On Linking the UK and EU Carbon Markets in Pursuit of Net-Zero

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May 12, 2025

Abstract

Adopting climate-neutral and net-zero emissions targets is central to climate strategies of many nations, aiming to mitigate the effects of climate change and promote a sustainable transition to low-carbon economies. This paper examines the potential for linking the newly established UK Emissions Trading Scheme (UK ETS) with the EU ETS as a means to achieve these objectives. We identify and assess the viability of linking tradeable permit markets based on (i) market design, (ii) political economy, (iii) economic, and (iv) environmental considerations. Uniting these four components, linking the UK and EU carbon markets could potentially be a viable strategy for fostering closer cooperation on developing key technologies such as engineered greenhouse gas removals, and for supporting a market for carbon capture and storage. A linked ETS could also align UK and EU climate policies, unlocking economic opportunities through increased innovative investment in developing clean energy technologies and infrastructure more widely across both regions.

Keywords: Market linking, Emissions trading, Energy transition, Policy architecture, Carbon neutrality

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List of abbreviations

ARP	Auction Reserve Price
BEIS	Department for Business, Energy & Industrial Strategy
CBAM	Carbon Border Adjustment Mechanism
CCM	Cost Containment Mechanism
CCS	Carbon Capture & Storage
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
CPS	Carbon Price Support
EC	European Commission
EEA	European Economic Area
EEX	European Energy Exchange
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
FOEN	Federal Office for the Environment in Switzerland
GBP	Great British Pound
GGR	Greenhouse Gas Removal
GHG	Greenhouse Gas
HFC-23	Trifluoromethane
HM Government	His/Her Majesty's Government
HM Treasury	His/Her Majesty's Treasury
ICE	Intercontinental Exchange
MAC	Marginal Abatement Cost
MRV	Monitoring, Reporting & Verification
MSR	Market Stability Reserve
$MtCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
N_2O	Nitrous Oxide
NER	New Entrants Reserve
RGGI	Regional Greenhouse Gas Initiative
SAM	Supply Adjustment Mechanism
TNAC	Total Number of Allowances in Circulation
UBFCCC	United Nations Framework Convention on Climate Change
UK	United Kingdom
USD	United States Dollar
VCM	Voluntary Carbon Market

1. Introduction

Emissions trading schemes (ETSs) have become prominent market-based policy tools to drive the decarbonisation of pollution-intensive industries. By putting a price on polluting emissions through the creation of markets of tradeable allowances, these schemes promote cost-effective emissions reduction (e.g., Montgomery, 1972; Ellerman, 2003; Stavins, 2008; Keohane, 2009). The United Kingdom (UK) relies on their UK ETS as a key mechanism for reducing domestic emissions and to incentivise investment targeted at decarbonisation. The current scheme was introduced in 2021 after the UK's exit from the European Union (EU) and its respective ETS. Since then, significant emphasis has been placed on the development of the UK ETS to ensure a functioning carbon market that supports the UK's transition towards net-zero by 2050, which was set in law in 2019. While potential linking with the EU ETS was a relevant part in the initial policy discussion during the design and startup phase of the UK ETS[1], it has been left out of the discussion since and is a missing — but crucial — aspect that warrants a closer inspection. Here we address the question whether linking the UK and EU schemes can be a viable policy option as part of an integral net-zero pursuit in the long run. With this we aim to inform the policy debate around ETS linkage in view of UK climate policy, as well as to provide a succinct review and account of the most relevant academic literature on linking emissions trading markets.

A number of linked ETSs are currently in operation, including the Regional Greenhouse Gas Initiative (RGGI) formed in 2009 by several Northeastern states in the United States , the Tokyo and Saitama market linked in 2011, Québec and California in 2014, and most recently Switzerland and the EU in 2020. In March 2024, the three governments of California, Québec and Washington formally expressed interest in linking, announcing in September 2024 their plans for extending the existing shared California-Québec carbon market to include Washington (Washington State Department of Ecology, 2024). The operation and performance of these markets can provide some lessons for ETS linkage. In the RGGI over the period of 2009 to 2017, carbon dioxide (CO_2) emissions declined by roughly a half, jobs were created, and an estimated yield of USD 5 billion in economic benefits achieved, through cost-savings from auction proceeds to fund energy efficiency programmes (Hibbard et al., 2018). In addition, an analysis of public health impacts of RGGI (covering the period 2009 to 2014) suggests that the initiative resulted in significant reductions of air pollutants harmful for human health, creating positive health benefits (Manion et al., 2017). The Tokyo-Saitama link, despite criticism on the lack of market liquidity due to low levels of trading activity across prefectural borders, achieved close to 100 percent compliance rates in the first compliance period of 2010/11-2014, with emissions reductions achieved beyond set targets (Rudolph et al., 2020).

[1] When the UK decided to develop their ETS, it was designed in a way to make it possible to link with the EU ETS, and in the Trade and Cooperation Agreement both parties agreed to cooperate on carbon pricing, expressing openness to consider linking their respective ETSs (EC, 2021).

On the other hand, there are cases of less successful linking initiatives. Ontario joined the Québec-California link in early 2018, only to de-link mid-2018 when a change in government caused an abrupt change in environmental policy direction due to lack of consensus over greenhouse gas (GHG) emissions reduction through an ETS (Carmody, 2019). Similarly, Australia pulled out of an agreement to link with the EU ETS, as its then newly elected government opposed the previous government's environmental policy, opting to terminate Australia's cap-and-trade initiative in 2014 altogether (Müller and Slominski, 2017). This shift in Australia's environmental policy meant that the proposed link with New Zealand's ETS also halted (Rudolph et al., 2020). Both the Ontario and Australia cases illustrate the vulnerability to short-term changes in government priorities towards the environment. The success and failure of such links prompt the question which policy and market factors should be considered when establishing a potential link between ETS systems. The objective of this paper is to review and discuss the key elements in a succinct way, and to draw some lessons relevant for UK's net-zero strategy.

Our discussion suggests that linking the UK ETS with the EU ETS is technically feasible from a market design perspective and could reinforce UK's net-zero strategy. While there are slight differences in specific market design elements, overall the two schemes have similar features to harmonise linking. This could also suggest a relatively streamlined linking process towards implementation. More specifically, linking could enhance market liquidity and strengthen the allowance price in the UK market, which has seen a steady decline in the past year and is now consistently valued below EU allowance prices. The opposite pattern could be witnessed in the initial years of the UK ETS operation.

This difference in allowance prices is an important issue to address, as it will impact the trading relationship between the UK and EU when the Carbon Border Adjustment Mechanism (CBAM) comes into effect in both jurisdictions. It is also crucial to ensure that the allowance price reflects a reliable market-based mechanism that can effectively drive decarbonisation in industries, while offering more flexible abatement options for regulated UK entities. Another important driver is the UK and EU's ambition to develop carbon capture and storage (CCS) markets, where regulatory barriers currently prevent cross-border transport and permanent storage of CO_2 between the jurisdictions. Regardless of how extensively the two jurisdictions prefer to integrate, some alignment is necessary to overcome regulatory barriers. On the other hand, a standalone UK ETS might provide the UK government flexibility needed in decision-making that is aligned with reaching the 2050 target, where the joint system would be subject to the EU legal framework and might decelerate required policy changes. Indeed, as a single jurisdiction, coordinating policy stringency is easier and swifter to implement relative to operating in a joint system comprising multiple jurisdictions. Despite this, however, considering the wider benefits of creating a joint UK-EU ETS towards an established harmonized carbon price, it is recommended that the UK considers permit market linkage in the discussions on the

Trade and Cooperation Agreement in the near term, and before the end of the current phase of both systems.

In what follows, Section 2 provides a basic background for ETS linkage and explores key literature surrounding the topic. Section 3 introduces the framework used to evaluate the potential compatibility of the UK and EU carbon markets for linkage. Section 4 concludes and provides some policy recommendations for further shaping the development of the UK ETS in view of market linkage in the context of net-zero and the energy transition.

2. Linking Emissions Trading Markets: Definitions and Scope

Links between emissions trading markets can be established between different ETS jurisdictions, whether these are nations, states, regions, or cities. Generally, linking entails that one jurisdiction acknowledges the emissions allowances of the other system for compliance, thus allowing allowances to be traded among polluting sources that are participating in the joined market. Alternative options to link markets can be considered, and jurisdictions typically can choose to establish an indirect link, a unilateral link, or a bilateral link (Partnership for Market Readiness, 2014). An indirect link is formed when an ETS has a unilateral or bilateral link to another ETS, which then has a unilateral or bilateral link to a third ETS. This causes an indirect link between the first and the third ETS system, which do not necessarily accept each other's allowances for compliance. A unilateral link is where one ETS accepts allowances for compliance from another ETS, but not vice versa. A bilateral link consists of both ETSs accepting the other's allowances for compliance. In view of the UK's net-zero targets, the bilateral link is the emphasis of this paper.

As jurisdictions link, allowance prices tend to converge to a new, 'common' price. The degree of price convergence depends on differences in market size; linking differently sized emissions markets tend to equalise the post-link price closer to the price of the larger system. This happens as emitters with higher marginal abatement costs (MAC) purchase allowances from the emitters in the lower price system with lower MAC, represented as the flow of allowances into the 'higher' pre-linked price system (Santikarn et al., 2018). Thus, linking fosters the 'discovery' of a common price. This is conducive to equalising MACs across regions, leading to an efficient allocation of abatement efforts (Flachsland et al., 2009; Cason and Gangadharan, 2011; Keohane et al., 2017). Linking also underpins the polluter pays principle, as the new average price 'burdens the laggards and disburdens the pioneers' (Rudolph et al., 2020, p.2).

The literature addressing climate change policy and emissions reduction emphasises the role of a common carbon price, but discusses the most appropriate way of achieving this – emissions trading, a carbon tax, or a hybrid of both. For instance, Pengg et al. (2019) and Ranson and Stavins (2016) support global cap-and-trade as a policy measure, while Cramton et al. (2017) has reservations about such a system. Stiglitz (2015) and Nordhaus (2015) note that it is not necessarily one over the other, as the goal of a global carbon price is the important factor, not the

policy used to achieve it. What all these papers agree on, however, is the need for cooperation toward a common goal, supporting the notion of a 'common' price for pollution.

A global carbon price, either through a global ETS by linked systems or through a global tax, might currently be too ambitious. There are currently 36 ETS initiatives—only a couple of them linked—with 89 (sub)nations having any form of carbon pricing policy in place, representing 24 percent of global GHG emissions (ICAP, 2024; World Bank, 2024). By linking ETSs, even a bilateral link can facilitate cooperation in reaching more ambitious environmental goals. The 2015 Paris Agreement recognizes the importance of cooperation (Article 6), allowing international emissions trading while facilitating the establishment of an improved framework for common accounting rules (UNFCCC, 2015).

Effects of linking ETSs can be categorized into political economy, economic, and environmental implications (Bodansky et al. 2016; Flachsland et al. 2009; Green et al., 2014; Ranson and Stavins, 2016). The literature supporting linking generally point out enhanced market liquidity and efficiency gains, as well as allowance price volatility and competitiveness concerns. Doda et al. (2019) show that linking ETSs can bring substantial cost savings due to increased efficiency and price stability. Efficiency gains arise from cost-effectiveness in achieving emissions reductions. The World Bank (2016) estimated that international linkage could reduce the cost of achieving emissions reductions set in the initial Paris Agreement pledges by 54 percent in 2050. Allowance price volatility can be reduced as uncorrelated price shocks are mitigated across the larger joined market, and the uniform allowance price can decrease competitiveness concerns among the market participants of the linked ETSs. Cason and Gangadharan (2011) provide experimental evidence of enhanced price discovery, ameliorating trading efficiency in linked markets. Doda and Taschini (2017) also demonstrate that linking can lead to overall efficiency gains. However, they also note that price volatility may not necessarily decrease for all individual markets involved. They emphasize the importance of carefully selecting potential jurisdictions for linkage, as differences in technology and market size can influence market outcomes. Additionally, partners' preferences and decisions on cost-sharing arrangements may affect the overall economic performance from linking.

Reasons why jurisdictions might not choose to link are mainly concerned with loss of jurisdictional autonomy, difficulties agreeing on design features (e.g., aforementioned cost-sharing rules), distributional effects of linking, and potential loss of domestic co-benefits (e.g., Newell et al., 2013). Findings by Holtsmark and Sommervoll (2012) raise concerns on the ambiguity of linking where, despite the potential for efficiency gains to be derived from cross-border abatement allocation, a non-cooperative equilibrium comes with inefficiently low abatement levels. A commentary by Green (2017) also discourages linking, noting the difficulty in managing and coordinating linked markets due to competing political control across jurisdictions. This extends beyond transboundary conflict of interest in politics, as domestic lobbying could also influence linkage. Habla and Winkler (2018) show that the hierarchical

structure of international environmental policies can be a reason why we have not witnessed the formation of many linked ETS markets.

A further point is that linking can expose smaller systems to systematic risk. This was the case for New Zealand's ETS in 2011/12, when an indirect link with the Clean Development Mechanism (CDM) led to a decline in New Zealand's allowance prices due to an increase of "imported" offsets from this voluntary carbon market (Ranson and Stavins, 2016; Diaz-Rainey and Tulloch, 2018).

3 A Framework for Assessing Market Linking

Ensuring that linking ETSs would potentially be feasible and functional requires careful consideration of key elements. Main market design characteristics that need to be considered concern issues surrounding price stabilisation, the use of carbon offsets, banking and borrowing of allowances, allowances allocation, determination of emissions reduction targets, the compatibility of monitoring, reporting and verification (MRV) mechanisms, as well as market coverage and compliance. Tuerk et al. (2009) categorise differences in ETSs into those that are unlikely to create barriers to linking (i.e., those which are relatively easy to harmonise) and those that are likely to be significant barriers. The former includes banking provisions, MRV rules, compliance periods, allocation methods, and rules governing new entrants. Though, Bodansky et al. (2016) and Keohane et al. (2017) highlight the importance of compliance in allowance transactions with effective registry operation to minimise the risk of double counting, which can lead to actual emissions being higher than reported. ETS characteristics that are likely to create significant barriers to linking include carbon offset eligibility, price stabilisation mechanisms, relative policy stringency, and emissions targets. It is unrealistic to assume different ETS systems to be identical in all aspects, but some harmonisation of key elements can be all that is needed for two ETS systems to successfully link (Bodansky et al., 2016). In what follows, we will systematically discuss key issues under the headers of market design, political economy, economic, and environmental considerations.

3.1 Market Design Considerations

The design of ETS markets plays a fundamental part in the compatibility of linking them. In view of harmonisation, significant market design aspects with respect to linking are price stabilisation mechanisms and the eligibility of carbon offset credits (Tuerk et al., 2009). We shall respectively discuss these two aspects below, including a discussion on banking and borrowing, and MRV.

The UK implemented two price stabilisation mechanisms in its current ETS design to ensure a smooth transition into a standalone ETS after leaving the EU in 2021: an Auction Reserve

Price (ARP) and a Cost Containment Mechanism (CCM).[2] The ARP functions as a minimum price for auction bids and is currently set at GBP 22 (based on rounded average EU ETS price over 2020), preventing too low prices that could undermine the credibility of the UK ETS (HM Treasury, 2021). The ARP was treated as a transitional pricing rule, which made it the main mechanism to foster allowance price stability in the initial period of the UK ETS. Where the ARP ensures a minimum price, on the other end of the spectrum the CCM is in place to ensure that no sustained spikes in the allowance price occur. In the initial years of operation, the CCM triggers were more sensitive than EU ETS triggers under the Market Stability Reserve (MSR) (a supply-based policy mechanism that addresses demand-supply imbalances of allowances, discussed below). In 2021, the CCM was triggered if for three consecutive months the average allowance price in the secondary futures market was double the average price in the preceding two-year period (this is the trigger level). In 2022, the CCM was triggered if the average price was two and a half times this, and in 2023 and onwards it is three times the average price in the preceding two-year period for six consecutive months (HM Treasury, 2021). If the CCM is triggered, appropriate measures by the UK government can be taken to ensure price stability, such as redistributing allowances between the year's auctions or increasing the volume of allowances to be auctioned, for example by drawing allowances from the market stability mechanism account.[3]

A UK government consultation that ran from December 2023 to March 2024 addressed the development of the UK ETS market policy. The emerging positions include continuation of the ARP and CCM as the key policy levers to address price fluctuations, and the implementation of a quantity-triggered Supply Adjustment Mechanism (SAM) to address market stability. The SAM functions in a similar way to the MSR in the EU ETS, where the supply of allowances is adjusted based on an upper and lower range threshold of the total number of allowances in circulation (TNAC). Whether or not these policy mechanisms will be adopted in the UK ETS remains to be seen and awaits the government's formal response (HM Government, 2023b).

The ARP and CCM control price movement through setting upper and lower boundaries of the allowance price, and function as a price collar. The MSR sets upper and lower boundaries on the quantity of allowances, adjusting supply accordingly to shape the allowance price. Linking two systems that have different price stabilisation mechanisms could make ETSs incompatible, or at the very least complicate linking (Hawkins and Jegou, 2014). According to Perino et al. (2021), the link between the Swiss and EU ETSs is an exception here, as the Swiss ETS is significantly smaller compared to the EU ETS. A similar conclusion might be more challenging to draw between the UK and EU ETS. While the UK market is notably smaller than

[2] It is beyond the scope of this paper to discuss the ARP and CCM design issues in specific detail. For a rigorous treatment on this see Murray et al. (2009), Fell and Morgenstern (2010), and Friesen et al. (2022).

[3] The CCM was triggered in December 2021 and January 2022, as the average price in the three consecutive months for both cases was above the trigger level at that time (i.e., GBP 52.88 and GBP 56.58, respectively); however, the UK government chose not to intervene in the market on both occasions (BEIS, 2022).

the EU ETS, it is not as small (as a domestic market) in comparison with the Swiss ETS. The number of regulated entities in the Swiss ETS is around 300, covering around 6 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2024, while the UK ETS has around 1,228 operators in 2024 and covered around 97 $MtCO_2e$ in 2023 (FOEN, 2024; UK Emissions Trading Registry, 2024). The UK has indicated implementing the SAM, which, as mentioned earlier, would function as a quantity-based mechanism, similar to the MSR. This would mitigate the problem for linking, where the UK ETS would then mirror the EU's MSR, making the two ETS compatible in that respect.[4]

The second important design feature that needs to be taken into consideration when linking ETS systems is the use of carbon offsets as a means of emissions reduction and meeting compliance obligations. Carbon offset credits are transferrable instruments of reduction or removal of emissions made through different projects (such as reforestation, for instance) to compensate for emissions that are emitted elsewhere. If the use of offsets is permitted, they add flexibility to an ETS, as emitters can meet their compliance requirements through potentially cheaper, easier, and faster emissions reduction measures outside their industry, especially if domestic options are more costly (Bumpus and Liverman, 2008). Despite this, ETSs can opt to not allow the use of offsets when there are environmental integrity concerns and/or if governments wish to encourage emissions reduction efforts domestically (Ranson and Stavins, 2016). It can be problematic if the linking jurisdictions do not consider the same offset credits as eligible in their systems, as the credits will affect the supply and thus the price of allowances in the joined ETS market. This also raises issues for compliance, as it becomes challenging to distinguish whether allowances originating from one jurisdiction are freed by offsets that are not eligible in another jurisdiction (Mehling et al., 2011).

The EU ETS has a history of using carbon offsets through the CDM and Joint Implementation credits, but due to environmental integrity concerns the use of credits from projects which destroy trifluoromethane (HFC-23) and nitrous oxide (N_2O) were banned in 2011 (EC, 2011). The use of offsets in general has been criticized, as determining reductions from offsets can be problematic and can undermine the effectiveness of an ETS (van Kooten and de Vries, 2013; Green, 2021). In the latest phase of the EU ETS (i.e., Phase 4), the use of offset credits is not allowed and there are no plans for adopting their use in the future (EC, 2022a).

When the UK ETS was formed, a similar decision was made to not allow using offsets, with the aim to incentivise abatement efforts domestically. It was, however, stated that the UK is open to reviewing the use of offsets in the future (HM Government, 2020). Indeed, recent developments in greenhouse gas removals (GGRs) through CCS brings this matter to the forefront of ETS market development in the UK. The UK in its main response to the 2022 consultation on developing the UK ETS indicated that the UK ETS could be an appropriate long-

[4] Another debate, beyond the scope of this paper, is whether a quantity-based or a price-based mechanism is more suitable; see Narassimhan et al. (2018), Fischer et al (2020) and Perino et al. (2021).

term market for GGR credits. Subject to further consultation, and after ensuring a robust MRV regime is in place to account for GGR offset use, the government intends to include engineered GGRs in the scheme.[5] Inclusion of "high-quality" nature-based GGRs could also be considered, but due to the identified concerns on permanence, costs and wider land management impacts this would require further examination. It is stated that the result would be a move towards an integrated market framework within which businesses can make economically efficient choices between paying to emit, paying to remove emissions, or investing to lower emissions. The interaction with voluntary carbon markets (VCMs) is also under consideration (HM Government, 2023a). Though the focus is on domestic engineered GGRs, this could mean that nature-based removals (the more common type of offsets available in VCMs) and eventually international offset credits could be included in the scheme.

On the other hand, the EU ETS has not made similar public plans on permitting offsets. However, within the recent revised Directive 2023/959 a request is set for the Commission to report to the European Parliament and to the Council by July 2026 on how emissions removed from the atmosphere and permanently stored could be covered by EU ETS (EC, 2023a; EC, 2024e). The EU is also developing a carbon removal certification framework to provide transparency and robustness in carbon removals, but this falls outside the scope of the EU ETS. Once such a framework is in place to create credible removals credits, there is potential for an integration into the EU ETS. Current legislation shows both ETSs to have a similar outlook on the use of offsets for the current phase, unless the UK is committed to bringing GGRs into the scheme in the future. If the EU follows suit to also include offsets, then the creation of a larger certified removals market can help scale up and deploy engineered GGR technologies, where the market is still nascent. Such a development could benefit both jurisdictions in reaching net-zero (or perhaps even net-negative) by 2050.

Let us finally turn to some other design elements. Related to the flexibility of an ETS system is the option to bank and borrow allowances. Banking especially can play a key part in achieving maximum gains from trade, as well as help to control price spikes and collapses as emitters can turn to banked allowances (Schmalensee and Stavins, 2017). The UK ETS allows for the banking of allowances, which remain to be valid indefinitely. Limited borrowing is also allowed, where a polluting entity can use allowances allocated for free in the current year for compliance in the previous year. These rules for banking and borrowing follow the EU ETS design (ICAP, 2022). Indeed, mirroring the EU ETS on this was suggested by the government when designing the UK ETS (HM Government, 2020).

The same applies for MRV, compliance design and treatment of new emitters. The UK scheme closely follows the EU ETS on this. Both systems have annual self-reporting frequency and verification by independent accredited verifiers is required before 31st March each year

[5] Examples of engineered GGRS include direct air capture and storage, and power bioenergy with carbon capture and storage.

(ICAP, 2022). The UK scheme also adopts some of the proposed EU ETS Phase 4 changes, such as reducing the frequency of improvement reporting as well as simplification of monitoring plans (HM Government, 2022). These changes mainly reflect simplifying and streamlining the MRV process in the UK.

The UK system also closely follows the EU ETS design regarding compliance. Both ETSs have a compliance period of one year from 1st January to 31st December with emitters having until April 30th of the following year to meet compliance and to surrender allowances. Treatment of new emitters is also similar in both schemes. Both have a New Entrants Reserve (NER), which sets aside allowances for new entrants and for existing emitters with increases in their operation capacity (ICAP, 2022).

3.2 Political Economy Considerations

Alongside the market design aspects discussed above, political economy concerns that influence linking of ETSs also require consideration. The relationship between different jurisdictions and the importance emissions trading or environmental concerns governments hold can influence linkage. Such concerns can be associated with the length and complexity of negotiations surrounding linking, the potential loss of domestic co-benefits and the (potential) loss of regulatory autonomy.

It is important to consider how long negotiations on linking can last for, a notorious example being the latest ETS linking agreement between the EU and Switzerland. Negotiations on linking started in 2011, concluded in 2015 and an agreement was signed in 2017. After legislative approval and ratification in 2019, the linked market officially came into operation at the beginning of 2020. This means that it took almost a decade to establish an operational link between the two markets. The never implemented link between the EU and Australia's ETS also had a relatively long timeframe to come fully into effect. The market link was agreed in 2012 with the plan to commence in 2018 (EC, 2012).

Another aspect concerns net-zero emissions targets. Similar targets would smoothen market linking, especially if these long-term targets are aligned and stable across both jurisdictions. Also, since the EU is already linked with the Swiss ETS, this would create an indirect link between the UK and Swiss ETS if the UK and EU were to link, potentially creating a multilateral carbon market.[6] Thus, the EU-UK link could potentially be expanded to include Switzerland from the start. This could reinforce more partners to join, which would be conducive to creating a more coordinated strategy towards climate change mitigation (see also discussion in Section 2). At the same time, a multilateral linking agreement might make negotiations more complex and lengthier. This could potentially deter other parties to participate and join the agreement.

[6] However, Green et al. (2014) suggest that such indirect links should be kept to a minimum, considering that political uncertainty can undermine the stability of the system.

The alternative, where the UK and EU start negotiations bilaterally, would still need to take the EU-Swiss link into account, which can complicate linkage discussions. Mehling and Haites (2009) point out, however, that if there are no restrictions on types and quantities of imported compliance units in bilateral links, the indirect link formed between two jurisdictions—through their respective bilateral links with a third jurisdiction—would be equivalent to that of a multilateral link between all jurisdictions. This would mean that, if all three jurisdictions agree on what is accepted for compliance, the indirect UK-Swiss link formed out of a UK-EU link would likely not be a major bottleneck. Still, it requires coordination across all jurisdictions to ensure a well-functioning carbon market.

Potential loss of domestic co-benefits with emphasis on domestic emissions reduction efforts can also cause difficulties in forming a link (Bodansky et al., 2016; Flachsland et al., 2009). Co-benefits are the indirect benefits gained from mitigation efforts, such as reduced local air pollution leading to improved human health and subsequently healthcare cost-savings. This can be a controversial argument against linking, as the redistribution of abatement efforts would in theory mean that these efforts are being efficiently (re)allocated into areas where average MACs are the lowest, fostering cost-effective linking. Loss of co-benefits as an obstacle for linking would not serve the cooperative global effort in reducing emissions. However, Holtsmark and Weitzman (2020) show that it is not a given that overall emissions under a linked ETS would decrease compared to independent emissions markets. This would deviate from the domestic objectives of emissions abatement, making linking an unattractive policy option. As discussed earlier, since emissions trading is subject to government alignment, it is important to consider this in market linking discussions.

If the link between the UK and EU were to create a joined carbon market, where abatement reductions are more affordable outside the UK system, this might be unpreferred if the goal is to achieve domestic mitigation efforts (i.e., within the UK). The UK government has declared its desire to reach net-zero through a strategy of "building back greener" involving policy changes in different sectors but aimed to reduce emissions across the whole UK economy (HM Government, 2021). If domestic efforts are seen as a priority, this could affect the willingness to link. Since the allowance price reflects the MAC of the jurisdiction, a post-link allowance price that could equalise closer to the currently higher EU ETS allowance prices (see Figure 1) would be beneficial for emissions abatement efforts in the UK. With the increase in allowance prices, the MAC for the UK increases, which would induce more domestic abatement. The opposite would be true for the EU, however, which could influence their decision on linking due to the implications on EU abatement efforts. Considering the significantly smaller ETS market size of the UK to the EU, the common post-linkage price would most likely not deviate significantly for EU participants for this to cause issues, however.

The most significant political economic concern, however, is often considered to be potential loss of regulatory autonomy (Green et al., 2014). As markets are in the process of being linked, design elements need to be coordinated (which in the EU-UK case are already reasonably harmonised, as mentioned earlier). This highlights the importance of agreeing on which and how environmental targets should be met.

The EU ETS functions in the EU's legal framework. A linked UK-EU ETS would then be subject to the EU regulatory framework. This means that any changes in joint ETS market design can become more difficult to implement. The most obvious example being the choice in the price stabilisation mechanism. If the joint market adopts a quantity-based mechanism but the UK then decides a price-based mechanism would be more appropriate, this requires unanimous agreement from EU Member States.[7] Gaining the unanimous vote of close to 30 countries with different national priorities can prove to be challenging. Indeed, it can be argued that the adoption of the MSR as a price stabilisation mechanism was a result of the EU legislative process, since it does not need the unanimous vote as a quantity-based mechanism (Fischer et al., 2020). Delbeke and Vis (2015) argue that the adoption of the ETS as the main carbon pricing policy is attributable to this legal framework, since it did not require a unanimous vote, which a carbon tax would have required. This suggests that a standalone UK ETS might allow the UK Government the flexibility needed to make effective decisions deemed necessary for aligning the UK ETS with the 2050 target. Any coordinated linking requirements, such as harmonising the price stabilisation mechanism, would most likely have to come from the UK being flexible in its design elements. Perino et al. (2021) suggest that rigidness which characterizes the choice of the price stability mechanism and the aversion to price-based measures could be a potential liability for the EU ETS as a linking partner.

On the other hand, being part of the EU ETS does not limit a country's options for increased environmental policy stringency. Several countries have implemented their own carbon taxes in addition to being part of the EU ETS (e.g., Sweden and Finland), and Germany has implemented a complementary ETS to cover transport and building sectors[8] (ICAP, 2024; World Bank, 2024). The UK Government could then, if necessary, increase their environmental ambitions through other means even in the presence of a UK-EU ETS link, which would not be affected by the EU's legal framework.[9]

[7] As set in Article 192(2) of the Treaty on the Functioning of the European Union (EU, 2007).

[8] The development of the new EU ETS II (separate from EU ETS) will now create a jurisdiction wide scheme to cover and address upstream emissions from fuel combustion in buildings, road transport and additional small industry sectors not covered by the existing ETS. The scheme aims to be operational by 2027 (EC, 2024b).

[9] Note that the UK adopted a carbon price floor via Carbon Price Support (CPS) rates in 2013 to complement the EU ETS to ensure a minimum price for carbon, meaning that such solutions have been used before and are an option.

3.3 Economic Considerations

Main economic arguments that affect linking relate to cost-effectiveness and gains from trade, competitiveness, and market liquidity concerns. Distributional effects of linking and the potential exposure to risk from the other system are also an aspect to be considered.

Gains from trade by ETS linking refer to increased consumer and producer surplus resulting from liberalized voluntary market exchange between entities. Flachsland et al. (2009) and Verde et al. (2020) discuss the efficiency gains and its distribution when two regions link. In the partial equilibrium analysis regions possess differently sloped MAC curves, where the flatter sloped curve can be either due to abatement being less expensive or because the system is larger than the other one, which has a steeper MAC curve. In theory, as the two ETSs link the pre-link allowance prices converge to an intermediate price level, which is closer to the pre-link price of the region with the flatter MAC curve. Under this new price, abatement can then shift from the region with higher abatement costs to the region with lower abatement costs. The former gaining from abatement cost savings and the latter from gains from revenue from sold allowances, which together represent savings in aggregate abatement costs.

For instance, assume the EU ETS represents the region with the flatter MAC with its much larger market size compared to the UK. The average 2021 primary auction market allowance price for the UK was GBP 51.62 and for the EU it was GBP 45.92[10] (ICE, 2024b; EEX, 2021). In April 2022, the secondary futures market price for DEC22 contracts for UK and EU allowances were GBP 75.25 and GBP 67.83[11], respectively (ICE, 2022a, 2022b). Since then the allowance prices of the two ETSs have started to diverge. Merely two years later the average primary auction market allowance price for the UK was GBP 53.36 and for the EU it was GBP 70.91[12] (ICE, 2024a; EEX, 2023). While UK ETS allowances initially traded at a higher price than EU ETS allowances during the early years of the scheme, this has changed since (Figure 1). From mid-2023 onwards the UK ETS allowance prices have been notably lower compared to EU ETS prices. This would bring the MAC in the UK to be lower than in the EU. The slump in UK ETS allowance prices could be a consequence of the government's move to bring an additional 53.5 million unallocated allowances to auction over 2024-2027 to compensate the net-zero cap alignment and to avoid resulting price spikes (HM Government, 2023a).

Some factors become important considering whether to link the two schemes in this context. Major price movements like price spikes are present in both systems around the same time periods. Being part of a linked market can help mitigate potential shocks and reduce price volatility, where a stable allowance price can help instil trust in a carbon pricing system. Even if linking would expose UK entities to imported price shocks, the UK and EU being relatively integrated economies would mean that shocks are possibly correlated across the two ETS regions

[10] EUR 54.13, with Bank of England 22nd August 2024 conversion rate of EUR 1 = GBP 0.8483
[11] EUR 79.96, EUR 1 = GBP 0.8483
[12] EUR 83.60, EUR 1 = GBP 0.8483

regardless of linking or not (Doda et al., 2019). The price spikes in December 2022 and February 2023[13] are present in both markets as separate ETSs (see Figure 1) and could be seen as evidence to this. It could be argued that concerns on experiencing price shocks are more prominent when the two jurisdictions are less integrated economies, including in terms of their approach to carbon pricing.

For the UK to rapidly lower emissions and decarbonise to achieve net-zero, high carbon prices are crucial. The UK ETS should feature increased allowance prices over time to instil credibility in the system. A link with the EU ETS, where the price would most likely converge towards the larger system's pre-link price, could be of high importance. This motivates linking the two schemes. However, it can be expected that the UK ETS prices would increase once no more unallocated allowances are introduced into the system and the net-zero aligned cap can fully take effect. Similarly, as part of the 2023 revision of the EU ETS, there are two cap reductions of 90 million allowances in 2024 and 28 million in 2026, while the scheme's annual reduction factor of the cap is increased from 2.2 percent to 4.3 percent for 2024-2027, and finally to 4.4 percent from 2028 onwards (EC, 2024d). As both these markets shrink in the long run, it is vital to consider market liquidity. Regulated entities will require more abatement options that linking the two schemes may provide.

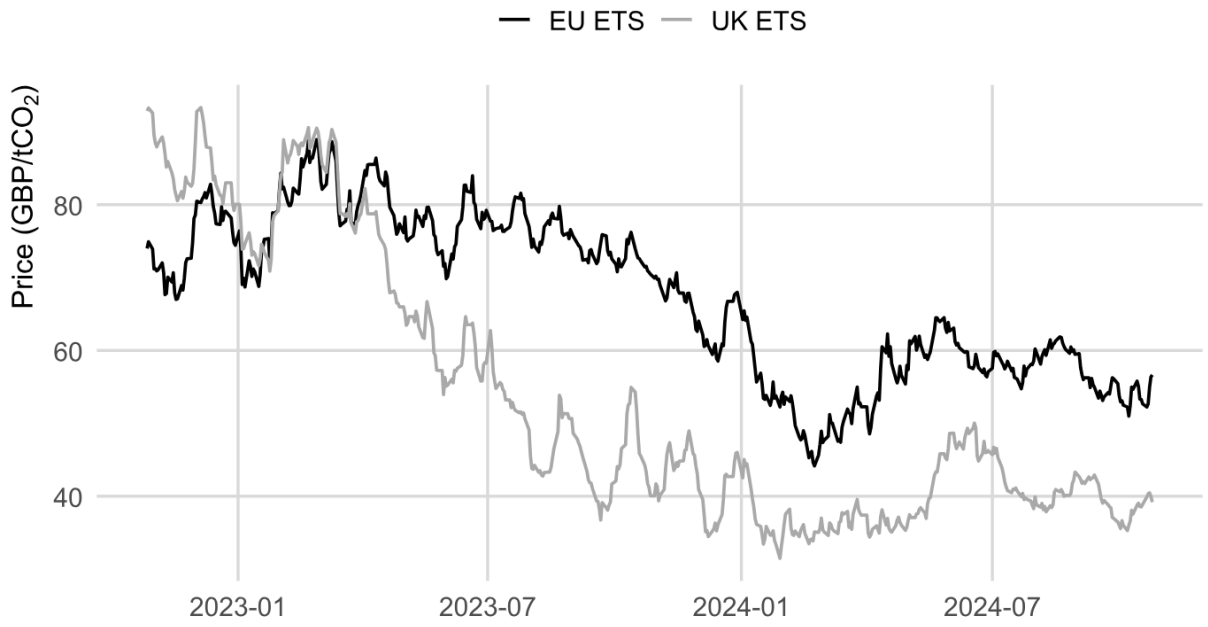

Figure 1. UK ETS and EU ETS Futures DEC24 Prices in GBP October 2022 to October 2024
Source: Data extracted from ICE (figure constructed by authors)

[13] The EU ETS system reached an all-time high in allowance price of around EUR 105 per tonne in February 2023; similarly the UK ETS experienced a price spike.

As there exists a price difference between these carbon markets, in theory, linking the schemes would then create benefits for both jurisdictions. The EU in the form of savings in abatement costs and to the UK in the form of revenue from sold allowances, as the allowance price converges to an intermediate level and the MACs equalize for the two regions. How the net gains are distributed among the linked jurisdictions can also be relevant when considering whether to link or not. Verde et al. (2020, p. 5) note that "in partial equilibrium analysis, linking ETSs with different marginal compliance costs always generates an efficiency gain". These net gains might not be distributed equally between the linked jurisdictions. The distribution of these gains depends on the relative slopes of the MAC curves with the region with the steeper MAC curve receiving a greater share (Flachsland et al., 2009). Distribution of gains at the individual level creates net winners and losers depending on their MACs and whether they are part of the higher-price or lower-price system (Ranson and Stavins, 2016). Some emitters in the UK market who are net sellers of allowances might benefit from a new higher price, while some net buyers of allowances in the UK might be disadvantaged.

Note that the potential gains from linkage are most notable when there are significant differences in pre-link prices, MAC profiles, and the size of the ETS markets (Haites and Mullins, 2001; Caillaud and Demange, 2017). The evolution of the allowance prices for the two ETSs have in the recent year started to diverge (though not to the extent as when comparing say the 2023 average allowance auction price of the RGGI of GBP 9.78[14] to the UK ETS's price of GBP 53.36 (ICAP, 2024; ICE, 2024a)). This would suggest a relatively notable change in the allowance price post linking when looking at the current price UK market participants face, and thus potentially significant efficiency gains from linking. This would also mean that a modest transfer of wealth will occur between the UK and EU from the allowance transactions, which can make the link more acceptable for the UK Government (Green et al., 2014). As allowance prices converge to a new common price in a linked carbon market, it can help reduce competitiveness concerns among polluting firms, who would then face similar abatement cost profiles (Edenhofer et al., 2007). Tiche et al. (2014) note that competitiveness concerns arising from carbon prices are higher for carbon intensive industries in smaller carbon markets. Taking into account that the EU is the UK's largest trading partner, with trade in carbon intensive goods, it can cause competitiveness concerns if the price of carbon is different for companies in these two regions, especially if the UK allowance price were to rise above the EU price in the future (Burke et al., 2021; EC, 2021). This is particularly important in relation to recent discussions surrounding CBAMs under development in both regions (discussed in section 3.4.).

The continuation of a uniform allowance price that would arise from a UK-EU ETS link would then reduce these competitiveness concerns (Tol, 2018). Indeed, when the establishment of a standalone UK ETS was under consideration, 42 industry groups (many who would be

[14] USD 12.81, with Bank of England 22nd August 2024 conversion rate of USD 1 = GBP 0.7632

registered participants in the carbon market), issued a letter to the UK Government urging for a link to be established between the EU and UK carbon markets, raising competitiveness concerns between the EU and UK industries (UK companies, 2021). According to Baumol and Oates (1971), carbon prices should be uniform, since carbon is a homogenous good and therefore the price of it should be the same among regions. Emitting a tonne of GHG anywhere in any region has the same environmental consequences for everyone (Pizer and Yates, 2015).

Market liquidity is also a motivator for linking. This is especially true for a carbon market of the size of the UK ETS, which is roughly 6 times smaller than the EU market based on the number of obligated entities.[15] Market liquidity can help reduce price volatility and market power (Mehling et al., 2011). In the UK ETS, being a relatively smaller market, means that a few large participants might enjoy a degree of market power, allowing them to influence allowance price. A link with the EU ETS increases the number of market participants, and can lead to decreased market power (Haites, 2016). Moreover, the UK ETS being still a relatively new market can suffer from lack of liquidity, which can then result in price spikes. This was seen in the period that triggered the CCM in December 2021 and January 2022, as mentioned in section 3.1. A link with the EU ETS would significantly increase the amount of market participants in the combined carbon market, providing greater abatement opportunities for UK ETS participants.

3.4 Environmental Considerations

Environmental issues are at the core of emissions trading, and it is only natural that they play a key part in linking ETSs. Main concerns discussed here are policy alignment in emissions reduction targets, carbon leakage concerns, and the development of carbon markets including CCS technology in achieving net-zero. Below we will systematically discuss these issues.

Setting emissions reduction targets defines the stringency of the ETS cap and guides other design aspects. Differences in emissions targets across jurisdictions can cause a barrier to linking (Ranson and Stavins, 2016). When the ETS was formed, the UK appeared to have a relatively more stringent approach by setting the initial emissions cap 5 percent lower than what the UK's notional share would have been under Phase 4 of the EU ETS if the UK had stayed part of the scheme (HM Government, 2020). In 2023, this cap was further adjusted downward to 939 million allowances, representing a 30 percent drop from the original 1,365 million allowances, ensuring a net-zero consistent cap in the first phase of the scheme (HM Government, 2023a). The emissions reduction targets set by the UK government for 2030 and 2035 are 68 percent and 78 percent, respectively, compared to 1990 levels, with a net-zero goal for 2050 (BEIS, 2021)[16]. In the medium term, the EU has a relatively less ambitious emissions reduction target of 55 percent by 2030

[15] UK ETS covers around 1,228 emitters, while the EU ETS covers 7,705. In 2023, The verified emissions of the UK and EU ETS markets are roughly 97 $MtCO_2e$ and 1,149 $MtCO_2e$, respectively (UK Emissions Trading Registry, 2024; EU, 2024; Nissen et al., 2024).

[16] The UK's new 2035 target of 81 percent reduction compared to 1990 levels was announced by Prime Minister Keir Starmer at the 2024 United Nations Climate Change Conference (COP29) (HM Government, 2024b).

compared to 1990 levels but is also committed to net-zero emissions by 2050 (EC, 2020). In February 2024, an ambitious new target was presented by the European Commission of reducing EU's emissions by 90 percent compared to 1990 levels by 2040. The decision to adopt this new target will fall on the next Commission that takes office after the 2024 European Elections (EC, 2024c). Having the same long-term net-zero objective facilitates cooperation and is conducive to harmonising market linking. Differing short-term goals may impact relevant upcoming policy decisions in the near term, however, which might influence governments' willingness to link. Such upcoming policy decisions could, for example, relate to the specific choice of the price stabilisation mechanism or the use of carbon offsets, both of which the UK Government has indicated it will reconsider as the market matures, as discussed in section 3.1.

As a single jurisdiction, coordinating policy stringency is easier and faster to implement compared to multiple jurisdictions. This can be seen from the quick implementation of the new UK ETS for which consultation started in May 2019, a concluding governmental response in June 2020, and the scheme in operation by May 2021. The UK administration was also able to quickly change the desired ARP to be higher than planned at first, as it was originally set at GBP 15 in 2020 but increased to GBP 22 before the start of the auctions in 2021. On the other hand, the implementation of the MSR in the EU ETS — as a long-term solution to demand-supply imbalances after the price crash due to allowance surplus in the early 2010s — was first introduced in 2015 and only began operating at the start of 2019 (EC, 2022b). However, as Woerman (2023) shows, initial asymmetric environmental policy stringency across different emissions trading programmes can be reflected in an "allowance exchange rate" to smoothen linking towards a more realigned market arrangement. Beyond policy stringency, other aspects can also be captured by the exchange rate, including alternative abatement options and price containment mechanisms across markets. Woerman (2023) demonstrates that the exchange rate choice has implications for both aggregate emissions and cost-effectiveness in the linked ETS outcome compared to independently operated markets. Depending on the exchange rate set, efficiency gains can be secured in a linked market, but the distribution may be unequal across linked entities.

Another consequence of varying policy stringency across independent markets is carbon leakage. Carbon leakage refers to having pollution-intensive production moved to areas with less stringent environmental policy, thus displacing emissions rather than reducing them (Tiche et al., 2014). The significance of leakage for emissions trading schemes is that even modest carbon prices can lead to carbon leakage concerns for emissions-intensive and trade-exposed companies. This can make it infeasible for the government to keep carbon prices at sufficiently high levels required for deep decarbonization (La Hoz Theuer et al., 2021). When the price of carbon equalises among linked markets, carbon leakage can be reduced between the jurisdictions involved, as firms will face a similar carbon cost burden (Jaffe and Stavins, 2007). How the impact of linking ETSs on carbon leakage materialises in practise is another matter. If a linked

jurisdiction faces a higher post-linked allowance price, this can potentially increase leakage in that region, while a jurisdiction that faces a lower price might see reduced leakage. The effect on leakage depends on the size of the changes in allowance price, as well as the jurisdictions' sensitivity to leakage (Türk, 2011). Due to the expected high carbon cost in both jurisdictions with governing bodies emphasising decarbonisation, carbon leakage is not as likely to occur or not of high concern in the long run between the two, even with currently diverging allowance prices (see section 3.3.).

To prevent carbon leakage, the EU ETS is implementing a CBAM which will gradually be aligned with the ongoing phase-out of free allocation of allowances until fully operational by 2026. The current plan is to have a levy on imports covering the following sectors: aluminium, cement, fertilisers, iron and steel, hydrogen and electricity (EC, 2024a). The UK has followed suit. After a consultation on carbon leakage risk, in December 2023 it was confirmed that a UK CBAM will be implemented by 2027, covering goods from the aluminium, cement, fertiliser, iron and steel, and hydrogen sectors[17] (HM Government, 2024a). Currently, the design of the two CBAMs differ slightly. The UK CBAM would function as an import levy by sector, set quarterly by the government with reference to previous UK ETS prices, while the EU CBAM requires importers to surrender certificates whose value is derived from the EU ETS allowance price at time of surrender.

An analysis by Burke et al. (2021) of the potential effect of the EU CBAM on the UK finds that a high convergence of policy would be most beneficial, since the EU is the UK's main trading partner in carbon-intensive goods. This would support market linkage. Since thee two jurisdictions have relatively similar environmental ambitions, it could be argued that it is unlikely that the UK would be subject to the EU CBAM in the long term, as its purpose is to prevent carbon leakage with regards to regions that have significantly laxer climate policy (Burke et al., 2021). Indeed, Türk (2011) points out that regions such as the EU are mainly concerned about carbon leakage to developing countries where carbon pricing policies can be lax or non-existent. However, the current allowance price divergence (see Figure 1) highlights the concerns that arise between the UK and EU as trading partners when there is a CBAM in place.[18]

If the UK completes their CBAM implementation, there is a potential for aligning the two adjustment mechanisms despite some differences in their design regarding cost structure and current scope. However, considering the UK in its consultation response stated that the certificate model is administratively more complex and not accurately reflective of the cumulative impact of other schemes in the UK (such as the CPS rates), it is not clear what the motivation would be to adopt one system over the other. However, it could be argued that having separate CBAMs with different mechanisms would not inhibit linking. The two jurisdictions could benefit from a

[17] Note the sector coverage is identical to the EU CBAM with the exception of electricity.

[18] A discussion supporting the alignment of the two ETSs with regards to the effects of CBAMs on the UK and EU can be found in the report by Frontier Economics (2024).

linked market with a common allowance price, as this renders the CBAMs negligible between the jurisdictions and still retain similar protection against carbon leakage, as CBAMs sit outside ETSs operations.

In the context of developing international carbon capture markets, as part of developing UK and EU CCS strategies, the alignment of the EU and UK ETSs is of paramount importance. Linking (or aligning) is required if the two jurisdictions wish to benefit from international trade and export of permanent carbon storage between themselves, avoiding regulatory barriers. Under the current framework, EU ETS installations would not benefit from the exemption to surrender allowances if exporting captured CO_2 for storage outside the European Economic Area (EEA), as this would not comply with Article 12(3a) of the EU ETS Directive (EU, 2003). This removes the incentive for EU emitters to export their CO_2 to the UK. Clarity on how CO_2 captured and exported for permanent storage is treated under different ETS schemes is required. The two schemes could, at the minimum, include some form of common regulation regarding the treatment of transport and storage value chain emissions and permanent storage of CO_2, where storage sites in the UK and EEA are legislatively treated equally. The EU ETS Directive and UK ETS Order could be amended to recognise storage in another jurisdiction that satisfies minimum CCS certification criteria[19].

4 Concluding Remarks

Emissions trading schemes (ETSs) are market mechanisms that promote cost-effective emissions reductions, which is vital in supporting energy transitions and help achieving long-term net-zero emissions targets. Yet many ETSs are operating independently and do not enable emissions trading between carbon markets. While originally many energy-intensive sectors in the UK were regulated under the EU ETS, after Brexit the UK developed and implemented their own independent ETS for trading carbon allowances. However, to assess the effectiveness of ETSs, a literature has emerged on the issue of linking such markets. Addressing this seems particularly pertinent in view of the UK's net-zero 2050 target. By reviewing relevant academic and policy literature on ETS linking, this paper attempts to draw some key lessons and implications for the functioning and performance of the UK ETS in relation to the EU ETS in the context of industry decarbonisation and transition towards net-zero emissions targets.

We identify and discuss ETS linking on the basis of four key components: (i) market design, (ii) political economy, (iii) economic, and (iv) environmental considerations. On this basis we conclude that linking the UK ETS with the EU ETS has potential to enhance the UK's efforts to meet its legally binding net-zero target by 2050. Both markets share several structural design features, making them congruent for linking. By joining forces, the two systems could increase

[19] Alternatively, negotiations with the EU could include the amendment of the Directive 2009/31/EC and the UK CCS licencing regime to recognise jurisdictions that hold equivalently regulated permitting of CO_2 storage sites.

market thickness, enhance carbon price stability, and provide more flexible and cost-effective emissions reduction options for regulated entities. These benefits could strengthen the UK's carbon market and support the broader UK and EU climate strategies, creating a more integrated and flexible carbon pricing mechanism. Linking can be an efficient option to ensure market resilience and liquidity for both the UK and EU, as both markets shrink with reduced caps to align with net-zero ambitions.

A linked UK-EU ETS could also facilitate cooperation on critical climate technologies, such as carbon capture and storage (CCS) and engineered greenhouse gas removals (GGRs). CCS currently faces regulatory barriers that hinder cross-border development, while the possible adoption of GGR credits for offset purposes in ETSs could help expand this underdeveloped market (currently under consideration in the UK). Aligning policies across jurisdictions through linked ETSs could unlock substantial benefits from investment for both regions.

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