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Defragmenting European Union climate policy

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Executive summary

THERE IS BROAD AGREEMENT that the European Union's post-2030 climate policy architecture – the framework of rules to reduce greenhouse gas emissions – needs to be simpler and more flexible, with market actors less constrained in how they mitigate emissions. However, simplification should not compromise the EU's climate goals and changing the architecture is politically contentious.

RINGFENCING OF ESTABLISHED climate compliance mechanisms and any delay in containing the emissions of lagging sectors could result in even more fragmentation in an already-fragmented climate-policy architecture. The cost of maintaining this fragmentation will rise, making the system even more inefficient. Higher costs and limited control over emissions in some sectors will undermine the EU's ability to credibly signal commitment to its climate target, undermining the confidence of investors and international partners.

TO AVOID THESE RISKS, simplicity and flexibility must mean the application of a carbon price across all parts of the EU climate architecture, with prices converging gradually. This can be achieved by linking the different systems through exchange rates that guide convergence towards a common carbon price, with the EU emissions trading system as the central hub.

CLIMATE POLICY IS MOST EFFICIENT when emissions reductions take place where they deliver the greatest climate benefit at lowest cost. Today's fragmented climate architecture prevents the efficient allocation of abatement resources, such as clean energy. Firms increasingly have incentives – arbitrage opportunities – to shift mitigation activities between differently priced compliance systems, raising overall costs. As more sectors and international links are added to the EU's climate architecture, these distortions will grow, requiring ever more intrusive and politicised regulation.

MANAGED CONVERGENCE of different climate policies should become a core design principle of the EU's climate policy architecture. By predictably phasing out fragmentation, overly pervasive regulation and complexity can be avoided.

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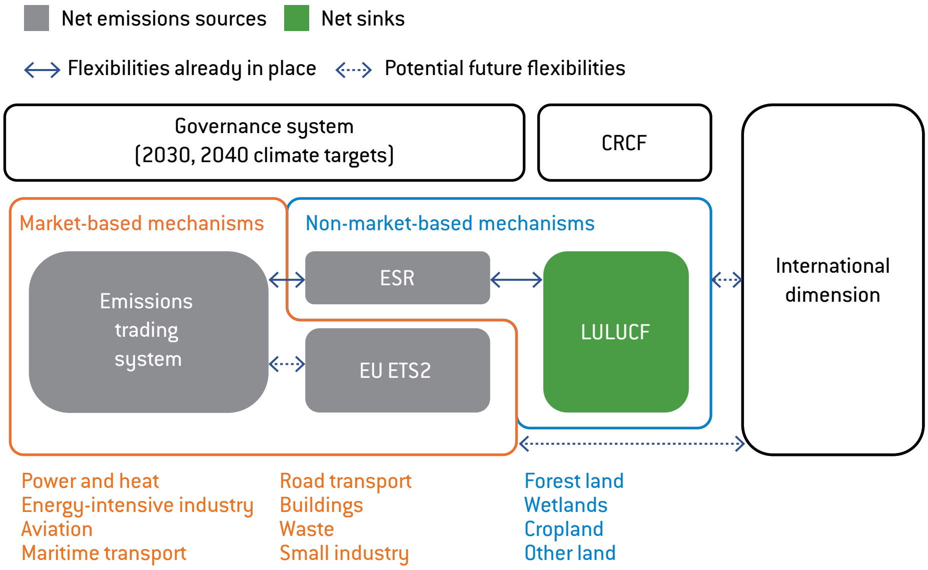
1 The EU climate policy architecture is fragmented

The European Union's climate policy architecture, meaning the ensemble of rules intended to cut greenhouse gas emissions and to adapt to the effects of global warming, has been put in place over more than two decades in a largely 'siloed' manner. To tackle specific issues, new instruments have been added alongside existing instruments, rather than replacing them. Multiple compliance schemes have been introduced, including market-based, non-market based and international mechanisms. These operate largely in parallel, rather than as part of an integrated system (Figure 1).

This fragmented architecture was justified to address the challenges of its time. But as EU climate targets have become more stringent – most recently with agreement in principle on a 90 percent emissions cut by 2040 compared to 1990[1] – the structure has become increasingly difficult to manage (Hurka and Steinebach, 2026). The European Commission has linked the 2040 target to the need to rethink the EU climate policy architecture beyond 2030, noting that *"it will examine how simplification and flexibilities across sectors could facilitate the achievement of the 2040 target"* (European Commission, 2025).

Simpler rules should reduce transaction costs and foster investment in the low-carbon transition. Greater flexibility should allow scarce resources, including land, labour, capital and energy, to be allocated more efficiently across sectors, technologies and time, helping to keep the cost of achieving climate neutrality manageable. However, it is unclear how simplicity and flexibility can be operationalised without watering down climate goals.

Figure 1: The EU's fragmented climate policy architecture



Source: Bruegel based on Edenhofer and Leisinger (2024). Note: LULUCF = land use, land-use change and forestry; CBAM = carbon border adjustment mechanism; CRCF = Carbon Removal Certification Framework; ESR = Effort Sharing Regulation (Regulation (EU) 2023/857).

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[1] See European Commission press release of 10 December 2025, 'EU agrees on a 2040 Climate target that sets a clear path towards a decarbonised and competitive economy', https://ec.europa.eu/commission/presscorner/detail/en/ip_25_2967.

When climate targets were less ambitious, policies were intended to facilitate least-cost mitigation and to enable policymakers to navigate the complex distributional challenges of early carbon pricing (eg Edenhofer *et al*, 2021). It was rational to focus first on sectors such as electricity for which mitigation and administrative costs were lowest, while regulating other sectors through separate approaches.

However, a rapid move now to a fully unified system would impose similar carbon costs on sectors with vastly different decarbonisation baselines. This entails significant distributional implications and risks creating political friction. For example, if the current carbon price in the EU emissions trading system were applied to agricultural products, the price of beef would roughly double[2].

At the moment, elements of both price convergence through the interaction of different compliance mechanisms and continued fragmentation appear to be built into the post-2030 architecture. On the side of 'convergence signals,' the EU's parallel emissions trading systems, the ETS (for power and industry) and ETS2 (transport and heating) might be linked and potentially even merged by 2031. In addition, the Carbon Removals and Carbon Farming Regulation (CRCF, Regulation (EU) 2024/3012) offers a starting point for controlled flows between compliance mechanisms.

'Fragmentation signals,' on the other hand, are sent via differentiated instruments. For example, to manage distributional concerns arising from a uniform carbon price on heating fuels, which will raise energy bills relatively more for lower-income households, the ETS2 price has been capped initially at €45/tonne of CO2 (the ETS2 starts in 2028). To counteract the pull of scarce resources such as land towards ETS sectors, the use of bioenergy in the ETS and ETS2 is subject to restrictive criteria. Some flexibility – in the sense of allowing overcompliance in one mechanism to balance shortfalls in other areas – has been introduced across compliance mechanisms. For instance, EU countries falling short against their national emission-reduction commitments under the Effort Sharing Regulation (ESR, Regulation (EU) 2023/857, which covers non-ETS sectors) can comply by cancelling ETS allowances, but this flexibility is deliberately limited and plays only a minor role in practice.

Any redesign of the post-2030 climate policy architecture therefore brings up a fundamental trade-off. Greater integration and flexibility should lower system-wide costs and improve efficiency, but could also intensify distributional impacts and trigger political resistance. Conversely, continuing with a fragmented framework would allow policy instruments to be tailored to sector-specific circumstances, enhancing political support, but resulting in greater complexity and higher overall mitigation costs. Fragmentation might have worked in the past, but for the future it could mean increasingly complex and costly interventions.

Controlled convergence in the EU climate policy architecture is essential to enable more flexible allocation of resources

In the face of this, we argue that establishing and promoting controlled convergence in the EU climate policy architecture as a main design principle post-2030 is essential for simplification, and to enable more flexible allocation of resources to where they deliver the greatest climate benefits. This approach will strengthen the political resilience of the climate policy architecture. However, greater simplicity and flexibility cannot come at the expense of environmental integrity. We therefore set out how convergence can be pursued while preserving ambition, focusing in particular on the conditions under which closer links between different compliance mechanisms can be designed to manage the risks of backsliding.

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[2] Assuming 100 kilogrammes of greenhouse gases are emitted per kilogramme of beef and a carbon price of €80/tCO2e, the carbon cost of a kilo of beef amounts to €8. With a current retail price for beef of €7.20/kilo, imposing the full carbon price would roughly double the beef price. See *Our World in Data*, 'Greenhouse gas emissions per kilogram of food product,' undated, https://ourworldindata.org/grapher/ghg-per-kg-poore. See also European Commission, 'Beef Statistics,' last updated 13 February 2026, https://agriculture.ec.europa.eu/data-and-analysis/markets/overviews/market-observatories/meat/beef-statistics_en.

2 Uncontrolled arbitrage makes fragmentation more costly

The EU's high degree of economic integration and its deeply intertwined energy system create incentives to exploit differences in mitigation costs across the different sectoral emission reduction mechanisms (Figure 1) and over time. Such arbitrage opportunities for companies and other market participants create pressure in favour of convergence, even when policy design seeks to keep compliance mechanisms separate.

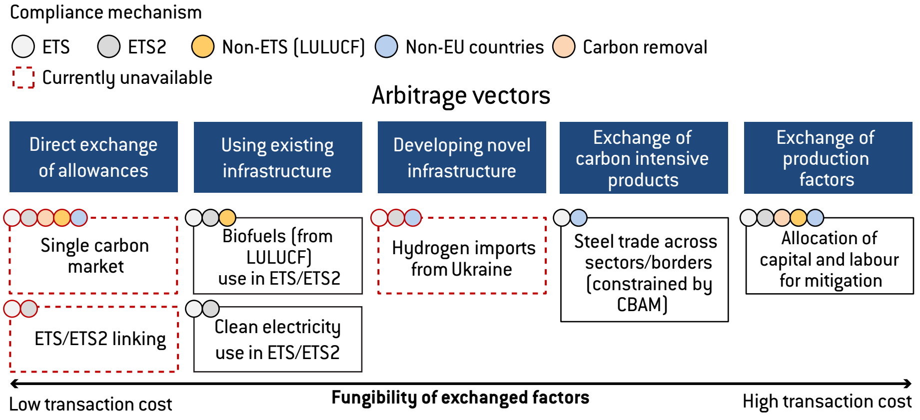
Capital, labour, land, clean energy and other valuable resources that can be invested/employed to lower emissions will be preferentially directed to reduce emissions in those sectoral mechanisms where compliance is most valuable This outflow of mitigation resources increases compliance cost in the less-stringent mechanisms, and reduces them in the more stringent ones, undermining the intended fragmentation.

Such unwelcome arbitrage implies two types of economic cost. First, it might be economically inefficient because the shuffled resources might have facilitated more mitigation in the weakly-regulated sector from which they flow than in the more stringent sector to which they are drawn. Second, policies to slow down such undesired arbitrage require additional bureaucracy and fragmentation that comes at substantial cost.

If some degree of convergence is unavoidable, the policy question is no longer whether convergence will occur, but how and at what pace it should be managed.

Arbitrage across climate compliance mechanisms can take many forms, including the direct exchange of carbon permits, shifting of energy resources between compliance mechanisms and any other transfer of production factors, such as capital or labour. Figure 2 outlines five major arbitrage vectors and their relevance for exchanges between compliance mechanisms within the EU climate policy architecture. The arbitrage vectors are ordered according to their interchangeability; exchanges that require the fewest extra resources and least additional time are on the left side of the figure.

Figure 2: Arbitrage opportunities arising from differences between compliance mechanisms



Source: Bruegel.

The direct exchange of carbon permits has a transaction cost of close to zero. However, the current EU climate policy architecture prohibits direct transfer of permits between compliance mechanisms, though this might change. The original EU ETS, which covers industrial, energy-related and some other emissions, and ETS2 that will start in 2028 to cover emissions from buildings and transportation (Figure 3)[3], may integrate or merge in the 2030s – the European Commission must assess by 2031 if this can be done. By contrast, the creation of a single carbon market, arguably the economically most efficient outcome, remains at best a long-term aspirational goal.

The EU must also decide how international carbon credits will be used to achieve the 2040 emissions target; such credits can be used to meet up to 5 percentage points of the target[4]. International carbon credits could either be made directly transferable or used indirectly to raise the emissions cap. Economically, permitted transfers would be pulled to the EU compliance mechanism with the highest emissions reduction cost.

There are also a number of indirect arbitrage opportunities, the easiest being shifting clean energy via existing infrastructure. This is permissible at least for the ETS, ETS2 and non-ETS policies, such as the land use, land-use change and forestry (LULUCF) segment, which covers agricultural emissions. An example of this is the use of biomass for energy production under the ETS and ETS2 and its interaction with the LULUCF framework. Certified bioenergy is produced using existing assets and, crucially, is treated differently by different compliance mechanisms. Bioenergy suppliers can choose to benefit from national renewables support, account for emissions as zero within ETS or ETS2 installations[5] or generate carbon removal credits when utilising bioenergy carbon capture and sequestration technology. This is all contingent on binary certification – that the production of this bioenergy is sustainable – which requires evidence of specific greenhouse-gas savings (usually 70 to 80 percent compared to fossil fuels) and compliance with land-use rules (no deforestation, no peatland)[6].

Allocating bioenergy from a relatively cheaper to a relatively more expensive compliance mechanism is costlier than a fully-harmonised system, but preventing such reallocation would be even less efficient.

By 2030, the EU is expected to rely on around 1900 TWh of bioenergy[7] – equivalent to more than half of the EU's current natural gas consumption – underscoring its quantitative importance in the energy mix. However, harvesting biomass reduces carbon stocks and sinks, the economic value of which is not yet properly recognised by the EU's compliance architecture, fertiliser use generates additional emissions and indirect land-use change – such as deforestation to expand agricultural land – can further increase the climate footprint (while also reducing biodiversity and other ecosystem services provided by forests). EU compliance mechanisms treat these emissions differently: emissions from certified biomass combustion are assigned a zero-emission factor under the ETS and ETS2, while the associated carbon stock changes[8] are recorded as emissions under LULUCF.

While the certification requirements reduce the scope for shifting bioenergy between the LULUCF segment and the ETS or the ETS2, they do not eliminate the underlying tension. As long as bioenergy emissions have different costs and are accounted for differently in the three compliance mechanisms, biomass will serve as a key vector of regulatory arbitrage between the mechanisms. With rising ETS prices, more bioenergy will be attracted to the ETS and ETS2. To maintain fragmentation of the mechanisms and prevent socially inefficient arbitrage (eg overusing not-really-net-zero biomass in the ETS and ETS2) the rules governing the inter-

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[3] See European Commission, 'ETS2, Buildings, road transport and additional sectors', undated, https://climate.ec.europa.eu/eu-action/carbon-markets/ets2-buildings-road-transport-and-additional-sectors_en.

[4] See European Commission, '2040 climate target', undated, https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2040-climate-target_en.

[5] Solid biomass (eg wood pellets), even if not certified as sustainable, currently does not have to pay the ETS2 price, while burning it in an ETS installation would require the corresponding costly allowances to be surrendered.

[6] As stipulated in Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources.

[7] The EU's 2020 Reference Scenario entails 166 Mtoe of energy available from biomass and waste for 2030. See European Commission, 'EU Reference Scenario 2020', undated, https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en.

[8] LULUCF assumes a living carbon stock (all the plants) that grows year-to-year, implying 'negative emissions' as more CO2 is sequestrated, or declining as more than a baseline is harvested, implying additional emissions.

face between the mechanisms will need to become increasingly complex (eg accounting for firewood in the ETS2) and themselves inefficient (eg preventing the use of genuinely net-zero residues in the ETS).

Another prominent example of exploiting arbitrage via existing infrastructure is clean electricity. Clean electricity can be used in processes governed by different compliance mechanisms, such as in industrial production regulated by the ETS, or for heating of buildings covered by ETS2. If the ETS price is higher than the ETS2 price, clean electricity will first be used to decarbonise ETS-covered processes such as industrial heat, before it is used for decarbonising domestic heating that falls under the ETS2, resulting in resource allocation that is not necessarily driven by whether it delivers the greatest system-wide efficiency or emissions reduction per euro invested. This will result in higher total costs compared to an efficient allocation of resources.

If new infrastructure is needed to enable arbitrage between compliance systems, higher transaction costs will likely result. For example, hydrogen from Ukraine could be imported to the EU via new infrastructure and used for ETS or ETS2 compliance. The need to build the infrastructure explains why this arbitrage vector would involve considerably higher transaction costs compared to use of existing infrastructure. Carbon capture and storage infrastructure that might be used for industrial activities or for carbon removals, with credits for carbon removals valued differently across compliance mechanisms, could also give rise to arbitrage.

Imports to the EU of carbon-intensive products such as cement, steel and aluminium could generate another form of arbitrage that firms might be able to exploit. The use of this arbitrage vector is, however, explicitly limited by the EU carbon border adjustment mechanism (CBAM; see section 3).

Lastly, economic actors will invest more capital and labour to mitigate an additional tonne of carbon dioxide in stringent compliance mechanisms than in weak ones, increasing mitigation costs in weakly regulated sectors.

The opportunities for arbitrage in the EU climate policy architecture imply that over time economic forces will drive some price convergence

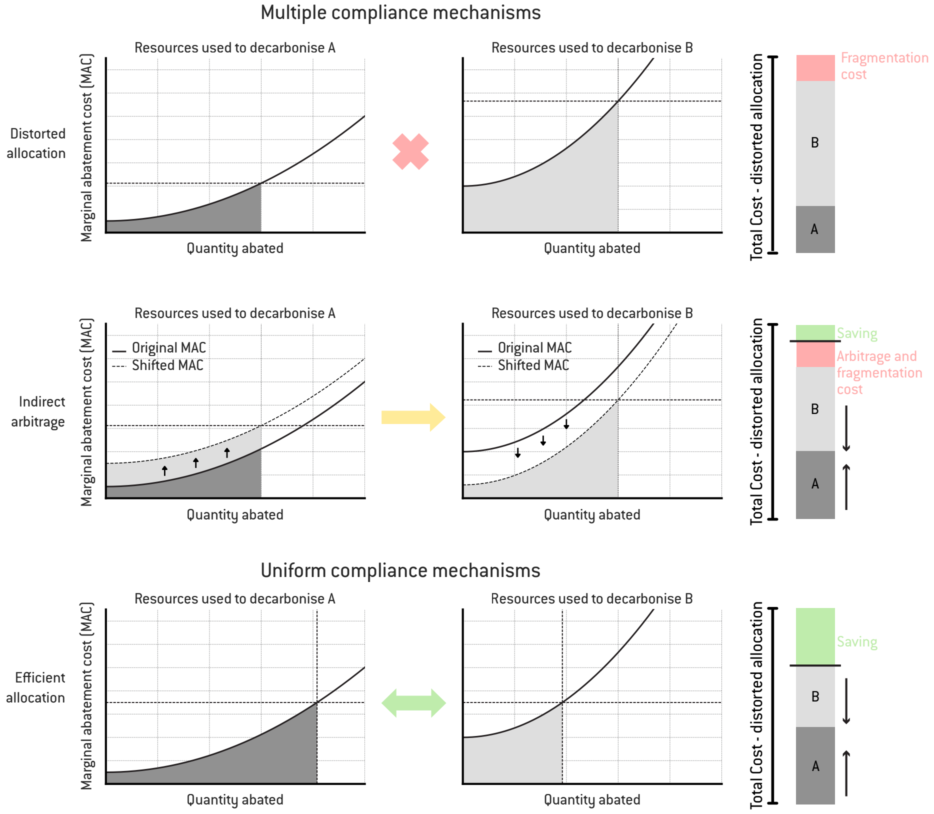
The opportunities for arbitrage in the EU climate policy architecture imply that over time economic forces will drive some price convergence across compliance mechanisms. Actors in the system will try to benefit from these arbitrage vectors. Furthermore, the marginal abatement cost in different compliance mechanisms will increase as easier mitigation opportunities become depleted. Attempting to maintain a fragmented compliance architecture by preventing flows of economic resources will both sustain inefficient deployment of resources and add additional bureaucratic burden, ultimately increasing the costs of the transition.

Figure 3 summarises the three basic cases of interaction between two compliance mechanisms and illustrates differences in total cost.

The first case entails maintaining full fragmentation. This leads to the least-efficient, highest-cost outcome for two reasons. First, the total emissions reduction cost is highest because the emissions-reduction burden is shared inefficiently. Companies must comply with different mechanisms and must, for example, use resources for relatively costly decarbonisation in compliance mechanism A rather than shifting some of the resources to enable more emission reductions in B (Figure 3). Second, preserving fragmentation entails administrative costs.

In the second case, companies can indulge in some arbitrage by shifting mitigation resources from compliance mechanism A to B (indirect arbitrage in Figure 3). Shifting resources from mechanism A, in which emission reductions have less value, to mechanism B, via which the same resources enable more valuable reductions (eg because the compliance mechanism is stricter), increases the marginal abatement costs in A and reduces marginal abatement costs in B. The total economic cost of achieving the sectoral targets will be lower than under completely fragmented climate policies without arbitrage. If direct arbitrage is limited or blocked, arbitrage will materialise indirectly through the shifting of resources between compliance mechanisms.

Figure 3: Resource misallocation in fragmented compliance systems



Source: Bruegel.

Finally, a uniform compliance mechanism yields the lowest cost and thus facilitates a fully efficient allocation of resources. In this scenario, marginal emissions reduction costs are equalised by carrying out less mitigation via the more expensive compliance mechanism B, and compensating for the shortfall by reducing emissions more via compliance mechanism A. This leads to the lowest-cost outcome.

Despite the incentives to exercise arbitrage between two compliance mechanisms, constraints limit the efficiency and scale of arbitrage, typically precluding perfect price convergence. Many arbitrage vectors can only shuffle a certain amount of mitigation from one compliance system to another. And most arbitrage vectors imply some inefficiency: the shuffled resources allow for less mitigation in the compliance system they are directed to than in the system they are directed from. Arbitrage only occurs because mitigation in the more stringent receiving system is much more valuable than the mitigation the transferred resources would have enabled in the sending system[9].

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[9] With increasing volume, arbitrage is often subject to increasing inefficiencies. This can imply an economic limit at which the marginal cost advantage between two systems is fully offset by the marginal inefficiency of the arbitrage vector.

3 The cost of maintaining fragmentation

Complementary to the idea that arbitrage vectors will *de facto* lead to convergence, the main challenge with maintaining fragmented regulation is that it reduces flexibility and simplicity, and this generates rising economic, political and administrative costs that accumulate over time. Maintaining fragmentation should become increasingly difficult for four reasons.

The first concerns credibility: efficiency losses from a fragmented architecture increase the overall financial burden when the carbon price increases and more activities fall within its scope. Policy design that further increases the cost of the transition will make the politics of the transition even more challenging by undermining the credibility of climate policy. As soon as elements of the policy architecture are watered down because they are seen as too expensive – as has happened in the wake of the 2022 energy crisis[10] – uncertainty arises for clean-energy investors. Higher costs therefore risk the political feasibility of ambitious climate goals and could, at the extreme, threaten the entire climate policy architecture.

The second reason why fragmentation will become a problem relates to competitiveness: firms struggle when more and more rules make regulation more complex. Blocking arbitrage vectors between compliance mechanisms creates challenges that would likely lead to exorbitant bureaucracy. For regulated firms, this can create high compliance costs. The EU carbon border adjustment mechanism (CBAM), for example, is designed to limit arbitrage between a stringent domestic carbon pricing regime and looser foreign systems. It does this by pricing the emissions embedded in certain traded goods. However, establishing legally robust methods to measure the carbon footprints of foreign products is complex and firms have incentives to circumvent the rules, for example by resource shuffling[11] or rerouting trade via third countries. This creates a regulatory feedback loop: legal circumvention forces a reactive expansion of rules, ultimately increasing complexity and administrative rigidity.

Policy path dependencies make it increasingly difficult to steer a fragmented architecture towards simplicity and flexibility

Third, policy path dependencies make it increasingly difficult to steer a fragmented architecture towards simplicity and flexibility. When complex rules are introduced to limit certain arbitrage opportunities between two compliance mechanisms, market participants will invest to exploit remaining opportunities that were not initially the most profitable avenues of arbitrage. When a whole small 'circumvention' industry develops, it starts to lobby hard to maintain the fragmentation on which its business model is built. The certification industries for sustainable bioenergy might be an example. Retaining a fragmented climate policy architecture thus risks locking in an increasingly complex regulatory framework.

A related fourth issue is institutional blindfolding. The institutions overseeing a compliance mechanism tend to focus on the integrity within 'their' mechanism, even if slight improvements to that mechanism generate significant costs for the efficiency of other compliance mechanisms. For example, the administrators of the ETS are not primarily concerned with global emission reductions in other countries if they block any inflow of international units.

Similarly, by objecting to formal linkages, they ignore that the resulting high carbon price differentials draw resources out of other compliance mechanisms, leading to higher emissions there.

These four dynamics of credibility, competitiveness, path dependencies and institutional blindfolding accumulate into what could be called a waterbed effect. If the strict separation between compliance mechanisms cannot be maintained, political efforts to increase integrity and stringency in one mechanism may lead to less integrity and stringency elsewhere in the

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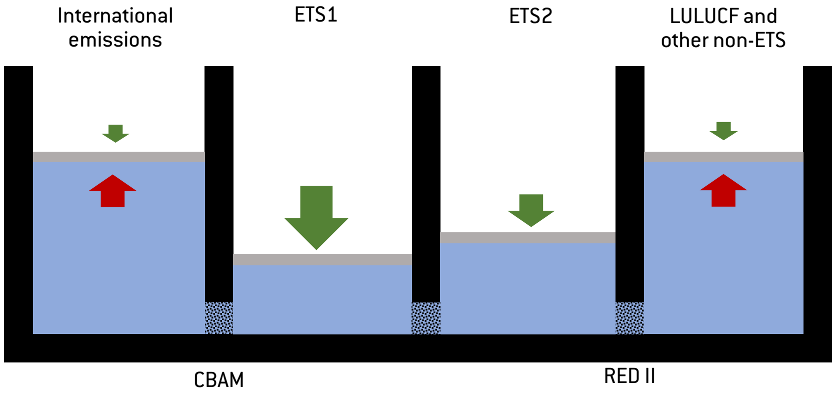
[10] For example, the REPowerEU Regulation (Regulation (EU) 2026/261) essentially 'frontloads' the auctioning of ETS allowances from the 2027–2030 auction pot to the 2023–2026 period, aiming to lower carbon prices at the front end.

[11] Resource shuffling occurs when an exporter diverts their existing 'clean' supply to a high-value market to earn a premium or meet regulations, while simultaneously replacing that local consumption with 'dirtier' supplies, resulting in little to no gain for the global atmosphere.

architecture. Figure 4 shows this for the ETS, ETS2 and other silos of the climate policy architecture. By analogy with a waterbed, if the ETS and ETS2 become more stringent compared to the other mechanisms (size of green arrows), arbitrage vectors imply that economic forces (red arrows) lead to political yield, ie lower stringency to allow arbitrage vectors to be utilised. As a consequence, overall emissions (blue area) are not reduced.

Figure 4: Emerging post-2030 architecture and inter-compliance dynamics ('waterbed')



Source: Bruegel. Note: RED II refers to the renewable energy directive (Directive 2018/2001/EU).

4 From fragmentation to conversion: a controlled-convergence approach

In this section, we lay out how to manage the transition from the current fragmented architecture to a simpler, unified long-term 'target' architecture. The target architecture would be straightforward: The ETS will be the host system ('hub'), to which all non-ETS emissions sources and sinks are linked via trade in mitigation units. The ETS would be the hub because: (1) it is the cornerstone instrument of EU climate policy, (2) it is a *de-facto* 'gold standard' for environmental integrity, and (3) trading is at the heart of the ETS. Such a target architecture around the ETS would leave no more opportunities for arbitrage.

For pricing to be efficient within the target architecture, all credits would have to be traded, first, without restrictions and, second, at their actual mitigation value. In relation to the latter, ETS allowances would act as the 'compliance gold standard,' into which all other activities can be converted (and thus traded), depending on their effective climate impact[12]. Since mitigation values differ for different activities, this implies the use of conversion rates.

A gradual approach to attain the target architecture should be followed because the conditions related to non-restriction and mitigation values of credits require trust in the robustness of the new system to be established over time. Drawing on Burke and Schenuit (2023) and Sultani *et al* (2024), we propose three steps to integrate each compliance mechanism into the target architecture (Figure 5): (1) establish marginal mitigation units, (2) make all mitigation

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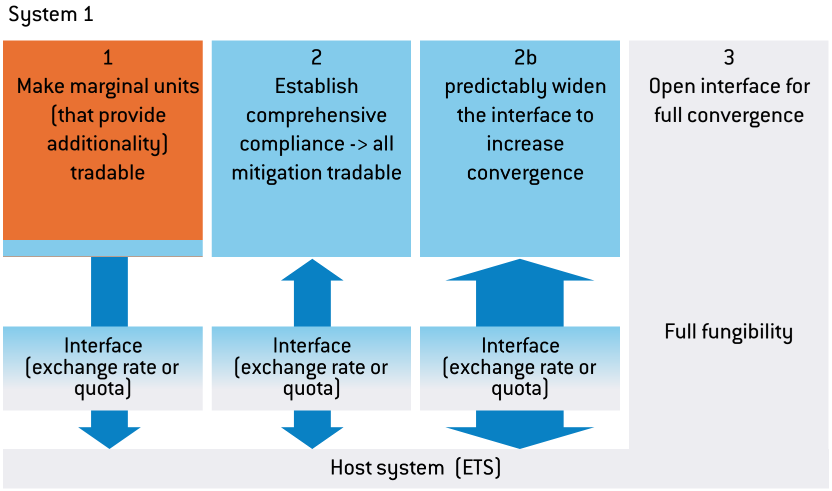
[12] Evaluation of the effective climate impact would need to ensure the activity's additionality and permanence. A mitigation activity is considered additional only when it would not have happened in the absence of the establishment of associated carbon credits. Permanence describes the associated temporal commitment of an abatement (or removal) activity.

in the sector tradable with the ETS, but retain a managed and restricted interface, (3) broaden the interface towards full convergence. Transition from one stage to another only happens after risk management has been accomplished successfully. We describe these steps in the following subsections.

Figure 5: Integration of additional compliance mechanisms into the ETS-based target architecture



Source: Bruegel.

4.1 Establish marginal mitigation units

Step 1 is particularly relevant for LULUCF (in fact, for agriculture, forestry and other land uses (AFOLU) more broadly), carbon-dioxide removal and non-EU countries (Figure 3), for which carbon credits[13] do not yet exist. Establishing such credits or units is challenging, mainly because it requires robust standards and methodologies to measure additionality and permanence with sufficient accuracy to ensure environmental integrity.

Many current credits fail to deliver genuine emissions reductions. In some cases, credits are awarded for activities that would have occurred anyway, such as certain tree-planting projects (West *et al,* 2023). In others, they are linked to emissions that would not have materialised in the absence of the crediting mechanism, as in the case of incentives related to increasing sulphur hexafluoride (SF6) emissions to obtain credits to reduce them (Schneider and Kollmuss, 2015). Credits can also enable offsetting that merely shifts emissions within the system, for example by closing one coal plant while opening another elsewhere. Ongoing work on carbon removals and carbon farming highlights the complexity and significant risk involved in designing high-integrity crediting systems[14].

Implementing step 1 will involve resolving a classic chicken-and-egg problem. It is unlikely that a fully robust emissions monitoring, reporting and verification (MRV) system can be developed without demand for mitigation units because shortcomings and uncertainties only become apparent when methodologies are applied in practice. However, creating demand for mitigation units without at least a basic MRV framework would risk undermin-

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[13] Economic agents can engage in a voluntary carbon market outside the EU-mandated patchwork of compliance systems. Voluntary compliance units are issued on a project basis, and typically used by (mainly private) entities to reduce their carbon footprints.

[14] Lambert Schneider, Anne Siemons and Felix Fallasch, 'Revised methodologies under the EU Carbon Certification Removal Framework continue to lack integrity,' *Oeko-Institut Blog*, 28 May 2025, https://www.oeko.de/en/blog/revised-methodologies-under-the-eu-carbon-certification-removal-framework-continue-to-lack-integrity/.

ing environmental integrity. A way out of this coordination problem would be to start with a deliberately limited scope, focusing on activities for which MRV is relatively straightforward, while creating incentives to improve MRV quality.

Two core elements of this first step could be implemented in practice.

First, tradable mitigation units can be introduced in straightforward cases with an initially narrow scope, ensuring feasibility through simple and effective MRV. In the AFOLU sector, the initial focus could be on large and relatively well-understood emission sources, such as *"methane from livestock and rice production, nitrous oxide from mineral and organic fertilisers, and carbon dioxide emissions from the cultivation of organic soils"* (Runge-Metzger *et al*, 2025; see also Marcu *et al*, 2025, and Material Economics, 2021). Similarly, removal units could initially be limited to large and already well-managed forests.

Creation of carbon dioxide removal units in other sectors could focus on technologies that offer high permanence. For international mitigation units, integrity could be safeguarded by restricting initially to countries with a high governance quality, long-term economic relationships with the EU and clear incentives to align with EU standards (Delbeke *et al*, 2024). Defining the initial scope in these ways can be thought of as a testing exercise that combines high potential benefits and relatively low risk.

Second, to improve MRV, the burden of proof should be placed on firms that supply mitigation units. This approach is already pursued under CBAM: the default emission intensity is high and firms must provide evidence to justify lower values. While verifying such evidence remains challenging, incentives could be created to increase accuracy. One option is to define best available technology standards for verification, rewarding compliance with these standards by assigning higher values to mitigation units that meet them. There is considerable potential to improve MRV in the AFOLU sector. For example, advances in earth observation offer significant potential to strengthen MRV.

Regarding the interface, given the initially high uncertainty and the need for learning, trade into the ETS should not be allowed during this phase, at least not directly. Instead, regulators could act as buyers of units, using economic valuation methods similar to those proposed for non-permanent carbon-dioxide removal by Edenhofer *et al* (2024) and forest-based mitigation by Gren (2024).

At a later stage, once their mitigation value has been proved, these units could be made eligible for compliance use. Firms that supply these units could hold a share in the future use and thus would have an incentive to demonstrate over time that the mitigation value is higher (Cantillon *et al*, 2025). In subsequent stages of system development, the prospect of selling low-cost mitigation at higher prices will provide a strong incentive to further develop the compliance system, especially in sectors with substantial low-cost mitigation potential. This could also facilitate the use of bridging policies, as public support could be linked to future sales into the compliance system, encouraging firms to build their business models on stacked revenues.

4.2 Manage the interface

Once MRV is good enough, limited trading of mitigation units into the EU ETS could be allowed. A limited approach, as proposed for carbon-dioxide removal by the European Scientific Advisory Board on Climate Change (2025), would safeguard against residual compliance risks and not endanger ETS stability through supply uncertainty. Limitations already apply to transfers of permits between the ETS and non-ETS sectors covered by the EU Effort Sharing Regulation.

While the principle of restricted integration is well-established, considerably less attention has been paid to how it could be implemented in a way that ultimately simplifies the compliance architecture (see Marcu *et al*, 2025, for an overview of international credit integration). Yet two design elements already stand out as particularly relevant: the choice between using price-based or quantity-based controls at the interface and the associated governance arrangements (Sultani *et al*, 2024).

At first sight, quantity controls at the interface might seem preferable because they are easier to implement and result in more predictable flows of credits between compliance mechanisms, providing some planning certainty for project developers. Quantity limits have previously been applied, for example on international credits from the Kyoto Protocol's Joint Implementation and Clean Development Mechanism[15] during the EU ETS's Phases 2 and 3.

However, quantity control comes with two important caveats. First, limiting volume flows between systems creates distributional challenges, as access rights to the interface must be allocated, raising questions about who is allowed to sell units into the ETS. These distributional effects might be amplified by the opportunity to secure rents (windfall profits) from access. Second, inefficiencies can arise if limits are set too low and more cost-competitive, high-integrity certificate supply (eg from carbon-dioxide removal) becomes available than initially anticipated. In such a scenario, those additional units would help in theory to lower the overall cost of mitigation in the host system, but are prevented from entering the market by the lack of access rights.

Price controls, such as levies or exchange rates between compliance mechanisms, offer advantages that have been overlooked

Price controls, such as levies or exchange rates between compliance mechanisms, on the other hand, offer a number of advantages that have so far been overlooked. Most importantly, they can improve selection of arbitrage routes, because more complex 'shuffling' activities should become too costly and expensive flows will be eliminated by the market. Evidence from the LULUCF sector suggests that even modest externality pricing – well below the optimal carbon price – can outperform complex regulatory approaches (Merfort *et al,* 2023). Price controls also allow for more flexible flows, enabling full Pigouvian pricing (sufficient to compensate for externalities) and convergence in the long run. In addition, price controls offer opportunities for the state to capture arbitrage rents, which could then be redistributed rather than accruing to private firms selling at the interface.

However, price-based controls also come with challenges. They may incentivise low-quality units when prices do not reflect the true social value of a credit. In addition, if every type of mitigation unit is associated with a specific price, a whole set of levies or exchange rates would be needed to govern credit flows. As a consequence, price-based controls do not necessarily lead to simplicity and might make the system more complex, generating additional political resistance before full convergence can be reached in the long run. More research is needed to identify control mechanisms that can support gradual convergence while managing distributional issues and upholding simplicity and efficiency in the medium term. Insights from the literature on carbon market linking – where similar challenges arise – could provide useful guidance (Quemin and de Perthuis, 2019).

When it comes to governance, new institutional arrangements for the unified system would credibly signal long-term commitment to a converging target architecture. The establishment of a European Carbon Central Bank has been suggested to manage carbon-dioxide removal certificate procurement and flows into the EU ETS (Rickels *et al*, 2022; 2024; Edenhofer *et al*, 2024). Alternatively, such an institution could be given a broader mandate, covering the carbon budget, price convergence and removal liability risks (Edenhofer and Leisinger, 2024). In theory, such a new institution could go beyond carbon removals and be responsible for overseeing connection of several interfaces to the hub. However, the broader the mandate, the less likely it is that political decision-makers would be willing to hand over control of these functions to such an institution. A pragmatic approach would therefore be to: (1) compile a list of functions required to manage the interface, (2) propose rules for each of these functions, and (3) decide whether those rules could be performed better by new institutions as opposed to existing governance structures.

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[15] UNFCCC, 'Mechanisms under the Kyoto Protocol', undated, https://unfccc.int/process/the-kyoto-protocol/mechanisms.

4.3 Convergence

In the final step, the interface will be widened to allow convergence of prices in a controlled manner. This is necessary because limited integration still implies inefficient levels of price differences. In taking the final step, expectations and banking of allowances must be taken into account – in anticipation of future unrestricted trade, market participants might bank lower-price carbon units to sell at higher prices later. Depending on banking opportunities and market participants' foresight, this may lead to immediate convergence once an opening of the interface is expected. Yet, full efficiency right away would imply strong distributional effects that might not be politically feasible (Edenhofer *et al*, 2021). Controlled, gradual convergence therefore offers a pragmatic balance between economic efficiency and political viability.

A choice will have to be made whether to rely on quantity-based measures (volume limits) or price-based instruments to manage how quickly prices are allowed to align. Quemin and de Perthuis (2019) found that, in general, controlling price conversion over time requires the use of exchange rates for both the trade between systems and the banking of credits within each system. This entails that when a credit is banked and the conversion rate is lower than one, its compliance value will depreciate, implying a trade-off with environmental effectiveness since using rates different from one leads to higher or lower overall emissions. That said, a simple rule for setting trading and banking conversion rates exists that can in principle be used to control the degree of convergence. More specifically, to attain a specific ratio of prices in both markets, one needs to set the banking and trading conversions at the identical target ratio. By adjusting the ratios over time, the pace of convergence can be controlled.

Borrowing could be allowed, permitting firms to emit in the present and settle their compliance obligations in the future. Borrowing can have different effects on convergence. Clean-up certificates (Lessmann *et al*, 2024) would allow firms to emit today while committing to future compensation through carbon removal. These certificates are sold against collateral, and may flatten the price path if future costs for CDR are (expected to) come down considerably.

Box 1: Examples of compliance system convergence

1 Between systems that have binding compliance mechanisms and systems that don't: international linking

While almost all countries have a climate target in the form of a Nationally Determined Contribution (NDC) under the Paris Agreement, the level to which targets are binding varies greatly. So far, international linking, which in principle could offer massive cost savings, has happened through project-based credits. For example, buyers such as Japan pay for mitigation projects in seller countries such as Vietnam. Whether such projects actually reduce emissions compared to a business-as-usual scenario is, however, very difficult to establish in an open system. Hence, allowing such units in buyer-country NDCs would only make sense if it also happens in seller countries with NDCs (ie climate targets) that are binding. In the strawman proposal by Zachmann (2025), the exchange value of carbon credits would be attached to the stringency and commitment of countries' NDCs. This would also ensure additionality when dealing with countries with less-binding NDCs.

In this example, convergence is achieved by using exchange rates that make mitigation units from countries with different levels of commitment equivalent within a single compliance system.

2 Between market-based and non-market-based compliance mechanisms: ETS and LULUCF

Because of the ETS exemption for certified biomass, biomass serves as an arbitrage vector between the EU's carbon market and the LULUCF compliance mechanism. Should bio-based carbon removals, such as bioenergy with carbon capture and storage (BECCS), become integrated into the carbon market, the incentives to shift biomass away from LULUCF and towards the ETS will increase (Sultani *et al*, 2024). To level the playing-field in incentives, internalisation is necessary of the positive external effects from use of land as a carbon sink and of its ecosystem services.

Since the economic value of LULUCF sinks and ecosystem services is not yet properly recognised by the EU's compliance architecture, such a value must first be attached to the marginal mitigation units from LULUCF, and they need to be made tradable (Cantillon *et al*, 2025; Runge-Metzger *et al*, 2025). As a preliminary step, it could also be an option to at least price the biomass externality at the interface with the EU ETS. Then the interface between the two compliance mechanisms could be widened further, and a step-wise and controlled convergence (eg with exchange rates between ETS and LULUCF mitigation units) could be achieved.

Convergence occurs here by putting a price on land-use mitigation and ecosystem services, which aligns incentives between the ETS and LULUCF, and allows the two systems to interact on comparable terms.

3 Between two market-based compliance mechanisms: linking the ETS and ETS2

Linking the EU ETS and ETS2 is a prominent example of compliance-system convergence involving two market-based mechanisms. As soon as integration of the two systems is anticipated, the long-term expectation of a uniform carbon price becomes self-reinforcing. From that point, maintaining substantially different prices (ie fragmentation) is difficult. Initial evidence for this could be observed during the first ETS2 auction, which cleared right at the then ETS price level[16]. Linking can be deemed successful if price convergence is achieved gradually and controlled over time, without increasing overall emissions (Quemin *et al*, 2026).

5 Conclusion

In the current EU climate policy architecture, different sectors have different compliance mechanisms and varying carbon prices and rules shape how resources are allocated to reduce emissions. From an economic standpoint, this is far from what would be best in the long run, which would be a uniform carbon price that eliminates fragmentation and delivers an optimal outcome overall. The question is how to move from today's patchwork of climate policies to a more unified framework.

Despite the fragmented nature of the EU's climate policy architecture, we contend that the interconnectedness of the EU economy and its energy system will in any case drive, through the presence of arbitrage opportunities, price convergence across compliance mechanisms. Direct arbitrage through the exchange of allowances across systems would lead to convergence of marginal abatement cost and could lower the total mitigation cost. However, rules often block this option. Indirect arbitrage, through shifting costly abatement resources from one compliance mechanism to another, leads to inefficient allocation of resources. Since inefficient arbitrage still drives converging forces, the convergence that will inevitably happen

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[16] See ICE, 'EUA 2 Futures,' https://www.ice.com/products/83048353/EUA-2-Futures/data?marketId=7932292&span=1.

over time might be too late, too costly or too messy. Such misallocation might be limited if controlled gradual linkage between compliance mechanisms reduces incentives for private actors to over-invest in enabling inefficient resource shuffling.

We show that linking different compliance mechanisms to the EU ETS as a hub would streamline the EU's climate policy architecture, offering the most integrity and creating a market by design. Compliance mechanisms should be linked gradually to tackle challenges relating to management of the distributional consequences and ensuring that new flexibility does not lead to watering down of ambition. A staged pathway towards a unified ETS-based climate policy architecture would emphasise learning and an overhaul of the governance framework at each stage of the process to safeguard political feasibility and efficiency.

Political commitment to an active approach to structured convergence over time will be critical to signal to market participants that investing in inefficient arbitrage opportunities may not be worthwhile. With this approach, both economic rent-seeking from exploitation of arbitrage opportunities and costly regulations to defend fragmentation can be avoided and thus, the burden on society will be reduced.

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