-and-credit system, there is no cap on GHG emissions. Instead, firms earn emission reduction credits when their emissions are below their baselines, which are set by historical emissions or performance standards. In both cases, allowances and generated credits can be sold on the secondary market to other entities with higher marginal abatement costs or higher emissions than their original baseline-determined free allocation.

There are two main ways for governments to distribute allowances free of charge. The first option is grandparenting, where historical emissions are used as the baseline. The second is benchmarking, where the share of freely allocated allowances is based on emission intensity or efficiency standards. Benchmarking provides free allowances to firms for emissions that fall below a certain level, determined either by unit of product or emission intensity. Benchmarking levels can vary for different industries depending on the methodology used and the aspired level of efficiency.

The second option, auctioning, allocates allowances through a competitive bidding process. The adoption of auctioning establishes a primary market for the initial distribution of allowances. Emitting entities can then trade allowances with each other on the secondary market. Auctioning has the advantage of generating government revenues, which can be reinvested in climate-related projects or used to protect vulnerable sectors, companies and households from the costs of carbon pricing (European Commission 2024a; Narassimhan et al. 2018).

Most ETSs use a hybrid approach in which covered entities in specific sectors receive some of their allowances for free but are required to purchase the remainder via auctions. Typically, this balance is adjusted over time, increasing the proportion of allowances allocated via auctioning rather than through free allocation (ICAP 2024a).

The participating entities are obligated to deliver annual emission reports as proof of their compliance. Entities that emit less than the number of allowances they hold can sell their surplus allowances to other actors on the secondary market. Entities with low abatement costs are thus incentivised to reduce their emissions, while those facing higher costs can comply by purchasing additional allowances on the market (ICAP 2024a; Narassimhan et al. 2018).

Banking has been introduced as a way to transfer allowances between trading periods in order to increase the overall efficiency of the secondary market. Banking allows companies to hold allowances beyond the current trading period, thus making it possible to sell them or to meet their own compliance obligations at a later date. In theory, this should even out market prices over time and reduce friction between trading intervals, leading to a stronger and consistent scarcity signal through the market price. The reverse mechanism (borrowing) takes place when companies borrow allowances they expect to receive for free from future trading periods. Borrowing provides entities with flexibility in determining their compliance strategy. However, by reducing mitigation action in the short term, borrowing can delay the emission reductions needed to achieve the environmental objectives of an ETS. Subsequently, most ETSs have either prohibited or limited borrowing. Another option to generate efficiency gains is to introduce spatial or sectoral flexibility measures. Offsetting enables entities to compensate for their emissions by investing in mitigation projects outside of the sectors regulated through the ETS.

When an entity invests in an offsetting programme, it receives carbon credits certified or at least acknowledged by the government. Entities can then trade these credits and – to a defined extent – use them to comply with the ETS allowance obligation.

High-integrity offsetting projects are paramount for such flexibility mechanisms to align with environmental and climate objectives.

Climate Data Frameworks in the EU and China

The EU and all its member states have signed and ratified the Paris Agreement (United Treaty Collection 2025). Based on this, the EU has set itself the goal of becoming the first climate-neutral economy and society by 2050 (European Commission 2024b). China, like the EU, has signed and ratified the Paris Agreement, thereby committing to its objectives (United Treaty Collection 2025). Through its 'dual-carbon goal', China aims to peak CO_2 (carbon dioxide) emissions before 2030 and achieve carbon neutrality by 2060 (The State Council 2021).

The 27 member states of the European Union jointly represent the world's fourth-largest GHG emitter with 3,221.8 $MtCO_2$-eq (carbon dioxide equivalents) in 2023, accounting for 6.1 per cent of the global total. However, EU emissions in 2023 were 7.5 per cent lower than in 2022 (Crippa et al. 2024). In the EU, the transport sector is responsible for the largest share of emissions (24 per cent), followed by the energy sector (20 per cent) and the buildings sector (14 per cent). The transport sector is the only sector to have recorded an increase in emissions between 1990 and 2022 (19 per cent). In contrast, the industrial and energy sectors achieved the highest emissions reductions, at more than 50 per cent each (Crippa et al. 2024).

As the world's largest emitter with 15,944 $MtCO_2$-eq (excl. LULUCF) in 2023, China accounts for 30.1 per cent of the global total. In 2023, China's emissions increased by 5.2 per cent compared to 2022. The power industry remains the largest contributor to the country's emissions with a share of 48.8 per cent in 2023. Other sectors also contribute significantly to China's emissions, such as industrial combustion (21.7 per cent) and industrial processes (11 per cent).* The transport sector showed the largest increase in emissions between 1990 and 2023 (1065 per cent), closely followed by the energy sector (917 per cent) and the process sector (650 per cent). Agriculture is the only sector that has reduced its emissions, by four per cent compared to 1990 (Crippa et al. 2024).

*Crippa et al. include, for example, non-metallic minerals, non-ferrous metals, solvents and other products and chemicals used in combustion for industrial manufacturing and industrial process emissions.

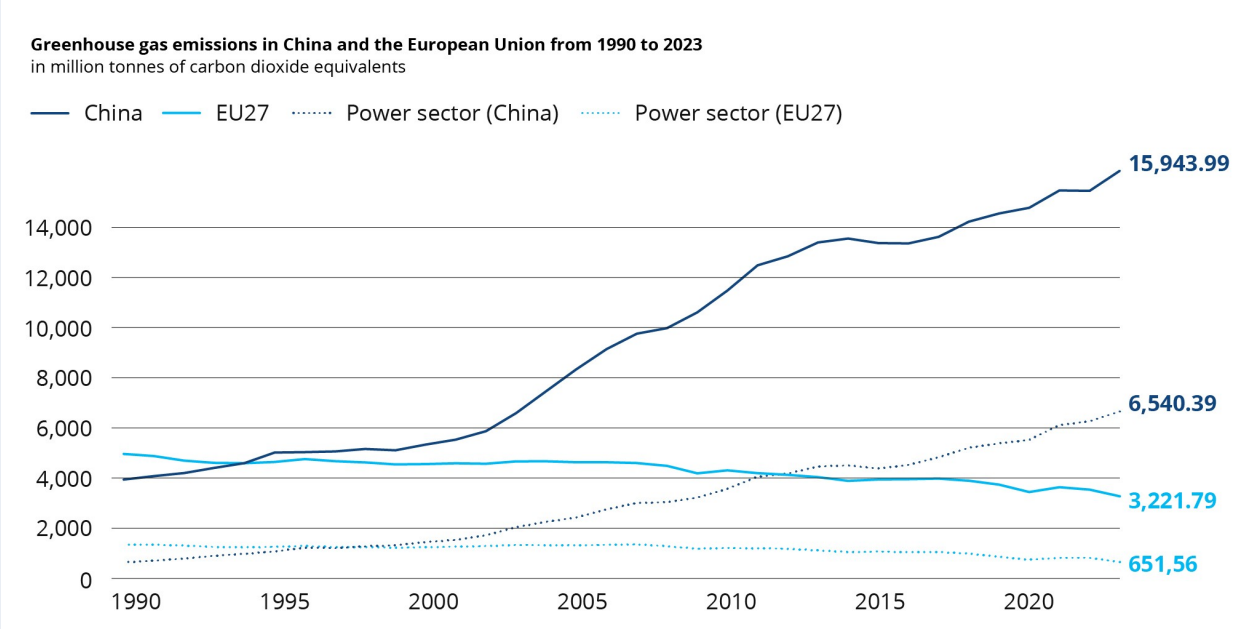

Figure 1: Greenhouse gas emissions in China and the European Union from 1990 to 2023. Own figure based on Crippa et al. (2024).

3 Comparative analysis of the EU ETS and the Chinese national ETS

This chapter analyses the design of EU ETS and the Chinese national ETS and compares the two systems on the basis of several criteria characteristic of ETSs, namely: policy and price development; covered emissions and sectors; caps and allowance allocation; market stability mechanisms; carbon leakage; monitoring, reporting and verification; and effects on emissions reduction.

3.1 Analysis of the EU ETS

In 2005, the EU introduced the world's first comprehensive ETS. In recent years, the instrument has been updated several times in line with economic reality and to ensure it is fit for purpose. The following sections provide an overview of the most important design features of the EU ETS.

3.1.1 Policy and price development

Ratification of the Kyoto Protocol, with its legally binding climate goals, led the EU to consider establishing new climate mitigation instruments, including the EU ETS. Initial ideas for a future ETS design were drafted in a Green Paper on GHG emissions trading within the European Union published in 2000 (COM(2000)87final 2000). Building on this Green Paper, the EU ETS Directive was drawn up in 2003 and adopted in 2005, putting in place the first emissions trading system worldwide. As the EU ETS is a market-based instrument to reduce GHG emissions, the price for an allowance is set by the principle of supply and demand. The supply is determined by the allowance cap, while demand is determined by the actual amount of covered emissions within the EU. Companies place bids to purchase EU Allowances (EUAs) either on the primary market, where emission allowances are auctioned to the market participants, or on the secondary market, where participants trade market spot and derivative contracts of emissions allowances. The auction clearing price represents the price at which the number of bids matches or exceeds the number of allowances auctioned (EEX 2024). The prices of allowances in the primary and the secondary market are very similar (Deutsche Bundesbank 2024; DEHSt 2024a). Policy development of the EU ETS was divided into four trading phases.

Significant Accompanying Climate Policies in the EU

Although economic instruments such as the EU ETS play a vital role in climate governance in the European Union, they cannot alone account for the EU's emissions reduction goals. The EU's climate policy mix therefore includes a variety of different climate mitigation policies aimed at achieving its climate objectives. The following outlines a selection of Europe's numerous climate policies.

Fit-for-55

Fit for 55 is a package of legislation designed to achieve the new target of reducing EU GHG emissions by at least 55 per cent by 2030. It includes new regulations for the EU ETS. Its scope has been extended to include emissions from maritime transport, with system allowances reduced (i.e. cap adjusted) more quickly and free allocation of allowances phased out in some sectors. Rules governing the use of revenues have also been adjusted. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has been implemented. More resources have been made available for the Modernisation Fund and Innovation Fund, while the Market Stability Reserve has been revised. All of these changes concern the fourth phase of the EU ETS; see p. 5.

Emission Trading System 2

Alongside the measures related to the EU ETS set out in the Fit for 55 package, a new ETS has been created for buildings, road transport and for combustibles and fuels for other sectors. The Emission Trading System 2 (known as "EU ETS 2") will commence operation in 2027, though reporting began in 2024. For more information on EU ETS 2, see Chapter 3.1.8.

Effort Sharing Regulation
The Effort Sharing Regulation was adopted in 2018, setting additional national targets for emissions reductions in sectors not covered by the EU ETS. It defines binding targets for member states' annual GHG emissions between 2021 and 2030 for the following sectors: buildings, agriculture (non-CO_2 emissions), waste management and transport (excluding aviation and international shipping, which have been added to the EU ETS). The Effort Sharing Regulation targets an additional reduction in the EU's total emissions of up to 10 per cent (Verde et al. 2021).

Renewable Energy Directive
Similarly to the Effort Sharing Regulation, the Renewable Energy Directive set binding targets for member states regarding the share of renewables in their final energy consumption. The targets differ between member states according to their GDP per capita, their initial RE share and their upscaling potential. A revised version of the Directive was adopted in 2023, raising the EU's binding renewable energy target for 2030 to a minimum of 42.5 per cent.

Energy Efficiency Directive
The Energy Efficiency Directive sets a target of 32.5 per cent reduction in energy consumption relative to a business-as-usual scenario.

First phase (2005–2007)

During the first phase from 2005 to 2007, the focus was to gain practical and administrative experience with the new policy instrument and to prepare for the second phase. Free trading of emission allowances was established across the EU. During this three-year phase, the EU ETS only covered power generators and energy-intensive industries. In the case of non-compliance, entities had to pay a fine of EUR 40 (CNY 311.50) per tonne. Member states had to determine their own cap and allocate the respective emission allowances, specifying the allocation decisions in their National Allocation Plans (NAPs). 5 per cent of the allowances were auctioned while the rest was distributed for free (Verde et al. 2019). While the first two years were marked by moderate allowance prices with an average annual price between EUR 17.30 and EUR 21.80 (CNY 134.72 and CNY 169.77), they fell to almost zero in 2007 (Hintermann 2010). Price fluctuation was due in part to an excess of allowances allocated via grandparenting compared to real emissions as a result of insufficient data, and in part due to uncertainty created through political debates around what policy action to take (Hepburn et al. 2006). The Commission therefore asked member states to reduce their allowance volume. Monitoring, reporting and verification (MRV) of emissions from the covered entities was also established.

Second phase (2008–2012)

Due to learnings from the first phase, the overall allowance cap was reduced by 6.5 per cent compared to the 2005 cap. The emission data gathered during the first phase helped to determine how to adjust the cap to actual emissions. Additionally, across all covered sectors, free allocation was reduced to 90 per cent (with 10 per cent auctioned). The economic crisis in 2008 led to reduced emissions and, subsequently, to more allowances being available, which resulted in low allowance prices.

In the beginning of 2012, the aviation sector was integrated into the EU ETS. Non-compliance became more expensive as the penalty increased to EUR 100 (CNY 778.75) per tonne (European Commission 2024c).

Third phase (2013–2020)

Several measures were taken to fix problems that developed in the previous phases. Instead of national caps, a single EU-wide cap on emissions was introduced. Auctioning became the default method for allowance allocation (instead of free allocation). The proportion of freely allocated allowances was severely cut to 43 per cent by implementing 100 per cent auctioning for power generation installations and increasing targets of auctioning for industrial installations less exposed to carbon leakage.

Definition: Carbon Leakage

Carbon leakage is defined as the relocation of greenhouse gas-emitting industries from countries with stricter climate protection policies to other countries in order to circumvent stricter requirements for greenhouse gas emissions. For more information on carbon leakage measures in the EU ETS, see Chapter 3.1.5.

In 2013, 20 per cent of the allowances for those industries were auctioned. By 2020, this had increased to 70 per cent. For the remaining free allowances, the applicable rules were harmonised using an ex-ante GHG performance benchmarking approach. Several new industries and GHGs were integrated into the EU ETS, including aluminium, petrochemicals, ammonia, nitric acid, adipic acid and glyoxylic acid production, as well as nitrous oxide (N_2O) and perfluorocarbons (PFCs) from the production of aluminium. Besides the inclusion of lleaking CO_2 from carbon capture, the transportation of the captured CO_2 in pipelines and its geological storage were included (European Union 2014). Furthermore, the Market Stability Reserve (MSR, further explained in Chapter 3.1.4) was introduced in 2018 due to low prices.

Fourth phase (2021–2030)

In the current trading phase, the EU ETS has been revised several times in line with more ambitious climate goals (see info box "Significant accompanying climate policies in the EU", Fit for 55, p. 4). The cap has been tightened and emissions from maritime transport included from 2024. The MSR was adjusted and free allocations reduced. Starting in 2026, there will be no further free allocation in the aviation sector (European Commission 2024d). By 2030, 100 per cent of the allowances for non-CBAM (Carbon Border Adjustment Mechanism; see Chapter 3.1.5 for further details) industries will be auctioned, while CBAM industries will receive an increasingly limited free allocation until 2034 (Bordignon and Gamannossi 2023). Furthermore, the possibility of carbon offsetting, which was permitted in phases two and three, ended due to oversupply and resulting low prices, along with a limited impact on domestic emission reduction (Sandberg 2012; Carbon Market Watch 2013). By 2026, the EU Commission will present a report on the feasibility of integrating municipal waste incineration facilities into the EU ETS. They are set to be integrated by 2028 – if feasible – and by 2030 at the latest (EU 2003/87/EC 2003).

Price development

While prices occasionally exceeded EUR 100 (CNY 778.75) in individual auctions, experts argue that the general price level has remained too low. The German Environment Agency determined the costs of the damage inflicted by one tonne of CO_2 at EUR 180 (CNY 1401.75) and recommends a price of EUR 250 (CNY 1946.88) per tonne of CO_2-eq (UBA 2018, 2024). Pietzcker et al. calculated that if the EU wants to achieve its 55 per cent emissions reduction target by 2030, the CO_2 price would need to be around EUR 130 (CNY 1012.4) for the power and industrial sectors (2021). For the road transport, buildings and agricultural sectors (currently not included in the EU ETS), the CO_2 price would have to be around EUR 275 (CNY 1946.9) per tonne. Road transport and buildings will be covered by the EU ETS 2 starting from 2027 (see Chapter 3.1.8); there are currently no concrete plans to cover the emissions from agriculture in an ETS. Price forecasts for the EU ETS 2 range from EUR 48 (CNY 373.8) to EUR 350 (CYN 2725.63) (Fiedler et al. 2024). The International Monetary Fund points out that CO_2 prices need to be in the region of at least EUR 71 (CNY 552.9) globally by 2030 to achieve the goals of the Paris Agreement and to create cost-effective net-zero pathways (Black, Parry and Zhunussova 2022).

3.1.2 Covered emissions, covered sectors

The EU ETS currently covers CO_2 emissions from heat and power generation plants with a rated thermal input in excess of 20 megawatt (MW) as well as from energy-intensive industry (DEHSt 2024b). From 2027, smaller plants will also be covered under the separate EU ETS 2. Energy-intensive industry specifically comprises oil refineries, steel works and the production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals. Stationary plants in the industrial sector can be excluded from the EU ETS if they are recognised as small emitters. Those plants can apply for exemption from individual emissions trading obligations if they meet several criteria, including annual emissions below 25,000 t CO_2-eq (DEHSt 2024c). Stationary installations were responsible for 34 per cent of GHG emissions in the European Economic Area in 2023 (EEA 2024b).

EU carbon prices
in euro per tonne of carbon dioxide equivalent

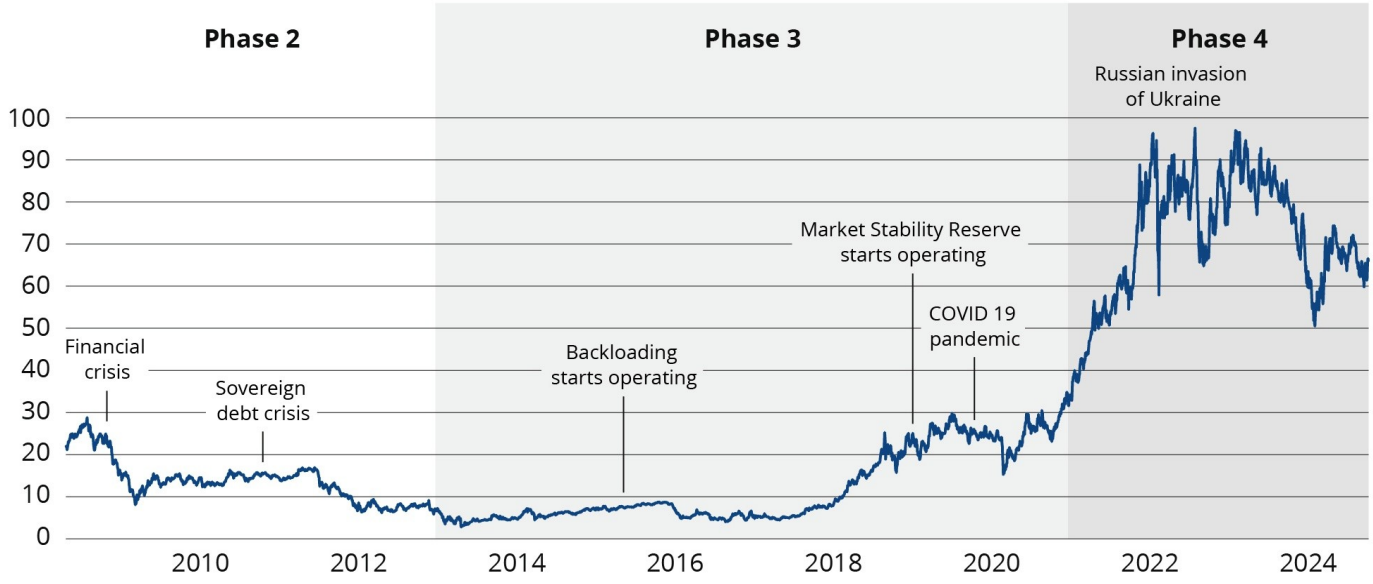

Figure 2: EU carbon prices since the start of Phase 2. Own figure based on Sandbag (2025), Life ETX (2024) and ICAP (2025).

Development of emissions and the cap in the EU ETS
in million tonnes of carbon dioxide equivalents

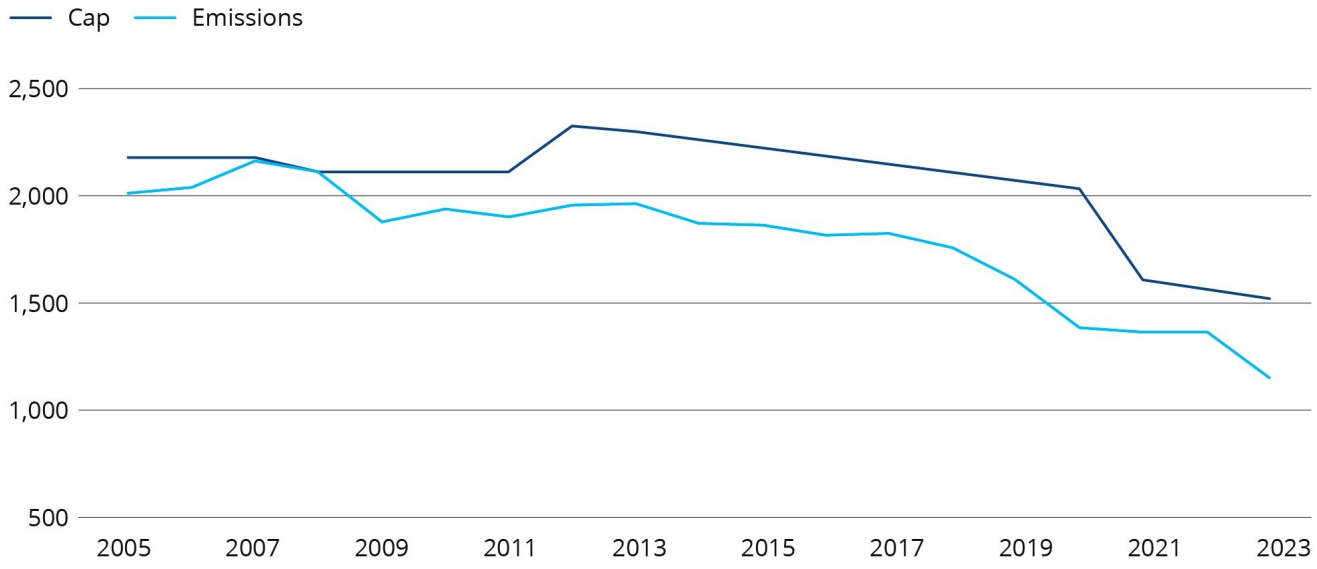

Figure 3: Development of emissions and the cap in the EU ETS. Own figure based on Sandbag 2024.

Furthermore, aviation within the European Economic Area and departing flights to Switzerland and the United Kingdom are covered by the EU ETS. Although direct GHG emissions from aviation only accounted for three to four per cent of the EU's total GHG emissions, the aviation sector is one of the fastest growing emissions sources (European Commission 2024d). In addition, CO_2 emissions from the maritime transport sector are completely covered for journeys between EU ports. Half of the emissions are included when the journey only starts or ends within the EU. Another growing source of GHG emissions, the maritime transport sector was responsible for three to four per cent of the EU's total CO_2 emissions in 2021 (European Commission 2024e). N_2O emissions are covered by the EU ETS if they stem from the production of nitric acid, adipic acid, glyoxylic acid or glyoxal; from 2026, N_2O and methane emissions fall under the EU ETS scope for the maritime sector. Alongside coverage of CO_2 emissions, HFCs are covered if they are a byproduct of EU ETS-covered industries, while PFCs are covered if they stem from the production of aluminium or alumina. The aluminium industry is forecast to achieve up to 30 per cent growth, partly due to an increase in aluminium demand for PV and electric transportation. In 2023, approximately 24 million tonnes of CO_2-eq were emitted by the aluminium industry in the EU (European Aluminium 2023).

Since 2024, companies involved in the incineration of municipal waste must monitor and report their emissions (European Commission 2023). They are set to be integrated into the EU ETS by 2028 if feasible, and by 2030 at the latest.

3.1.3 Caps and allowance allocation

The number of permissible GHG emissions from sectors covered by the EU ETS is limited by a "cap". The cap represents the total number of emission allowances per year, where one allowance represents one tonne of CO_2-eq. GHGs other than CO_2 are quantified by CO_2-eq. A company must surrender one allowance for each tonne of CO_2-eq it emits. As shown in Figure 3, the cap decreases every year. The annual decrease is defined by a linear reduction factor (LRF) in alignment with the EU climate targets. When the climate goal for 2030 was tightened in 2023, the Fit for 55 package adjusted EU climate policies accordingly. The ambition of the EU ETS was raised, increasing the reduction in GHG emissions from 43 per cent to 63 per cent in the EU ETS sectors by 2030 compared to 2005. The LRF was also increased accordingly. The LRF was initially fixed at 1.74 per cent during the third phase and was set "on the basis of the average total quantity of allowances issued annually in 2008-2012" (European Commission 2024f). In the fourth phase, the linear reduction factor was initially increased to 2.2 per cent and further to 4.3 per cent in 2024 due to the higher climate target for 2030. In 2028, the LRF will increase again to 4.4 per cent (UBA 2023).

The default method for the allocation of allowances in the EU ETS is auctioning. However, to prevent carbon leakage, some allowances are distributed via free allocation. Power generation received free allocations until 2013 while the industry still receives a large share of their allowances for free (for percentages of free allowances see Figure 4: EU ETS compliance process. Own figure based on European Commission 2022.For each company, the actual amount of freely allocated allowances is based on specific sectors' "performance benchmarks, which reflect an average emissions

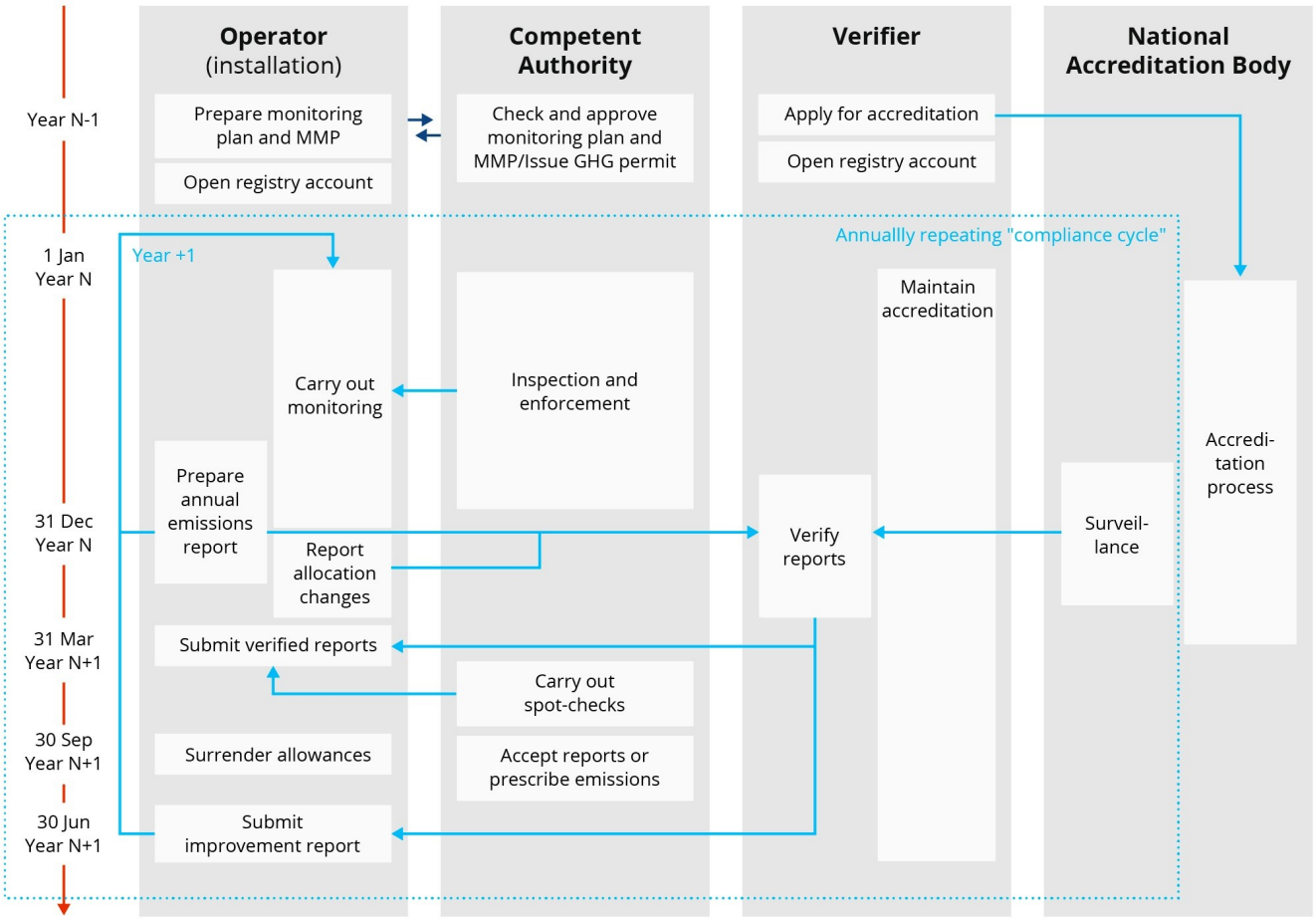

Figure 4: EU ETS compliance process. Own figure based on European Commission 2022.

intensity per unit of product of the 10 per cent most efficient installations in each sector" (European Commission 2024g). At the beginning of the fourth phase, more than 95 per cent of allowances for the industrial sector were allocated free of charge. However, this free allocation will be phased out gradually between 2026 and 2034 (European Parliament 2022a). The aviation sector currently also receives most of their allowances for free. From 2026 onwards, however, all the allowances for aviation will be auctioned (Life ETX 2024).

3.1.4 Market stability mechanism

The EU market stability mechanism, the Market Stability Reserve, was introduced in 2018 because a large surplus of ETS allowances had accrued since 2009, leading to low CO_2 prices. These low prices weakened incentives for companies to invest in decarbonisation measures. The surplus was primarily driven by the 2008 economic crisis, which led to lower-than-expected emissions, along with additional EU regulations on energy efficiency and renewable energy, which reduced the demand for allowances in the energy sector. Furthermore, a high volume of international offsetting credits, which companies could use for EU ETS compliance until 2020, also contributed to the oversupply (Bayer and Aklin 2020; European Commission 2024h). Nevertheless, Bayer and Aklin (2020) point out that low CO_2 prices are not the sole indicator of an ineffective ETS. They can also be a sign of an effective ETS, as demand for allowances decreases if companies cut their emissions.

"Backloading" of allowances from auctions took place in 2014 (400 million allowances), in 2015 (300 million allowances) and in 2016 (200 million allowances) to rebalance supply and demand in the short term and minimise price volatility. The backloaded allowances were not auctioned but transferred to the MSR.

The MSR helps to regulate the EU ETS allowance balance by automatically removing surplus allowances from the market and adding them to the MSR. Those allowances are then either brought back into the system if the demand and supply balance is tight or partially deleted if the oversupply persists. The MSR provides some flexibility for allowance supply balancing and thus aims to reduce price volatility and increase planning security.

3.1.5 Carbon leakage

In order to prevent carbon leakage – "the shifting of greenhouse gas emitting industries outside the EU to avoid tighter standards" (European Parliament 2023) – due to the emissions price imposed by the EU ETS, the EU introduced the Carbon Border Adjustment Mechanism through Regulation (EU) 2023/956, which entered into force in May 2023. The CBAM covers carbon-intensive products at risk of carbon leakage, namely cement, iron, steel, aluminium, fertilisers, electricity and hydrogen. The free allocation of allowances, previously the main measure against carbon leakage to ensure that industries with high exposure to global competition only had to purchase a limited number of emission allowances, will be reduced gradually as the CBAM is phased in (see Figure 5). As a climate instrument geared to companies, the idea behind the CBAM is to set an equivalent price for embedded emissions from goods produced in non-EU countries and imported into the EU (without an effective carbon price) to level the playing field within the EU. Since the end of 2023, importers of iron, steel, aluminium, cement, fertiliser, hydrogen and electricity into the EU must report the embedded emissions in their products. In the proposed Omnibus I package, from February 2027 onwards (as opposed to 2026, as set out in Regulation (EU) 2023/956 currently in force) importers will be required to purchase CBAM certificates in line with the amount of embedded emissions in imported products. The CBAM certificate price will correspond to the current EU ETS allowance price, thereby subjecting imported goods to the same carbon price as goods produced in the EU. This is intended to create a level playing field and increase the CO_2 price signal of the EU ETS as free allocation is phased-out, while also promoting decarbonisation globally. The mechanism is being introduced in two phases: the transitional phase from 2023 to 2025 and the definitive regime starting in 2026. Figure 5 shows the gradual replacement of free allocations for certain industries in the EU ETS by the CBAM over an eight-year period from 2026 to 2034.

Transitional phase (2023–2025)

In October 2023, the transitional phase of CBAM entered into force. Producers, importers and authorities must collect and report all relevant information on direct and indirect emissions embedded in their product. The transitional phase is a learning process to eventually adjust the methodology of CBAM.

Further legislation has been proposed to simplifying the CBAM rules. In February 2025, a legislative proposal was tabled to amend the CBAM Regulation in order to simplify and strengthen it as part of the Omnibus I package (COM(2025) 87 final 2025/0039(COD) 2025). The proposal includes a new CBAM-specific *de minimis* threshold for small-volume importers, the opportunity for CBAM declarants to freely choose between reporting actual embedded emissions or default values, and a mandate for the European Commission to determine default carbon prices for third countries where applicable. This complementary legislative act (Omnibus I) is still a proposal at the time of writing and has not yet been officially adopted.

Pathway of EU ETS free allowances phase-out and Carbon Border Adjustment Mechanism (CBAM) phase-in from 2025
in percent

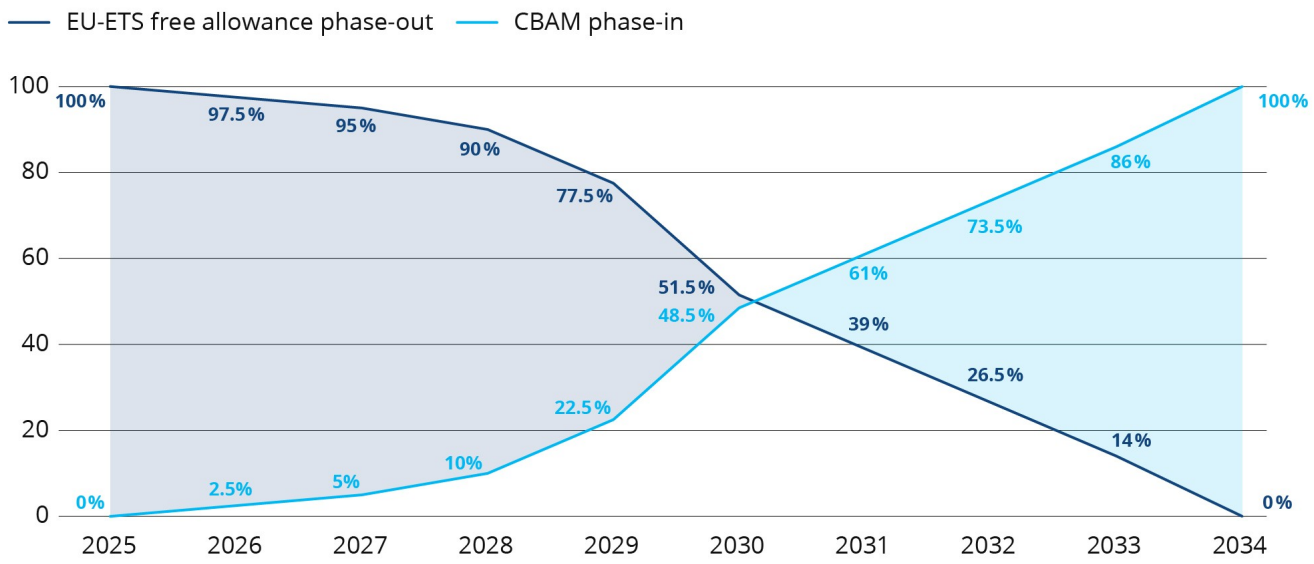

Figure 5: Pathway of the EU ETS free allowance phase out and CBAM phase in from 2025. Source: Own figure based on Europeam Parliament 2022a.

Definitive regime (from 2026)

From 2026 – or 2027, as proposed in the Omnibus I package – direct emissions will be covered for the aluminium, iron, steel and hydrogen sectors. For all other sectors covered by the CBAM, indirect emissions will also be included. EU importers of goods covered by the CBAM must be authorised CBAM declarants in order to continue importing CBAM goods into the EU. After reporting the third-party verified emissions embedded in their imported products to the relevant national competent authority, importers must surrender the respective number of CBAM certificates on an annual basis. The price of CBAM certificates is based on the weekly average EU ETS auction price.

Importers will be able to deduct carbon prices that have already been effectively paid during the production of the imported good. This approach incentivises non-EU countries to introduce, extend or strengthen their own emission pricing schemes.

3.1.6 Monitoring, reporting and verification

The EU ETS has an annual compliance cycle which includes the monitoring, reporting and verification of emissions. Monitoring and reporting is regulated by the Monitoring and Reporting Regulation, while the rules for verification and accreditation are set out in the Accreditation and Verification Regulation. Operators covered by the EU ETS must have a monitoring plan. Furthermore, they must submit an emissions report that has been verified by an accredited verifier. Once the report has been verified by a third-party verifier, the allowances must be surrendered (European Commission 2022, 2024j). The third-party verifier must be accredited by the National Accreditation Body as shown in Figure 6.

3.1.7 Effects on emissions reduction

A number of EU policy measures have an impact on emissions reduction. The overarching legislation is contained in the Green Deal, which includes the EU Climate Law (that sets the reduction targets) and the Fit for 55 package. The info box on page 7 details some of the policies that contribute to European climate targets. The Green Deal is accompanied by several funds to finance climate protection measures and support lower income member states and households. For example, the Climate Social Fund aims to ensure that the carbon price in EU ETS 2 does not place an excessive burden on vulnerable groups. The Just Transition Mechanism supports the regions, industries and workers most affected by the green transition, while the Modernisation Fund allocates shares of EU ETS revenues to 10 lower-income member states to finance energy efficiency, energy storage and renewable energy projects (European Council 2025). The European Commission published data showing that emissions from all installations participating in the EU ETS decreased by roughly 15.5 per cent in 2023 compared to 2022. Emissions covered by the EU ETS had fallen by 47 per cent on 2005 levels (European Commission 2024k). The reasons for the decrease in emissions are manifold but they include the rising allowance price, rising fuel prices making coal power generation unappealing, renewable energy policies to decarbonise the power sector, and more efficient and lower industrial output (EEA 2024b).

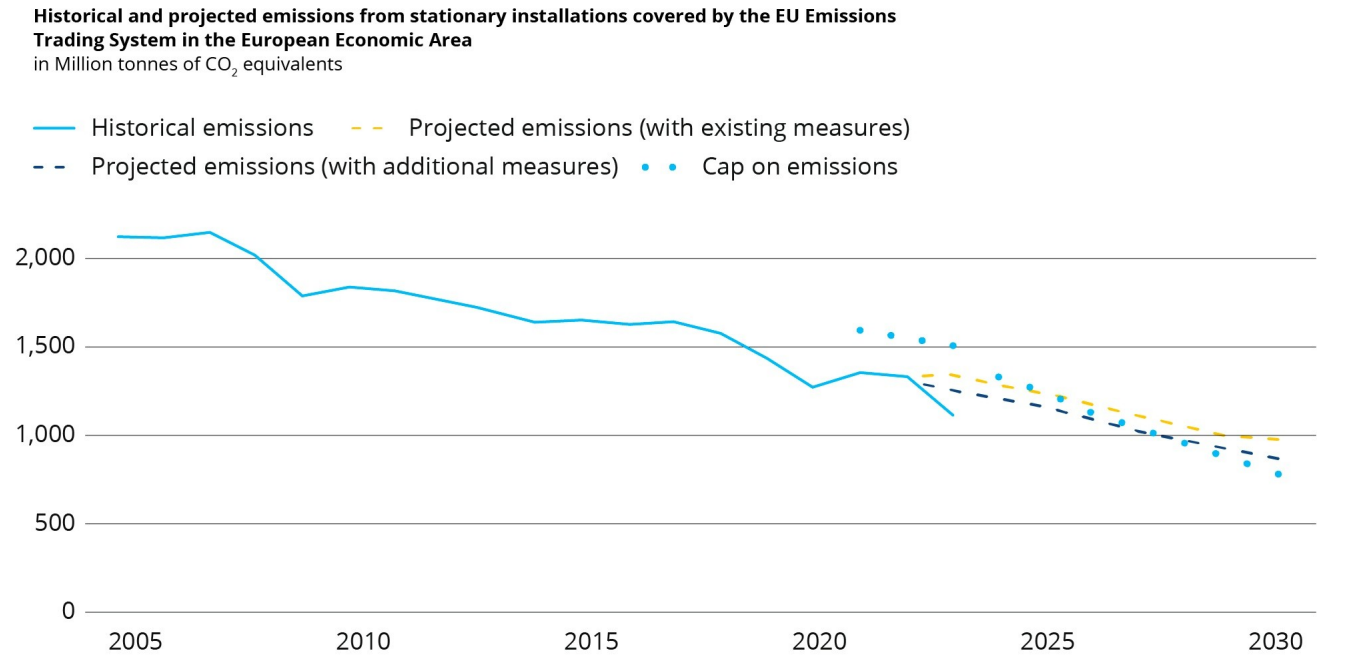

Figure 6: Historical and projected emissions from stationary installations covered by the EU Emissions Trading System in the European Economic Area, Source: EEA 2024b.

In 2023, there was a record decrease in power sector emissions. Emissions from electricity production decreased by 24 per cent compared to 2022 due to an increase in renewable energy generation. Furthermore, the EU ETS incentivised fuel-switching from coal to gas, leading to an emissions reduction of 88 Mt in 2005 and of 59 Mt in 2006 (Delarue et al. 2008). Additionally, fuel efficiency increased in response to rising carbon prices (Germeshausen 2020). The IEA states that changes in the merit order due to higher allowance prices incentivised emissions reductions. Less efficient power plants that use fossil fuels and produce high levels of emissions are losing their position in the merit order. This means fewer operating hours in an economic dispatch model in which high-emitting power stations are becoming less profitable (2020b).

Energy-intensive industry was able to reduce emissions by 7.5 per cent compared to 2022 because of reduced output and efficiency increases. While emissions in other sectors decreased, emissions in the aviation sector continued to rise (European Commission 2024k).

Projections for a "with existing measures" scenario show that stationary ETS emissions will likely achieve a 54 per cent reduction by 2030 on 2005 levels (see Figure 6). If additional measures are taken, a 59 per cent reduction until 2030 is anticipated on 2005 levels. The main drivers in these scenarios are emissions reductions in the power sector and manufacturing industries (EEA 2024b).

Several studies have sought to quantify the efficacy of the EU ETS. Bayer and Aklin (2020) found that "the EU ETS saved about 1.2 billion tons of CO_2 from 2008 to 2016, roughly 3.8 per cent relative to total emissions over this period". They determined that those reductions were mainly driven by sectors covered under the EU ETS, which emitted around 11.5 per cent less than they would have in a contrafactual world without the EU ETS. Wagner et al. (2014) provide plant-level evidence of the efficacy of the EU ETS on emission reduction of ETS-covered manufacturing plants in France. Their results indicate that the EU ETS led to a significant reduction in GHG emissions (15–20 per cent) at ETS plants, compared to non-ETS plants.

3.1.8 Outlook: Future developments

Since 2024, a separate EU ETS 2 has been in its two-year reporting phase for some emissions not yet covered by the EU ETS, with MRV requirements already in place. The EU ETS 2 comprises the road transport and buildings sectors as well as emissions from smaller industrial energy facilities. The ETS 2 will also be a cap-and-trade system with emissions pricing starting in 2027. However, it will use an upstream approach, targeting the actors responsible for bringing fossil fuels into circulation rather than the emitting installations (downstream approach). In case of exceptionally high energy prices, as defined in Article 30k of the ETS Directive, the ETS 2 can be postponed until 2028. The EU ETS 2 is accompanied by the Social Climate Fund (SCF) with dedicated funding for the most vulnerable affected groups, such as households in energy or transport poverty (European Commission 2024l).

The EU ETS will be reviewed in 2026 to prepare the system for its fifth phase beyond 2030. One important factor for its cap and accompanying instruments, such as the MSR, will be the 2040 climate target to be set by the European Commission. Accordingly, the European Commission will develop a post-2030 policy framework, which will most likely include adjustments to the EU ETS and EU ETS 2. Nevertheless, some changes are already underway. Free allocation for CBAM industries will gradually be phased out between 2026 and 2034. The last emission allowances in the EU ETS are to be auctioned in 2039, at least for the industrial and power sectors. While companies can still use previously purchased certificates ("banking") to cover their ongoing emissions, they will no longer also be able to buy new allowances from other market participants (Packroff 2024). As Europe deals with hard-to-abate residual emissions, compensation with carbon removal is being considered to achieve net-zero emissions. Accordingly, integrating Carbon Removal Certificates into the ETS might be an option to permit residual emissions exceeding available ETS allowances. In this case, entities in EU ETS could fulfil part of their obligations by surrendering a respective amount of removal certificates instead of EU ETS allowances. However, this option will only be further specified by the EU ETS review report in 2026 (Edenhofer and Leisinger 2024).

According to the proposal for simplification of the CBAM, the European Commission plans to review the CBAM in the second half of 2025 (COM(2025) 87 final 2025/0039(COD) 2025). The review process will focus on issues including the mechanism's impact on imports from developing countries, particularly the least developed countries (European Parliament 2022b).

3.2 Analysis of the Chinese national ETS

The past decade has seen the gradual development of an ETS in China. This chapter firstly examines the historical development of China's ETS. It then examines the design of the Chinese national ETS and its impact on emission reductions in more detail. It concludes with an outlook on future development of the Chinese ETS.

3.2.1 Policy and price development

In 2011, China announced the establishment of several regional ETS pilots. These were launched sequentially at both provincial and municipal level, starting in 2013 (Chen et al. 2017; Lo 2013). During this trial period, ETS policies were set up in the provinces and cities of Beijing, Shanghai, Tianjin, Shenzhen, Chongqing, Guangdong and Hubei (Zhang et al. 2014; Yan et al. 2020). The implementation of the pilot ETSs can be divided into three phases.

First phase (2013–2015)

In the first phase (2013-2015), the pilots were set up. Trading platforms were established to facilitate electronic bidding and the transfer of emission allowances. In 2012, a national-level voluntary offset programme, the Chinese Certified Emission Reduction (CCER) programme, was introduced. It allowed companies to offset a certain share of their emissions by purchasing credits from specific emission reduction projects, such as afforestation and renewable energy generation. Limits on the use of offset credits varied across the pilots, ranging from 1 to 10 per cent. Project type requirements also varied across the pilots.

Second phase (2016–2017)

The second phase (2016-2017) was characterised by stable trading volumes and carbon prices in the majority of the markets. The pilots in Hubei, Guangdong and Shenzhen proved the most efficient in terms of coverage, liquidity and effective trading days. In 2017, the National Development and Reform Commission (NDRC) released its National Carbon Market Development Plan, setting out a three-phase plan for nationwide implementation of an emissions trading system. In the same year, the CCER offsetting programme was provisionally stopped due to low trading activity and inadequate standardisation (Wu 2024).

Third phase (2018–2021)

During the third phase (2018–2021), responsibilities for the ETSs were transferred from the NDRC to the newly created Ministry of Ecology and Environment (MEE). At the end of the trial period in 2021, the ETS pilots covered more than 20 industries including iron, steel, power and cement, with a cumulative transaction volume of 480 Mt CO_2-eq (CNY 11.4 billion / EUR 1.46 billion) (Liu et al. 2021).

Implementation (2021– present)

Building upon the technical and institutional foundation laid by the pilots, the Chinese national ETS officially launched in 2021 (Long and Golder 2023). Online trading began in July 2021. As of December 2024, the national ETS has undergone two compliance periods. In 2021, participants were required to surrender their Chinese Emission Allowances (CEAs) for 2019 and 2020; in 2023, they had to surrender their CEAs for 2021 and 2022. The regional pilot systems coexist with the national ETS – though it is specified that, once an entity is covered by the national system, it transitions and is no longer part of the pilot system to which it previously belonged.

In January 2024, China relaunched its voluntary CCER offset programme. At the national level, the Chinese carbon trading landscape thus consists of two components: the Chinese national ETS and the CCER. In contrast to the national ETS, the CCER does not include a compliance obligation. It is expected that credits will either be bought by ETS-covered high-emitting entities aiming to offset their excess emissions or by companies seeking to demonstrate climate awareness and corporate responsibility. The CCER covers offset credits from several sectors, including afforestation, solar thermal power, offshore wind and mangrove creation. These were chosen due to their comparably high reliance on offset credit sales for profitability (Wu 2024).

In May 2024, with the introduction of the new Interim Regulation on Carbon Emissions Trading Management in China, institutional responsibilities were clarified further. Any future changes, for instance to the GHG coverage or the sector scope of the national ETS, will be proposed by the MEE and submitted to the State Council for approval.

In March 2025, the MEE released a work plan to expand the sectoral coverage of the national ETS to include the cement, steel and aluminium industries (see Chapter 3.2.2). The plan was officially approved by the State Council.

Chinese carbon prices
in euro per tonne of carbon dioxide equivalent

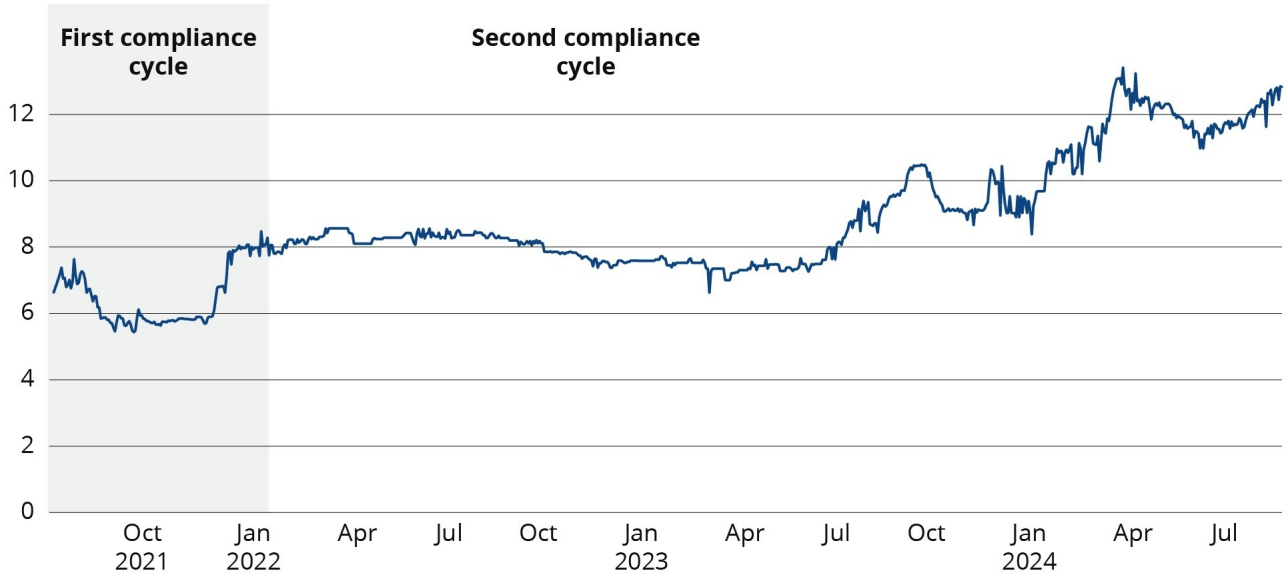

Figure 7: Prices during the first and second compliance cycles of the National ETS. Own figure based on ICAP (2025).

Price development

During the second compliance cycle (2021–2022), the price at market closure fluctuated between CNY 50 to CNY 82 per tonne (EUR 6.42 to EUR 10.53) on the secondary market. By the end of 2023, the composite price for market closing was at CNY 79.42 (EUR 10.2) per tonne. In April 2024, the price in the national ETS exceeded CNY 100 (EUR 12.84) per tonne for the first time (MEE 2024). The last reported price was CNY 98 per tonne (EUR 12.58) in January 2025 (ICAP 2025c). However, due to relatively generous free allocation rules, prices on the secondary market only apply to a small portion of the overall amount of allowances.

Since its operation started in 2021, China's national ETS has seen a steady increase in trading activities. During the first compliance cycle, the cumulative trading volume equalled around four per cent of annual ETS-covered emissions. By the end of 2023, the cumulative trading volume in CEAs reached 442 million tonnes, with a cumulative transaction volume of CNY 24.92 billion (EUR 3.2 billion). During the second compliance cycle (2021–2022), the cumulative trading volume was 263 million tonnes, with a cumulative transaction volume of CNY 17.62 billion (EUR 2.26 billion) – an increase of 47 per cent and 125 per cent on the first cycle, respectively.

However, the national ETS currently does not generate any state revenue as allowances are either allocated for free or bought from other companies on the secondary market. Auctions have been in place at the provincial level only, with the Beijing and Shenzhen pilots generating state revenue. Beijing's ETS has generated total revenue of USD 38.67 million (CNY 277.697 million / EUR 35.66 million) since its inception, with revenue reaching USD 22.72 million (CNY 163.06 million / EUR 20.94 million) in 2023. The revenues are credited to the city treasury. The Shenzhen revenues are used for climate mitigation and to supplement the general budget.

3.2.2 Covered emissions, covered sectors

The Chinese national ETS currently only covers direct CO_2 emissions from the power sector (coal-fired and gas-fired power plants, including combined heat and power). It includes 2,257 companies in the power sector with close to 5.1 billion tons of CO_2 emissions per year, accounting for more than 40 per cent of national CO_2 emissions. For an entity to be included in the national ETS, it must generate annual emissions in excess of 26,000 tCO_2.

Under the MEE work plan issued in March 2025, energy-related and process-related CO_2 emissions from the cement, steel and aluminium industries will be integrated into the national ETS. The initial compliance deadline is set for the end of 2025 and will cover emissions generated in 2024. In the case of aluminium production, PFC and hexafluoroethane (C_2F_6) emissions will also be covered by the ETS. The expansion will be implemented in two phases. Phase 1 (2024–2026) is intended to familiarise companies with the national ETS and enhance data quality. covered entities will receive free CEAs for the first compliance year (2024) equivalent to their verified emissions. For 2025 and 2026, allowance allocation will be output-based and intensity-controlled, mirroring the methodology used in the energy sector. Phase 2 (starting in 2027) will seek to enhance the mitigation impact by tightening the emissions intensity benchmarks (ICAP 2025b). This policy reform will integrate an additional 1,500

companies into the ETS, increasing the total covered CO_2-eq to eight billion tonnes.

3.2.3 Caps and allowance allocation

CEAs are currently allocated free of charge through the baseline-and-credit or tradable performance standard (TPS) mechanism, which constitutes the primary market for emission allowances. The allocation primarily relies on output-based benchmarking as the main allocation method (Fischer 2001; Goulder et al. 2022). The benchmarks for annual allowances are determined via a pre-allocation method by the MEE, based on historical CO_2 emission levels, and are adjusted ex-post based on actual production levels in the respective compliance year. Entities received allowances at 70 per cent of their 2018 output multiplied by a corresponding benchmark factor (MEE 2021). Allocation was subsequently adjusted to reflect actual generation in 2019 and 2020. Companies are not required to purchase additional allocations for emissions that occur due to an increase in production. Instead, they receive free allowances proportional to their increase in production volume (Long and Goulder 2023). This approach thereby incentivises efficiency increases rather than a switch from high-emission energy sources to low-emission or renewable sources (ICAP 2025). Currently, four benchmarks are defined within the Chinese ETS: conventional coal plants below 300 MW, conventional coal plants above 300 MW, unconventional coal (such as coal gangue, coal slime and coal water slurry) and natural gas (Karplus 2021). As depicted in Table 1, the benchmarks for all four types were set at more stringent levels in 2023 and 2024 than in the previous compliance period.

Following their distribution via free allocation on the primary market, companies can trade CEAs on the secondary market via the National Carbon Emission Trading Centre, which is managed by the Shanghai Environment and Energy Exchange. If the covered companies' actual emissions exceed their free allocated quota, they must purchase more allowances on the secondary market. If their emissions are lower, they can sell their surplus CEAs. As of January 2024, companies can also offset up to 5 per cent of their verified emissions through the CCER scheme.

In contrast to a cap-and-trade system, the Chinese national ETS deploys a relative cap made up of the sum of individual allowance allocations, which fluctuates based on the actual production of covered entities (ICAP 2024d). According to ICAP, the national cap was estimated at approximately 4,500 $MtCO_2$ in 2019–2020 and 5,000 $MtCO_2$ for 2021–2022 (ibid.).

	Benchmark for electricity generation (tonne of CO_2 (tCO_2) per megawatt-hour (MWh))			Benchmark for heat production (tCO_2 per gigajoule (GJ))		
	2022	2023	2024	2022	2023	2024
Conventional coal plants above 300 MW	0.8177	0.7950	0.7910	0.1105	0.1038	0.1033
Conventional coal plants below 300 MW	0.8729	0.8090	0.8049			
Unconventional coal	0.9303	0.8285	0.8244			
Natural gas	0.3901	0.3305	0.3288	0.056	0.0536	0.0533

Table 1: Benchmark values for the 2022–2024 compliance periods (ICAP 2024c)

Banking and borrowing

Borrowing was temporarily permitted in 2021 and 2022, allowing companies with a shortfall of 10 per cent or more to borrow from pre-approved allowances for 2023. Companies could borrow up to 50 per cent of the shortfall under this mechanism. Since 2023, borrowing from future compliance periods has again been prohibited. Banking is allowed in the Chinese national ETS as a means to increase market liquidity. The final allocation plan for 2023 and 2024 adds a 10,000-tonne baseline allowance, allowing companies to bank up to 10,000 CEAs plus 1.5 times their net sales during this period (ICAP 2024c).

3.2.4 Market stability mechanism

In May 2021, the MEE announced the potential establishment of a market-regulating and protection mechanism. This would enable the MEE to respond to high price volatility, for instance through buy-backs, auctions or by adjusting the rules on CCER use. The necessary triggers and specifics of this mechanism are yet to be defined.

3.2.5 Carbon leakage

Due to liberal free allocation rules, firms are currently protected from having to pay a carbon price for most of their emissions. China has, therefore, not yet introduced any further measures to prevent carbon leakage. However, companies in several Chinese industries may be affected by the EU CBAM, which requires EU importers of certain goods (primarily iron and steel, aluminium, fertiliser and cement) to purchase CBAM certificates equal to their embedded emissions. As one of the EU's key trading partners, Chinese companies would account for approximately 15.3 per cent of all imports into the EU covered by this mechanism (Chen et al. 2025). If goods are already covered with an effective CO_2 price, importers will be able to deduct those from the CBAM certificates they are required to purchase. Details on the carbon price paid in a third country, however, still requires clarification from the EU Commission via implementing acts.

3.2.6 Monitoring, reporting and verification

The MRV system for China's carbon market has developed continuously since 2013 and now covers eight key sectors (Karplus et al. 2020). The MRV framework requires covered entities to monitor their emissions and submit their emission reports by the end of April each year for the previous year. Province-level ecological and environmental authorities are responsible for selecting and paying third-party verification agencies. According to current guidelines, verification must be completed by the end of June and results are to be made publicly available (ICAP 2024d). The only exception exists for the cement, electrolytic aluminium and steel industries, where verification is due at the end of September.

An evaluation framework for the overall functioning of the ETS is currently being developed (MEE 2021). A new regulation entered into effect in May 2024, significantly strengthening penalties for non-compliance, data fraud and market manipulation. Going forward, covered entities that fail to deliver emission data in the respective compliance year will be fined CNY 50,000 to CNY 200,000 (EUR 6,421 to EUR 25,682). Non-compliance will result in fines ranging from five to ten times the market value of the surrender gap, based on the average price in the month before the compliance deadline. In serious cases, the gap will be deducted from the following year's allocation and the government may require the company to suspend their production.

3.2.7 Effects on emissions reduction

Given China's commitment to reach peak carbon emissions before 2030 and reduce carbon emission intensity by 60 to 65 per cent by 2030, this section aims to analyse the trading scheme's efficacy as a means of emissions reduction.

Despite extensive ex-post analysis of China's pilot ETSs has been conducted, few studies have reviewed the effect of the Chinese national ETS on emissions reduction to date. According to the Progress Report on China's National Carbon Market, published by the Chinese government in 2024, the emission intensity of national thermal power generation (CO_2 emissions per unit of electricity by thermal power generation) decreased by 2.4 per cent between 2018 and 2023. Furthermore, the emission intensity of electricity generation (CO_2 emissions per unit of electricity) decreased by 8.8 per cent compared to 2018 (MEE 2024).

However, whether China's national ETS will have a significant effect on emission reduction in its current form remains the subject of considerable debate (CREA 2024). Achieving the carbon intensity and carbon peak targets by 2030 would require a minimum marginal abatement cost of CNY 345/tonne (EUR 45.46/tonne) (Tang et al. 2020). Thus, the current carbon price in China's national ETS is still far from the optimal price for meeting its emissions reduction targets. This limitation is largely attributed to the lack of an overall and declining cap on emissions and the reliance on free allocation as the main allocation method, which ultimately results in carbon prices being too low (Fang et al. 2021). While free allocation is commonly used in the initial phases of establishing an ETS, most countries eventually transition towards an auction-based allocation mechanism. China has indicated its intention to explore the introduction of auctioning (China MEE, 2021a; China, State Council General Office 2021).

3.2.8 Outlook: Future developments

According to the Progress Report on China's National Carbon Market, China will gradually transition towards auctioning as the main allocation method, starting with a combination of free and paid CEA allocation methods, gradually increasing the proportion of the latter. In addition, the Interim Regulation indicates that a centralised cap on emissions should be expected in the future. However, no specific timeline has been set out for its establishment. The MEE also announced an increase in the variety of trading products, trading entities and trading methods, but has yet to provide specifics. (MEE 2024).

In July 2024, the MEE published its draft allocation plan for the power sector for 2023 and 2024 (ICAP, 2024d). In addition to the updated benchmark values, compliance periods will now cover only one year.

As noted in Chapter 3.2.2, China will integrate cement, steel and aluminium into its national ETS, with the initial compliance deadline set for the end of 2025, covering emissions from 2024. The sectoral expansion is expected to increase demand for CCERs, with key emitters allowed to use the voluntary market credits to offset 5 per cent of their total emissions. Looking further ahead, the MEE has indicated plans to incorporate petroleum refining, chemicals, non-ferrous metal processing, building materials, pulp and paper as well as aviation into the Chinese national ETS.

The EU CBAM will come into force from 2026, imposing a levy on a selected number of carbon-intensive imports into the EU, based on the products' embedded CO_2 emissions and the EU emission allowance price. Importers will be able to deduct effective CO_2 prices from the amount of CBAM certificates they need to purchase. The exact mechanism for carbon prices paid in a third country still requires clarification. Since China is one of the EU's biggest trading partners and the largest source of CO_2 emissions embodied in EU import trade, Chinese companies will inevitably be affected by this policy. However, the introduction of CBAM also brings about positive effects. For instance, products with comparatively low carbon emissions gain a competitive advantage over more carbon-intensive goods, thereby contributing to the clean industry transformation. Other key trading partners of China such as Canada, the United Kingdom (UK) and Japan have also proposed or already introduced similar mechanisms to address carbon leakage caused by their carbon pricing instruments.

3.3 Comparison of the EU ETS and the Chinese national ETS

When comparing the EU ETS with the Chinese national ETS, it is important to consider several differences between the two systems when interpreting their implementation and results. Key differences include the fact that ETS development started in China in 2013 with province-level pilot programs, with the Chinese national ETS only starting operation in 2021. By contrast, the EU ETS has been in operation EU-wide since 2005. This study confines its analysis to a comparison between the Chinese national ETS, introduced in 2021, and the EU ETS in its current form. It excludes the provincial pilot programmes due to the limited scope of this analysis. Furthermore, China and the EU have very different historical, political and economic backgrounds. The EU is a union of 27 member states with their own governments, while China has a one-party government. Subsequently, policy decision and implementation processes in the EU differ from those in China: the Chinese government has greater influence over domestic companies than the EU has over companies in its member states. Another important difference is that China has more regulated financial, energy and electricity markets, limiting the potential for market participants to react directly to CO_2 price signals.

Covered emissions and sectors

While the EU ETS covers a number of GHGs across several sectors, the Chinese national ETS currently only covers direct CO_2 emissions from the energy sector. However, China decided to integrate the iron, steel, cement and aluminium industries into its ETS, covering direct CO_2 for all industries, as well as CF_4 and C_2F_6 for the aluminium industry. The final plan was published in the first half of 2025. Starting with a two-year introductory period (2024–2026), the MEE has begun to collect relevant emission data from the respective sectors, aiming to allocate the first round of emission allowances in 2025, covering emissions from 2024.

The EU ETS currently covers CO_2 emissions from the following sectors: (1) electricity and heat generation, (2) energy-intensive industry, (3) domestic aviation (flights within the EEA and flights from the EEA to the UK or Switzerland) and (4) maritime transport (50 per cent of emissions from voyages starting or ending outside of the EU and 100 per cent of voyages within the EU). In addition to CO_2 emissions, it covers N_2O emissions from the production of nitric acid, adipic acid, glyoxylic acid and glyoxal. It also covers PFCs from aluminium production as well as HFCs if they are a byproduct of ETS-covered industries.

From 2027 onwards, the EU ETS 2 will also cover the transport and buildings sectors as well as industrial and energy facilities not yet covered by the EU ETS due to their smaller size.

The inclusion of several sectors and GHG emissions increases the economic efficiency and potential for emissions reductions of an ETS. As shown in Chapter 3.1.2, the EU ETS covered more sectors from the outset (energy sector and energy-intensive industry) than the Chinese national ETS (energy sector). In the second and third trading periods, the EU expanded its coverage to the domestic aviation (from 2013) and maritime transport sectors (from 2024). China is also extending its ETS towards certain energy-intensive industrial sectors (iron, steel, cement and aluminium) between 2024 and 2026. In this context, China could benefit from EU experience regarding administration and MRV modalities, though it can also draw on experience gained from Chinese provincial pilots. When integrating further sectors into an ETS, it is important to consider that pricing emissions in certain sectors can have more direct economic and social impacts for individuals. Measures to ensure social justice should be considered when extending the scope of an ETS, specifically for expansion to cover buildings, road transport and the agricultural sector, given the direct financial impact for citizens.

Allowance cap

While the EU ETS is characterised by its cap and the explicitly defined linear reduction factors that reduce the cap on an annual basis, China has not yet introduced any cap to its ETS. The Chinese national ETS therefore does not provide for a binding reduction path. Instead, an increase of overall emissions within covered sectors is permissible. However, China aims to introduce stricter emissions reduction mechanisms to its national ETS in the future: according to the Chinese State Council, a 'dual-control' system focusing on both CO_2 emission intensity and total emissions is planned for implementation during the 2026–2030 period, indicating a transition towards stricter emission controls by 2030 (State Council of The People's Republic of China 2024).

According to Vollebergh and Corjan (2020), the cap in the EU ETS ensures a "credible and binding reduction of emissions within the ETS sectors", while price volatility can be reduced by introducing mechanisms like an MSR. However, it is important to have sufficient and reliable data on current emissions of firms in order to set an adequate cap. The Chinese pilot phase was, therefore, an important initial step to compile enough information (Narassimhan et al. 2018).

Allowance allocation

In the EU ETS, auctioning is the default allocation method for allowances for the energy sector. However, free allocation based on performance benchmarks (10 per cent of best-performing EU installations) still plays a role for industries under threat of carbon leakage. The EU significantly revised allowance allocation over the different phases to pass on the CO_2 price signal to market participants. Free allocation in the energy sector was abolished in 2013, meaning that electricity generators are now required to purchase 100 per cent of their EUAs on the primary or secondary market. However, most energy-intensive industry actors at risk of carbon leakage currently still receive the majority of their allowances for free. In return, they need to provide proof of certain environmental performance and decarbonisation measures, such as submitting decarbonisation plans and implementing efficiency measures. As explained in Chapter 3.1.5, this free allocation for industries at risk of carbon leakage will be phased out gradually from 2026–2034 while the EU CBAM puts an equivalent carbon price on imports.

In contrast, in the Chinese national ETS, the primary market only consists of free allocation using output-based benchmarking. Therefore, only those companies exceeding the benchmark have to pay an actual carbon price on the secondary market.

In summary, free allocation continues to play a far more prominent role in the Chinese national ETS compared to the EU ETS. This entails several potential drawbacks: according to Weishaar et al. (2022), free allocation distorts the carbon market by suppressing the carbon price, preventing actual price signals that would incentivise emissions reductions from reaching companies, and even leading to windfall profits. On top of this, China misses out on state revenue.

The EU Modernisation and Innovation funds

The EU Innovation Fund is a financial mechanism to support the commercial demonstration of innovative low-carbon technologies in the EU. It is financed through revenues generated by the auctioning of 530 million allowances under the EU ETS. The Innovation Fund targets projects involving renewable energy, energy-intensive industries, carbon capture and storage, and energy storage across all EU member states. By focusing on breakthrough technologies with significant emission reduction potential, it supports both scalability and market uptake. Its structure ensures that ETS revenues are reinvested into transformative solutions.

The EU Modernisation Fund is a financial mechanism to specifically support ten lower-income EU member states in transitioning to GHG neutrality. It is funded by 2 per cent of allowances auctioned under the EU ETS, directly linking climate investment to carbon pricing. The Modernisation Fund prioritises investments in renewable energy, grid upgrades and infrastructure modernisation.

Price development

The price of allowances in the EU has fluctuated: while the average annual price was between EUR 4.30 and EUR 7.60 (CNY 33.49 and CNY 59.19) from 2012 to 2017, prices peaked at over EUR 100 (CNY 778.75) for a short period in 2023. In April 2025, the price was around EUR 66 (CNY 513.98) (Sandberg 2025). In 2023, the price in the Chinese national ETS averaged CNY 79.42 (EUR 10.2) per tonne. In April 2024, it exceeded CNY 100 (EUR 12.84) per tonne for the first time. As shown in Figure 8, the price level in the EU ETS still exceeds that in the Chinese national ETS by a wide margin. Therefore, the EU ETS currently provides stronger incentives for emissions reduction than the Chinese national ETS. However, the price development in the Chinese national ETS over recent years, combined with the government's announcement of its plans to introduce a cap accompanied by auctioning, suggest that the prices in the Chinese national ETS have the potential to increase significantly in the future.

Revenue

In the EU, the revenue generated from auctioning ETS allowances goes to national budgets, the Innovation Fund and the Modernisation Fund (see info box). Since 2013, the cumulative revenue generated by the EU ETS exceeds EUR 200 billion (CNY 1,557.5 billion). In 2023, auctions raised EUR 43.6 billion (CNY 339.5 billion), of which EUR 33 billion (CNY 257.0 billion) was distributed to EU member states. Germany, for instance, received EUR 7.7 billion (CNY 60.0 billion). In terms of the use of these funds, up until June 2023, member states were required to invest at least 50 per cent in climate-related and energy-related projects. As of mid-2023, all revenues must be put towards such green projects.

In contrast, the Chinese national ETS has not implemented an auctioning mechanism to allocate allowances, and so does not generate revenues for the state. At present, auctioning only exists on the regional level, as the Shenzhen and Beijing regional pilots have introduced partial auctioning. Beijing's ETS has generated total revenue of CNY 277.7 million (EUR 35.7 million) since its inception, including revenue of CNY 163.16 million (EUR 21.0 million) in 2023. These revenues are allocated to the respective city treasury.

Market stability mechanism

While the EU established the Market Stability Reserve in 2018 in order to react to high price volatility, China has currently only implemented corresponding mechanisms at the regional pilot scale. Due to the low prices in the Chinese national ETS, and the fact that only very few companies are required to pay this CO_2 price on the secondary market, there has been no need to implement market stability mechanisms so far.

A key challenge for emissions trading systems is that, in contrast to other markets, the number of allowances on the market is determined by regulation or law, which prevents the free adjustment of supply to unexpected changes in demand (European Commission 2024h). Hence, there is an increased probability of exogenous shocks leading to price volatility. Market stability mechanisms aim to address this shortcoming. Another option to tackle price volatility is the introduction of price floors and ceilings to set minimum and maximum levels for allowance prices.

Average European and Chinese emissions trading price
in euro per tonne of carbon dioxide equivalent

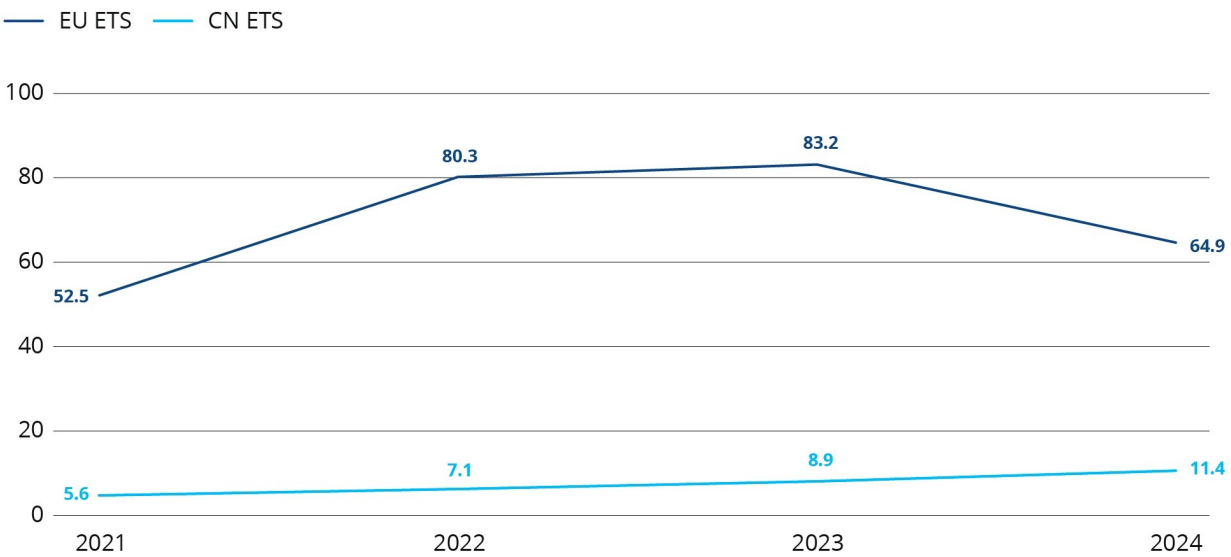

Figure 8: Average European and Chinese emissions trading price. Own figure based on Table Media (2024).

Carbon leakage

To prevent carbon leakage, both the EU and China initially introduced free allocation. In 2026, the EU CBAM will enter into the definitive period and thus increase the steering effect of the CO_2 price for industries at risk of carbon leakage. The CBAM will impose a levy on certain products from carbon-intensive industries imported into the EU. In parallel with this, the free allocation of ETS allowances for those industries will be phased out. Products subject to this new policy are specified in the EU's high-carbon leakage list (EU 2019/708 2019). The CBAM may have impact on Chinese exporters of iron, steel, aluminium, fertiliser and cement. If goods are already covered with an effective CO_2 price in China, importers will be able to deduct this from the CBAM certificates they need to purchase. China has not introduced any further carbon leakage measures to date.

Monitoring, reporting and verification (MRV)

Both the EU and China have MRV systems in place. An annual compliance cycle exists in the EU ETS, while the Chinese national ETS requires covered installations to develop an authorised monitoring plan, including installation information such as activities, emission sources and monitoring methods. In China, the MEE and the provincial and municipal ecology and environmental departments engage third-party verifiers to verify companies' emissions reports. In the EU, third-party auditors also verify emissions in the EU ETS before final oversight by the competent national authorities in each EU member state.

Effects on emission reduction

While it is hard to prove causal effects of an ETS on emission reduction due to various other policies and economic effects, significant emission reductions are evident in the EU ETS, especially for sectors not in receipt of free allocations (see Chapter 3.1.7). Between 2005 and 2023, emissions covered by the EU ETS fell by 47 per cent (European Commission 2024k). For China, most studies investigating carbon pricing effects on emissions reduction to date have focused on the regional pilots. Thus, it is difficult to determine the extent to which the Chinese national ETS contributes to emission reduction – especially as total emissions in China have continued to rise. However, there is some evidence of a decrease in emission intensity: according to the Progress Report on China's National Carbon Market, the emission intensity of national thermal power generation decreased by 2.4 per cent between 2018 and 2023, with the emission intensity of electricity generation falling by 8.9 per cent over the same period (MEE 2024). Huang et al. (2022) concluded that the Chinese national ETS has great potential to reduce carbon emissions. However, compared to the EU ETS, the steering effect of its CO_2 price might be small as the regulated electricity price and dispatch limits the possibility of market participants to react directly to price signals (ICAP et al. 2024).

4 Potential options for the future development of the Chinese national ETS

Building on the comparative analysis, this chapter derives potential options for the future development of the Chinese national ETS. Given that it only commenced operation since 2021, the Chinese national ETS can benefit from experience gained in the EU ETS while also learning from Chinese regional pilots.

4.1 Options for the future scope of the Chinese national ETS

The EU ETS has been an effective instrument to reduce GHG emissions across all covered sectors, achieving the biggest impact in the energy sector. Furthermore, in some sectors, the EU ETS covers several other GHGs in addition to CO_2.

There is potential for China to reduce its emissions, and thus achieve its climate targets, by extending its national ETS coverage to further sectors and GHGs. The decision to integrate the iron, steel, cement and aluminium industries, covering direct CO_2 for all industries as well as CF_4 and C_2F_6 for aluminum production, is a first step in this direction.

Looking to the future, China could prepare steps to further expand its national ETS to domestic aviation, maritime transport and, potentially, the buildings and road transport sectors – as the EU did.

Regarding the integration of further GHGs into the Chinese national ETS, particular consideration should be given to methane (CH_4) and nitrous oxide (N_2O). CH_4 is 25 to 28 times more damaging to the climate than CO_2 and China is its biggest emitter, accounting for 14 per cent of total global emissions. N_2O is a long-lived GHG roughly 270 times more powerful than CO_2 and is responsible for approximately 10 per cent of net global warming (UNEP and FAO 2024). N_2O emissions in China increased by 140% from 1978 to 2015 – a growth rate 1.8 times greater than the rest of the world. These GHGs should therefore be afforded specific consideration. One possible approach may be to start by integrating CH_4 and N_2O into selected sectors already covered by the Chinese national ETS with suitable MRV and compliance conditions, before expanding to other ETS-covered sectors. Another approach could be to integrate CH_4 and N_2O emissions from the outset for potential newly covered sectors, such as maritime transport. In the EU, for instance, the ETS will also cover CH_4 and N_2O emissions in the maritime transport sector from 2026.

Options at a glance:

- Expand the Chinese national ETS to further sectors such as domestic aviation, maritime transport and, potentially, the buildings and road transport sectors.
- If the Chinese national ETS expands to the maritime transport sector, CH_4 and N_2O emissions should be included from the outset.

4.2 Options for the future design of the Chinese national ETS

Setting a cap on emission allowances, and thereby transitioning from intensity-based allocation towards a cap- and-trade system, could significantly increase the efficacy of the Chinese national ETS (Karplus 2021). The cap could be accompanied by a linear reduction factor (LRF) mechanism to ensure an annual cap decrease. China could also derive its cap and the LRF from its own climate targets, as in the EU. This has two advantages: firstly, it ensures a binding emission reduction path in line with China's climate targets. Secondly, it contributes to increased planning security for industrial sectors with long-term investments, such as cement, steel and aluminium, as it provides a predictable emissions reduction pathway and reliably increases the long-term competitiveness of low-emission technologies (ICAP et al. 2024). While China is planning to introduce a centralised cap, the timeline and scope remain unclear. For the CO_2 price signal to develop, and to increase the overall efficiency of the Chinese national ETS, China should also consider further deregulation of its power sector.

Moreover, China may wish to consider transitioning to an auction mechanism. There are two reasons to introduce auctioning. Firstly, it would increase the efficiency of allowance distribution and very likely strengthen the effect of the Chinese national ETS on emissions reduction. According to IEA analyses, introducing a 17.5 per cent share of auctioned allowances in 2030, increasing to a 25 per cent share by 2035, could double China's electricity-related emissions reductions by 2035. This would save an additional 840 million tonnes of CO_2 while retaining the same benchmark tightening (IEA 2024; IEA 2022). Secondly,

as the transformation towards carbon neutrality requires high levels of investment, introducing auctioning would generate state revenues which could then be used to finance climate programmes, support investments or fund programmes to mitigate the economic and social impact of high carbon prices. In the EU, for example, revenues from the EU ETS must be used for energy-related and climate-related purposes and to address social hardship that arose through carbon prices since 2023. The EU Modernisation Fund and Social Climate Fund could serve as models for a Chinese approach. Zao, Wang and Cai (2022) found that carbon pricing without some form of revenue recycling increases income inequality in China. The Chinese national ETS has substantial potential to generate state revenue. In the IEA scenario mentioned above, the introduction of partial auctioning (25 per cent by 2035) would result in an annual revenue stream of around USD 39 billion (CNY 260 billion / EUR 33.38 billion) (ibid.).

Another driver of emissions reduction and ETS efficacy is ensuring an effective allowance price. While low prices impede investments in clean technologies, high prices can put place an excessive financial burden on citizens and companies. If China decides to transition to a cap-and-trade system and further liberalise its power market, an MSR mechanism similar to that in the EU could help to decrease price volatility. However, given China's regulated power sector and the limited flexibility in price formation, a more suitable option could be to introduce auctioning in combination with a defined price corridor. The minimum and maximum price would have to be carefully chosen to avoid jeopardising the emission reductions set by the cap.

Options at a glance:

- Transition to a cap-and-trade system and introduce an LRF mechanism in line with Chinese climate targets.
- Further deregulate the power sector to develop the CO_2 price signal.
- Introduce auctioning to increase emissions reductions and generate state revenue.
- Implement an allowance price corridor that is high enough to reach climate goals but not so high that it places an undue burden on companies and citizens.

5 Conclusion

There are some limitations to the findings and recommendations of this comparative analysis, which result from general and institutional differences between the two ETSs. Firstly, the Chinese national ETS has only been in operation for four years, which limits the available data and research on its effects on emissions reduction. Secondly, the EU and China have different government and market systems. Nonetheless, this comprehensive review of their ETSs' distinct design features offers valuable insights into potential reasons for their differing effects on emissions reduction. With more countries opting to introduce an ETS, both China and the EU have an essential role to play in setting standards, promoting best practices and fostering international cooperation towards global carbon pricing mechanisms.

This comparative study reviewed the policy development, key design features and recently announced policy adjustments of the ETS in the EU and China. It shows that there are several differences in the design features of both systems. Firstly, the EU ETS uses a cap-and-trade approach politically defining a fixed cap on overall emissions in line with EU climate targets, while the Chinese national ETS operates as a baseline-and-credit system using output-based free allocation, combined with a tradable performance standard, and does not place a cap on emissions. This suggests that the Chinese national ETS is currently less effective and achieves less predictable overall emission reductions than the EU ETS.

Bearing in mind the difficulty in proving causality, the analysis suggests that the EU ETS has significantly contributed to large emission reductions within the covered sectors. Since its introduction in 2005, total emissions in the covered sectors have been reduced by 47 per cent. The Chinese national ETS has so far shown a more moderate effect on emission reductions in its shorter history. However, there is evidence of a decrease in emission intensity of entities covered by the Chinese national ETS. According to the Progress Report on China's National Carbon Market, emission intensity of national thermal power generation decreased by 2.4 per cent and emission intensity of electricity generation by 8.8 per cent between 2018 and 2023 (MEE 2024).

A notable strength of the EU ETS lies in its extensive sectoral coverage (energy sector, energy-intensive industry, aviation, maritime transport and, from 2027, buildings and road transport) and its GHG emission coverage, which includes not only CO_2 but also N_2O, HFCs and PFCs from certain industries.

While currently limited to the power sector, the Chinese national ETS has started to expand its scope to several energy-intensive industries, such as cement, iron, steel and aluminium production effective from 2026. This expansion will increase its coverage from 40 per cent to approximately 70 per cent of the country's overall CO_2 emissions.

However, since the Chinese primary market relies fully on output-based free allocation, the carbon prices on the Chinese secondary market for emission allowances currently remain low (averaging EUR 12.6 /tCO_2-eq; CNY 98.0/tCO_2-eq in January 2025) compared to the EU (averaging EUR 76.9 /tCO_2-eq; CNY 598.9 /tCO_2-eq in January 2025). In addition, this carbon price only needs to be paid by a small number of companies exceeding their intensity-based and output-based free allocation. Those companies purchase CEAs from other companies with surplus CEAs, so the Chinese national ETS currently generates no revenue for the state. One way to increase the price signal could be to gradually transition towards auction-based allocation: in addition to increasing the efficacy of the Chinese ETS in terms of emission reduction, this could also generate substantial state revenues, which could be reinvested into climate change mitigation measures. Furthermore, a market stability reserve similar to the EU's could be an effective way to address price volatility once a cap and auctioning are introduced to the Chinese ETS. In the meantime, introducing auctioning in combination with a price corridor could be a feasible way to ensure stronger price signals.

Generally, countries need to consider the fact that emissions embedded in products are not solely a national phenomenon but rather the combined result of decisions taking by multiple actors in global supply chains. As climate policy-induced costs differ between countries, solutions must be developed to expand the price signal of ETSs towards imports from other jurisdictions with no carbon pricing in place, thereby addressing the risks of carbon leakage. The EU took an initial step in tackling this challenge by introducing the CBAM, which will enter fully into force in 2026 and will have implications for numerous Chinese companies exporting to the EU.

Both the EU and China have established MRV frameworks, although differences remain in the specific details of their application. China is expected to align its MRV standards more closely with those in the EU, facilitating compliance with international instruments such as the EU CBAM.

International cooperation and exchange on ETSs represent an important way to improve their efficacy. By analysing the EU and Chinese national ETS, this report hopes to have contributed to that end.

6 List of Abbreviations

C&T	Cap and trade
C_2F_6	Hexafluoroethane
C3S	Copernicus Climate Change Service
CBAM	Carbon Border Adjustment Mechanism
CCER	Chinese Certified Emission Reduction
CEA	Chinese Emission Allowances
CH_4	Methane
CNY	Chinese yuan
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
DEHSt	German Emissions Trading Authority (Deutsche Emissionshandelsstelle)
EEA	European Environment Agency
EEX	European Energy Exchange
ETS	Emissions trading system
EU	European Union
EU ETS	European Union Emissions Trading System
EU ETS 2	Second European Union Emissions Trading System
EU-27	27 European Union member states
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
GJ	Gigajoule
ICAP	International Carbon Action Partnership
MEE	(Chinese) Ministry of Ecology and Environment
MRV	Monitoring, reporting and verification
MSR	Market Stability Reserve

Mt	Megaton
MW	Megawatt
MWh	Megawatts per hour
N_2O	Nitrous oxide
NDRC	(Chinese) National Development and Reform Commission
PFC	Perfluorocarbons
SCF	Social Climate Fund
tCO_2	Tonne of carbon dioxide
TPS	Tradable Performance Standard
UBA	German Environment Agency (Umweltbundesamt)
UK	United Kingdom
UNEP	United Nations Environmental Programme
WMO	World Meteorological Organization

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