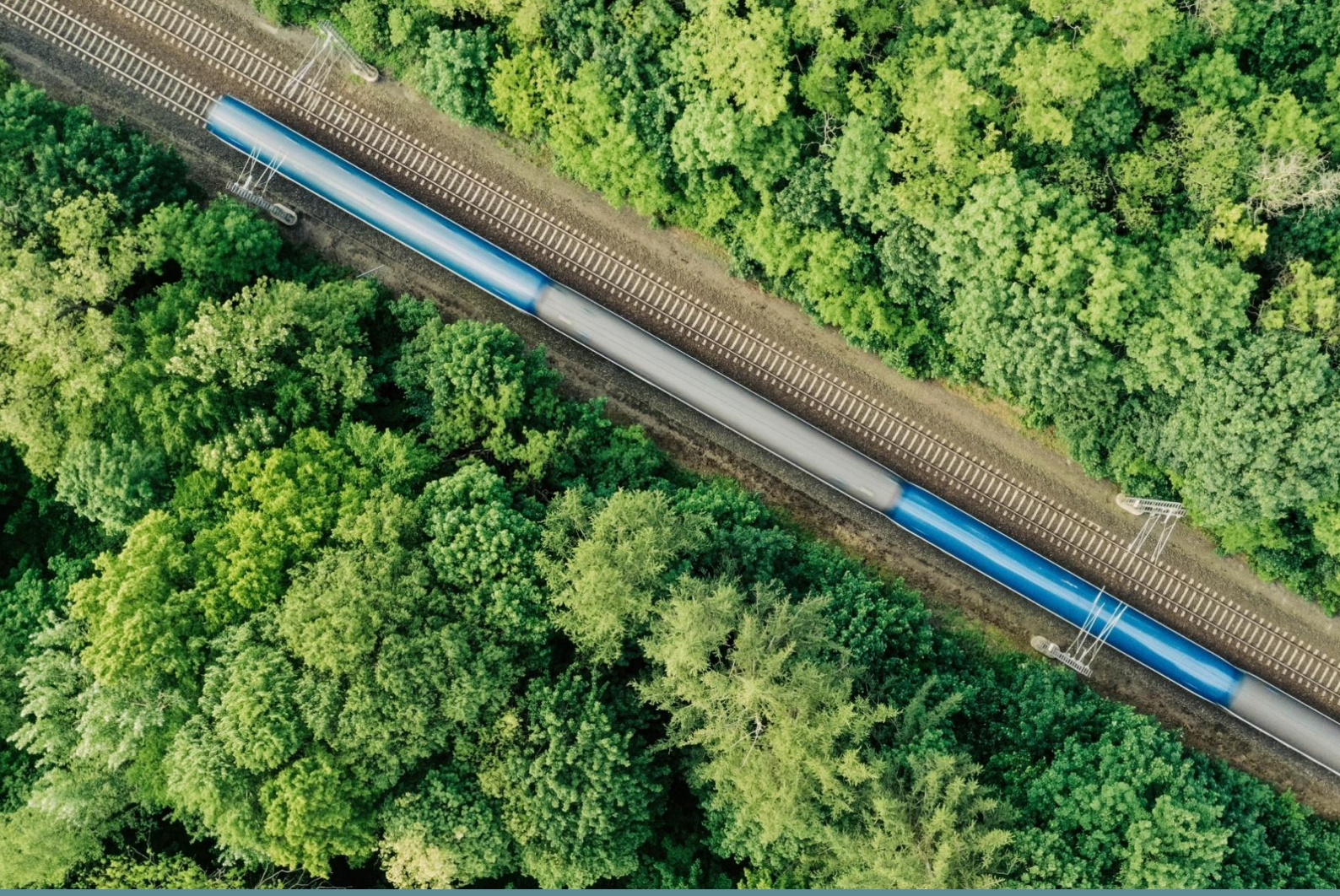


Towards EU climate neutrality

Progress, policy gaps and opportunities

Chapter 10: Pricing emissions and rewarding removals

Assessment Report 2024

European Scientific Advisory Board on Climate Change

Contents

10 Pricing emissions and rewarding removals

Key messages

Achieving climate neutrality requires a policy mix with a sufficiently high, credible and consistent price signal for GHG emissions.

By internalising the externalities of GHG emissions in the market (making the polluter pay), carbon pricing is an effective tool to incentivise producers and service providers to shift towards lower-emission processes, and to incentivise consumers to reduce their consumption of GHG-intensive products and services. It also enables emission reductions to occur where they are most cost-effective. Carbon pricing therefore achieves predefined climate policy goals at the lowest cost ([1]).

Carbon pricing also needs to be complemented by measures to address social impacts and other market failures and to support investments in infrastructure and innovative new technologies, as well as action to prevent carbon leakage (where production and emissions relocate to places not subject to ambitious climate policies). The appropriate complementary measures are different for each sector and policy issue, and are discussed in the other chapters of this report.

In the EU ETS, the carbon-pricing signal needs to be credible so that producers and consumers are empowered to make long-term investments to reduce emissions.

Needs. Carbon pricing systems' efficiency hinges on a stable, long-term regulatory environment to incentivise low-emission investments. Interventions should therefore aim to stabilise expectations about future renegotiations of rules and targets for the carbon market (e.g. price caps, market stability reserve (MSR)), and ideally be based on clear rules.

Gaps. Successive revisions of the EU ETS have increased both the level of the carbon price and its resilience to economic shocks (such as the COVID-19 pandemic). By further accelerating the decline in emissions, the latest (Fit for 55) revision of the EU ETS Directive brings forward the end of the supply of allowances for stationary installations to 2040.

However, there is not yet a clear strategy to prepare the carbon market and relevant sectors for this **(policy gap)**. EU ETS governance, including the existing stability mechanisms, is yet to be adjusted to account for such scarcity of allowances and their effects on allowance price volatility, and ultimately the producers and consumers concerned. The potential contribution of carbon capture and utilisation (CCU) and CDR as well as international linking under the EU ETS is also unclear ([2]).

Recommendation C1. Discussion on carbon pricing in the sectors covered by the EU ETS needs to begin urgently, given the need to provide certainty for long-term investments.

Questions that need to be clarified include the amount and timing of allowances to be issued after 2030; the future design of the MSR; the relationship between EU ETS and other carbon markets, such as the EU ETS 2 and potentially third-country carbon markets; and the appropriate way to incorporate CDR. A very low, or net zero, cap does not require the replacement of a cap-and-trade system when permits for carbon removal can compensate for residual emissions. However, net negative emissions might require

([1]) In this chapter, 'carbon pricing' refers to the pricing of GHG emissions (including non-CO_2 emissions).
([2]) The revised ETS directive (Article 30(5)) requires the European Commission to produce a report on these matters, accompanied by a legislative proposal where appropriate, by 31 July 2026.

new incentive schemes for sustainable removals. The Advisory Board will consider this issue further in future work, including a report on carbon removal, which is planned for publication in 2024.

The risk of carbon leakage needs to be addressed, without undermining the incentive to reduce emissions.

Needs. Successive reviews of the EU ETS have increased the carbon price (to about EUR 90/t CO_2e in recent years), which is projected to increase further towards and beyond 2030. This increases the incentive for emission reductions, but also the **risk of carbon leakage**. EU policies need to adequately address this risk, while maintaining a strong incentive to reduce emissions.

Gaps. The EU's traditional response has been to issue free allowances to sectors considered exposed to the risk of carbon leakage**.** However, several assessments raise concerns that free allocation creates distortions and complexities, and there is uncertainty concerning its overall impact on the carbon market. Free allocation can also reduce the incentive for mitigation action by consumers and downstream industries (see Chapter 5 'Industry', Chapter 6 'Transport' and Chapter 7 'Buildings'). Replacing it with auctioning of allowances, combined with a carbon border adjustment mechanism (CBAM), would restore this incentive. Ultimately, free allocation cannot be sustained in the longer run, as the ETS cap – and therefore the number of allowances available for free allocation – will decline rapidly to reach zero before 2040.

The CBAM is superior to free allocation, as it applies carbon pricing to both domestic and imported products (thereby also maintaining a stronger incentive for demand-side measures), and does not conflict with the projected decline in the ETS cap. However, the CBAM will be only phased in gradually (from 2026 to 2034), does not yet cover all ETS sectors or address the risk of carbon leakage for EU exporters, and might be circumvented switching imports from raw materials to more refined products (which are not covered by the mechanism). Continued issuing of free allowances for some sectors up to 2030 and beyond represents an **ambition gap**.

Recommendation C2. The EU should further develop alternatives to free allocation for addressing the risk of carbon leakage, to maintain adequate protection even when the cap reduces further. To this end:

— the European Commission should monitor the introduction of the CBAM carefully, with a view to expanding it to more products and sectors, as stipulated in the CBAM regulation;
— the EU should in parallel engage in diplomatic efforts to introduce comparable carbon pricing in the EU's major trading partners.

The European Commission should also conduct or encourage further research into the extent of carbon leakage in recent years, the effectiveness of successive EU ETS reforms in preventing it, and potential policy options other than those mentioned above.

The EU ETS 2 (covering fuel use in buildings, transport and additional sectors) will need to be reformed to provide a stronger, more predictable price signal and greater convergence between the two emission trading systems.

Needs. The EU ETS 2 needs to put a price on emissions of GHGs that is high enough and credible enough to spur a target-consistent trajectory of emission reductions in the relevant sectors.

Gaps. While the original EU ETS appears to have reached a sufficiently high carbon price and ambitious trajectory, **it is unclear whether the EU ETS 2 will be stringent enough to meet its target** of reducing emissions by 43 % below 2005 levels by 2030. Modelling studies suggest that the carbon price in these

sectors could reach well in excess of the EUR 45/t CO_2e soft price cap agreed in the revised EU ETS Directive. This would cause additional allowances to be released on to the market, thereby de facto weakening the emissions cap and jeopardising achievement of the target **(ambition gap)**.

Decarbonising these sectors while keeping the carbon price low will require additional measures by the EU and Member States, such as addressing non-market barriers in the transport and buildings sectors (see key messages of Chapters 6 'Transport' and 7 'Buildings'). The coverage of the EU ETS 2 overlaps with the sectors covered by individual Member State targets under the ESR. Therefore, the potential release of new allowances (in response to the soft price cap) will increase the reliance on Member States implementing additional policies (in these or other sectors) in order to achieve their ESR targets (potential **implementation gap**) (see Chapter 14 'Climate governance').

Maintaining two separate emissions trading systems creates distortions and perverse incentives. The EU ETS and the EU ETS 2 have different carbon prices, caps and governance regimes. In the short term, this difference can be justified for pragmatic reasons. The EU ETS has been developing continuously for nearly 20 years, while actors in the buildings and road transport sectors will experience emissions trading for the first time under the EU ETS 2. However, maintaining multiple prices and systems weakens the cost-effectiveness of carbon pricing as a way of encouraging emission reductions where they are least expensive **(policy inconsistency)**. One example of this is electrification of the buildings and transport sectors, which is both encouraged by subjecting fossil fuels in heating and road transport to the EU ETS 2 carbon price and discouraged by subjecting electricity to a (higher) carbon price under the EU ETS.

Recommendation C3. The EU ETS 2 should be reformed for after 2030 to give greater certainty regarding the overall quantity of allowances and strength of the emission price signal associated with fuel use in transport, buildings and the other sectors covered. Including these sectors in the EU ETS (or other options for linking the two systems) should also be considered.

The EU ETS 2 will operate only from 2027 (potentially 2028). Hence, its initial years should be used as a trial period to inform design choices in later trading phases after 2030. Key parameters to monitor will include the level and volatility of the allowance price, the amount of additional allowances released in response to potentially high prices, the functioning of the auctioning, monitoring and reporting systems, the impact on carbon prices and energy taxes at the Member State level, and the system's effect on the uptake of emission reduction measures.

After 2030, the EU ETS 2 should, at a minimum, feature a carbon price high enough to achieve an emission reduction target consistent with the EU's climate neutrality goal, and enhanced credibility so that it is clear to participants whether it will resemble a traditional cap-and-trade system (in which quantity is fixed and prices could be high) or a carbon tax (in which prices are predictable but there is less certainty over the resultant emission reductions).

The European Commission should also propose options for increasing convergence between the two emissions trading systems. Options include creating a single emissions trading system (with a single emissions cap, carbon price and set of governance arrangements ([3])), and more gradual options such as allowing trading between the two systems so that their prices converge over time.

([3]) The ETS Directive (Article 30i) requires the European Commission to report on the implementation of EU ETS 2 by January 2028, and to assess by October 2031 the feasibility of integrating its sectors into EU ETS 1.

Expand coverage of emission pricing to missing sectors, including agriculture and land use.

Needs. All major sources of GHG emissions and opportunities for removals need to be covered by a price incentive to reduce emissions and increase removals.

Gaps. Although the recent Fit for 55 package more than doubles the scope of EU carbon-pricing policies, **some sectors are still not covered by explicit emission pricing (ambition gap / policy gap)**. Plans to include or expand the coverage of carbon pricing (including pricing of non-CO_2 GHG emissions) are at different stages of maturity. There is no EU-level price on emissions in **agriculture/food, forestry** and **land use**, which suffer from an overall lack of incentives to reduce emissions and increase removals (see Chapter 8 'Agriculture' and Chapter 9 'Land use, land use change and forestry'). The European Commission is currently studying ways of introducing some form of emission-pricing mechanism in these sectors. Municipal **waste** incineration may be incorporated into emission trading (in accordance with the ETS Directive), taking into account the risk of diverting waste streams to landfill or third countries. In **aviation**, intra-EU flights are covered by the EU ETS; expansion to extra-EU flights is dependent on further legislation and the development of the international carbon offsetting and reduction scheme for international aviation **(implementation gap)**.

Recommendation C4. The EU should start preparations now with a view to introducing pricing instruments in the agricultural/food and LULUCF sectors, in order to incentivise emissions reductions and carbon removals. These instruments need to take into account the technical complexity of measuring emissions and removals, and attributing them to land management and mitigation actions, as well as differences in the permanence of various natural removals. Discussions on the development of carbon removal certification for land, and pricing of non-CO_2 emissions in agriculture, should therefore explore these complexities, focus on solutions that are scientifically robust and feasible, and convert the solutions into concrete legislative proposals for after 2030. Policymakers will need to pay particular attention to whether land-based carbon removal should be rewarded as part of a system for pricing of non-CO_2 emissions in agriculture, or whether non-CO_2 emissions and carbon removal should be treated separately. They should also take account of the possibility that such carbon-pricing efforts will be affected by emission leakage through international trade (see also Chapters 8 'Agriculture' and 9 'Land use, land use change and forestry').

For international aviation, the EU should ensure that the same carbon price applies to all outgoing flights (including to third-country destinations), whether through the EU ETS, the carbon offsetting and reduction scheme for international aviation (CORSIA) or a combination of the two (see also Chapter 6 'Transport').

Reform energy taxation so that relative price signals are consistent with climate goals.

Needs. Effective carbon prices in the EU today can vary from zero to over EUR 100/t CO_2e, depending on the Member State, activity and fuel use. This can mean that some cost-effective options for reducing emissions are not pursued, while costlier options may need to be considered instead.

A lot of the difference in effective carbon prices is due to implicit carbon pricing (meaning taxes levied for other reasons, such as excise duties). While differences are justifiable (because climate policy is not the only goal of taxation), instances where the tax system actively encourages climate-damaging activities need to be removed.

Gaps. The current ETD permits energy tax differentials that are inconsistent with climate goals. For example, fossil fuels can be taxed less than electricity. In some cases, activities that are not covered by

explicit carbon pricing (such as agriculture and extra-EU flights) can also be exempted from energy taxation entirely **(policy inconsistency)**.

Recommendation C5. The EU should adopt the proposed reform of the ETD and consider further options for aligning taxation and incentives to reduce emissions.

Adoption of the revised Fit for 55 ETD proposed by the European Commission would go a long way towards addressing inconsistencies between energy taxation and climate policy. It would remove exemptions (the ability to tax energy use below established minimum rates), tax fuels based on energy content (rather than volume) and establish a hierarchy whereby carbon-intensive fuels are taxed the most.

Further improvements could be introduced, such as taxing electricity based on the carbon content of the energy used to produce it (this is an option for Member States but not an obligation in the European Commission's proposal).

Carbon-pricing policies need to be complemented by redistributive policies to mitigate adverse social impacts, and by measures to address market failures and support investments in infrastructure and innovative new technologies.

Needs. Carbon pricing provides social benefits by reducing the impacts of climate change and fossil fuel consumption, as well as reducing dependence on fossil fuel imports. However, in most cases carbon pricing is regressive (a heavier burden falls on people with low incomes and certain vulnerable groups). Therefore, it needs to be accompanied by complementary or compensation measures that can alleviate its burden without undermining its effectiveness. These include targeting non-market barriers to reducing emissions (thereby lowering abatement costs and hence the carbon price needed to achieve a given level of emission reduction) and recycling revenues from carbon pricing to make low-emission substitutes available, accessible and affordable for vulnerable groups (see Chapter 11 'Whole of Society Approach'). Carbon-pricing revenues should also continue to fund the development and deployment of innovative new technologies with the aim of bringing their prices down to the point where they would be competitive at the prevailing carbon price.

Gaps. Under the revised ETS Directive, Member States must spend all the revenue they receive from auctioning ETS allowances for climate and energy-related purposes, including the decarbonisation of energy and transport, RD & D of innovative new technologies, energy efficiency, providing support to vulnerable households and compensating sectors exposed to carbon leakage. Nevertheless, **ambition gaps** exist. While the potential revenue from carbon pricing will expand once the CBAM begins to collect payments from 2026, there is no requirement to spend these proceeds on climate- and energy-related purposes. Replacing the remaining free ETS allowance allocations with auctioning would further increase revenues earmarked for energy and climate purposes.

Recommendation C6. Resources for climate and energy-related expenditure should be expanded by ending the free allowance allocation in the EU ETS and requiring revenues collected by the CBAM to be spent for climate- and energy-related purposes.

10.1 Scope and overview

This chapter provides an overview of the role of carbon prices in the EU climate policy mix, and assesses the consistency of the main policies that affect the pricing signal. Carbon pricing in this sense refers to the collection of economic measures that affect the cost of emitting GHGs. It includes both explicit measures designed to reduce emissions (such as the EU ETS) and implicit measures that act as de facto carbon prices (such as taxes on energy).

Other forms of regulation that affect GHG emissions are considered in Chapter 14 on governance, as well as in earlier sectoral chapters. The distributional consequences of carbon pricing (and of climate policies in general) are considered in Chapter 11 on whole-of-society approaches.

10.2 The role of carbon pricing in the policy mix

Carbon pricing as climate policy

There is a consensus in the relevant literature that a sufficiently high carbon price plays an important role in reducing GHG emissions and achieving climate neutrality (ECB, 2022; IEA, 2022e; IMF, 2019; Koch et al., 2022; OECD, 2021). Carbon pricing can incentivise reductions cost-effectively, since it enables the market (both producers and consumers) to identify and exploit the most cost-effective way to reduce emissions. It also incentivises investment in low-carbon technologies, and generates additional fiscal revenues, which can be recycled to finance complementary policies or compensation measures, alongside decarbonisation.

Carbon pricing as fiscal policy

The tax system can be used as a means to correct externalities, hence providing (dis)incentives to induce behavioural change, for example by discouraging smoking, or by encouraging innovation and investment.

When it comes to influencing GHG emissions, some policy measures price emissions explicitly, while others, such as excise taxes on fuel, act as implicit carbon prices. The latter are typically not designed to control GHG emissions in the first place, and are not calculated as a price per tonne of CO_2 equivalent, but nevertheless put a price on emissions at the margin.

Carbon pricing is therefore capable of raising revenue to compensate low-income households or finance green infrastructure while aligning price incentives with climate goals. However, by reducing GHG emissions, successful carbon prices run the risk of undermining their own revenue base in the long term as the economy decarbonises (EEA, 2022g). Therefore, carbon pricing should not be understood as a traditional fiscal instrument, feeding national budgets sustainably with revenue streams. However, carbon pricing can be used together with other fiscal instruments to reduce horizontal and vertical inequality (Hänsel et al., 2022).

Carbon pricing within the EU

In the EU today, carbon pricing is applied through several overlapping measures at both the European and national levels.

The EU ETS is an EU-wide cap-and-trade system, which was created in 2005 following several failed attempts to establish an EU-wide carbon and energy tax (Delbeke and Vis, 2019). At the time (and still today) decisions on taxation required unanimity among Member States, whereas environmental measures such as a cap-and-trade system required only qualified majority approval.

Environmental taxes are not set at the EU level, although they are subject to some common rules as part of the EU's single market, including the minimum tax rates set out in the ETD. However, the ETD has not been revised since 2003, in part because any reforms need to be approved unanimously (EP, 2021).

According to Eurostat data, environmental taxes in the EU consist primarily of energy taxes, although explicit carbon taxes also exist in 14 Member States (Eurostat, 2022a). Environmental taxes represent 5.5 % of government revenues from taxation and social contributions in the EU. While the vast majority of this share (78 % in 2021) comes from energy taxes, revenue from the auctioning of EU ETS allowances represented 6.4 % of total energy tax revenue in 2020. However, the share of environmental taxation in total tax revenue has been falling since 2009 (i.e. revenues have risen more slowly than GDP and overall tax revenue). Environmental taxes are most often levied per unit of physical consumption and are fixed in nominal terms. Hence, their real value tends to fall over time unless adjusted for inflation or gradually adapted (EC, 2021q; Eurostat, 2013).

Carbon pricing combined with complementary policy instruments

While carbon pricing is traditionally acknowledged as the cost-effective way to achieve an emission reduction objective (Jenkins (2014) citing earlier literature), there is an ongoing debate about how ambitious climate targets are best achieved by including carbon pricing within a wider policy mix (Goulder and Parry, 2008; Jaffe et al., 2005; Koch et al., 2022).

Such research indicates that the theoretically cost-optimal solution is not always feasible or sufficient because of market failures, which justify complementing emission pricing with other policy instruments such as standards, bans or subsidies ([4]). Market failures hindering the uptake of potentially cost-effective mitigation options include imperfect information, split incentives ([5]), principal–agent relationships, network externalities or insufficient R & D investments (see Hood (2011) for a more complete overview). Addressing these market failures though complementary measures can therefore improve the effectiveness and reduce the cost of a carbon-pricing regime, by improving the uptake of theoretically low-cost mitigation measures. Examples of other instruments include minimum efficiency standards and labelling, building codes, or policies and incentives for expanding vehicle charging infrastructure.

The need to bring forward and reduce the cost of immature technologies is also often cited as a justification for supplementing carbon pricing with other measures (Kalkuhl et al., 2012). A policy combination can be justified because current societies are locked in to high-emitting technologies in terms of infrastructure, institutions and markets. Furthermore, incumbent emitting technologies have been able to reach very low costs through decades of learning, economies of scale and increasing returns through network effects, which place new technologies at a competitive disadvantage at the beginning of their lifetimes. For example, Stiglitz (2019) points out that high carbon prices may be needed to switch to low-emission technologies, but maintaining them may not require such high carbon prices once these same effects take hold for the new technologies.

Combining carbon pricing with complementary measures can also be justified when there are multiple market failures to be addressed simultaneously (e.g. reduce GHG pollution, encourage innovation, address distributional concerns, raise revenue). For example, Kalkuhl et al. (2013) demonstrate a second-

([4]) 'Market failure' means when decisions based on market prices do not generate an efficient allocation of resources because of market distortions such as externalities. Externalities are costs or benefits incurred by third parties by production or consumption. Pollution is an example of a negative externality. Education is an example of a positive externality (because it benefits society as well as the individual student).

([5]) 'Split incentives' means when the costs and benefits of an action accrue to different people, for instance in the building sector, where renovations would be the responsibility of the landlord, but the benefits in terms of energy savings would accrue to the tenant.

best situation in which carbon pricing is effective in reducing emissions, while a complementary renewable energy subsidy limits the resultant energy price increase. Some authors (e.g. Stiglitz, 2019) raise concerns about the level of carbon prices because of their political consequences. Some command-and-control regulation can lower the level of explicit carbon tax required to achieve a given emission reduction, and thereby reduce the adverse distributional consequences of the tax. However, the overall economic costs – often hidden – will increase and have to be paid by consumers or producers.

Use of revenues from carbon pricing

Targeting the use of carbon-pricing revenues is one way to combine the price-incentive effect of carbon pricing with other objectives (such as redistribution to low-income groups, or funding innovation). This is also a core feature of the EU ETS. In the Fit for 55 revision of the ETS Directive, Member States are required to spend their share of the revenues from allowance auctioning on climate- and energy-related purposes, which can include investing in decarbonisation of energy and transport, R & D and energy efficiency, providing support to vulnerable households or transport users, and compensating sectors exposed to carbon leakage (EU, 2023c) ([6]). In addition, a share of allowances is managed at the EU level (rather than by Member States) for improving energy efficiency and modernising energy systems in lower-income Member States (Modernisation Fund), and supporting innovation in low- and zero-carbon technologies (Innovation Fund). The new EU ETS 2 features a Social Climate Fund to be spent by Member States on similar purposes (including temporary direct income support for vulnerable households and transport users), funded by a combination of auctioning revenues and national co-financing.

Following the revision of the ETS Directive, there are two remaining opportunities for increased revenue recycling in EU carbon-pricing policies. Firstly, there is currently no requirement for Member States or the EU to spend CBAM revenues on energy and climate-related purposes (although a recital in the CBAM regulation mentions the need for the EU budget to support adaptation in least developed countries) (EU, 2023n). Legislation on the use of the EU's own resources ([7]) created by the CBAM is still being debated but, at the time of writing, does not contain such a requirement (EP, 2023). Secondly, replacement of free allocation in the EU ETS by auctioning, would create additional revenues to be used for climate- and energy-related purposes.

Data covering 2013–2020 indicates that Member States spent 75 % of their auctioning revenues on climate- and energy-related purposes between 2013 and 2020. However, five Member States did not meet this requirement individually (EEA, 2023q).

Carbon pricing under Fit for 55

The de facto approach to carbon pricing in the EU and its Member States has also been to integrate explicit carbon pricing into a broader portfolio of climate and non-climate policies, taxes and subsidies. With the proposals of the European Green Deal, the EU is attempting to expand carbon pricing to areas not already covered. The rest of this chapter considers carbon pricing under the Green Deal, in particular the EU ETS, the EU ETS 2 and the reform of the ETD.

([6]) 'Carbon leakage' refers to the displacement of emissions to regimes outside the EU where climate governance is laxer. According to the directive, Member States must seek to limit compensation to leakage-exposed sectors to 25 % of the revenues or below (and provide justification if this share is higher). The list of eligible spending areas is in Article 10(3) of the ETS Directive.

([7]) EU 'own resources' are sources of revenue for the EU budget (as opposed to carbon-pricing revenues that can be spent by Member States).

10.3 EU Emissions Trading System (energy supply, industry, international transport and maritime)

The EU ETS has been the EU's climate flagship policy since 2005. Since then, it has been revised multiple times, resulting in an extended scope, a more ambitious emission cap, more stringent allocation rules and increased recycling of auctioning revenues for climate purposes. The latest revision of the EU ETS was concluded in 2023, based on the European Commission's proposal under the Fit for 55 package. It had the following key outcomes.

- **Extension of the system to the maritime sector, to be concluded by 2026.** Furthermore, the European Commission is mandated to consider the extension of the system to waste incineration by 2026, with a view to include the sector as of 2028.
- **Further tightening of the emissions cap.** This is to be done both by increasing the annual linear reduction factor (from the current 2.2 % to 4.4 % by 2028) and by imposing two one-off reductions in 2024 and 2026. As a result, the current directive would reduce the cap to zero by around 2040.
- **Adjusting the MSR**. The MSR consists of ETS allowances that have been withdrawn from the market but can be released back into it under certain conditions. The latest adjustments include maintaining the current ('accelerated') rate at which allowances enter the MSR, capping the maximum size of the MSR at 400 million allowances from 2024, and gradually invalidating excess MSR allowances above that level (EU, 2023b).
- **Gradual transition from free allocation to a carbon border adjustment mechanism (CBAM) for specific sectors.** The aim is to shield the relevant sectors against the risk of carbon leakage.
- **More rapid phase-out of free allocations for the aviation sector.** This is to be implemented by 2026.
- **Changes to the distribution of auctioning revenues.** These include an increase in the volumes of the Modernisation Fund and the Innovation Fund, and a requirement for Member States to spend all of their auctioning revenues (or an equivalent amount) on climate- and energy-related purposes.
- **Creation of EU ETS 2, a parallel emissions trading system for buildings and road transport and other sectors.** This is discussed in Section 10.4.

The progressive tightening of the EU ETS cap, together with other reforms, has caused the carbon price to increase considerably over time, from EUR 5/t CO_2e in the mid 2010s to EUR 80–90/t CO_2e in recent years. It has remained at higher levels despite external shocks such as the COVID-19 pandemic and the energy crisis in 2021–2022 (Bruninx and Ovaere, 2022; Pahle et al., 2023). As a result, the incentive that the EU ETS provides for GHG emission reductions is stronger now than ever before.

Continued effort is needed to combat carbon leakage without undermining the carbon price signal.

While auctioning is the default allocation methodology under the EU ETS, a substantial proportion of EU ETS allowances (48 % of total supply in 2013–2020) are allocated for free, mainly to sectors that are considered to be exposed to the risk of carbon leakage (EC, 2023g).

The rationale behind free allocation is that these sectors are considered unable to pass on the cost of the EU ETS to their customers downstream in the value chain without losing competitiveness and thus market share to non-EU producers that do not face a comparable carbon cost ([8]). As a result, the EU ETS could lead to displacement of production (and related GHG emissions) to outside the EU. To prevent this, ETS firms in certain sectors are given a certain amount of allowance (based on benchmarks) for free.

([8]) This applies both to EU firms that are competing on the EU market with non-EU producers that import their products into the EU and to EU firms that export their products and are competing with non-EU producers outside the EU.

This should reduce the actual carbon cost they face, thereby reducing the need to pass this cost through to their customers.

Free allocation therefore risks weakening the incentive for demand-side mitigation measures (such as improved material efficiency or material substitution) by reducing the need for firms to pass through the ETS cost through to their customers. In addition, several assessments have suggested that free allocation creates distortions in the carbon market, the extent of which continues to be debated in the literature. There is debate over whether or not free allocation affects firms' production and mitigation decisions (Teixidó et al., 2019; Venmans, 2016; Zaklan, 2023), and over the extent to which it has enabled windfall profits through over-allocation of allowances or passing carbon costs on to consumers (Cludius et al., 2020; Neuhoff and Ritz, 2019).

Recent EU ETS reforms extended the use of free allocations into trading phase IV (2021-2030). The revision introduced more dynamic allocation benchmarks by aligning free allowances with actual production levels. Still, substantial free allocations are permitted to continue until 2030. For 2021–2030, sectors that are considered exposed to the risk of carbon leakage (and thus eligible for continued free allocation) account for 94 % of total industrial GHG emissions under the EU ETS (EC, 2019e), and over 40 % of the aggregated ETS cap is projected to be allocated for free (ECA, 2020b) ([9]).

In the first two phases of the EU ETS (up to 2013), the scientific literature did not find significant evidence of carbon leakage caused by the EU ETS (Cludius et al., 2020; Hintermann et al., 2020; Verde et al., 2019). However, studies that include more recent data do find (non-causal) evidence of carbon leakage (while confirming the lack of such effects prior to 2013). A study by the European Central Bank (ECB) (2023a) observes that emission reductions in EU ETS industries within the EU were more than offset by a simultaneous rise in emissions from the same industrial sectors outside the EU, and that sourcing high-emission inputs from within the EU translates into a competitive disadvantage. Similarly, De Beule et al. (2022) found (non-causal) evidence of investment leakage, meaning that multinational enterprises respond to more stringent climate policy by investing outside the EU. The risk of carbon leakage strongly depends on the development of climate policies in other major economies outside the EU. In that respect, it is positive to note that uptake of cap-and-trade systems and carbon taxes is increasing, including in emerging economies (World Bank, 2023). Furthermore, there is some evidence that the adoption of carbon pricing in one country can explain the subsequent adoption of carbon pricing in other countries (Linsenmeier et al., 2023).

To further address the risk of carbon leakage, the EU adopted the CBAM that will start to operate as of 2026. Under this mechanism, a price equivalent to the ETS price is put on imports of certain carbon-intensive products and their precursors ([10]) into the EU. It will be phased in gradually between 2026 and 2034, with a corresponding phase-out of free allocation for the same products under the EU ETS ([11]). For sectors that are exposed to the risk of carbon leakage but not (yet) covered by the CBAM, free allocation will continue. This means that free allocation will coexist with the CBAM, and a substantial share of the allowances under the EU ETS cap is still expected to be allocated for free until at least 2030.

The newly adopted CBAM could reduce carbon leakage by ensuring that both domestic production and imports face a carbon price (meaning that all suppliers to the EU market have an incentive to reduce emissions). Its introduction – combined with a corresponding phase-out of free allocation – would also provide a stronger incentive for demand-side mitigation measures (e.g. material efficiency or substitution), as it would ensure that the carbon cost is passed down the value chain.

([9]) Before taking into account the impact of the CBAM, which is expected to reduce this share.

([10]) Cement, iron and steel, aluminium, fertilisers, electricity and hydrogen.

([11]) For example, in 2026, a carbon price will be levied on imported steel based on 2.5 % of its climate impact, and the amount of allowances allocated to EU steel producers will be decreased by an equal 2.5 %. This share increases to 5 % in 2027, 10 % in 2028, 22.5 % in 2029, 48.5 % in 2030 and so on, to reach 100 % by 2034.

On the other hand, even with the introduction of the CBAM, removing free allocation could place EU exporters at a disadvantage if they are competing in third-country markets against firms that are not subject to a carbon price (Evans et al., 2020). Furthermore, both the European Commission (2023f) and the ECB (2023a) point out that it may be necessary to expand the CBAM's coverage further downstream. Otherwise, there may be an incentive to avoid the carbon price by switching from importing raw materials to importing more refined products. To this end, the product scope will be reviewed during the scheme's transitional phase.

Because of the rapid decline of the ETS cap – which is expected to reach zero before 2040 – the allowances available for free allocation will become more and more scarce. This means that in any case the EU needs to consider further alternatives to free allocation to address the issue of carbon leakage. One option is a further extension of the CBAM, which has the additional advantage that it can sharpen incentives to reduce emissions (Jakob, 2023). However, this would still leave the issue of EU exporters unresolved. This underlines the need for (i) climate policies to encourage innovation, scale-up and cost reduction for zero emission technologies so that they become the more competitive choice; and (ii) the EU to pursue diplomatic efforts to encourage carbon pricing in the EU's trading partners and ensure a level playing field and strong mitigation incentives for both imports and exports.

Preparations must start now to make the EU ETS fit for 2040.

With the Fit for 55 revision of the EU ETS Directive, the emissions cap is expected to reach zero by 2039 ([12]). Specifically, the increase in the emissions cap's annual linear reduction factor, eventually to 4.4 % from 2028 onwards, and the lack of a sunset clause for this provision, combined with the invalidation of allowances held in the MSR above a level of 400 million (equivalent to 31 % of verified EU ETS emissions in 2022) ([13]) are decisive reform elements.

Still, both the European Commission's long-term scenarios and the scenarios underpinning the Advisory Board's 2040 advice indicate considerable residual GHG emissions in 2040 in sectors covered by the EU ETS (in particular in industry and in international aviation and maritime transport), which means demand for allowances will not reduce to zero.

This brings the 'endgame' of the EU ETS in sight, raising questions about how governance and stability mechanisms must be adjusted to account for trade frictions under low liquidity (Pahle et al., 2023).

The possible consequences of the latest revision (assuming there are no further reforms of the EU ETS governance) are explored by Pahle et al. (2023). They include more rapid emission reductions and banking of allowances as participants anticipate the future scarcity of allowances. In an optimistic outcome, this could drive investment in green technologies, thereby reducing the demand for allowances. However, considering potential impacts beyond modelling, the price of allowances could become increasingly high and volatile, calling the political credibility of the ETS into question.

There are numerous options available to policymakers for avoiding the outcome described above. In principle (and without prejudging future advice of the Advisory Board or forthcoming political discussions) these could include the following.

— **Increasing liquidity.** This could be done by expanding the scope of the EU ETS, for example by including smaller operators and other sectors (such as agriculture and waste, or linking with the new

([12]) The 2039 extrapolation excludes aviation.

([13]) The ETS Directive establishes the 'invalidation' of allowances above 400 million, but also stipulates that legislators could revise this in the light of a hypothetical European Commission proposal based on the annual review of the functioning of the European carbon market.

EU ETS 2 covering transport and buildings); or by linking to emissions trading systems elsewhere in the world (FTI consulting, 2023; Ferrari, 2023; Pahle et al., 2023).

— **Incorporating CDR into the ETS.** This will require a governance framework that balances the need to scale up carbon removal technologies against the risks associated with relying on these technologies and the risk of crowding out emission reduction as the primary means for achieving climate neutrality (Strefler et al., 2021) ([14]).
— **Further regulatory changes.** These may include adjustments to the cap or MSR, shifting to a more price-based approach by introducing floor and ceiling prices, or replacing the EU ETS with a carbon tax.
— **Establishment of a carbon central bank.** It could perform some combination of all the above, with the intention of keeping carbon prices or net emissions within a trajectory consistent with EU policy goals (Edenhofer et al., 2023; Rickels et al., 2022).

By agreeing to a steeper, stricter emission reduction path, the latest revision of the ETS Directive has ushered in the endgame of the ETS and placed it within current investment horizons. This in turn increases the urgency of addressing questions around the future of climate governance, in particular the EU ETS, in a credible way (Dolphin et al., 2023). The next scheduled review of several of the abovementioned issues related to the EU ETS Directive and the MSR is due in (July) 2026, and further assessment of the different options for post-2030 governance needs to start now. The Advisory Board will contribute to this in future work, including its upcoming report on carbon removal, which is planned for publication in 2024.

10.4 EU Emissions Trading System 2 (buildings and road transport)

The revised ETS Directive creates a separate EU ETS 2 for buildings and road transport and additional sectors (mainly smaller industry) (EU, 2023c). By introducing an additional emissions trading system, the EU has significantly enhanced its policy architecture; EU carbon pricing, and monitoring and reporting of emissions are expanded to additional sectors; and additional fiscal revenues will be generated by auctioning emission allowances issued under the new system. This in turn enables further spending on climate- and energy-related purposes (including support to vulnerable groups through a dedicated Social Climate Fund). However, design features of the system make it difficult to predict its contribution to achieving the EU's 2030 climate target. Most of this difficulty relates to uncertainties related to the soft price cap set at EUR 45/t CO_2e in the initial years of the system.

The EU ETS 2 expands the coverage of carbon pricing.

The EU ETS 2 will become operational in 2027 (or 2028, in the event of exceptionally high fuel prices), with data collection and reporting starting in 2025. In the impact assessment accompanying the original EU ETS 2 proposal, the European Commission stated that the EU ETS 2 should operate as part of a broader policy mix to decarbonise the transport and building sector, given the existence of non-market barriers such as split incentives, lack of information and lack of access to finance (EC, 2021al). EU co-legislators have therefore decided that, at least until 2030, the sectors covered by the EU ETS 2 will also continue to be covered by the ESR, thereby supporting Member States in meeting their ESR targets.

The implementation of an EU-wide carbon-pricing mechanism in the road transport and buildings sectors is an important step forward, which is expected to drive further GHG emission reductions. As

([14]) CO_2 that is captured and stored geologically is exempt from the requirement to surrender EU ETS allowances (according to Article 12 of the EU ETS Directive). The Fit for 55 revision of the directive extends this exemption to GHGs that have been captured and utilised, mandating the European Commission to develop implementing legislation on how to ensure that the utilised GHGs do not enter the atmosphere.

pointed out by the German scientific platform on climate protection (WPKS, 2022), it strengthens climate governance in several different ways compared to having these sectors are governed only by national measures contributing to ESR targets. Firstly, the EU ETS 2 provides direct incentives to lower emissions by means of the price signal. Secondly, it introduces a compliance mechanism that reduces the reliance on each Member State's bespoke policies and measures as an incentive for reducing emissions, and on the ESR compliance procedure (see Section 14.2).

The EU ETS 2 carbon price is uncertain.

The emissions cap and auctioning of allowances in the EU ETS 2 will be calculated so as to achieve a 43 % emission reduction in regulated sectors (combined) by 2030 (compared to 2005 levels). This is consistent with these sectors' contribution to an overall 55 % emission reduction target as per the European Commission's MIX scenario (EC, 2021c). In the buildings and road transport sectors, there is considerable uncertainty about price elasticities and future market developments, and it is not clear *ex ante* how actual prices may develop. The original European Commission proposal estimated allowance prices of between EUR 48 and EUR 80, with the lower estimate assuming there are more complementary emission reduction measures to accompany the carbon price (EC, 2021c). However, other studies suggest a carbon price of EUR 200–300 in the absence of sufficient accompanying measures (Abrell et al., 2022; Agora Energiewende, 2023; Rickels et al., 2023).

Price formation under the EU ETS 2 is regulated in several ways, either using a rule-based procedure or by direct intervention of the European Commission. To prevent sudden price peaks in the starting phase of the system, auction volumes will be frontloaded (130 % of volumes for 2027). The frontloading mechanism is 'cap neutral', as quantities will be deducted from auctioning volumes between 2029 and 2031. Additional allowances will be released if the allowance price exceeds EUR 45/t CO_2e for two consecutive months (the soft price cap in initial years of the system). These additional allowances will come from a separate MSR, which will be endowed initially with 600 million allowances (equivalent to 80 % of the sectors' target-consistent emissions for 2030 ([15])). Unlike the EU ETS, for which surplus allowances already in circulation were placed in the MSR, the initial reserve for the EU ETS 2 will contain allowances that are additional to the quantity calculated to be consistent with the 43 % reduction target.

It is also not clear how many allowances will be released on to the market if the soft price cap is exceeded. According to the directive, the first triggering of the cap would result in the release of 20 million allowances (equivalent to 3 % of the sectors' target-consistent 2030 emissions[15]). Additional tranches of 20 million, 50 million or 150 million allowances could be released on to the market several times depending on how allowance prices develop (explained in the directive's Article 30h).

There are significant risks to the EU's climate targets and social compatibility.

If the EU ETS 2 fails to meet its 43 % reduction target, there is a considerable risk that the EU will fail to reach its 2030 target under the ESR. This places pressure back on Member States to address the shortfall by adopting further national policies and measures in ESR sectors, either in transport and buildings or in other sectors such as agriculture and land use. The ESR features a flexibility mechanism, which grants Member States the option to sell any surplus of their reductions under the ESR sectors to others to efficiently achieve compliance. However, it is unclear *ex ante* whether sufficient annual emission allocations will be available to fill potential emission gaps, in particular given ESR's slow-acting and relatively weak compliance mechanisms (see Section 14.2).

([15]) See Table 46 of European Commission (2021c).

In this context, Member States that already have ambitious carbon prices covering EU ETS 2 sectors should maintain them, since this would help mitigate the risks of not meeting national obligations under the ESR and increase the predictability of investment decisions. Furthermore, the introduction of the EU ETS 2 will reduce the risk of intra-EU carbon leakage by placing an EU-wide floor on the level of ambition.

If the EU ETS 2 prices reach the higher end of price projections, the distributional impacts of uncompensated carbon pricing can be significant. In the course of the Fit for 55 package, the EU has decided to establish a Social Climate Fund to mitigate adverse effects of the EU ETS 2 on vulnerable groups (see Section 11.4 for a detailed explanation). Each Member State is eligible for a specified maximum share of Social Climate Fund funding based on a 'solidarity' formula (EU (2023l), Annex I). However the size of the fund is capped at EUR 65 billion, irrespective of the value of the carbon price. While the Social Climate Fund has been broadly welcomed by stakeholders (EurActiv, 2023), it remains unclear at this stage whether the combination of the fund and national auction revenues will be sufficient to balance distributional concerns and vulnerability issues in the EU ETS 2 context (Pahle, 2023).

The underlying logic of having two separate emissions trading systems merits revisiting beyond 2030.

As discussed above, the EU will, from 2027, operate two separate emissions trading systems, each with separate carbon prices, caps, allowance allocation methods, and systems for managing the price or quantity of allowances. This appears suboptimal, since the underlying logic of carbon pricing is to allow the market to identify and incentivise the most cost-effective emission reductions wherever they might be. One example of this is electrification of the buildings and transport sectors, which is encouraged on the one hand by subjecting fossil fuels in heating and transport to the EU ETS 2 carbon price, but discouraged on the other hand by subjecting electricity to a (probably higher) carbon price under the EU ETS.

There may be political, economic and administrative reasons for maintaining separate carbon markets at least in the short term. These include the fact that EU ETS is a tried and tested system that has been refined over nearly 20 years, while emissions trading may be new to the participants in the EU ETS 2. Furthermore, price changes in the buildings and transport sectors may be more salient to consumers than in the EU ETS sectors (since consumers purchase both heating and transport fuel directly). This provides a political (and distributional) rationale for policymakers' decision to introduce the EU ETS 2 in a more gradual manner, in particular given uncertainties over the EU ETS 2 carbon price and the likely success of policymakers in reducing it through complementary mitigation measures in these sectors.

However, the case for maintaining separate markets is likely to weaken over time, firstly because policymakers and the public will gain experience of operating the EU ETS 2, and secondly because (other things being equal) the EU ETS cap will shrink towards net zero (or net negative emissions), placing a very high price on some carbon emissions and causing attention to shift to the sectors that continue to emit. Options for merging the two markets include the creation of a single emissions trading system (a single price, cap and set of governance arrangements). Alternatively, policymakers could consider more gradual convergence options involving linking (the possibility of importing allowances from one system to the other under certain conditions) (Edenhofer et al., 2022).

10.5 Energy Taxation Directive

Taxation of the embodied emissions in energy varies across Europe.

Effective carbon prices within the EU (the prices created by fuel excise taxes, carbon taxes and emission allowances combined) can vary widely between Member States and between different sectors and applications. This is mostly because taxation is decided primarily at the Member State level, and partly because taxation serves numerous policy objectives apart from climate policy goals.

While a comprehensive survey of effective carbon taxes within the EU is beyond the scope of this chapter, a number of key characteristics are noted here.

- There are **substantial differences in effective carbon taxation between Member States and between sectors**. Transport fuels (diesel and petrol) face relatively high implicit carbon prices compared with other sectors, ranging between Member States from less than EUR 150/t CO_2 to over EUR 350/t CO_2 (Matthes and Graichen, 2022). These prices consist overwhelmingly of excise duties rather than explicit carbon taxes (OECD, 2023a). However, there are numerous sectoral reductions and exemptions. For example, agriculture and energy-intensive industries pay the least tax relative to the amount of energy they consume (Trinomics, 2020).
- **Explicit carbon taxes are levied in 14 Member States** according to Eurostat (2022a), while the European Commission estimates that 7 Member States have carbon taxes covering the buildings and transport sectors, with prices in 2020 ranging from EUR 19 to EUR 115 per tonne of CO_2 (EC, 2021c)
- **Tax rates sometimes favour carbon-intensive choices.** For example, effective carbon rates for coal are much lower than the rates for gasoline and diesel quoted above. Although most coal uses are subject to explicit carbon pricing under the EU ETS (around EUR 90 at time of writing), excise duties for coal are much lower (ranging from EUR 0 to EUR 25/t CO_2) (OECD, 2023a). Similarly, electricity is taxed more highly than gas per kWh (Rosenow et al., 2023).

The ETD aims to harmonise tax levels but is not aligned with the EU's climate objectives.

The Energy Taxation Directive (2003/96/EC) sets minimum taxation levels across Europe to ensure that the internal market can function effectively. It was introduced in 2003 with one of its main objectives being to harmonise energy taxation, avoid the distortions between different energy carriers (such as gas and electricity) and avoid energy tax competition across Europe. This harmonisation is ultimately aimed at strengthening the internal market by addressing possible distortions from the relocation of energy-intense businesses to beneficial tax regimes.

In 2011, the European Commission proposed to restructure the ETD to reflect both energy content and emissions. Following 4 years of unsuccessful negotiations, the proposal was withdrawn, as Member States were unable to reach a unanimous agreement. In 2019, the European Commission published an evaluation report on the ETD (EC, 2019b), concluding that energy taxation can be an important part of the economic incentives that steer energy transition. Considering the need for an updated ETD, the Council invited the European Commission to analyse and evaluate potential options, with a view to publishing a proposal for a revision.

The European Commission's proposal to update the ETD aims to address this misalignment.

In 2021, as part of the Fit for 55 package, the European Commission proposed a revision of the ETD to 'remove outdated exemptions and reduced rates that currently encourage the use of fossil fuels' (EC, 2021ai). It would introduce a new scale of tax rates based on the energy content and environmental

performance of the fuels and broadens the tax base to include more products in its scope, such as electricity, hydrogen and sustainable biofuels. Some of the main changes can be summarised as follows.

— Fuels and electricity would be taxed according to their energy content and environmental performance, rather than their volume. This change aims to help consumers to make more climate-cautious choices.
— A simpler product categorisation would be introduced, to simplify taxation and ensure that the most harmful fuels are taxed in the highest tax band.
— Exemptions for certain fuel uses, such as home heating, would be phased out, and so would the option for Member States to tax agricultural energy use at zero, thereby removing the possibility of taxing fossil fuels below specified minimum rates.
— Fossil fuels used for intra-EU transport by air or sea should no longer be exempt from energy taxation.

The proposal would tax energy use and price GHG emissions with a wider scope than the current ETD. One of the main challenges is to find ways to align EU-wide energy taxation with climate policy objectives. Low tax rates on fossil fuels increase the relative cost of switching to cleaner technologies and can delay the energy transition. According to the proposal, conventional fossil fuels (i.e. petrol, gas, oil) will be subject to the top minimum rate of EUR 10.75/GJ when used as motor fuel and EUR 0.9/GJ when used for heating. The next category applies to fuels such as fossil gas and liquefied petroleum gas, which will be taxed at a lower rate for a transition period of 10 years. In this transition period, a minimum rate of EUR 7.17/GJ will be charged when they are used in transport and EUR 0.6/GJ for heating. After the 10-year transition period, they will be taxed at the same rate as conventional fossil fuels. Electricity will be taxed at the lowest minimum rate, EUR 0.15/GJ, regardless of its use ([16]). Low-carbon hydrogen can also benefit from the same rate for a transition period of 10 years (EC, 2021z).

The European Commission proposal builds on the *ex post* evaluation of the ETD in 2017, which, in line with the better regulation guidelines, assessed the performance of the directive against the basic principles of relevance, effectiveness, efficiency, coherence and EU added value (EC, 2019b). The evaluation identified significant shortcomings in both the directive and its implementation. On effectiveness (i.e. progress made towards achieving policy objectives), the ETD was found to have made only a limited contribution to smooth functioning of the internal market, given the absence of an indexation mechanism and the multiple exceptions granted in certain industries. In terms of relevance and coherence, the ETD shows a gap between the needs of EU climate targets and the objectives the ETD was designed to address back in 2003 (for example, it enables electricity to be taxed more highly than fossil gas). The potential of synergies from the alignment of fiscal polies with policies in the domains of energy and transport remains unexploited. In the meantime, policy gaps and inconsistencies in implementation hamper the achievement of EU climate objectives.

Without a revision, the ETD undermines the effectiveness of the EU's carbon-pricing regime.

At the time of the writing of this report, progress on the revision of the ETD is limited, in part because of the requirement for revision to be approved by unanimity among Member States (as opposed to the qualified majority required for most Fit for 55 legislation). As previous sections of this chapter point out, taxes are not the only type of carbon price signal operating in the EU, and the Fit for 55 package should see a deepening and extension of explicit carbon pricing in several sectors. Nevertheless, the ETD in its current form enables the continuation of energy tax rates that run counter to the EU's climate goals by

([16]) Article 13 of the proposal also permits Member States to adopt a tiered approach to the taxation of energy inputs into electricity production, whereby taxation would reflect the input's relative carbon intensity.

taxing carbon-intensive energy carriers more lightly than low-carbon alternatives or by prolonging disparities in the carbon tax signals between Member States or different sectors of the economy. The ETD should therefore be revised in a manner similar to the European Commission proposal in order to correct these policy inconsistencies.

Additional opportunities for aligning energy taxation with climate goals include taxing electricity differently depending on its source (e.g. coal, wind) and offering preferential tax treatment for electrified transport or shore-side electricity for ships ([17]). The European Commission proposal allows Member States to exploit these opportunities by applying exemptions to these cases but stops short of giving them EU-wide preferential treatment.

10.6 Remaining gaps in the EU carbon-pricing regime

This section discusses emission pricing in agriculture and LULUCF. More general discussions of options for managing emissions and removals in these sectors can be found in Chapters 8 and 9, respectively.

With the most recent revision of the ETS Directive, the EU's carbon-pricing regime is extended to the maritime sector, road transport and fuels for heating in buildings. It might also be extended to (municipal) waste incineration as of 2028, based on an assessment by the European Commission to be carried out by 2026 (see Section 10.3).

As a result, the share of EU emissions and removals that are covered by an EU-wide carbon price will increase from 36 % at the time of writing ([18]) to 73 % in the second half of the 2020s (74 % if the EU ETS is extended to waste incineration) ([19]). However, the remaining 26 % (795 Mt CO_2e emissions and 230 Mt CO_2e removals in 2021) would remain excluded from any EU-wide carbon-pricing mechanism by 2030. Most of this carbon price gap, illustrated in Figure 74, is related to the absence of an EU carbon-pricing mechanism for the agriculture and LULUCF sectors, and the remainder is due to the partial exclusion of certain sectors (international aviation and maritime; non-CO_2 emissions from energy production, transport and combustion; and some smaller sectors including waste landfilling, wastewater treatment, etc.).

As all sectors will need to contribute to the 2050 climate neutrality objective, this gap should be addressed. Applying a carbon-pricing mechanism to the agriculture and LULUCF sectors would provide a clear financial incentive for farmers and forest managers to reduce emissions and increase removals, and for consumers to reduce the consumption of GHG-intensive agricultural products (see Chapter 8 'Agriculture'). It would also reduce the potential for intra-EU leakage ([20]) of emissions related to agriculture, forestry and other land use (Stepanyan et al., 2023), and address the uneven distribution of incentives for biomass use versus carbon removal (see Chapter 9 'Land use, land use change and forestry').

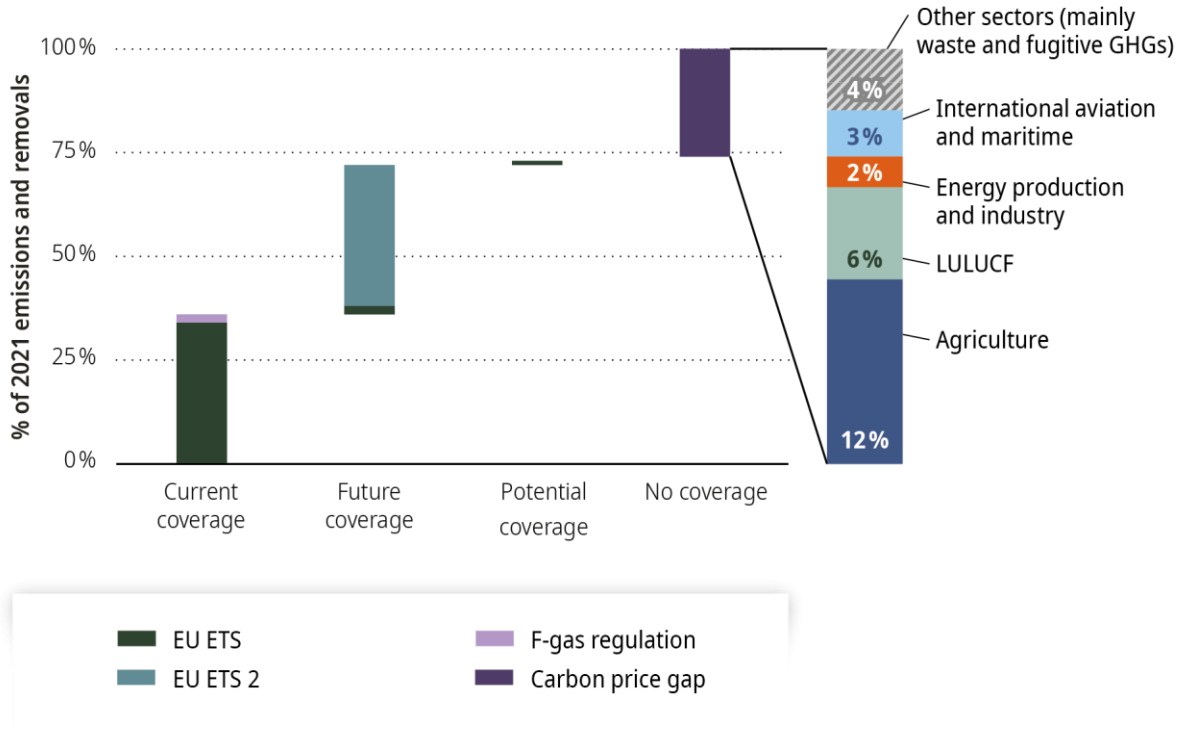
([17]) Shore-side power allows ships to turn off their engines (powered by tax-exempted fossil fuels) and connect to the electricity grid, thereby reducing local air pollution, and potentially GHG emissions, compared with using electricity generated on board the ship.

([18]) Hydrofluorocarbon emissions are currently covered by the F-gas regulation, which is considered to be a cap-and-trade system, and are therefore covered by a carbon or GHG price.

([19]) Based on the latest available data on GHG emissions and removals in 2021.

([20]) displacement of activity to regions with laxer climate policies

Figure 74 Scope of EU-wide carbon-pricing mechanisms (% of 2021 EU-wide GHG emissions and removals)



Notes: Agriculture includes both energy (CRF category I.A.3.c) and non-energy (category 3) GHG emissions. Energy production and industry include fugitive GHG emissions (category I.B). The denominator for determining the share is all EU GHG emissions and removals (both expressed as positive values) in 2021, including emissions from international aviation and bunkers but excluding indirect CO_2 emissions, as reported in the latest GHG inventories.

Sources: For the numerator: current coverage based on verified EU ETS data and the reported emissions from hydrofluorocarbons in the 2023 EU GHG inventory; future coverage under the EU ETS based on intra-EU, 'at berth' and half of extra-EU CO_2 emissions as reported by (EC, 2023k); future coverage under the EU ETS 2 based on the reported GHG emissions under the 2023 EU GHG inventory for road transport (CRF category I.A.3.b), the residential sector (category I.A.4.a) and the commercial/institutional sector (I.A.4.b); potential coverage based on an estimated 52 Mt CO_2e from waste incineration (this is an estimation, as the majority of waste incinerators recover energy and are therefore reported under the broader 'energy production' sector in GHG inventories); breakdown of the carbon price gap based on the 2023 EU GHG inventory data.

For **CDR**, the European Commission has proposed a certification framework based on four "QU.A.L.ITY" criteria (Quantification, Additionality, Long-term storage, and 22ustainability) (EC, 2022w). However, each of these criteria represents a key conceptual challenge to carbon pricing in land use (forestry and agricultural soils), as articles such as those by McDonald et al. (2023) and Wells et al. (2023) point out. It is challenging scientifically to quantify emissions and removals, and even more so to prove causality between management actions and carbon fluxes, due to the heterogeneity of the systems involved. Demonstrating additionality is also challenging because detailed checks may be needed to ensure that changes are the result of mitigation actions that go beyond existing requirements. Long-term storage cannot be guaranteed for land-based mitigation because carbon stored in soils and vegetation is inherently non-permanent and can be released by fire, natural disturbances, and changes in climate conditions or land management. This implies that land-based emission reductions and removals cannot be considered equivalent to other types of mitigation or removal unless sophisticated systems are put in place to ensure that the mitigation continues over time. Sustainability is challenging, since it involves

ensuring that carbon-pricing incentives incorporate (or at least do not conflict with) several other environmental and social objectives. Despite these challenges, excluding land-based carbon fluxes from carbon pricing can create a loophole (Isermeyer et al., 2021), for example by incentivising the use of straw for energy (to avoid CO_2 emissions from fossil fuels) while failing to incentivise the carbon sequestration benefits of returning it to the field.

When it comes to pricing **non-CO_2 emissions in agriculture**, some of the same challenges apply – in particular, heterogeneity – and the need for on-site measurement if emissions and mitigation are to be calculated accurately. Isermeyer et al. (2021) provide a review of practical options. For CH_4 emissions associated with livestock, they suggest emission pricing could work by introducing a default emission value per ruminant animal (e.g. cattle, goats and sheep). For N_2O, pricing could be based on the nitrogen surplus calculated at the farm level (the difference between annual nitrogen inputs and outputs) or by subjecting sales of nitrogen fertiliser to a carbon price. When introducing emission pricing in agriculture, the same risks of carbon leakage apply as those discussed in the context of the CBAM above and will need to be taken into account.

Options for designing a carbon tax in agriculture have been considered by the Danish climate council (Klimarådet, 2023), and at the time of writing the government of New Zealand is developing a system to commence mandatory emissions reporting in 2024 and carbon pricing in 2025 (He Waka Eke Noa, 2022; New Zealand government, 2022; O'Connor, 2023). The New Zealand proposal contains a number of interesting design choices that could inform ongoing discussions among the European Commission and European stakeholders. Emission reporting will occur at the farm level, through the use of standardised calculation tools whereby the cost per farm will be a function of estimated CH_4 and N_2O emissions, with discounts awarded for specified mitigation actions. The initial scheme will apply separate emission prices for CH_4 and N_2O, as well as rewarding certain carbon sequestration activities. In this way, the proposal appears to resemble an emissions tax and incentive scheme for encouraging sectoral mitigation, rather than a cap-and-trade market based around tradable tonnes of verified CO_2e emissions and removals. However, the New Zealand government has stated that its eventual aim is to include scientifically validated forms of on-farm carbon sequestration in its national emissions trading system covering other sectors of the economy. Introducing carbon pricing in agriculture also raises issues of international trade and emission 'leakage' (Henderson and Verma, 2021; Zech and Schneider, 2019). The general economic principles of this question are the same as those discussed in Section 10.3 in the context of the EU ETS and the CBAM. However, questions specific to agriculture will also need to be considered and addressed.

At the EU level, the European Commission is currently exploring options for pricing emissions and rewarding removals in the land sector, including through surveying the public (EC, 2023bd), commissioning research (EC, 2023am) and holding discussions in the expert group on carbon removal (EC, 2023af). As part of this effort, a study by Trinomics (2023a) examined a number of options for introducing an emissions trading system in agriculture, exploring the pros & cons of different "points of obligation" including farm-level, upstream (producers and importers of fertilizer and feed), and downstream (meat and dairy processors). It found that an on-farm point of obligation is likely to be the most complex administratively but may provide the most direct incentive to reduce emissions. The study also stressed that "vertical arrangements" could be put in place to incentivise mitigation along the value chain. For example this could incentivise manufacturers and importers to produce and supply low-emission feed and fertilizer, and incentivise food producers to substitute away from the highest emitting animal products. Emissions pricing can also involve action further down the "farm to fork" value chain (such as differentiated VAT rates). These kinds of action are considered in Chapter 8 on agriculture. The Trinomics study also points out that administrative costs, combined with economies of scale, may mean that large farms benefit the most from the opportunity to generate credits from mitigation actions, implying that ways to limit adverse impacts on small farms will need to be identified.

The European Commission's deliberation needs to be followed up by a concrete legislative proposal, with a view to extending carbon pricing to the agricultural and LULUCF sectors after 2030. The Advisory Board will consider this issue further in future work, including a report on carbon removal expected to be published in 2024.

10.7 Summary table

Table 16 Policy consistency summary – pricing emissions and rewarding removals

Policy inconsistencies	– Differences in the carbon price between the EU ETS and the EU ETS 2 introduce discrepancies such as subjecting electricity and fuels to different carbon prices in the buildings and transport sectors. – The ETD allows fossil fuels to be taxed less than electricity.
Policy gaps	– The EU does not yet have a clear strategy to prepare the carbon market and relevant sectors for the era of very low emissions and the prospect of the allowance supply reaching zero by 2040 – Agriculture/food and land use are not covered by explicit carbon pricing.
Ambition gaps	– The latest reform of the EU ETS does not phase out free allowances completely. They continue in industrial sectors not covered by the CBAM. – The EU ETS 2 may fall short of its own 2030 target because of uncertainties concerning the level of the carbon price, and design features that may de facto loosen the cap. – Not all revenue from carbon pricing is allocated to climate action. While EU ETS revenues must be used for specified climate action purposes, a similar requirement for CBAM revenues has not been confirmed at the time of writing. In the EU ETS, replacing free allocation with auctioning would release additional revenue.
Implementation gaps	– Potential gap: the risk of the EU ETS 2 missing its target places pressure on Member States to increase the stringency of national policies and measures in pursuit of national ESR targets. – Legislation enabling the expansion of the EU ETS to extra-EU flights is yet to be proposed.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