International Carbon Action Partnership

ACCOUNTING FOR THE LINKING OF EMISSIONS TRADING SYSTEMS UNDER ARTICLE 6.2 OF THE PARIS AGREEMENT

Discussion paper prepared for the International Carbon Action Partnership

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Stockholm Environment Institute
Lambert Schneider

Öko-Institut e.V.
Johanna Cludius

International Carbon Action Partnership Secretariat
Stephanie La Hoz Theuer

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Öko-Institut e.V.

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Executive summary

After the adoption of the Paris Agreement and the preparation of countries' first nationally determined contributions (NDCs), policy-makers around the world are planning and implementing climate change mitigation policies to achieve their NDCs. Emission trading systems (ETSs) are increasingly embraced as a policy to reduce emissions in a cost-effective manner. Several jurisdictions are also considering, or have already established, links between their systems.

When linking ETSs internationally, allowances can flow across international borders. This, in turn, can change the level of emissions in the participating countries. As such, an important question arises as to whether and how linking affects the achievement of NDCs, and whether and how countries should account for such links under the Paris Agreement. Article 6.2 of the Paris Agreement establishes a framework that allows countries to engage in international carbon market mechanisms and to account for their use towards their NDCs. International linking of ETSs is seen as one important application of Article 6.2. The European Union (EU) and Switzerland, for example, have declared that they intend to account for their ETS link through Article 6.2.

This discussion paper explores how countries could account for the international linking of ETSs under the Paris Agreement, and how linking could be accounted for in the context of (sub-national) jurisdictional mitigation targets.

General aspects of accounting for the linking of ETSs

By allowing allowances from one jurisdiction to be used for compliance in another jurisdiction, linking enables greenhouse gas (GHG) abatement to take place wherever it is cheapest. More mitigation will occur in the jurisdiction that has lower abatement costs (and therefore exports allowances), and less mitigation will occur in the jurisdiction that has higher abatement costs (and therefore imports allowances). Linking thereby supports the ability of countries to achieve their *aggregate* mitigation targets at lowest cost. In so doing, however, linking may impact countries' progress in achieving their (individual) NDCs. If the shift in emissions is not accounted for towards NDCs, linking could make it more difficult for the *importing* country to achieve its NDC. Since importing allowances from another country allows the regulated entities to emit more, the country's emissions from its ETS sectors may be higher than the ETS cap. If this effect is significant, it could undermine the country's ability to achieve its NDC. When countries engage in linking ETSs, they may therefore have an interest that the shift in emissions from the linking is appropriately reflected and accounted for in relation to their NDCs. The same may hold for sub-national jurisdictions that use ETSs to achieve jurisdictional mitigation goals.

Linking can affect the achievement of NDCs whenever allowances flow across international borders. This can occur in two ways: first, through separate ETSs being linked internationally – such as the EU ETS and the Swiss ETS, or the California and Québec systems. Second, within a single ETS that includes Parties to the Paris Agreement with separate NDCs – such as the EU (which has a single NDC) and Iceland, Liechtenstein and Norway, which joined the EU ETS but have separate NDCs. Both situations are considered when referring to 'linking' in this paper.

Countries could pursue different options to ensure that international linking of ETSs is appropriately reflected in formulating and accounting for NDCs under the Paris Agreement. First, they could account for the linking of ETSs under Article 6.2 of the Paris Agreement – which is the focus of this study. Alternatively, countries with a linking agreement or a joint ETS could communicate a single NDC or communicate two targets in their NDC: a common ETS target and separate targets for their non-ETS sectors. Finally, countries could also decide simply not to account for the link, e.g., where the shift in emissions from linking is very small in relation to the countries' total emissions.

Quantifying the shift in emissions from linking ETSs

A prerequisite for accounting for the linking of ETSs is estimating the shift in emissions that occurs in each jurisdiction as a result of linking. Ideally, the number of 'internationally transferred mitigation outcomes' (ITMOs) accounted for under Article 6.2 would exactly correspond to the shift in emissions that occurs in each jurisdiction as a result of linking (i.e. the increase or decrease in emissions as compared to the situation of no linking). In this case, accounting for ITMOs would match with the changes in emissions that countries observe in their GHG inventories used to track progress towards NDCs.

In practice, this is more complex than it may appear at first glance. A key challenge is that the *actual* shift in emissions cannot be empirically observed. Once two systems are linked, it is impossible to determine the exact emission levels in the jurisdictions in the absence of linking and to compare them with the emission levels observed under linking. Policy-makers from both jurisdictions therefore need to identify and agree on methods to *estimate* – i.e. approximate – the shift in emissions. In doing so, they may have an interest to identify approaches that give a fair representation of the *likely* actual shift. Underestimating the shift could disadvantage the importing jurisdiction because the emission increase in the importing jurisdiction would be higher than the amount of ITMOs that the jurisdiction could account for. Similarly, overestimating the shift could disadvantage the exporting jurisdiction because the emission decrease in the exporting jurisdiction would be lower than the amount of ITMOs that the jurisdiction would account for.

Two broad approaches could be pursued to estimate the shift in emissions: economic modelling and using information on allowances. This paper focuses on the latter because economic modelling could involve considerable uncertainties, because information on allowances is readily available to ETS regulators, and because using information on allowances could allow for quantifying the shift in a transparent and reproducible manner.

In principle, the flow of an allowance from one jurisdiction to another implies that emissions may increase by one tCO_2e in the importing jurisdiction while they have to be reduced by one tCO_2e in the exporting jurisdiction. In practice, the implications are more complex because regulated entities are typically allowed to hold and bank allowances between years. Moreover, ETSs can include price stability mechanisms and allowance reserves, allow using offset credits, or enable the voluntary cancellation of allowances. This implies that the flow of an allowance from one jurisdiction to another may not necessary imply a shift in emissions and that a snapshot of information on allowances at one specific point in time, or over one calendar year, may not necessarily be a representative picture of the actual shift in emissions.

This discussion paper identifies four broad approaches to estimate the shift in emissions based on the amount of allowances issued, held in accounts, transferred between jurisdictions, and/or surrendered for compliance (see Table ES-1).

Table ES-1: Approaches to determine the shift in emissions from linking of ETS

Approach	Description
Approach A: Comparing emissions with caps	This approach compares the emissions from regulated entities in each jurisdiction with the size of the cap of that jurisdiction. A shift in emissions is only accounted for if emissions in one of the jurisdictions exceed the jurisdictional ETS cap. If that is the case, the shift is estimated as the allowance shortfall in that jurisdiction, which is made up by allowances from the other jurisdiction.
Approach B: Net transfers of allowances	This approach estimates the shift in emissions as the net amount of allowances transferred between the jurisdictions.
Approach C: Surrender of allowances	This approach estimates the shift in emissions based on the volumes of 'foreign' allowances surrendered in each jurisdiction. The shift in emissions is calculated as the difference of foreign allowances used in jurisdiction A and foreign allowances used in jurisdiction B. The calculation could either be based on the actual origin of the allowances (Approach C1) or the origin could be approximated in proportion to the size of each jurisdiction's cap (Approach C2).
Approach D: Combining information on transfer and surrender of allowances	This approach combines information on allowance transfers and allowance surrender to estimate the shift in emissions. The shift in emissions is calculated as the difference between own allowances transferred to another jurisdiction and 'foreign' allowances surrendered.

The implications of these approaches are illustrated by way of a simplified model of two jurisdictions with linked ETSs. Our brief assessment of the four approaches suggests that there is no single best solution. All approaches have some benefits but also drawbacks. Importantly, each of the approaches leads to different estimates for the shift in emissions. Policy-makers may therefore have to carefully consider which approach is best suited in the context of their ETSs, also taking into account the particular circumstances and information available:

- Comparing emissions in each jurisdiction with their respective caps (Approach A) is simple but always determines the lowest possible outcome with regard to the *actual* shift in emissions. It is thus likely to *underestimate* the actual shift, which would disadvantage the importing jurisdiction and advantage the exporting jurisdiction when it comes to communicating or accounting for jurisdictional or NDC targets.
- Caution may be needed when using information on the *transfer* of allowances to estimate the shift in emissions (Approach B), particularly with ETSs with a large number of allowance holdings, as a shift in the location of allowance holdings may not necessarily imply changes in abatement and emissions.
- Countries could consider employing, or building on, approaches that estimate the shift in emissions based on the number of allowances *surrendered* by the regulated entities (Approach C). Since the surrender of allowances reflects emissions from the regulated entities, this approach may be better suited to reflect the actual shift in emissions compared to using information on the transfer of allowances (Approach B).
- Combining information on transfer and surrender of allowances (Approach D) could be a way forward to reflect the actual availability and surrender of allowances but leads to different values for the shifts in the two jurisdictions.

For approaches that draw on the number of units that are available to regulated entities (Approaches A and C2), it is important to consider all ETS features that may affect the availability of units, including price stability mechanisms and allowance reserves, allowance cancellations, offset credits, banking of allowances from previous periods (or borrowing from future periods), and – possibly in the future – the use of allowances to meet obligations under the International Civil Aviation Organization (ICAO) or the International Maritime Organization (IMO).

Another key consideration is the time period for which the shift in emissions is estimated and accounted for. Where possible, it is recommended to estimate and account for the shift cumulatively from the start of linking to the most recent year, as this option best reflects the nature of ETSs, which cap emissions continuously over time. Furthermore, over longer periods of time, the four approaches to estimate the shift in emissions are likely to converge to some extent, giving more similar results than in single years. If longer time periods are used, the choice of the approach becomes thus less important and the actual shift in emissions may be approximated more robustly.

Implications for NDCs and accounting under the Paris Agreement

In a last step, the paper explores how countries may formulate future NDCs in order to facilitate linking of ETSs and how they could account for the linking towards their NDCs under the Paris Agreement or towards jurisdictional goals. An important challenge is the inherent differences between the design of ETSs and the type of targets, policies and actions communicated in countries' first NDCs. Whereas ETSs typically set a cap expressed as absolute GHG emissions over a continuous period of time, NDCs often establish mitigation targets for a single year and often include metrics other than GHG emissions. Reconciling these differences is critical in order to ensure robust accounting for the linking of ETSs under Article 6.2 of the Paris Agreement.

To facilitate further international linking of ETSs and robust accounting for the resulting shift in emissions, several aspects merit consideration:

- Definition and quantification of ITMOs: The international transfer of an ETS allowance may not necessarily result in a 'mitigation outcome'. It is therefore recommended that the transfer of ETS allowances be detached from ITMOs. Furthermore, given that several approaches are available to estimate the shift in emissions, international guidance under Article 6.2 could provide flexibility to countries to quantify ITMOs in different ways. Ensuring environmental integrity, as required under Article 6.2, could be facilitated through reporting requirements that provide transparency and require countries to describe and justify the approaches they apply to quantify the shift in emissions. This information could be subject to a technical expert review under the enhanced transparency framework established under Article 13 of the Paris Agreement.
- Expression or conversion of NDCs in GHG metrics: Accounting for the shift in emissions from linking of ETSs is only possible in GHG metrics. Countries that wish to account for the linking towards NDCs should therefore have established a GHG emissions target or convert mitigation policies or targets in non-GHG metrics into a corresponding GHG emissions target. International guidance under Article 6.2 could therefore include participation requirements that require countries to do so if they wish to account for the linking towards their NDCs.
- Coverage of GHG emission targets: To ensure robust accounting, the GHG emissions targets should either cover the full scope of the ETS – i.e., include all gases and emissions sources covered by the ETS – or the shift in emissions should be accounted for assuming that it solely occurred within the scope of the GHG emissions target. The latter option would require applying corresponding adjustments to all international transfers associated with the linking of ETSs, regardless of the coverage of the NDC of the transferring country.
- Common values for global warming potentials (GWPs): Jurisdictions and countries accounting for the linkage of ETSs towards jurisdictional or NDC targets should use the same set of GWP values. International agreement on common GWP values, as envisaged in paragraph 31(a) of decision 1/CP.21, would thus facilitate international linking of ETSs.
- Common time frames of jurisdictional or NDC targets: Robust accounting can only be ensured if the participating jurisdictions or countries have targets that cover the same period (e.g., 2021 to 2030, which could be covered through a single year target for 2030 or multi-year targets for the period 2021 to 2030).

International agreement on common NDC implementation periods (e.g., 2031-2035, 2036-2040), as envisaged under Article 4.10 of the Paris Agreement, would thus facilitate international linking of ETSs.

- Ensuring that accounting is representative of action over time: To ensure robust accounting, it is critical that the number of ITMOs that are accounted towards NDCs be representative of the shift in emissions over time. Given that ETSs cap emissions over a continuous period of time, international accounting for the linking of ETSs is simpler if countries also adopt a cumulative long-term emission reduction trajectory or continuous multi-year targets as the basis for accounting. Where countries have single-year targets, they could account for ITMOs only in their target years but would have to ensure that the amount accounted for is representative of the mitigation over the relevant NDC implementation period. It is unclear which options would work best in the context of ETSs as different circumstances may have to be accommodated for, such as an ETS link that starts in the middle of an NDC implementation period. For this reason, international guidance needs to strike a balance between giving countries flexibility in NDC accounting, while providing assurances and safeguards to ensure robust accounting. As a first step, international guidance under Article 6.2 could establish the principle that accounting for international transfers shall be representative of the mitigation actions and progress towards NDCs over time. This could be accompanied with reporting requirements for countries to provide transparency and justify the approaches applied, as well as a review of the reported information under Article 13 of the Paris Agreement. The ex-ante determination and review of an approach to account for ITMOs over time could also be established as a participation requirement.

Lastly, further research is necessary to assess in more detail the implications of the different approaches for estimating and accounting for the shift in emissions. This could include testing the identified approaches using actual data from existing ETSs and further analyzing the options available to robustly account for the linking of ETSs towards NDC targets over time.

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1 Introduction

After the adoption of the Paris Agreement and the preparation of countries' first nationally determined contributions (NDCs), policy-makers around the world are planning and implementing climate change mitigation policies to achieve their NDCs. Emission trading systems (ETSs) are increasingly embraced as a policy to reduce emissions in a cost-effective manner (International Carbon Action Partnership, 2018).

Several jurisdictions are also considering, or have already established, links between their systems (International Carbon Action Partnership, 2018). California and Québec linked their sub-national ETSs in 2014, creating the first international linkage of ETSs. More recently, the European Union (EU) and Switzerland signed an agreement to link their systems (European Union, 2017). In Japan, Tokyo and Saitama have also linked their systems. Some ETSs also cover several countries or sub-national jurisdictions. The European Union Emissions Trading Scheme (EU ETS) integrates the 28 EU member states in addition to Iceland, Liechtenstein and Norway (Santikarn, Li, La Hoz Theuer, & Haug, 2018). The Regional Greenhouse Gas Initiative (RGGI) brings together a compact of nine Northeastern and Mid-Atlantic U.S. states (International Carbon Action Partnership, 2018).

Linking of ETSs is pursued to achieve several policy objectives. Key rationales include improved cost efficiency and market liquidity, as well as reduced concerns about competitiveness and leakage (for more information see Santikarn et al., 2018, Chapter 2). By reducing the cost of abatement, linking could facilitate the adoption of more ambitious ETS caps. Linking, however, also brings about several challenges. Linking increases a system's exposure to external influence, both economically and environmentally. Political and economic developments in one system, such as economic crises for example, would automatically affect the linking partner (Ranson & Stavins, 2014). This applies also to environmental impacts: if the integrity of one of the systems is in doubt, then this could undermine the integrity of the whole linked market. Linking may also create perverse incentives for linking partners to set less ambitious reduction targets in order to accrue more benefits from allowance exports (Flachsland, Marschinski, & Edenhofer, 2009; Green, Sterner, & Wagner, 2014; Helm, 2003).

When linking ETSs internationally, allowances can flow across international borders. This, in turn, can change the level of emissions in the participating countries. As such, an important question arises as to whether and how linking affects the achievement of NDCs, and whether and how countries should account for such links under the Paris Agreement.

Article 6.2 of the Paris Agreement establishes a framework that allows countries to engage in international carbon market mechanisms and to account for their use towards NDCs. International linking of ETSs is seen as one important application of Article 6.2. Indeed, several authors, countries and stakeholders have proposed that the 'net flow' of allowances between linked ETSs could be accounted for as 'internationally transferred mitigation outcomes' (ITMOs) under Article 6.2 of the Paris Agreement (Howard, 2018; Mehling, Metcalf, & Stavins, 2018; Obergassel & Asche, 2017; Schneider, Füssler, et al., 2017). The linking agreement between the EU and Switzerland (European Union, 2017), for example, foresees that the 'net flows' of allowances be accounted for in accordance with principles and rules approved under the United Nations Framework Convention on Climate Change (UNFCCC). A key requirement for accounting for the linking of ETS under Article 6.2 of the Paris Agreement is that countries apply 'robust accounting to ensure, inter alia, the avoidance of double counting'. If robust accounting is not applied, aggregated global GHG emissions could increase (Schneider & La Hoz Theuer, 2018).

This discussion paper explores how countries could account for the international linking of ETSs under the Paris Agreement, as well as how linking could be accounted for in the context of jurisdictional mitigation targets. As a first step, the paper provides an overview of general aspects for accounting for the linking of ETSs, in particular how linking shifts the emissions between the participating jurisdictions and how this shift can be reflected under the Paris Agreement (section 2). An important prerequisite for accounting for the linking of ETSs is quantifying the shifts in emissions; the paper identifies four possible approaches to quantify the shift in emissions and

discusses their advantages and drawbacks (section 3). The paper then identifies and discusses important implications for formulating NDCs and accounting under the Paris Agreement or towards jurisdictional goals. An important challenge is the inherent differences between the design of ETSs and the type of targets, policies and actions communicated in countries' first NDCs. Whereas ETSs typically set a cap expressed as absolute GHG emissions over a continuous period of time, NDCs often establish mitigation targets for a single year and often include metrics other than GHG emissions. The paper discusses whether and how these differences can be reconciled in order to ensure robust accounting (section 4). The findings of the paper can inform both the ongoing negotiations on international guidance for Article 6.2, as well as the bilateral agreements between jurisdictions on how to account for ETS linking. The paper provides conclusions and recommendations that are relevant for policy-makers and experts involved in international negotiations and bilateral linking agreements (section 5).

This paper uses specific terminology and makes a number of assumptions. The term 'allowances' is used to refer to the compliance instruments that are allocated or auctioned to regulated entities under an ETS. The use of 'countries' is meant to encompass the EU with its 28 member states. When referring to 'NDCs', the paper also includes intended nationally determined contributions (INDCs) submitted prior to the adoption of the Paris Agreement. Mitigation targets communicated in NDCs are referred to as 'NDC targets'. Article 6.2 allows countries to use ITMOs to achieve NDC targets, but the nature and metrics of ITMOs are still unclear. It is here assumed that ITMOs are expressed as one metric tonne of CO_2 equivalent (tCO_2e). When referring to 'linking' of ETS, this includes both linking between two separate ETSs as well as allowance flows that occur within a single ETS but across countries or jurisdictions with separate NDCs or jurisdictional targets. This paper also focuses on 'full linking', in which allowances can flow unrestricted between the participating countries or jurisdictions, and does not consider other forms of linking that restrict the transfer or use of allowances or indirect forms of linking, such as the recognition of the same type of offset credits (Burtraw, Palmer, Munnings, Weber, & Woerman, 2013; Mehling, Metcalf, & Stavins, 2017; Schneider, Lazarus, Lee, & van Asselt, 2017).

2 General aspects of accounting for the linking of ETSs

2.1 How does linking affect GHG emissions across countries?

Linking of ETSs can affect *where* and *when* emissions are reduced. By allowing allowances from one jurisdiction to be used for compliance in another jurisdiction, linking enables GHG abatement to take place wherever it is cheapest. In a well-functioning market, the linking of two ETSs shifts GHG abatement from the jurisdiction with higher abatement costs to the jurisdiction with lower abatement costs. Although allowances may be transferred in both directions, a difference in abatement opportunities and costs across jurisdictions implies that there is a net flow of allowances from the jurisdictions with lower abatement costs to the jurisdiction with higher abatement costs. The direction of the net flow may, however, change over time if circumstances change in the jurisdictions. Linking can also affect *when* emissions are reduced, because it affects the allowance price and can thereby change the incentives for, and the timing of, investments in GHG abatement.

Linking of ETSs may thus 'shift' the *location* and the *timing* of abatement in the participation jurisdictions. We here refer to a 'shift' in emissions as the difference between the emissions level in a jurisdiction observed under linking as compared to the emissions level that would occur in the absence of linking in the same period.

By shifting where and when emissions are reduced, linking may impact countries' progress in achieving their (individual) NDCs. If the shift in emissions is not accounted for towards NDCs, linking could make it more difficult for the importing country to achieve its NDC. Since importing allowances from another country allows the regulated entities to emit more, the country's emissions from its ETS sectors may be higher than the ETS cap. If this effect is significant, it could undermine the country's ability to achieve its NDC. When countries engage in linking of ETSs, they may therefore have an interest that shift in emissions from the linking is appropriately reflected and accounted for in relation to their NDCs.

The same may hold for the linking between sub-national jurisdictions. If sub-national jurisdictions use ETSs to achieve jurisdictional mitigation goals, they may also wish to account for the shift of emissions implied by the linking of their ETSs when reporting progress towards the achievement of their jurisdictional goals. If the jurisdictions are located in more than one country, the linking could not only affect the achievement of jurisdictional goals but also the NDC targets of the respective countries. National governments therefore may also have an interest to ensure that any international linking between sub-national jurisdictions is appropriately reflected and accounted for in relation to their NDC targets, especially if the jurisdiction is a net importer of allowances.

2.2 Under which forms of linking are emissions shifted between countries?

For the purpose of accounting for NDC targets, an important consideration is under which conditions allowances can flow across international borders, as allowance flows between countries can imply shifts in GHG emissions between the countries, thereby affecting the countries' reported progress towards achieving their NDC targets.

Allowances could flow across international borders in two instances:

- Linking between separate ETSs: Two countries, or sub-national jurisdictions located in different countries, could establish separate ETSs and link their systems by mutually recognizing allowances from the other jurisdiction. Allowances can flow between accounts of the participating systems and thus across international borders. Examples are the links between the EU ETS and the Swiss ETS, as well as between California and Québec.
- Joint ETS: A group of countries, or sub-national jurisdictions, could participate in a joint ETS. In this case, allowances flow only between registry accounts within the joint ETS. If the ETS covers more than one country, these allowances can flow across international borders. An example is the EU ETS, which was

established by EU Member States but now also includes the European Free Trade Association (EFTA) countries Iceland, Liechtenstein and Norway.

In both instances, emissions may be shifted between countries. Both instances are thus considered in this paper and referred to as 'linking'.

2.3 How could shifts in emissions between countries be generally accounted for towards NDCs?

Countries could pursue different options to ensure that international linking of ETSs is appropriately reflected in formulating and accounting for NDCs under the Paris Agreement:

- Accounting under Article 6.2 of the Paris Agreement: Countries could account for the shift in emissions from linking their ETSs under Article 6.2 of the Paris Agreement. This requires establishing appropriate methods to estimate the shift in emissions. A key challenge is that the actual shift may not simply correspond to the net flow of allowances observed between the countries. This is because ETSs can have different design features which can affect the timing and location of GHG abatement, such as the possibility to hold and bank allowances, price stability mechanisms, or the use of offset credits. Furthermore, accounting for NDCs involves a number of challenges, depending on the NDCs of the involved countries. Exploring these issues in further detail is the focus of this paper.
- Single NDC: Countries that participate in a joint ETS, or that link two separate ETSs, could communicate a single NDC. Article 20 of the Paris Agreement foresees that 'regional economic integration organizations' can become a Party to the Agreement and can thus communicate a single NDC. If countries communicate a single NDC, any shifts in emissions between member states as a result of an ETS are automatically accounted for, since progress towards achieving the NDC is assessed by comparing the aggregated progress of all countries of the regional economic integration organization with the single NDC target. An example is the EU, which communicated a single NDC target. The shift in emissions is, however, only automatically reflected in the case of allowances flows between the 28 EU member states, and not to in the case of allowances flows in relation to the three non-EU partners Iceland, Liechtenstein and Norway.
- Separate NDCs with a common ETS target and separate targets for their non-ETS sectors: Countries might, in principle, also communicate two targets in their NDC: one for the sectors and gases covered by a joint ETS and one for non-ETS sectors and gases. In this case, the ETS target would be formulated as a joint target of the participating countries, whereas the non-ETS targets would be country-specific. Similar to the approach of a single NDC, this approach would automatically account for any shifts in emissions due to allowances flows between countries. Progress towards achieving the targets would be assessed separately for the joint ETS target and the two individual non-ETS targets. This approach is similar to the effort sharing arrangements within the EU, where each member state has an individual non-ETS target and all member states together have a joint ETS target. Under this approach, the countries would thus have a joint responsibility for achieving their joint ETS target, and an individual responsibility for achieving their respective non-ETS targets. This sharing of responsibility might raise legal and practical challenges, e.g., with regard to the responsibility if a joint ETS target is not achieved. It would also require establishing appropriate methods to track progress towards the two separate targets under Article 13 of the Paris Agreement, e.g., through separate GHG inventories for ETS emissions and non-ETS emissions.
- No accounting: Countries could also decide not to account for the shift in emissions from linking ETSs when accounting for their NDCs. The participation in cooperative approaches under Article 6.2 is voluntary. Article 6.2 thus provides an *opportunity* but no *obligation* to account for the international transfer of mitigation outcomes. The provisions of Article 6.2 suggest, however, that either *both* countries involved in a transfer should account for it, or that *none* of the countries should account for it. If only one country would account for the transfer of mitigation outcomes, this could lead to double counting of emission reductions. Not accounting for the shift in emissions from linking of ETSs may be a reasonable and pragmatic approach where the shifts are very small in comparison to the overall emissions of the countries, or where the

countries are confident that they will achieve their NDC targets, regardless of whether the shift in emissions from linking is accounted for.

The options above could, in principle, also be applied to accounting at the level of (sub-national) jurisdictional mitigation goals.

2.4 How could linking be accounted for under Article 6.2 of the Paris Agreement or under jurisdictional mitigation targets?

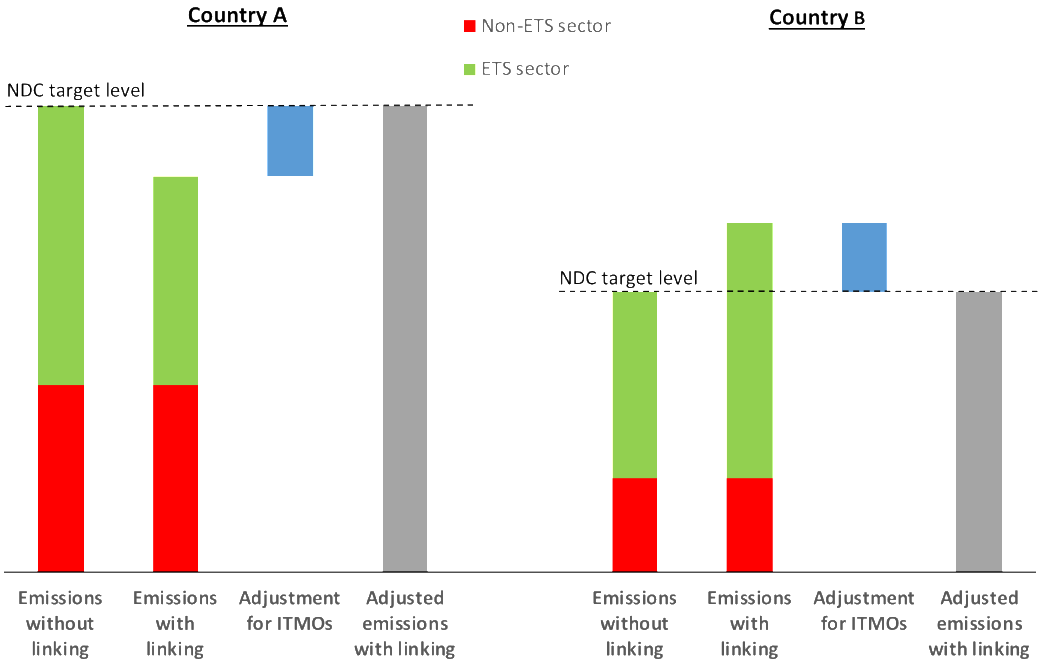
The cooperative approaches under Article 6.2 of the Paris Agreement establish a framework for using 'internationally transferred mitigation outcomes' (ITMOs) to achieve NDCs. Linking of ETSs is seen as one important application of this framework. The decision adopting the Paris Agreement foresees that accounting for ITMOs be implemented on the basis of 'corresponding adjustments' for the emissions covered by the NDC (decision 1/CP.21, paragraph 36).

In the ongoing negotiations, several options have been proposed for the operationalization of corresponding adjustments. A key issue is defining what should be adjusted (also referred to as the 'basis' for corresponding adjustments). Here it is assumed that accounting occurs by making adjustments to reported emissions (also referred to as emissions-based accounting approach).

Ideally, the number of ITMOs accounted for under Article 6.2 through corresponding adjustments would exactly correspond to the shift in emissions that occurs in each jurisdiction as a result of linking (i.e. the increase or decrease in emissions as compared to the situation of no linking). In this case, accounting for ITMOs would match with the changes in emissions that countries observe in their GHG inventories used to track progress towards NDCs.

This is illustrated in Figure 1 below, where linking between two countries A and B leads to a decrease in emissions in the ETS sectors of country A and an equivalent increase in emissions in the ETS sectors of country B. In the absence of linking both countries would exactly achieve their NDC targets. Without accounting for the linking, country A would in this example over-achieve its NDC target while country B would not achieve its target. If the shift in emissions is accounted for as ITMOs - by adjusting the total reported emissions – both countries would exactly achieve their targets.

Figure 1: Accounting for the shift in emissions from linking ETSs under Article 6.2 of the Paris Agreement



This form of accounting can be reflected in an accounting balance. Table 1 illustrates an emissions-based accounting balance for the above example. In this example, the shift in emissions is assumed to amount to 15 $MtCO_2e$ in both countries (line 3b). Country A adds this number to its reported emissions to account for the decrease in emissions due to the linking, whereas country B subtracts this number from its reported emissions to account for the increase in emissions due to the linking (line 4b). If both countries accounted for the shift in this way, they would both achieve their NDC targets (line 5b). The same basic accounting approach could not only be applied at the level of NDCs but also at the level of ETSs or at the level of jurisdictional targets that include both ETS sectors and non-ETS sectors.

Table 1: Example of an emissions-based accounting balance ($MtCO_2e$)

		Jurisdiction A	Jurisdiction B
Accounting balance *without* accounting for the ETS link			
1a	NDC target level	100	60
2a	Actual emissions	85	75
3a	Difference between the target level and the actual emissions (negative values denote that emissions are lower than the target)	-15	+15
Accounting balance *with* accounting for the ETS link			
1b	NDC target level	100	60
2b	Actual emissions	85	75
3b	Shift in emissions due to the ETS link (negative values denote fewer emissions)	-15	+15
4b	Adjusted actual emissions (calculated by adjusting line 2b with line 3b; a decrease in emissions leads to an addition to actual emissions)	100	60
5b	Difference between the NDC target level and the *adjusted* actual emissions (negative values denote that emissions are lower than the cap)	0	0

3 Quantifying the shift in emissions from linking ETSs

A prerequisite for accounting for the linking of ETSs is estimating the shift in emissions that occurs in each jurisdiction as a result of linking.

Quantifying the shift in emissions that occurs as a result of linking is more complex than it may appear at first glance. A key challenge is that the *actual* shift in emissions cannot be empirically observed, as the situation of no linking is 'counter-factual': once two systems are linked, it is impossible to determine the exact emissions levels in the jurisdictions in the absence of linking in order to compare them with the emissions levels observed under linking. Policy-makers from both jurisdictions therefore need to identify and agree on methods to *estimate* – i.e. approximate – the shift in emissions. A second challenge is that emissions may not only shift from one jurisdiction to another but could also shift in *time* as a result of linking. As linking affects the price of allowances, it can affect *when* investments in GHG abatement are made. This could lead to a situation where the shift in emissions is not necessarily symmetrical between two jurisdictions in a specific period: emissions could decrease more in one jurisdiction than they increase in the other, or vice versa. To address this, policy-makers could pursue two approaches: they could either determine two different shifts in emissions for each jurisdiction for a specific period, or they could determine one equivalent shift in emissions that is likely to represent a fair picture of the two different shifts in the two jurisdictions.

Furthermore, in estimating the shift in emissions, policy-makers may have an interest to identify approaches that give a fair representation of the *likely* actual shift. Underestimating the shift could disadvantage the importing jurisdiction because the emissions increase in the importing jurisdiction would be higher than the amount of ITMOs that the jurisdiction could account for. In Figure 1 in section 2.4 above, for example, country B would no longer achieve its NDC targets because the adjustment (blue bar in Figure 1, line 3b in Table 1) would then be smaller than the increase in emissions due to linking. Similarly, overestimating the shift could disadvantage the exporting jurisdiction, because the emissions decrease in the exporting jurisdiction would be lower than the amount of ITMOs that the jurisdiction would account for: in Figure 1, country A would no longer achieve its NDC targets because the adjustment (blue bar in Figure 1, line 3b in Table 1) would then be larger than the decrease in emissions due to linking.

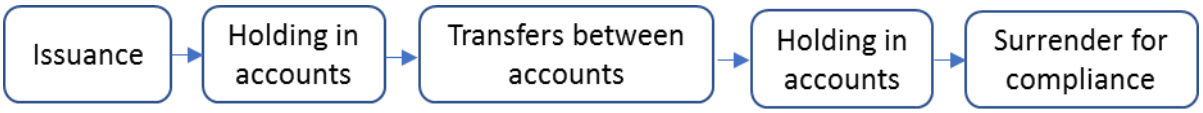
In principle, two broad approaches could be pursued to estimate the shift in emissions. First, the emissions levels in the absence of linking could be estimated through economic modeling and compared to the observed emission levels under linking. The accuracy of this approach would strongly depend on how well the model would be able to reflect changing circumstances and the decisions of the participating entities. In practice, economic modeling could involve considerable uncertainties. The further this approach would be applied to the future, the more uncertain it may be.

A second broad approach is using information on allowances. In principle, the flow of an allowance from one jurisdiction to another implies that emissions may increase by one tCO_2e in the importing jurisdiction while they are reduced by one tCO_2e in the exporting jurisdiction. In practice, the implications are more complex, because allowances can flow back and forth between jurisdictions and regulated entities are typically allowed to hold and bank allowances between years. Moreover, ETSs can include price stability mechanisms and reserves (such as floor and ceiling prices, quantity-based mechanisms that involve reserves, or new entrant reserves); allow for the use of credits from offsetting mechanisms; or include other elements that may affect where and when emissions are reduced. This has two important implications: first, this means that the flow of an allowance from one jurisdiction to another may not necessary imply a shift in emissions. And second, this means that a snapshot of information on allowances at one specific point in time, or over one calendar year, may not necessarily be a representative picture of the actual shift in emissions.

This discussion paper focuses on how to estimate the shift in emissions with information on allowances. In addition to avoiding complex modelling exercises, this has the advantage that information on allowances is readily available to administrators. It also allows determining the shift in a transparent and reproducible manner.

The paper explores four different approaches for using information on allowances to estimate the shift in emissions. These approaches draw on information from different stages of the life cycle of an allowance, including the number of allowances issued in a period (e.g. a calendar year or ETS compliance period), the number of allowances held in holding accounts at a specific point in time (e.g. at the end of a calendar year), the number of allowances transferred between holding accountings in a period, and/or the number of allowances surrendered for compliance purposes in a period (see Figure 1).

Figure 2: Life cycle of ETS allowances



To illustrate the different approaches and their implications, Section 3.1 introduces a simple example of two jurisdictions that is used throughout the paper. Section 3.2 provides an overview of the four different approaches that could be pursued to estimate the shift in emissions. Sections 3.3 to 3.6 describe each of the approaches. Section 3.7 discusses in more detail the implications of specific ETS features such as allowance reserves, voluntary cancellations, and the use of offsets, among others.

3.1 Two-jurisdiction example of linked ETSs

To illustrate the different approaches to estimate the shift in emissions from linking of ETSs, a simple example of a linking agreement between two hypothetical jurisdictions A and B is used. This example is purely hypothetical, and the values used in the example only serve to illustrate differences between the approaches. In this section, first the hypothetical situation of no linking is introduced. This is then compared to situation with linking.

In the example, a number of simplifying assumptions are made; the implications if these assumptions do not hold are discussed in section 3.7. For simplicity, it is assumed here that both jurisdictions establish their ETSs at the same point in time and immediately establish a link. The example applies to the first year (or any longer period starting from the first year) of the ETSs. It is also assumed the ETSs have no price stability mechanisms, reserves nor allow offsets. The amount of surrendered allowances is assumed to correspond to the emissions of the regulated entities, and no allowances are cancelled, such as cancellation for voluntary climate offsetting or other purposes. Lastly, it is also assumed that the ETS caps are ambitious, i.e. they require the regulated entities to reduce emissions and do not include 'hot air'.

Figure 3 illustrates our two-jurisdiction example in the first period for the situation where a link between the two ETSs would *not* have been established. Jurisdiction A issues 135 million allowances in this period, whereas jurisdiction B issues 110 million allowances, making the latter a slightly smaller ETS. The regulated entities in jurisdiction A surrender 125 million allowances at the end of the period and keep 10 million allowances for future use. The regulated entities in jurisdiction B surrender 105 million allowances and keep 5 million allowances for future use. Combined emissions from both systems in this period are thus equal to 230 $MtCO_2e$, and thus 15 $MtCO_2e$ lower than the aggregated cap of 245 $MtCO_2e$. It is thus assumed that the regulated entities in both jurisdictions make use of the flexibility provided through banking. It is assumed that it is more cost-effective for them to reduce their emissions below the cap and to bank unused allowances to future years. This can be observed in many ETSs.

Figure 3: Example of two ETSs without linking

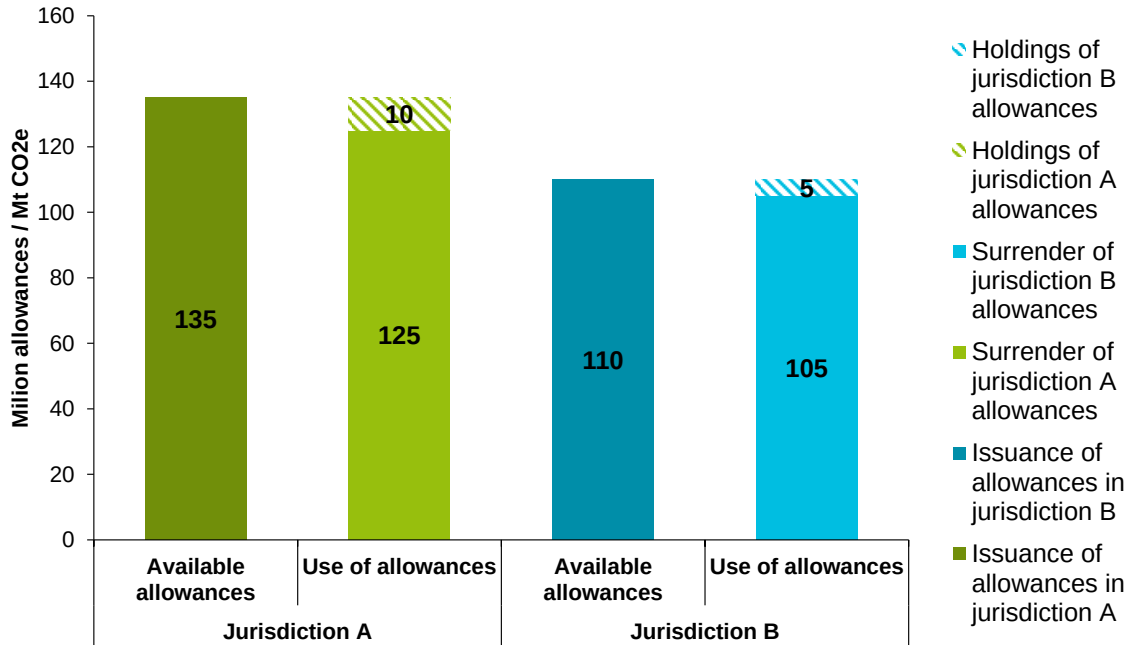
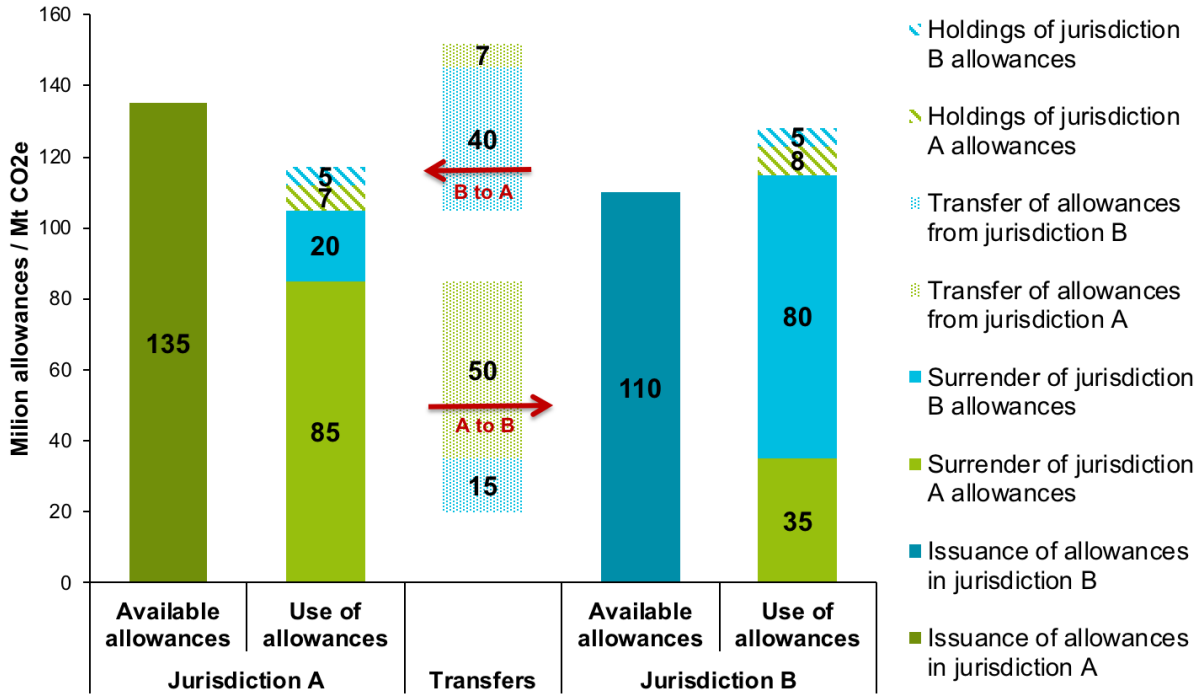


Figure 4 illustrates the same two-jurisdiction example in the same first period, but for the situation where the two jurisdictions link up their systems. The GHG abatement costs are assumed to differ between the two jurisdictions. Entities therefore engage in allowance transactions, resulting in a different level of emissions in both jurisdictions as compared to the situation without the ETS link. It is assumed that the link affects both how many and when emissions are abated.

In the example, as a result of the link, entities in jurisdiction A reduce emissions by a further 20 $MtCO_2e$ compared to the case without the link, resulting in total emissions of 105 $MtCO_2e$ in jurisdiction A. By contrast, entities in jurisdiction B emit 10 $MtCO_2e$ more, resulting in total emissions of 115 $MtCO_2e$ in jurisdiction B. This means that the actual shift in emissions as a result of the link is a decrease of 20 $MtCO_2e$ in jurisdiction A and an increase of 10 $MtCO_2e$ in jurisdiction B. The shift is not symmetrical in this period because there is also a shift in time. The aggregate emissions from both jurisdictions are assumed to decrease by 10 $MtCO_2e$ due to the linking, resulting in combined emissions from entities in both jurisdictions equal to 220 $MtCO_2e$, as compared to 230 $MtCO_2e$ without linking. Respectively, combined holdings of allowances at the end of the period are also higher by 10 million allowances compared to the situation without linking. These allowances are banked into future periods. Whether this shift in time leads to a shift across jurisdictions depends on how banked allowances are used by jurisdictions A and B in future periods.

As allowances from the two jurisdictions are fully fungible, entities in both jurisdictions hold and surrender allowances from both jurisdictions A and B (see 'use of allowances' columns in Figure 4; dashed bars indicate allowances that are banked into future periods). Allowances could flow forth and back several times between the jurisdictions, as indicated by the red arrows and dotted bars in the center of the Figure.

Figure 4: Example of two ETS with linking



In our two-jurisdiction example of linked ETSs, the emissions of regulated entities in jurisdiction B (115 $MtCO_2e$) are higher than the emissions cap (110 $MtCO_2e$). If the shift in emissions across jurisdictions A and B is not accounted for, then jurisdiction B could be perceived as not achieving its target. In practice, however, the actual shift in emissions (i.e., the difference between the emissions level in a jurisdiction observed under linking compared to the emissions level without linking) is not known. Policy-makers therefore need to select an approach that reasonably approximates the actual shift, based on information on allowances. Possible approaches to approximate the actual shift in emissions are identified and discussed in the next sections.

3.2 Overview of approaches to estimate the shift in emissions from linking

Several approaches could be employed to estimate the shift in emissions in each of the two jurisdictions as a result of linking. Based on interviews with ETS practitioners and an assessment of the available information on allowances, four approaches are identified (Table 2).

Table 2: Approaches to estimate the shift in emissions from linking of ETSs

Approach	Description
Approach A: Comparing emissions with caps	This approach compares the emissions from regulated entities in each jurisdiction with the size of the cap of that jurisdiction. A shift in emissions is only accounted for if emissions in one of the jurisdictions exceed the jurisdictional ETS cap. If that is the case, the shift is estimated as the allowance shortfall in that jurisdiction, which is made up by allowances from the other jurisdiction.
Approach B: Net transfers of allowances	This approach estimates the shift in emissions as the net amount of allowances transferred between the jurisdictions. Under this approach, transferred volumes are aggregated to yield a net flow in one direction, which is assumed to represent the shift in emissions.
Approach C: Surrender of allowances	This approach estimates the shift in emissions based on the volumes of 'foreign' allowances surrendered in each jurisdiction. The shift in emissions is calculated as the difference of foreign allowances used in jurisdiction A and foreign allowances used in jurisdiction B. The calculation could either be based on the actual origin of the allowances (Approach C1) or the origin could be approximated in proportion to the size of each jurisdiction's cap (Approach C2).
Approach D: Combining information on transfer and surrender of allowances	This approach combines information on allowance transfers and allowance surrender to estimate the shift in emissions. The shift in emissions is calculated as the difference between own allowances transferred to another jurisdiction and 'foreign' allowances surrendered.

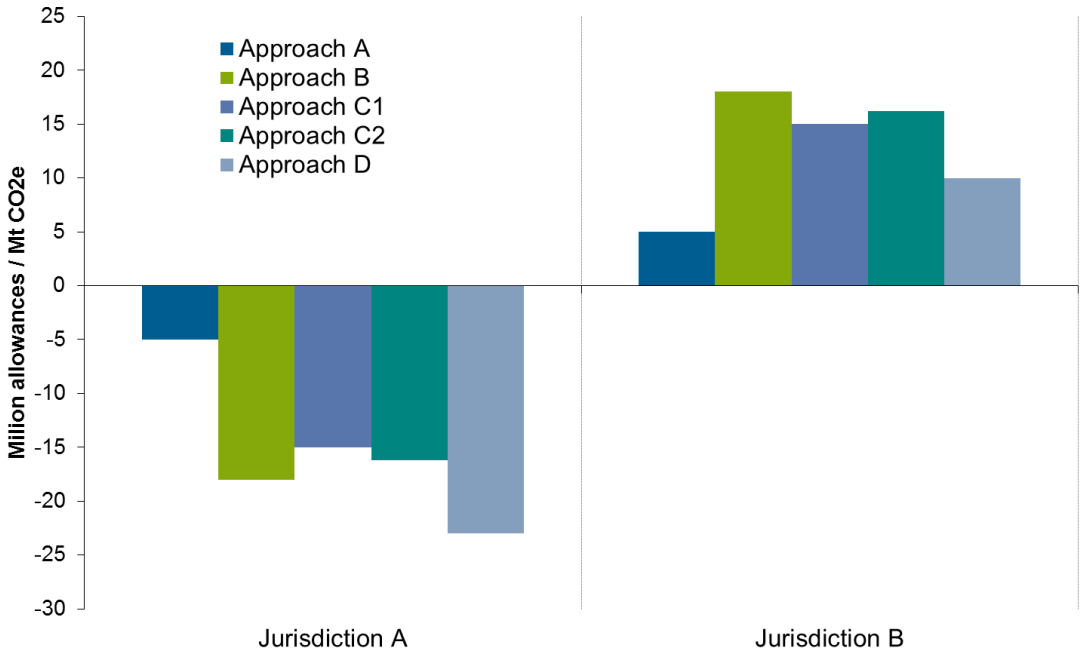
Table 3 illustrates what information on allowances is used to estimate the shift in emissions under the four approaches identified above. Information on allowance holdings is not necessary for the calculation of any of the approaches. For some approaches, however, the shift in emissions could be calculated in several alternative ways, using different combinations of information on allowances; some of these alternative calculations could also employ information on holdings. Appendix 1 provides more information on each approach, including equations to calculate the shift in emissions. Appendix 2 provides a discussion on information sources.

Table 3: Information on allowances used to determine the shift in emissions under Approaches A to D

Approach	A	B	C	D
Issuance	✓		(✓)	
Holdings				
Transfers		✓		✓
Surrender	✓		✓	✓

Figure 5 shows the results for the calculated shift in emissions for our two-jurisdiction example. Each of the four approaches yields different results for the shift in emissions. The results vary considerably among the approaches, ranging from a shift of -5 / 5 $MtCO_2e$ for Approach A to -23 / 10 $MtCO_2e$ for Approach D. For the first three approaches (A to C) the estimated shift in emissions is symmetrical for the two jurisdictions, whereas for Approach D it is asymmetrical. Note that, as discussed in section 4.5.2, if effects are cumulated over a long period of time, the shift in emissions estimated using the different approaches are likely to converge over time.

Figure 5: Calculated shift in emissions for Approaches A to D for the two-jurisdiction example



Each approach is discussed in more detail in the sections 3.3 to 3.6 below. The approaches are assessed with regard to the following criteria:

- Under which conditions the approach is likely to represent a good estimation of the *actual* shift in emissions that results from linking the ETSs. This also includes considerations on whether the approach is robust considering ETS features such as allowance reserves, voluntary cancellations and banking.
- Administrative simplicity, e.g., with regard to availability of information to each individual administrator, practical implementation, etc.
- Communication to public, i.e. ease of communication of the approach and how well it can be replicated.

3.3 Approach A: Comparing emissions with caps

This approach compares the emissions from regulated entities in each jurisdiction with the size of the cap of that jurisdiction. Under this approach, a shift in emissions is only accounted for if one of the two jurisdictions would not achieve its jurisdictional ETS cap without accounting for the shift in emissions due to the ETS link. The calculated shift in emissions corresponds to the degree that the emissions exceed the cap in that jurisdiction. It is calculated based on the difference between the *issuance* and *surrender* of allowances in the jurisdiction where emissions exceed the cap. Figure 6 illustrates the information on allowances that is necessary to estimate the shift in emissions under this approach. Parameters relevant to the calculation are shaded in red.

Figure 6: Information on allowances used in Approach A

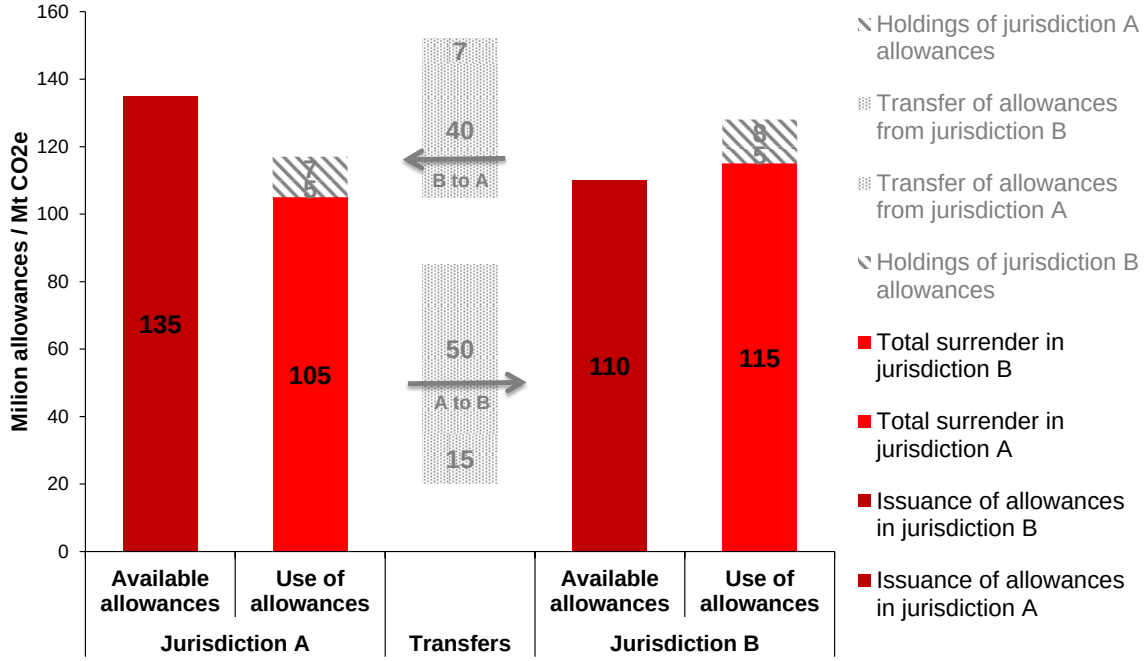


Table 4 summarizes the calculation for the two-jurisdiction example. The difference between the surrender and issuance of allowances amounts to -30 $MtCO_2e$ in jurisdiction A (indicating that emissions are below the cap) and 5 $MtCO_2e$ in jurisdiction B (indicating that emissions exceed the cap). This implies that at least 5 million allowances from jurisdiction A (the 'exporting' jurisdiction) were used for compliance in jurisdiction B (the 'importing' jurisdiction). The implied shift in emissions is equal to -5 / 5 $MtCO_2e$.

Table 4: Example calculation of the shift in emissions for Approach A ($MtCO_2e$)

	Issuance	Surrender	Difference	Shift in emissions
Jurisdiction A	135	105	-30	-5
Jurisdiction B	110	115	5	5

The logic of approach A is that the shift in emissions is assumed to correspond to the degree to which emissions in one of the jurisdiction exceed that jurisdiction's ETS cap. This has two important implications. First, this approach always determines the lowest possible outcome with regard to the *actual* shift in emissions, as it looks at the minimum amount of allowances that have to be transferred from the exporting to the importing jurisdiction in order for the importing jurisdiction to achieve its jurisdictional ETS cap. In reality, a larger shift may have taken place. This approach is thus likely to *underestimate* the actual shift. This is also illustrated in Figure 5 where Approach A returns the smallest estimated shift in emissions. Second, unlike the other approaches outlined in this paper, a shift in emissions is not always accounted for. Rather, there is a 'trigger' for accounting for the shift. This could lead to a situation where a shift actually occurs but is not accounted for, because emissions are still below the cap in both jurisdictions.

Therefore, while this approach ensures that both jurisdictions in aggregate achieve their ETS caps, the likely underestimation of the actual shift, as well as the existence of the 'trigger', might advantage the exporting jurisdiction (jurisdiction A in the example) over the importing jurisdiction (jurisdiction B in the example) when it comes to communicating and accounting for the achievement of broader jurisdictional goals or NDC targets. This is because Approach A implicitly allocates the aggregated over-achievement in the linked ETSs (if any) to the

exporting jurisdiction. The shift in emissions is calculated such that the importing jurisdiction exactly achieves its jurisdictional ETS cap, whereas the exporting jurisdiction over-achieves its jurisdictional ETS cap. The exporting jurisdiction could thus communicate to the public that its emissions were reduced below its ETS cap, whereas the importing jurisdiction could only communicate that it has *just* achieved its ETS cap. This potential 'bias' in the estimate of the shift in emissions may also have implications for the achievement of broader jurisdictional targets or NDC targets: the exporting jurisdiction may have to abate less in sectors not covered by its ETS in order to achieve its jurisdictional or NDC target (or it may have to buy fewer carbon market units), whereas the importing jurisdiction would still have to take the full envisaged action in non-ETS sectors to achieve its target.

In the case of a joint ETS which consists of jurisdictions with separate jurisdictional targets or NDC targets, this approach would also require that the overall cap of the ETS be disaggregated into individual caps of the participating jurisdictions.

Specific ETS features, such as price stability mechanisms and allowance reserves, allowance cancellations, offset credits, and banking from pre-linking years, can be incorporated into this approach with the provisions identified in section 3.7 below.

With regard to the ability to communicate the approach to the public, Approach A adopts a simple logic that is in principle easy to understand. However, it might be difficult to justify to the broader public if the estimated shift in emissions is equal to zero over longer time periods - even where an actual shift in emissions (e.g., due to differences in abatement costs) is likely to occur. An advantage of this approach is that the information required is publicly available and can thus be easily replicated.

A challenge of this approach is when linkages occur among more than two jurisdictions. If multiple links are established and the emissions exceed the cap in one of the jurisdictions, it would not be immediately obvious how the corresponding decrease in emissions should be apportioned to the other jurisdictions. In this case, criteria would need to be developed to apportion the shift in emissions to the two jurisdictions, e.g., based on the respective degree to which emissions are below their caps.

3.4 Approach B: Net transfer of allowances

This approach estimates the shift in emissions as the net amount of allowances *transferred* between the jurisdictions. In our two-jurisdiction example, a total of 65 million allowances are transferred from jurisdiction A to jurisdiction B, and 47 million allowances are transferred from jurisdiction B to jurisdiction A. This gives a net transfer of 18 million allowances from jurisdiction A to jurisdiction B (i.e., 65 million minus 47 million). Figure 7 illustrates (shaded in red) which information is needed to perform this calculation.

Figure 7: Information on allowances used in Approach B

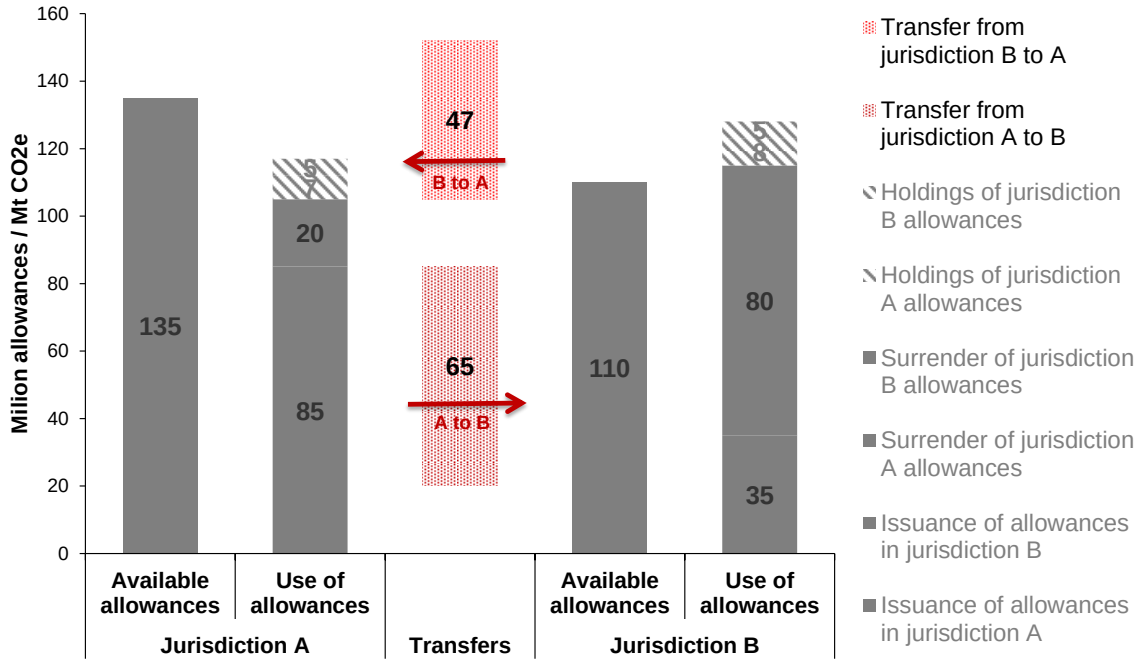


Table 5 illustrates the calculation for our two-jurisdiction example.

Table 5: Example calculation of the shift in emissions for Approach B ($MtCO_2e$)

	Transfers to the other jurisdiction	Shift in emissions
Jurisdiction A	65	-18
Jurisdiction B	47	18

Alternatively, a variation to this approach could be using information on the *origin* of the transferred allowances. In this case, the shift in emissions would be calculated based on the net amount of *domestic* allowances that were transferred to the other jurisdiction.

At first sight, Approach B may be an intuitive response to what is often meant by the concept of accounting for 'net flows', as it reflects how allowances 'flow' across jurisdictional borders. Yet this approach is subject to significant challenges: in this approach, allowances that are transferred across borders but held (or banked) for future use would still be assumed to result in a shift in emissions. This, however, may not be a representative description of the *actual* shift – as the *geographic location* of the held allowance may be of limited consequence for present or future *reduction efforts*. Approach B could thus yield non-representative results for as long as allowances are being banked; over time, as banked allowances are used up, this effect would be evened out.

This approach requires processing a large amount of information on the flow of units over time. However, this should not present a challenge because the necessary information should be readily available in registries and transaction logs.

Where the information is readily available, it would be possible to apply this approach at any point in time – i.e., jurisdictions would not have to wait until the end of a compliance period in order to calculate the shift in emissions. This could be a useful feature where ETS compliance cycles do not match with countries' reporting cycles under the UNFCCC.

It is possible that some jurisdictions do not make information on transfers available to the public. Where jurisdictions aim at full transparency in the calculations, detailed information on allowance flows would therefore have to be published.

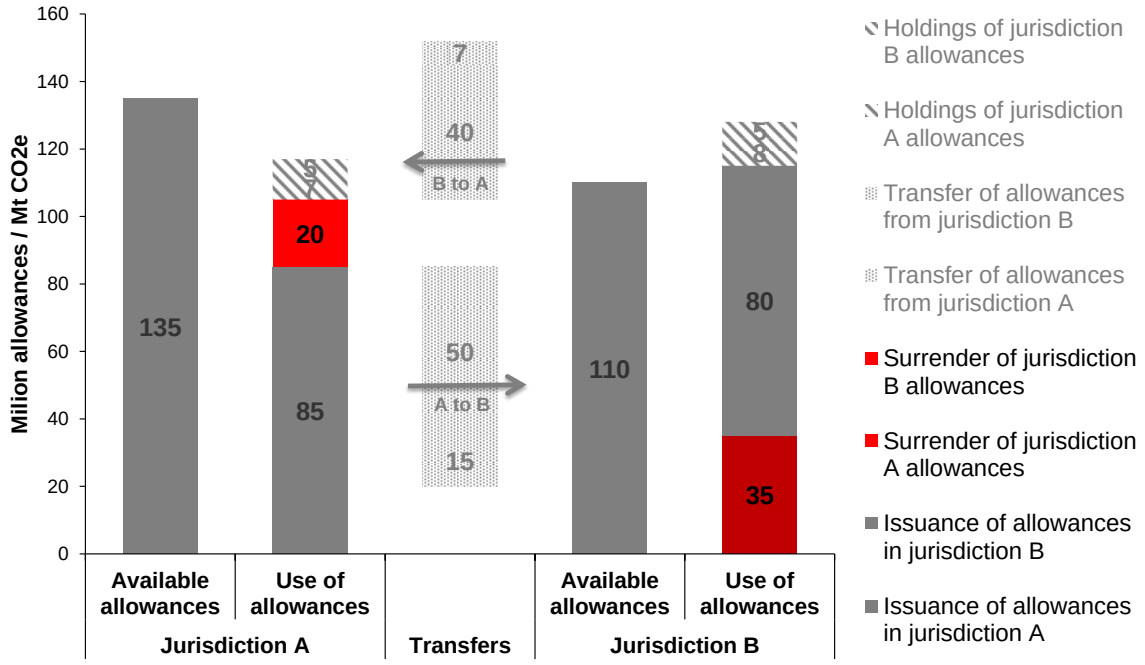
3.5 Approach C: Surrender of allowances

This approach estimates the shift in emissions based on the volumes of 'foreign' allowances surrendered in each jurisdiction. The shift in emissions is calculated as the difference of foreign allowances used in jurisdiction A and foreign allowances used in jurisdiction B. The calculation could either be based on the actual origin of the allowances (Approach C1) or the origin could be approximated in proportion to the size of each jurisdiction's cap (Approach C2).

3.5.1 Approach C1: Net surrender of allowances from the other jurisdiction

Approach C1 estimates the shift in emissions based on the *actual* origin of allowances used. The shift in emissions is calculated as the difference between the number of allowances issued in jurisdiction A but used in jurisdiction B and the number of allowances issued in jurisdiction B and used in jurisdiction A. In our two-jurisdiction example, 20 million allowances issued in jurisdiction B are surrendered in jurisdiction A and 35 million allowances issued in jurisdiction A are surrendered in jurisdiction B (Figure 8).

Figure 8: Information on allowances used in Approach C1



These two amounts are netted out, leading to a calculated shift in emissions of -15 / 15 $MtCO_2e$ (Table 6).

Table 6: Example calculation of the shift in emissions for Approach C1 ($MtCO_2e$)

	Use of allowances from the other jurisdiction	Shift in emissions
Jurisdiction A	20	-15
Jurisdiction B	35	15

Applying *allowance surrender* as the main concept for estimating the shift in emissions avoids some of the challenges associated with Approach B, which focuses on allowance transfers. As the surrendering of allowances is equal to the level of emissions from jurisdictions (assuming full compliance), approaches based on allowance surrender may also be better suited at estimating shifts in emissions than approaches based on allowance transfers.

Approach C1 relies on information on the *origin* of allowances. It may therefore be necessary to ensure that the origin of allowances can be determined in any joint ETS or in ETSs with any joint reserves, as discussed further in section 3.7.

In some instances, strategic behavior could influence the outcome from this approach: if it is possible for market participants to identify the origin of allowances (e.g., through serial numbers), this could, in theory, provide an opportunity for entities to choose to surrender allowances from one particular jurisdiction instead of other. This type of strategic behavior could become relevant in situations of regulatory uncertainty, e.g., where there are concerns that another jurisdiction might delink from the joint system.

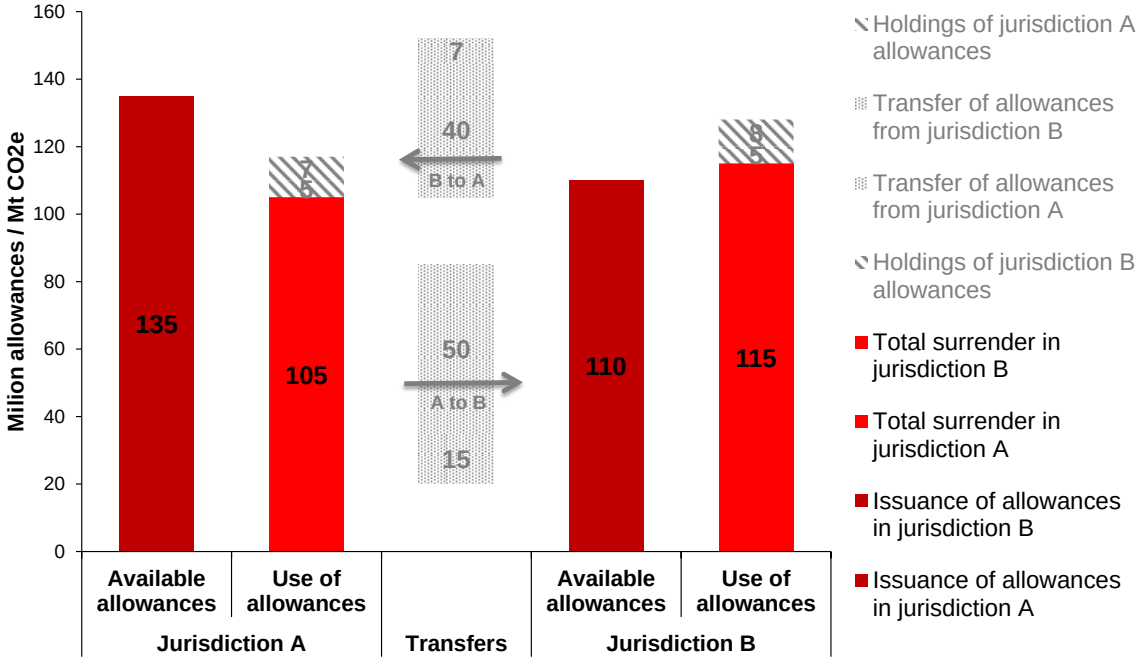
If market participants cannot identify the origin of allowances, then such strategic behavior would not be possible. The results of the approach would then still depend on the actual composition of allowances surrendered, which could have some random variations over time. While such variations would be evened out over time, they could affect shift in emissions calculated for shorter time periods. Random variations might also have a larger impact where small jurisdictions link to large ones.

This approach is administratively simple. Similar to Approach A, however, this approach can only be implemented at the end of a compliance period, as this is when information on allowance surrendering would be available. With regards to public availability of information, it seems likely that not all jurisdictions make information on the origin of surrendered allowances available to the public. Inasmuch as jurisdictions aim at full transparency in the treatment of calculations, this information would therefore have to be published, at least in aggregate figures.

3.5.2 Approach C2: Allowance surrender relative to the share in issued allowances

Instead of employing information on the *actual* origin of allowances, Approach C2 uses a *proxy* for the origin of allowances surrendered in each jurisdiction. The amount of allowances surrendered from each jurisdiction is assumed to be proportional the size of the cap (i.e. the allowances issued in each jurisdiction). It is thus assumed that the split in allowances *surrendered* in each jurisdiction reflects the split of allowances *issued* by each jurisdiction. In our example, jurisdiction A issues 135 million allowances, i.e., 55% of the total allowance volume issued in the first period in both jurisdictions, whereas jurisdiction B issues 110 million allowances, i.e., 45% of the overall amount of allowances issued (Figure 9).

Figure 9: Information on allowances used in Approach C2



These shares (55% / 45%) are then applied to the amounts surrendered in each jurisdiction: of the total amount of allowances surrendered in jurisdiction A (105 million), 45% (i.e., 47.25) would be understood to originate from jurisdiction B. Likewise, of the total amount of 115 million allowances surrendered in jurisdiction B, 55% (i.e., 63.25) would be understood to originate from jurisdiction A. These numbers are netted out, leading to an estimated shift in emissions of -16 /16 $MtCO_2e$ (Table 7).

Table 7: Example calculation of the shift in emissions for Approach C2 ($MtCO_2e$)

	Use	Issuance	Share of combined issuance	Assumed use of allowances from the other jurisdiction	Shift in emissions
Jurisdiction A	105	135	135 / (135+110) = 55%	45% *105 = 47.25	-16
Jurisdiction B	115	110	110 / (135+110) = 45%	55% *115 = 63.25	16

As Approach C1, Approach C2 also has the advantage of employing information on the *surrender* of allowances, which is likely to be more representative of the actual shift in emissions than using information on allowance transfers. Unlike approach C1, this approach does not rely on information on the origin of allowances, making it simpler to apply. This also avoids any potential issues regarding strategic behavior or random variations in the composition of allowances used over time, as discussed for Approach C1 above.

As with approach A, specific ETS features, such as price stability mechanisms and allowance reserves, allowance cancellations, offset credits, and banking from pre-linking years, can be incorporated into this approach with the provisions identified in section 3.7 below.

This approach is administratively simple, even more so than Approach C1, as it relies only on the total volume of allowances issued and surrendered by each jurisdiction. Similar to approach A, however, this approach can only be implemented at the end of a compliance period, as this is when information on allowance surrender would

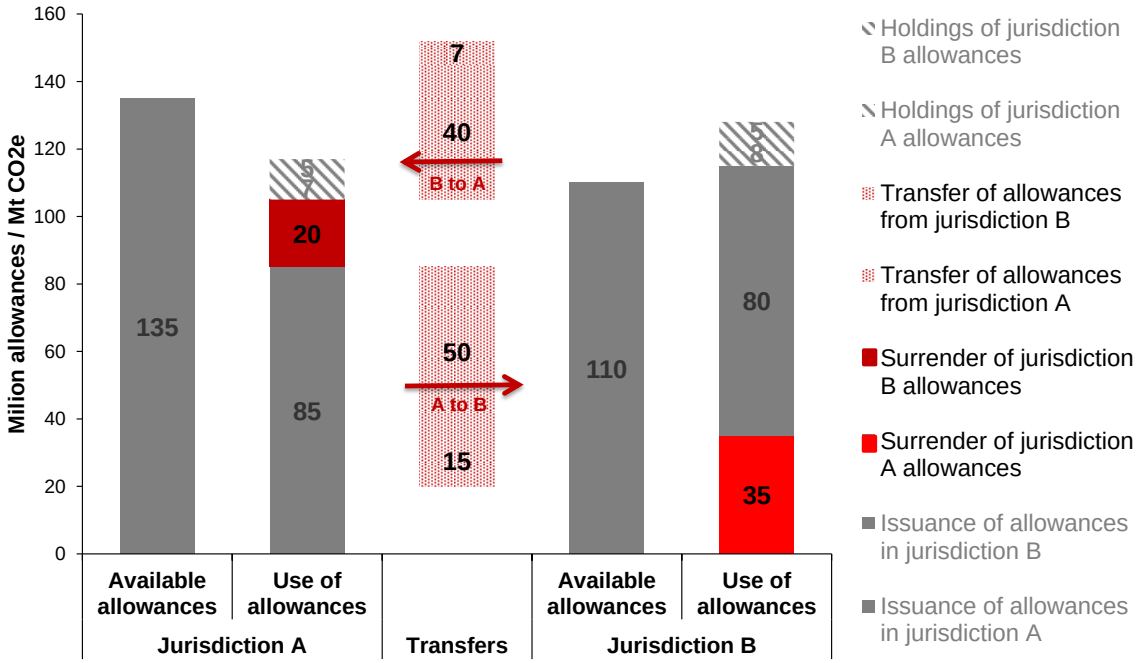
be available. Information on overall volumes issued and surrendered is publicly available, such that the calculations can easily be replicated by interested stakeholders.

3.6 Approach D: Combining information on transfer and surrender of allowances

A fourth approach could *combine* information on transfer and surrender of allowances (Figure 10). Drawing on an approach proposed by Howard (2018), this approach would use information about both allowance transfers and allowance surrender. This is based on the rationale that in the exporting jurisdiction, allowances are no longer available to the regulated entities once they have been transferred and can therefore not be used towards achieving the ETS cap of the exporting jurisdiction. In the importing jurisdiction, allowances could be re-sold and transferred to another jurisdiction, until they are surrendered for compliance. Therefore, they are only accounted for when they are surrendered.

This approach could be employed in several ways, e.g., netting total transfers and surrender, and/or taking into account the origin of allowances. The example below estimates the shift in emissions with information on net transfers (taking into account the origin of allowances) and on the surrender of foreign units.

Figure 10: Information on allowances used in the estimation of Approach D



In terms of net outgoing transfers, in the two-jurisdiction example 50 million allowances from jurisdiction A are transferred to jurisdiction B. Of these, 7 million allowances flow back to jurisdiction A. The net outgoing transfer is thus 43 $MtCO_2e$. Similarly, the net outgoing transfer from jurisdiction B is 25 $MtCO_2e$ (40 million outgoing jurisdiction B allowances, 15 million of which return to jurisdiction B). In our example, entities in jurisdiction A surrender 20 million allowances from jurisdiction B, whereas entities in jurisdiction B surrender 35 million allowances from jurisdiction A. The estimated shift in emissions for this approach would be equal to -23 $MtCO_2e$ in jurisdiction A and 10 $MtCO_2e$ in jurisdiction B (Table 8).

Table 8: Example calculation for the shift in emissions for Approach D ($MtCO_2e$)

	Transfer to the other jurisdiction	Use of allowances from the other jurisdiction	Shift in emissions
Jurisdiction A	43	20	-23
Jurisdiction B	25	35	10

A few important challenges are worth noting. First, combining information on allowance transfers and allowance surrender means that, unlike other approaches, the shifts in emissions calculated for each jurisdiction are not symmetrical. This may presents some accounting challenges when it comes to accounting towards jurisdictional targets or NDC targets. When accounting under the Paris Agreement, adjustments to account for ETS links would no longer be "corresponding" in one specific period of time. This could have several implications, including that ITMOs could be banked in time and that it may be more complicated to reconcile corresponding adjustments over time.

The approach would also be affected by holdings/banking, much like Approach B. The administrative burden of this approach would depend on which combination of information is used, but it would in any case require information on allowance transfers. At the same time, the calculation could only be completed at the end of the compliance period (as it requires information on allowance surrenders). From a communication point of view this approach may present certain challenges, as not all information is in the public domain, and it could be difficult to explain why shifts are not symmetrical (even in a two-jurisdiction system).

3.7 Implications of specific ETS features

In exploring several approaches to estimate the shift in emissions across linked ETSs in sections 3.3 to 3.6 above, a number of simplifying assumptions were made, as laid out in section 3.1. In this section, the implications of specific design elements of ETSs are explored, dropping the respective simplifying assumptions. The analysis includes:

- Price stability mechanisms and allowance reserves;
- Allowance cancellations and use of allowances under ICAO/IMO;
- Offset credits; and
- Banking of allowances from periods before the establishment of the link.

These ETS features all alter the number of allowances that are available to regulated entities in a specific period or year. This can affect the number of allowances transferred and surrendered in the linked ETSs, thereby affecting the shift in emissions between the jurisdictions.

Price stability mechanisms and allowance reserves are often included in ETSs to prevent excessive price variability and/or balance supply and demand of allowances in the market. Examples include the Allowance Price Containment Reserve (APCR) in California and Québec, as well as the Market Stability Reserve (MSR) in the EU ETS. These mechanisms can reduce or increase the amount of allowances in circulation in case a specific price or volume trigger is reached. Such mechanisms thus change the amount of allowances available to entities in the ETS, typically by affecting the amount of allowances auctioned.

In the simplified example above (section 3.1), it is assumed that all allowances issued are also made available to the market (typically via auctions or free allocation). In reality, this may not hold, since allowances may be placed in reserves. In order to take reserves into account, it would therefore be necessary to consider the actual amount of allowances made *available* to the market, either via auctions or free allocation. Other ETS-related reserves, such as new entrant reserves, would have similar effects.

Allowance cancellation refers to the disposal of an allowance without accounting it against verified emissions. To date, such cancellations typically take place in the context of the voluntary market. Under the EU ETS, however, two additional allowance cancellations provisions are now in place: as of 2023, the volume of allowances in the MSR will be capped, which may lead to the cancelation (officially termed "invalidation") of a large volume of allowances in that year and potential further cancellations in future years, depending on emissions development (EU Directive 2018/410, page 76/8). Moreover, EU member states will be allowed to cancel allowances in order compensate for closures of electricity generation capacity in their territory (EU Directive 2018/410, page 76/20). The RGGI Emissions Containment Reserve also contains cancellation provisions (RGGI Model Rule 2017, page 121). These adjustments, if/when they occur, will be directly reflected in changes to in the number of allowances auctioned or allocated for free, i.e. the cancelled allowances will never enter the market. Allowances that are bought and canceled voluntarily, on the other hand, would have to be accounted for.

Moreover, a possible future use of allowances under ICAO or IMO could also affect the amount of allowances available to regulated entities. Rules under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), for example, could in the future include provisions for the use of ETS allowances by airlines. This net outflow of allowances from ETSs would then affect the availability of allowances to regulated entities in a similar way as in the case of voluntary cancellations.

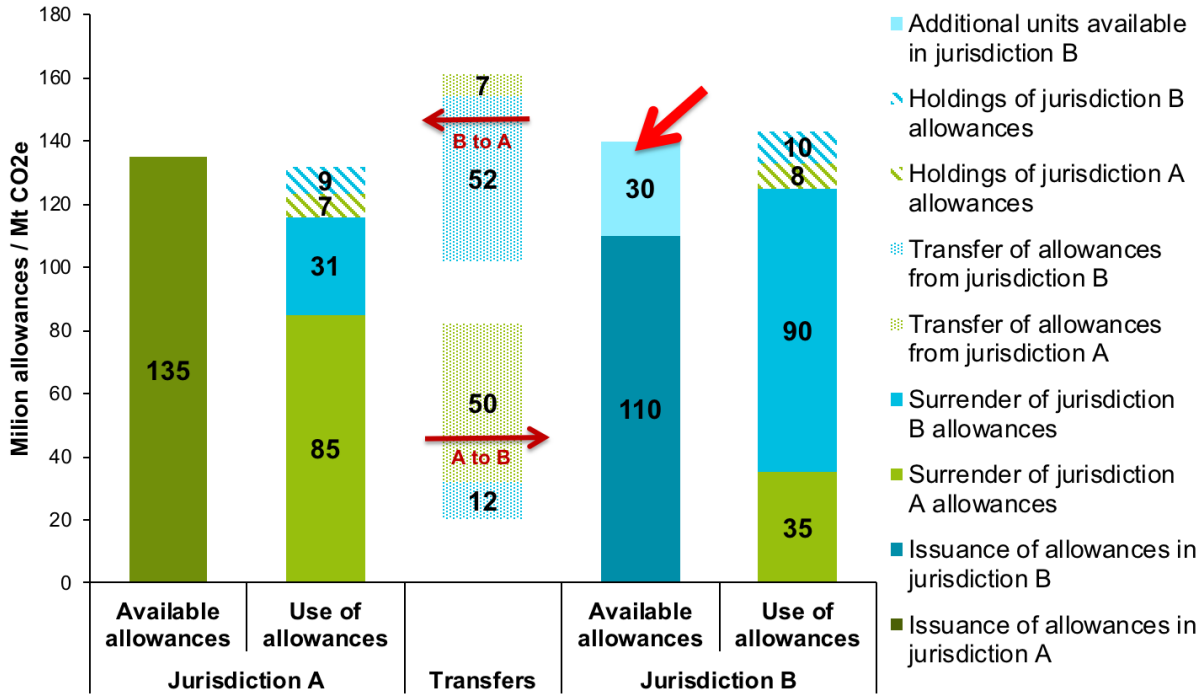
Several ETSs allow regulated entities to use offset credits. Offset credits are generated from emission reductions achieved outside the scope of the ETS. This can include credits from activities implemented in the same jurisdiction as the ETS or in other jurisdictions, including other countries. Bringing offsets into the ETS in effect increases the number of units that are available to regulated entities.

Finally, banking of allowances from a previous period also influences the volume of allowances available in the current period.

In order to illustrate the implications of these ETS features, Figure 11 expands our two-jurisdictional example introduced in section 3.1 by assuming that in the period an additional amount of 30 million units (highlighted by the bright red arrow) are available in jurisdiction B. This amount is assumed to be the result of additional allowances made available due to the net effect of reserves, banking of allowances from previous periods, offset credits, voluntary cancellation of allowances, and the use of allowances towards ICAO or IMO.

It is assumed that the increased availability of allowances in jurisdiction B affects emissions in both jurisdictions. Compared to the situation with linking but without this additional amount of allowances (Figure 4), emissions in jurisdiction B are assumed to rise by 10 $MtCO_2e$, those in jurisdiction A by 11 $MtCO_2e$, and holdings of jurisdiction B allowances also increase in both jurisdictions.

Figure 11: Two-jurisdiction example with additional units available in jurisdiction B



The example illustrates that a change in the amount of allowances available in one jurisdiction can affect both jurisdictions and change the amount of allowances transferred and surrendered. ETS features that affect the number of available allowances thus influence all approaches for estimating the shift in emissions. For those approaches that only use information on the *transfer* or *surrender* of allowances to estimate the shift in emissions (Approaches B, C1 and D), a change in the number of available allowances is automatically reflected in the approach. For those approaches that use information on the amount of allowances made available to the regulated entities (Approaches A and C2), the actual availability of allowances needs to be determined. This can be done by balancing the implications of all ETS features that affect allowance availability, as applicable:

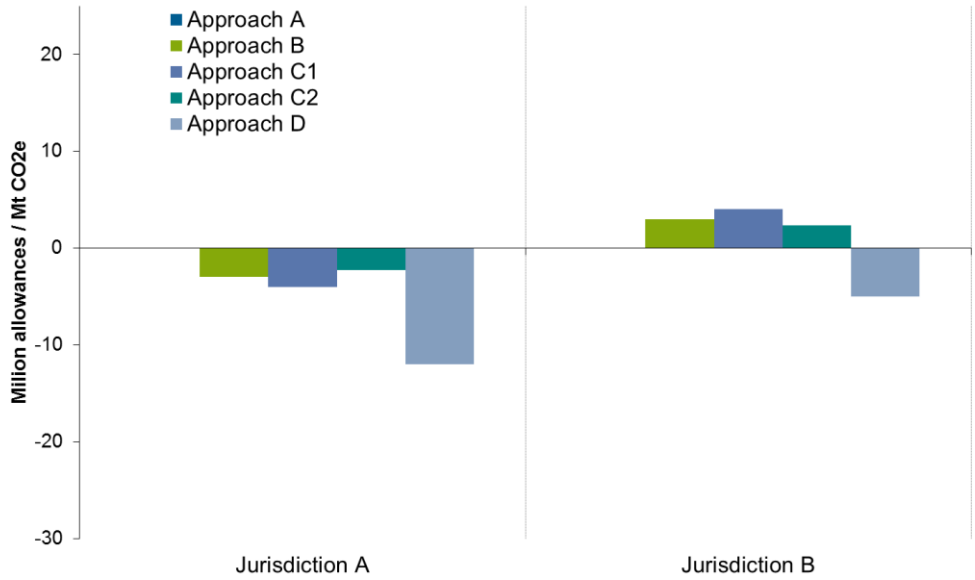
Allowances available
= Allowances auctioned or allocated for free
+ offset credits
+ allowances banked from previous periods
– allowances in circulation that are cancelled
– allowances used under ICAO or IMO
– allowances taken out of the market into reserves

For approaches that rely on information about the *origin* of allowances (i.e., Approaches C1 and D), it is also necessary to ensure that the origin can be identified where allowances are put into reserves. This would not represent a challenge for jurisdictions that operate separate reserves (e.g., in California / Québec and in the EU / Switzerland). In the presence of a joint reserve (e.g., the MSR, which represents a joint reserve for the EU, Iceland, Liechtenstein and Norway), estimations may be skewed if the composition of this reserve were not representative of the relative size of each jurisdiction's cap within the linked system. In this case, the composition of allowances in the joint reserve should be explicitly taken into account in the estimation.[1]

[1] How this could be explicitly taken into account depends on the specific rules for intake and outflow of allowances from each jurisdiction into and out of the reserve and is not explored further in this report.

Figure 12 re-calculates the shift in emissions for all approaches based on these considerations. Compared to the case of linking without the additional 30 million allowances available to jurisdiction B (Figure 5), the shift in emissions is now smaller. Approach A returns a zero shift in emissions as the emissions are in both jurisdictions lower than the individual ETS caps. All other approaches lead to smaller estimated shifts in emissions after the amount of allowances available in jurisdiction B has increased.

Figure 12: Calculated shift in emissions taking into account specific ETS features



4 Implications for NDCs and accounting under the Paris Agreement

This section explores how countries may formulate future NDCs in order to facilitate linking of ETSs and how they could account for the linking towards their NDCs. The findings can be informative for the ongoing negotiations on international rules for the implementation of the Paris Agreement and the implementation of these provisions by linking partners. Many of these issues are also relevant for accounting towards jurisdictional targets.

An important cross-cutting challenge is the large diversity of mitigation contributions that countries communicated in their first NDCs. Most countries have established GHG emissions targets, including targets expressed as absolute emissions level, targets in relation to a business-as-usual (BAU) emissions scenario, or intensity targets such as emissions per gross domestic product (GDP). Some GHG emission targets cover all sectors and all GHGs, while others cover only part of the economy or only some gases. Many countries also communicated targets in other metrics than GHG emissions, such as targets for the amount of renewable energy generation or the size of land to be afforested. Some countries have communicated only policies, strategies or actions to reduce GHG emissions, without a quantified target level. NDCs are also diverse with regard to several other aspects: the target periods or years covered; the conditionality of targets upon the provision of international support; the values used for global warming potentials (GWPs); the methods used to track progress towards targets; and the accounting for the land-use sector (Schneider, Füssler, et al., 2017).

How NDCs are formulated does not necessarily match with how ETSs are designed. Difficulties can also arise if linking partners have different types of NDCs. Bridging these differences is critical for ensuring robust accounting for the linking of ETSs. This section discusses a number of these challenges, including matters that are discussed in international negotiations and by jurisdictions that are in the process of establishing methods for accounting for the linking of ETSs in the context of jurisdictional mitigation goals.

4.1 Nature and relationship of ITMOs and ETS allowance

Article 6.2 of the Paris Agreement refers to 'internationally transferred mitigation outcomes' (ITMOs). In the ongoing negotiations under the Paris Agreement, it is not yet clear what ITMOs are and how they relate to international transfers of ETS allowances.

ITMOs are characterized by three main features: they reflect mitigation outcomes, they are internationally transferred, and they can be used to achieve NDC targets. The further nature of ITMOs is yet unclear and controversial among countries. Some countries propose that ITMOs are units that are issued to electronic registries and transferred and acquired between countries, similar to the Assigned Amount Units established under the Kyoto Protocol. Others propose that they constitute 'net flows' between countries or reported amounts that are subject to a corresponding adjustment. Another open question is the metric of ITMOs. Some countries propose that an ITMO should correspond to one metric tonne of carbon dioxide equivalent (tCO_2e), whereas others propose that other metrics may be used as well. In the context of ETS, only tCO_2e would work.

An important consideration for international linking of ETSs is the relationship between ITMOs and ETS allowance flows. A first question is whether ITMOs are distinct from ETS allowances. ETS allowances are not necessarily internationally transferred. They also do not necessarily represent a mitigation outcome (which is often interpreted as an emission reduction) but rather a permit to emit. Unlike ITMOs, ETS allowances are established under national law. Given these considerations, one could argue that they are distinct from ETS allowances.

A second question is how ITMOs relate to ETS allowance flows. This relationship could be defined in at least three different ways:

- *Each transfer* of an ETS allowance between two interlinked ETSs is considered as an ITMO;

- ITMOs are directly linked to ETS allowances flows, but only represent the *net* amount of allowances transferred between interlinked ETSs over a given period of time (e.g., a calendar year); or
- ITMOs represent an estimate of the likely shift in emissions due to linking between the two ETSs, which could be derived from a variety of approaches, as discussed in section 3 above.

The first two options would imply that countries would have to pursue Approach B, as described in section 3.4 above. While this approach has certain advantages, it may not necessarily provide a representative picture of the actual shift in emissions. It is therefore recommended to implement the third option. The main advantage of this option is that it detaches the quantification of ITMOs from ETS allowance flows and therefore allows pursuing approaches that may be better suited to approximate the actual shift in emissions. This option also provides flexibility to countries to use different approaches when estimating the shift in emissions, depending on their preferences and the context of their ETSs. A possible disadvantage of this option could be that its robustness depends strongly on the implementation by countries. This could raise concerns that countries might not apply robust accounting or not ensure environmental integrity. An obligation for countries to report which approach they implement, including how it ensures robust accounting and environmental integrity, and international review of the reported information might mitigate these concerns.

4.2 Metrics of mitigation targets

Countries have communicated in their first NDCs mitigation targets in *GHG metrics*, such as absolute GHG emission targets or emission targets in relation to a BAU emissions path, as well as targets in *non-GHG metrics*, such as renewable energy targets. In the case of linking of ETSs, it would be very difficult – if not impossible – to appropriately account for NDC targets in metrics other than GHG emissions. In contrast to crediting mechanisms, where credits can be associated with particular mitigation actions, it is not possible in the case of ETSs to associate information on allowances with a particular mitigation action, such as the generation of renewable electricity. Approaches using information on allowances would not allow determining how linking affects the progress towards targets in *non-GHG* metrics. This would, however, be necessary to avoid double counting if NDC targets were not expressed in GHG metrics (Schneider, Füssler, et al., 2017).

To robustly account for the shift in emissions from linking ETSs, it is therefore recommended that countries have established a *GHG emission target* or that they have converted policies or targets in non-GHG metrics into a corresponding GHG emissions target. The GHG emissions target could be expressed as an absolute, relative or intensity target. As relative or intensity targets can – at least *ex-post* – be converted into absolute GHG emissions targets, shifts in emissions can still be robustly accounted for if such systems were linked. To date, all countries with implemented ETSs have established GHG emissions targets in their NDCs. In this regard, this issue is currently not a practical challenge.

4.3 Coverages of mitigation targets

Some countries have communicated GHG emission targets that cover the entire economy – i.e., including the entire geographical coverage, all sources of emissions, and all GHGs that are addressed under the UNFCCC – whereas other targets include only part of the economy. If the coverage of an ETS is broader than the coverage of a GHG emissions target in an NDC, this constitutes challenges for accounting. As it is not possible to associate a shift in emissions with a particular mitigation action, it would not be possible to determine whether the shift occurred inside or outside the scope of the target.

To ensure robust accounting, NDC targets should therefore at least cover the *full scope* of ETSs. Alternatively, as a conservative approach, a country with a more limited scope of the NDC target could account for the shift in emissions assuming that all emission reductions occurred *within* the scope of its NDC target. This could, however, affect the ability of the country to achieve its NDC target; if emissions were reduced *outside* the scope of its NDC and transferred to another country, the country could not use these emission reductions to achieve its NDC and may thus have to reduce emissions further to achieve its NDC target. To date, all countries with

implemented ETSs have established GHG emissions targets in their NDCs that are broader in scope than their ETS. Therefore, the scope of current NDCs and currently implemented or planned ETSs does not pose barriers for accounting for the linking of ETS. Some countries with ETSs, however, do not have economy-wide targets. If they would broaden the coverage of their ETSs without broadening the coverage of their NDCs accordingly, this could constitute a barrier for linking.

4.4 Use of GWP values

The GWPs of GHGs are specified in the assessment reports by the Intergovernmental Panel on Climate Change (IPCC). The scientific understanding of the GWP of gases has advanced over time and the GWP values depend on the current concentrations of these gases in the atmosphere. Therefore, GWP values are updated in each IPCC assessment report, sometimes leading to significant revisions compared to previous estimates (Graichen, Cames, & Schneider, 2016).

The Paris Agreement envisages that, for second and subsequent NDCs, countries account for emissions and removals in accordance with 'common metrics assessed by the IPCC' (paragraph 31(a) of decision 1/CP.21). This provision points to the use of common GWP values. In their first NDCs, however, countries use a range of different GWP values, including from the second, fourth and fifth assessment report of the IPCC (Graichen et al., 2016).

Where ETSs cover emissions from non-CO_2 gases, the use of different GWP values by the jurisdictions or countries linking their ETS can lead to an increase (or decrease) of aggregated emissions from the participating jurisdictions (Schneider, Füssler, et al., 2017). As it is not possible to associate the estimated shift in emissions to specific mitigation actions, it is also not possible to identify which gas was affected and adjust accordingly for differences in GWP metrics. Jurisdictions and countries engaging in linking of ETSs that cover non-CO_2 gases should therefore use the same GWP values, both with regard to the values used in the ETSs and the values used for accounting for their NDCs. Alternative, though less accurate, approaches could include simplified estimates of the likely mixture of gases affected by a shift in emissions (Schneider, Füssler, et al., 2017). In existing linking agreements to date, all countries use GWP values from the forth assessment report for the first NDC (except for Liechtenstein and Iceland, which do not specify the value).

4.5 Accounting for the linking of ETSs over time

When accounting for the linking of ETSs towards jurisdictional or NDC targets, an important and complex issue is how the shift in emissions can be robustly accounted for over time. This issue is challenging for two reasons: first because ETSs and jurisdictional or NDC targets usually have different target time frames; and second because ETSs commonly allow for banking (or borrowing) of allowances whereas it is unclear whether accounting for NDCs under the Paris Agreement will foresee banking and borrowing.

Implemented and planned ETSs typically establish continuous multi-year phases and allow for the banking of allowances between phases. While the setting of caps is often derived from targets for a single year (e.g., for 2030), all implemented and planned ETSs cap emissions over a multi-year period (e.g., from 2021 to 2030). The possibility of banking allowances provides regulated entities with temporal flexibility. They could, for example, reduce emissions well below the cap in the early years of an ETS and use the banked allowances to exceed the cap in later years of the ETS. Some ETSs also implicitly enable 'borrowing', as they allow regulated entities to surrender allowances issued for year X+1 in year X.

At the same time, many countries and jurisdictions have mitigation targets for single years. Under the Paris Agreement, many countries with ETSs have communicated a 2030 target in their first NDC. Some countries have indicated a target for the year 2025 and some have provided a multi-year budget or indicated that they will do so (Graichen et al., 2016). Article 4.10 of the Paris Agreement envisages that countries agree on 'common time frames' for NDCs, though it is yet unclear whether these will include continuous multi-year periods, such as

under the Kyoto Protocol, or single years, and whether all countries will effectively apply the same time frames. Some sub-national jurisdictions with ETSs, such as California and Québec, also have sub-national mitigation targets for single years, such as 2020 or 2030. In contrast to ETSs and the approach under the Kyoto Protocol, the Paris Agreement does not establish emissions budgets with units, or provisions to bank such units between target periods.

When engaging in the linking of ETSs and accounting for the resulting shift in emissions towards jurisdictional or NDC targets, countries have to identify accounting approaches that bridge these differences between ETSs and jurisdictional or NDC targets in robust ways.

4.5.1 Challenges for accounting over time

Some challenges for ensuring robust accounting over time arise irrespective of whether jurisdictions engage in linking. The possibility of banking, and any implicit borrowing, under ETSs provides the regulated entities with flexibility as to when they reduce their emissions. As a consequence, the emissions in an ETS can exceed the ETS cap in specific years or over a period. This is challenging if jurisdictions have single-year targets, as they may not achieve their single-year target if the ETS emissions are higher than the cap in that year.

Emissions from ETSs could vary year-by-year for different reasons, including not only the abatement opportunities and the cap, but also weather conditions, international fuel prices or economic developments. This general risk – which is independent from linking of ETSs – would be lower under a multi-year target trajectory, but still exists if a large amount of allowances is banked across periods under the ETS and if such banking is not mirrored under an international accounting framework.

This is further complicated when it comes to linking of ETSs. Any estimation of the shift in emissions for a specific single year may not be representative of what occurs over a longer period of time. Moreover, estimating the shift with one of the approaches discussed above for a single year may not lead to results that reasonably reflect the actual shift in that year. The longer the time periods considered, the more reliable the approaches are. This poses problems for countries accounting for the linkage of ETS towards single-year targets.

These implications can affect the ability of countries to achieve jurisdictional or NDC targets in specific periods or years. The implications and accounting challenges are illustrated in Figure 13 and Figure 14 for a two-jurisdiction example for the period 2010 to 2030. In this example, the ETS in jurisdiction A starts in 2010, whereas the ETS in jurisdiction B starts in 2015. Both jurisdictions have a linearly declining ETS cap, with the ETS of jurisdiction B being smaller than that of jurisdiction A. In the early years of the ETSs (phase one), regulated entities in both jurisdictions reduce their emissions well below the cap, and bank unused allowances into future years (Figure 13). In 2021, the two jurisdictions link their ETSs, which results in a net transfer of allowances from jurisdiction A to jurisdiction B. After establishing the link, emissions in both jurisdictions increase, exceeding the respective caps in both ETSs in phase two (red and blue columns in Figure 14). In aggregate, over both jurisdictions and both phases, the ETS cap is overachieved (grey column in Figure 14); however, while emissions are below the cap in jurisdiction A (red and blue columns in Figure 14), they exceed the cap in jurisdiction B.

Figure 13 Cumulative emissions and caps in two example jurisdictions

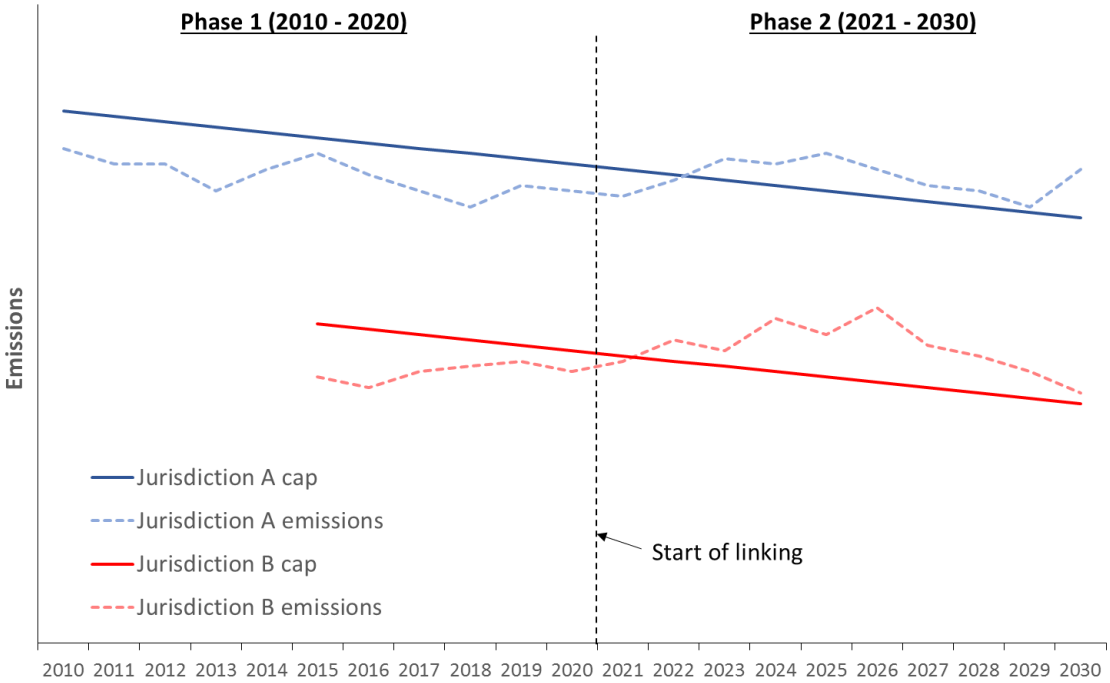
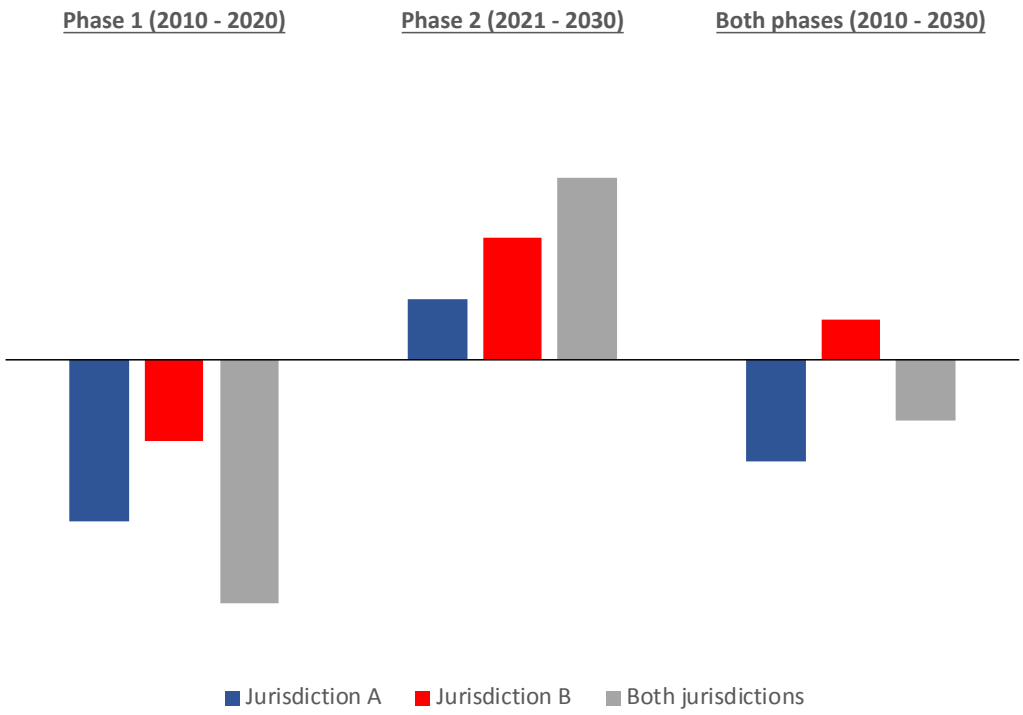


Figure 14 Difference between emissions and the cap in two example jurisdictions



The example illustrates several accounting challenges.

A key challenge for both jurisdictions is the banking of allowances from the period before linking. While both jurisdictions achieve their ETS targets in aggregate over both phases when accounting for the shift in emissions, emissions exceed the cap in both jurisdictions in the period 2021 to 2030 (Figure 14), due to the significant banking of allowances from phase 1 to phase 2. As a result, both jurisdictions could face difficulties in achieving

their jurisdictional or NDC target in phase two. This risk arises irrespective of whether the countries have a multi-year or a single-year target.

The example also illustrates the importance of considering banking when estimating the shift in emissions between jurisdictions. While the impact of banking is automatically reflected by approaches that only use information on the transfer and/or surrender of allowances (Approaches B, C1 and D), approaches that rely on the amount of allowances available to regulated entities (Approaches A and C2) have to explicitly account for these banked allowances when determining the amount of allowances available to entities (cf. section 3.7). In our example, Approach A would no longer work if it was only applied to the period of linking (phase two) and banking into this phase from before the link were not taken into account. This is because Approach A only works if the underachievement in one jurisdiction is matched or exceeded by the overachievement in the other jurisdiction. Since both jurisdictions have higher emissions than their cap in phase two, this is not the case. Approach C2 could still be applied and is less 'vulnerable' to banking but may give a result that is less representative if the banking of allowances is not reflected when determining the allowances available in the respective ETS.

A further feature of this example is that emissions in jurisdiction A are unusually high in 2030. The unusual circumstances in that year could undermine the ability of jurisdiction A to achieve a single year target for 2030, particularly as it has to account for the shift in emissions from jurisdiction B to jurisdiction A. Even if the calculation of the shift in emissions between linked ETSs is technically feasible for a single year, this is likely not representative – as the availability, transfer and surrender of allowances in specific years may not reflect the cumulative impact over time. Both the net transfer of allowances between jurisdictions (used in Approach B) and the surrender of allowances from the other jurisdiction (used in Approach C1) could strongly vary year-on-year. For similar reasons, an annual application of Approach D, is also likely to be affected by year-on-year variations.

4.5.2 Accounting for the linking of ETSs independent from jurisdictional or NDC targets

In some instances, ETS jurisdictions may wish to simply account for the shift in emissions between their ETSs, without necessarily accounting for the shift towards broader jurisdictional or NDC targets that also cover non-ETS sectors.

In this case, a simple approach could be accounting for the *cumulative* impact from the start of linking until the most recent year, taking into account allowances banked from a pre-linking period where applicable. This means that an aggregated shift in emissions over the period would be calculated based on the aggregated amounts of allowances available, transferred or surrendered over the entire period. The main advantage of cumulative accounting is that it avoids year-on-year variations and gives a representative picture of what happened over time – which is also what matters for the atmosphere. In general, the longer the period considered, the more the different approaches to estimate the shift in emissions will converge and provide more similar results. A cumulative determination of the shift in emissions will also lead to fewer variations among the different approaches to estimate the shift in emissions.

Where jurisdictions need year-on-year information on the likely shift in emissions between the ETSs, they could pursue two different options: they could calculate the shift based on annual data, or they could use approximations from cumulative data, such as allocating the cumulative shift in emissions to single years in proportion to the size of the aggregated ETS. Further research would be necessary to determine which approach works best.

4.5.3 Choosing appropriate time frames for jurisdictional or NDC targets

A key choice for countries is the time frame of jurisdictional or NDC targets. Countries that link their ETSs may have to carefully consider which time frames best facilitate robust accounting for the link. Time frames may also

be specified under Article 4.10 of the Paris Agreement. In principle, countries could adopt three different time frames:

1. Cumulative long-term targets: Countries could adopt a cumulative NDC target for a long period of time that is used as the basis for accounting for international transfers, such as a trajectory from 2021 to 2050. This target could include intermediate targets, subject to any agreement on common time frames for NDCs under the Paris Agreement. An example is Armenia, which communicated a cumulative emissions target of 633 $MtCO_2e$ over the period 2015 to 2050. A variation to a cumulative long-term target could be continuous multi-year targets with the possibility of banking any overachievement to future periods (similar to the banking of AAUs between commitment periods under the Kyoto Protocol).
2. Multi-year targets for common periods: Countries could adopt multi-year targets for common periods (e.g., 2031 to 2035, 2036 to 2040, etc.), with or without the possibility of banking overachievement to future periods.
3. Single-year target for common years: Countries could adopt single-year targets for common target years (e.g., 2030, 2035, etc).

Cumulative long-term targets would align the nature of ETSs with the broader jurisdictional or NDC target. Aligning the ETS cap trajectory with the jurisdictional or NDC target would provide more assurance to the country that its NDC target will be achieved. Any year-on-year variations or the banking of allowances to future years would not pose a risk for the country. The same holds for the linking of ETSs: countries could account for the cumulative impact from linking both at ETS level and at the level of jurisdictional or NDC targets, and would have assurance that in aggregate their jurisdictional or NDC targets will be achieved. One caveat could be the possibility of implicit borrowing (surrendering allowances from year X+1 in year X), which could constitute a risk for achieving the jurisdictional or NDC targets. Cumulative targets – or the possibility of banking over-achievement to future years – may, however also raise concerns, in particular with regard to banking of 'hot air' into the future. Independent evaluations indicate that the ambition of current NDC targets varies strongly, despite the uncertainties and limitations in assessing such ambition. A number of countries are projected to significantly over-achieve their NDC targets with current policies in place (Aldy & Pizer, 2016; CAT, 2017; Höhne, Fekete, den Elzen, Hof, & Takeshi, 2017; La Hoz Theuer, Schneider, Broekhoff, & Kollmuss, 2017; Meinshausen & Alexander, 2017; Rogelj et al., 2016). If these countries were to bank the over-achievement of their targets into the future, this could reduce overall ambition.

Multi-year targets for common periods would address some of the challenges for accounting for the linking of ETS. Most importantly, year-on-year variations would pose less risks for countries, as they would be smoothed out over the multi-year period. Significant banking of allowances over longer periods of time could, however, still pose the risk that countries may not achieve a multi-year target in a specific period if banking is not possible when accounting for NDC targets.

Single-year targets are the most complex to account for, as the situation in a specific year may not be representative of a longer period in time. Under single-year targets, countries could pursue a range of options to ensure that the amount accounted for in the single target year is representative of what happened over time. Two options discussed are determining the 'average' shift in emissions over a multi-year period or 'linearizing' which assumes an increasing trend in the shift in emissions over time (Hood, 2017; Howard, Chagas, Hoogzaad, & Hoch, 2017; Lazarus, Kollmuss, & Schneider, 2014; Schneider, Füssler, et al., 2017). In the context of linking of ETSs, both options may not necessarily be representative, for example, if the direction of the shift in emissions changes over time, or if two ETSs link in between two single year targets. Moreover, if ETS caps become more stringent over time, the shift in emissions might also decline over time, rather than increase, as assumed in the 'linearizing' approach. Further research is necessary to better understand the implications of different accounting options.

5 Conclusions and recommendations

This discussion paper explored key issues and options for how shifts in emissions due to the linking of ETSs can be accounted for in the context of jurisdictional and NDC targets. The analysis identified two broad challenges. First, quantifying the shift in emissions that results from linking of ETSs is not straight-forward, mainly because the *actual* shift cannot be observed empirically. Second, the design of ETSs and the characteristics of first NDCs communicated under the Paris Agreement (as well as some jurisdictional targets) differ in several aspects, in particular with regard to the time frame of mitigation targets. These challenges can be partially addressed through appropriate accounting approaches.

The paper identified four different approaches through which to estimate the shift in emissions from linking of ETSs, all of which lead to different results.

The brief assessment of these approaches suggests that there is no single best solution. All four approaches have some benefits but also drawbacks. A simple approach is accounting for the shift in emissions only to the degree that one of the jurisdictions would otherwise not achieve its ETS target (Approach A). This approach always determines the lowest possible outcome for the *actual* shift in emissions and is thus likely to *underestimate* the actual shift. While this approach ensures that both jurisdictions achieve their ETS targets, the likely underestimation might disadvantage the importing jurisdiction and advantage the exporting jurisdiction. Caution may be needed when using information on the transfer of allowances to estimate the shift in emissions (Approach B), in particular in ETSs with a large number of allowance holdings, as a shift in the location of allowance holdings may not necessarily imply any abatement action and shift in emissions. For this reason, countries could consider employing, or building on, approaches that estimate the shift in emissions based on the number of allowances *surrendered* by the regulated entities (Approaches C1 or C2). Since the surrender of allowances reflects the emissions from the regulated entities, these approaches are likely to better reflect the actual shift in emissions compared to using information on the transfer of allowances (Approach B). Combining information on allowance transfers and allowance surrender (Approach D) could be a way forward to reflect the actual availability and surrender of allowances but leads to different values for the shifts in the two jurisdictions.

For approaches that draw on the number of units that are available to regulated entities (Approaches A and C2), it is important to consider all ETS features that may affect the availability of units, including price stability mechanisms and allowance reserves, allowance cancellations, offset credits, use of allowances to meet obligations under ICAO or IMO, and banking of allowances from previous periods.

A further key consideration in bilateral agreements is the time frame used for estimating and accounting for the shift in emissions. Where possible, it is recommended to estimate and account for the shift cumulatively from the start of linking to the most recent year, taking into account allowances banked from a pre-linking period where applicable. This approach seems best suited to reflect the nature of ETSs, which cap emissions continuously over time. It is also important to note that, over longer periods of time, the four approaches to estimate the shift in emissions are likely to converge to some extent, giving more similar results than in single years.

The analysis can also be informative for the ongoing negotiations on international rules for the implementation of the Paris Agreement and the implementation of the provisions of the Paris Agreement by countries. To facilitate further international linking of ETSs and robust accounting for the resulting shift in emissions, several aspects merit consideration:

- Definition and quantification of ITMOs: The international transfer of an ETS allowance may not necessarily result in an actual shift in emissions (and thus a mitigation outcome). We therefore recommend that the transfer of ETS allowances be detached from ITMOs. Furthermore, given that several approaches are available to estimate the shift in emissions, international guidance under Article 6.2 could provide flexibility to countries to quantify ITMOs in different ways, as long as these reasonably estimate the shift in emissions.

If such flexibility is provided, Parties may wish to assure that the quantification of ITMOs ensures environmental integrity. This could, for example, be facilitated through reporting requirements that provide transparency and require countries to describe and justify the approaches they apply to quantify the shift in emissions. This information could be subject to a technical expert review under the enhanced transparency framework established under Article 13 of the Paris Agreement.

- Expression or conversion of NDCs in GHG metrics: Accounting for the shift in emissions from linking of ETSs is only possible in GHG metrics. Countries that wish to account for the linking towards NDCs should therefore have established a GHG emission target or convert mitigation policies or targets in non-GHG metrics into a corresponding GHG emissions target. International guidance under Article 6.2 could therefore include participation requirements that require countries to do so if they wish to account for the linking of ETSs towards their NDCs.
- Coverage of GHG emission targets: To ensure robust accounting, the GHG emissions targets should either cover the full scope of the ETS – i.e., include all gases and emissions sources covered by the ETS – or the shift in emissions should be accounted for assuming that it solely occurred within the scope of the GHG emissions target. The latter option would require applying corresponding adjustments to all international transfers associated with the linking of ETSs, regardless of the coverage of the NDC of the transferring country.
- Common GWP values: Jurisdictions and countries accounting for the linkage of ETSs towards jurisdictional or NDC targets should use the same set of GWP values. International agreement on common GWP values, as envisaged in paragraph 31(a) of decision 1/CP.21, would thus facilitate international linking of ETS.
- Common time frames of jurisdictional or NDC targets: Robust accounting can only be ensured if the participating jurisdictions or countries have targets that cover the same period (e.g. 2021 to 2030, which could be covered through a single year target for 2030 or a multi-year targets for the period 2021 to 2030). International agreement on common NDC implementation periods (e.g., 2031-2035, 2036-2040), as envisaged under Article 4.10 of the Paris Agreement, would thus also facilitate international linking of ETSs.
- Ensuring that accounting is representative for action over time: To ensure robust accounting, it is critical that the number of ITMOs that are accounted towards NDCs be representative of the shift in emissions over time. Given that ETSs cap emissions over a continuous period of time, international accounting for the linking of ETSs is simpler if countries also adopt a cumulative long-term emission reduction trajectory or continuous multi-year targets as the basis for accounting. Where countries have single-year targets, they could account for ITMOs only in their target years but would have to ensure that the amount accounted for is representative of the mitigation over the relevant NDC implementation period. It is unclear which options would work best in the context of ETSs, as different circumstances may have to be accommodated for, such as an ETS link that starts in the middle of an NDC implementation period. For this reason, international guidance needs to strike a balance between giving countries flexibility in NDC accounting, while providing assurances and safeguards to ensure robust accounting. As a first step, international guidance under Article 6.2 could establish the principle that accounting for international transfers shall be representative of the mitigation actions and progress towards NDCs over time. This could be accompanied with reporting requirements for countries to provide transparency and justify the approaches applied, as well as a review of the reported information under Article 13 of the Paris Agreement. The ex-ante determination and review of an approach to account for ITMOs over time could also be established as a participation requirement. Based on further research and analysis on implementation options, including for the linking of ETS, international guidance could be further specified and amended, as part of a work programme for the next years or a review of the international guidance.

Lastly, further research is necessary to assess in more detail the implications of the different approaches for estimating and accounting for the shift in emissions. This could include a testing of the identified approaches using actual data from existing ETSs and further analyzing the options available to robustly account for the linking of ETSs towards NDC targets over time.

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Appendix 1: Additional information approaches

This Appendix presents further information on the different approaches of how to estimate the shift in abatement, including mathematical formulae and information on alternative options for estimation.

Approach A

The shift in abatement can be calculated based on information on the status and flow of allowances as follows:

$$Difference_A = Use_A - issuance_A$$

$$Difference_B = Use_B - issuance_B$$

Where:

Use_A	=	Total use of allowances in jurisdiction A during the applicable period
Use_B	=	Total use of allowances in jurisdiction B during the applicable period
$Issuance_A$	=	Total amount of allowances issued in jurisdiction A during the applicable period
$Issuance_B$	=	Total amount of allowances issued in jurisdiction B during the applicable period
$Difference_A$	=	Difference between total use of allowances and allowances issued in jurisdiction A
$Difference_B$	=	Difference between total use of allowances and allowances issued in jurisdiction B

Then, three cases are possible, depending on whether jurisdictions over- or underachieve:

1. Jurisdiction A underachieves and jurisdiction B overachieves: $If\ (Difference_A > 0; Difference_B < 0)$: $Shift_A = Difference_A\ and\ Shift_B = -Difference_A$
2. Jurisdiction B underachieves and jurisdiction A overachieves: $If\ (Difference_A < 0; Difference_B > 0)$: $Shift_A = -Difference_B\ and\ Shift_B = Difference_B$
3. Both jurisdictions overachieve: $If\ (Difference_A < 0; Difference_B < 0)$: $Shift_A = 0\ and\ Shift_B = 0$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)

Approach B

The shift in abatement is calculated as follows under the three options:

- Option (i): Calculation based on allowance transfers between the jurisdictions:

  $$Shift_A = Transfer_{B\to A} - Transfer_{A\to B}$$

  $$Shift_B = Transfer_{A\to B} - Transfer_{B\to A}$$

  Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)
$Transfer_{A->B}$	=	Allowances transferred from jurisdiction A to jurisdiction B during the applicable period
$Transfer_{B->A}$	=	Allowances transferred from jurisdiction B to jurisdiction A during the

applicable period

- Option (ii): Calculation based on the use and holdings of allowances from the other jurisdiction:

$$Shift_A = (Use_{B\ in\ A} + Holdings_{B\ in\ A}) - (Use_{A\ in\ B} + Holdings_{A\ in\ B})$$

$$Shift_B = (Use_{A\ in\ B} + Holdings_{A\ in\ B}) - (Use_{B\ in\ A} + Holdings_{B\ in\ A})$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)
$Use_{B\ in\ A}$	=	Use of allowances from jurisdiction B in jurisdiction A during the applicable period
$Use_{A\ in\ B}$	=	Use of allowances from jurisdiction A in jurisdiction B during the applicable period
$Holdings_{B\ in\ A}$	=	Allowances from jurisdiction B held by entities in jurisdiction A at the end of the applicable period
$Holdings_{A\ in\ B}$	=	Allowances from jurisdiction A held by entities in jurisdiction B at the end of the applicable period

- Option (iii): Calculation based on aggregate information on the issuance, use and total holdings of allowances:

$$Shift_A = Use_A + Holdings_A - issuance_A$$

$$Shift_B = Use_B + Holdings_B - issuance_B$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)
Use_A	=	Total use of allowances in jurisdiction A during the applicable period
Use_B	=	Total use of allowances in jurisdiction B during the applicable period
$Holdings_A$	=	Total allowances holdings in jurisdiction A at the end of the applicable period
$Holdings_B$	=	Total allowances holdings in jurisdiction B at the end of the applicable period
$Issuance_A$	=	Total amount of allowances issued in jurisdiction A during the applicable period
$Issuance_B$	=	Total amount of allowances issued in jurisdiction B during the applicable period

Table 9: Example calculation of the shift in abatement for Approach B

Option (i)		Transfer to other jurisdiction			Shift in abatement
	Jurisdiction A	65			-18
	Jurisdiction B	47			18
Option (ii)		Use of allowances from other jurisdiction	Holdings of allowances from other jurisdictions		Shift in abatement
	Jurisdiction A	20	5		-18
	Jurisdiction B	35	8		18
Option (iii)		Issuance	Use	Holdings	Shift in abatement
	Jurisdiction A	135	105	12	-18
	Jurisdiction B	110	115	13	18

Approach C1

The shift in abatement is calculated based on the following information:

$$Shift_A = Use_{B\ in\ A} - Use_{\ A\ in\ B}$$

$$Shift_B = Use_{A\ in\ B} - Use_{\ B\ in\ A}$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)
$Use_{B\ in\ A}$	=	Use of allowances from jurisdiction B in jurisdiction A during the applicable period
$Use_{A\ in\ B}$	=	Use of allowances from jurisdiction A in jurisdiction B during the applicable period

Approach C2

Similar to approach E, this approach also uses information on the use of allowances to estimate the shift in abatement. However, the use of allowances from the other jurisdictions is not determined directly, but rather approximated taking into account the share of each jurisdiction in total allowances issued in the linked ETS:

$$Shift_A = Share\_issuance_B * Use_{\ A} - Share\_issuance_A * Use_{\ B}$$

$$Shift_B = Share\_issuance_A * Use_{\ B} - Share\_issuance_B * Use_{\ A}$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A during the applicable period (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B during the applicable period (negative value = more abatement)
Use_A	=	Total use of allowances in jurisdiction A during the applicable period
Use_B	=	Total use of allowances in jurisdiction B during the applicable period
$Share\_issuance_A$	=	Share of jurisdiction A in total allowances issued by both jurisdictions during the applicable period
$Share\_issuance_B$	=	Share of jurisdiction B in total allowances issued by both jurisdictions during the applicable period

Approach D

The shift in abatement is calculated as follows under the two options:

- Option (i): Calculation based on allowance transfers between jurisdictions and use of allowances from the other jurisdictions:

$$Shift_A = Use_{B\ in\ A} - Transfer_{A \to B}$$

$$Shift_B = Use_{A\ in\ B} - Transfer_{B \to A}$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B (negative value = more abatement)
$Use_{B\ in\ A}$	=	Use of allowances from jurisdiction B in jurisdiction A
$Use_{A\ in\ B}$	=	Use of allowances from jurisdiction A in jurisdiction B
$Transfer_{A->B}$	=	Allowances transferred from jurisdiction A to jurisdiction B
$Transfer_{B->A}$	=	Allowances transferred from jurisdiction B to jurisdiction A

- Option (ii) Calculation based on use and holdings of allowances from other jurisdiction (this approximates transfers by using use and holdings of allowances)

$$Shift_A = Use_{B\ in\ A} - (Use_{A\ in\ B} + Holdings_{A\ in\ B})$$

$$Shift_B = Use_{A\ in\ B} - (Use_{B\ in\ A} + Holdings_{B\ in\ A})$$

Where:

$Shift_A$	=	Shift in abatement in jurisdiction A (negative value = more abatement)
$Shift_B$	=	Shift in abatement in jurisdiction B (negative value = more abatement)
$Use_{B\ in\ A}$	=	Use of allowances from jurisdiction B in jurisdiction A
$Use_{A\ in\ B}$	=	Use of allowances from jurisdiction A in jurisdiction B
$Holdings_{B\ in\ A}$	=	Allowances from jurisdiction B held by entities in jurisdiction A
$Holdings_{A\ in\ B}$	=	Allowances from jurisdiction A held by entities in jurisdiction B

Table 10: Example calculation for the shift in abatement for Approach D

Option (i)	Transfer to the other jurisdiction	Use of allowances from the other jurisdiction	Shift in abatement
Jurisdiction A	43	20	-23
Jurisdiction B	25	35	10
Option (ii)	**Use of allowances from the other jurisdiction**	**Holdings of allowances from the other jurisdiction**	**Shift in abatement**
Jurisdiction A	20	5	-23
Jurisdiction B	35	8	10

Appendix 2: Data sources

This appendix describes how information on allowances can be gathered, as well as potential challenges in this regard. For this purpose, ETS registries and transaction logs play a central role: they record, for all accounts active in this ETS, information on allowances bought at auction or allocated for free, the current holdings of allowances, allowance transactions, as well as information on the surrender or cancellation of allowances.

Allowances put in circulation

The total number of allowances issued in an ETS is determined primarily by the ETS cap. Allowances are issued by the authority responsible for the ETS and can be allocated free of charge and/or auctioned. Free allocation typically takes place once per year, with possible small adjustments made throughout the cycle. Auctions usually take place periodically throughout the compliance cycle. It is important to note that the volume of allowances issued in a certain compliance cycle may differ from the cap. The volume issued may be *lower* than the cap due to various reasons: first, ETSs often have a reserve for new entrants. This reserve may not be entirely used in a particular year or period. Second, ETSs often require installations that close or significantly reduce capacity to return allowances. And third, allowances may be put into a reserve of a price stability mechanism – they are issued to a certain account for this purpose, but not put into circulation. The amount put in circulation may also be *higher* than the cap, e.g., in the case of price ceilings that allow for extra allowances to be created in excess of the cap. ETS administrators typically have access to all information on the cap, free allocation, auctions, reserves, etc. For some data points, however, the information may be available only at the end of the compliance cycle. If joint auctions are held in linked ETS it is important that allowances be attributable to individual jurisdictions.

Allowance holdings

Regulated entities and other ETS participants can hold allowances in accounts before they are used for compliance at a certain point in time. The amount of holdings represents the stock of allowances and is the result of previous activities such as issuance, transfer and use. In case banking is possible in an ETS (which is the case in all ETS operational at the time of writing) the holdings of an account represent the outcome of all activities carried out by this account since the beginning of the banking period until today. Information on holdings in accounts are available to ETS administrators, typically through a registry and/or a transaction log. For some of the approaches to calculate the shift in abatement it is necessary to distinguish not only the total amount of allowances held in a certain registry, but also their origin. This can be achieved if the origin of the allowance can be attributed to a certain jurisdiction, e.g., through its serial number. Serial numbers are generally available in ETS that are linked or are planning to link (e.g., WCI jurisdictions, EU, Switzerland). However, these serial numbers may not be available to participants, but only to regulators.

Allowance transfers

Transfers of allowances between accounts depend on individual decisions by market participants, and may be motivated by numerous reasons. Transfers by regulated entities may, for example, be related to selling or purchasing allowances according to the entity's emissions in a given year. Allowances may also, however, be transferred between several accounts of the same entity for management purposes, as well as for hedging strategies for future years. Transfers may also involve non-regulated entities, such as banks (Cludius & Betz, 2016).

Box 1: When does an allowance cross the border between two jurisdictions?

For some approaches to calculate the shift in abatement it is necessary to determine at what point an allowance is deemed to have been transferred between two jurisdictions. An allowance can be said to have been transferred when it moves from the registry in one jurisdiction to the registry in the other jurisdiction. Since all regulated entities within one jurisdiction have their account in the registry of this jurisdiction, this approach is in line with emission registries under the UNFCCC, where emissions are attributed to the jurisdiction where those emissions took place. Nevertheless, it is not absolutely necessary that separate registries be available to follow this approach. For example: under the EU ETS, EU Member States and Iceland, Liechtenstein and Norway share a *single* registry (but have separate NDCs). Yet as each account falls under the responsibility of a separate "national administrator", it is nevertheless possible to know when allowances have been transferred between EU member states and Iceland, Liechtenstein and Norway.

The information on transfers between accounts is available to ETS administrators typically through a registry and/or a transaction log.

Allowance use

The 'use' of allowances in a certain period relates primarily to the surrender of allowances for compliance purposes, which in turn is related to verified emissions. Some approaches for the calculation of the shift in abatement effort employ aggregate figures on allowance use, whereas others require that the origin of a used allowance be known (e.g., through a serial number). Another form of allowance use would be voluntary cancellations. In case these cancellations are negligible, allowance use can be approximated by verified emissions, meaning that no specific registry information would be necessary. However, this is only the case if the origin of the used allowance does not need to be determined.