International Carbon Action Partnership

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MCC Mercator Research Institute on Global Commons and Climate Change

Emissions Trading and the Role of a Long-run Carbon Price Signal

Achieving Cost-effective Emission Reductions under an Emissions Trading System

June 2017, Berlin, Germany

International Carbon Action Partnership Secretariat

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Summary for Policymakers

Emissions trading is now a well-established tool for reducing greenhouse gas (GHG) emissions in an effort to mitigate the impacts of global climate change. By the end of 2017, Emissions Trading Systems (ETSs) will regulate more than seven billion tons of CO_2e, with 19 systems operating worldwide. This paper is concerned with market or regulatory imperfections that could disrupt the dynamic cost effectiveness, i.e. achieving reductions at least cost over time, of an ETS and examines options for how these imperfections may be addressed.

Objectives of an ETS and the role of the allowance price

The economic rationale for applying an ETS to achieve emission reduction targets is well established. By allowing flexibility over where emission reductions take place, least cost options are taken up broadly across the economy. By providing flexibility as to when emission reductions take place, firms can make choices about the timing of investments -- whether to abate now, or to compensate another firm to abate now while delaying abatement at their own facilities to a later point in time. Importantly, an ETS allows market participants to form expectations about future carbon prices, connecting today's investment decisions with expected future carbon prices and abatement costs.

In theory, an ETS achieves cost effectiveness for any chosen reduction target. Crucially, this depends on classical economic assumptions -- that decision-makers are rational and operate with perfect foresight, that information about prices and costs is complete, and that the program has unlimited banking and borrowing. The economic mechanism behind this is that marginal abatement costs, the costs for an additional unit of emissions avoided, converge across the covered entities as the market discovers the cheapest possible options for the respective reduction target. The same mechanism works across time as discounted marginal abatement costs converge for future time-points. Under such conditions, a clear allowance price emerges. It represents the intertemporal marginal cost of abatement. The resulting price over time (which increases at the social discount rate) is referred to as the dynamic cost-effective abatement pathway.

What might preclude an ETS from achieving cost dynamic effectiveness?

Shocks such as economic crises, technological developments, or complementary policies, for instance promoting energy efficiency or renewable energies, can decrease demand for allowances, resulting in lower allowance prices. Low prices, below levels anticipated in the initial program design, have been common in some emissions markets, leading newer ETSs to directly protect themselves against price drops with a reserve price at auction or other minimum price controls (See Figure E.S. 1).

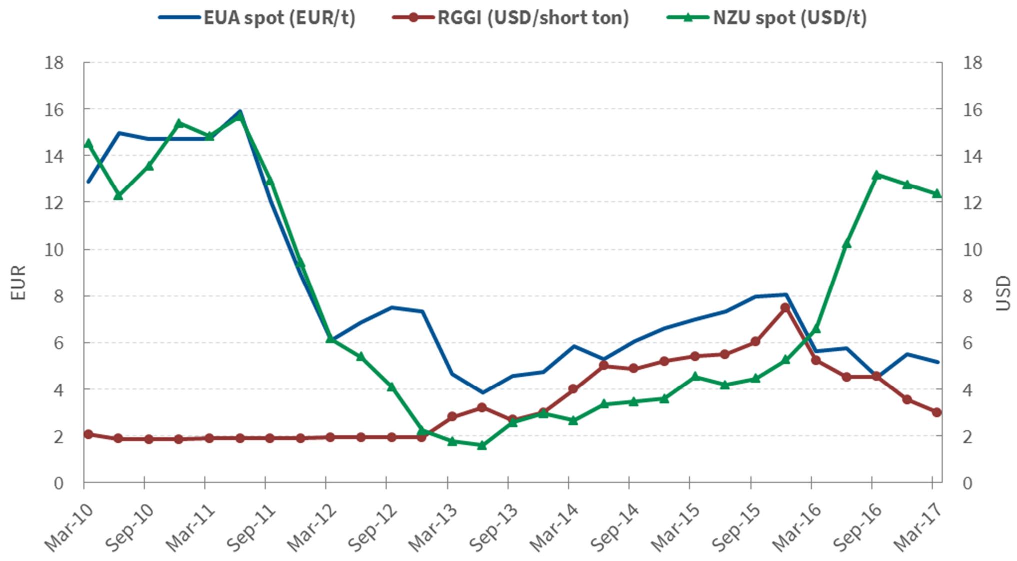


Figure E.S.1: Allowance price development in three longest established ETSs

Low prices resulting from exogenous shocks would not be a concern under a static perspective, which considers an ETS effective as long as the annual caps are met. However, low prices are problematic when they are the result of market or regulatory imperfections that depress the allowance price. Moreover, when depressed allowance prices are the result of ancillary policies promoting specific technologies under the sources covered by the cap, they erode the additionality of those policies, undermining cost-effectiveness even further. When today's allowance price signal is out of line with long-term objectives, investment decisions are made with disregard for long-term carbon budgets. As a consequence, economies might lock into carbon-intensive infrastructure whose emissions have to be abated at higher costs in the future. Furthermore, lower prices today may slow down innovation and technological learning, making future emission reductions more costly.

However, it is difficult to ascertain whether low prices are associated with external demand shocks, or with inherent market and regulatory imperfections. Making such a distinction is important, as the associated policy response may differ depending on the cause of the low price. More empirical research is needed across different allowance markets to assess the presence and magnitude of market and regulatory imperfections.

The paper starts out by introducing a conceptual framework to assess the dynamic cost-effectiveness of an ETS. This framework is then applied to assess three potential market and regulatory distortions that might hamper intertemporal performance, providing evidence where available. These effects are not mutually exclusive and may interact when multiple market and regulatory imperfections are present.

1) Myopia: Myopia is present when participants display a limited time horizon. Kollenberg and Taschini (2015) argue that if participants have insufficient regard for long-term strategies then the allowance price will not be determined by the overall carbon budget, but rather by short-term conditions. In other words, the unwillingness or inability of market participants to consider the long term leads to allowance prices that disregard expected future costs of compliance. When allowances are relatively abundant in the present compared to the future (depending on the cap trajectory) myopia will induce prices that are too low to be dynamically cost-effective. The extent to which market participants are myopic is difficult to assess, due to a lack of conclusive empirical evidence.

2) Excessive discounting: An ETS achieves dynamic cost-effectiveness when the market values future allowances with a discount rate which would be considered socially optimal. Excessive discounting denotes behavior where market participants value future allowances far less than a social planner would. This might be the case because participants are institutionally limited to hold emission allowances beyond those needed for immediate hedging or because risk averse market participants factor in future potential regulatory interventions which may depress allowance price trajectories.

3) Regulatory uncertainty and political commitment: A high extent of regulatory uncertainty surrounding an ETS is likely to encourage participants to focus on the short-term or alternatively increase the risk premium, the expected additional benefit for carrying risk, required to bank surplus allowances. Lessons from real options theory (Dixit and Pindyck, 1994) suggest that investors may be better off waiting for additional information on the stringency and design of future climate policy than making costly irreversible investments into low carbon technologies (Blyth et al., 2007; Fuss et al., 2007).

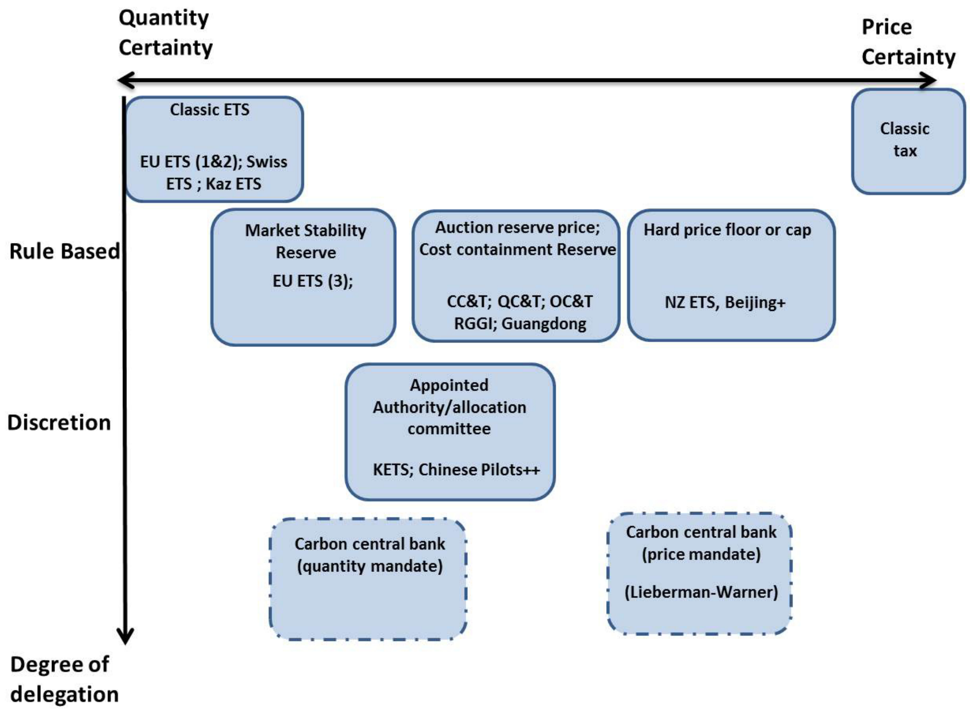
Related, there is evidence that doubts surrounding a system's long-term viability or stringency can dampen prices or invoke speculative behavior. In a market that is dominated by such dynamics, assuming increasing marginal abatement costs,[1] delayed abatement would result in steeply rising future prices if original (stringent) allowance caps are to be met. Such drastic price increases would put significant pressure on policymakers to intervene either to relax the cap or implement alternative reforms in order to avoid the related societal costs. Such dynamics feed already existing regulatory uncertainty surrounding future targets and might intensify market participants' focus on the short term.

Addressing market imperfections: tools to adjust the allowance market

At least partially in response to these market and regulatory imperfections, of the 18 ETSs operating today, most systems include some mechanism to adjust the allowance market. The theoretical set of options can be mapped in a two-dimensional ETS governance space. The horizontal dimension represents the extent to which the chosen tool to adjust the market targets allowance quantities or prices. At one end of the spectrum is a pure ETS where prices have no limits and the quantity of allowances is fixed. At the other end is a carbon tax. In between are many different hybrid options – for example, ETSs containing

[1] Marginal abatement costs are generally expected to increase over time as low cost options are exhausted first, leaving more expensive abatement options for later. This however might not be the case if technological progress reduces future abatement costs below current costs.

price floors, corridors, or cost containment reserves. The vertical dimension refers to the institutional arrangements for adjusting the market and the extent to which governance for the ETS has been delegated away from the government. In a textbook ETS, there is no delegation of governance: the government (legislative or executive, depending on the jurisdiction and the nature of the change) implements changes directly. However, the market could also be adjusted in part automatically via a rule-based mechanism or by an independent body.



Note: a box with a solid line denotes a governance model that has been implemented. A box with a dashed line represents one that has been proposed. + As the government is not required to maintain the price floor, this is not a strict hard price floor. ++The regional ETS in China are pilots with the main aim of testing options for the national system. As a result, they operate with more flexibility and less formal procedures. Details regarding the operation of delegated authorities are sparse.

Figure E.S.2: ETS Governance Space – an empirical mapping of tools to adjust the allowance market, based on Grosjean et al (2014).

Price instruments explicitly maintain allowances prices within a pre-determined range. Prices are supported either via a reserve price at auction (RGGI, California, Québec, Ontario) or through a hard price floor where the regulator intervenes in the secondary market to support prices (Beijing). High prices are restricted either via a cost containment reserve (RGGI, California, Québec, and Ontario), which releases a limited number of additional allowances from a reserve to the market when certain trigger prices are reached or through a hard price cap where the government guarantees to defend the upper price level by releasing an unlimited number of allowances or charging a fixed fee for emissions at a set price (New Zealand (NZ) ETS).

If credible, price control measures can guide price expectations of market participants and to some extent prevent the distortions resulting from myopia and excessive discounting. Experience with different systems indicates that a price floor may also be set at a level below what is required to induce abatement. However, this still results in a guaranteed abatement "fee" that raises revenues and, at the same time, reinforces government commitment to the longevity of the system until prices rise or further adjustment are made.

Somewhat less directly, quantity control measures automatically add or subtract allowances from the market according to predefined triggers based on the quantity of allowances in circulation in order to indirectly affect price formation. A Market Stability Reserve (MSR) will be implemented in the EU ETS in 2019. As with other market interventions, the levels at which the triggers are set is important. If quantity thresholds are set too low, prices may be bid up beyond what is cost-effective. Conversely, if the thresholds are set too high, they will likely be ineffective (not correcting for myopia and excessive discounting).

Some jurisdictions have delegated control of the allowance market to an independent authority or executive committee (Korea ETS, some Chinese pilots). The relative independence of such a body is meant to shield it from political pressure and should enable it to build a reputation for announcing and enacting its policy on the basis of a clear and transparent framework.

Finally, as alternative to the direct management of the allowance market, Ismer and Neuhoff (2006), Helm et al. (2005), and Pizer (2011) have pointed to the potential of selling government backed guarantees of future carbon prices as a means to restore long-term investor confidence and set a de facto minimum price.

Enhancing political commitment - embed the ETS in a long-term policy framework

Providing certainty over the long-term carbon budget through the trajectory of the allowance cap can reduce regulatory uncertainty, therefore providing a more credible signal for investments in low carbon technologies and infrastructure. At the same time, pre-defined periods (or phases as in the EU ETS) in a trading program can provide a structured and transparent timeline for reviews and interventions, which provide flexibility for policymakers to respond to shocks while still maintaining confidence in the market and maintaining long-term mitigation goals. Hence, the cap setting process including the cap period, the relationship of the cap with long--term climate targets of a jurisdiction, and the institutional setting for changing the cap are key elements through which policymakers can balance the commitment-flexibility trade-off.

Building constituencies in support of the ETS

The introduction of an allowance price will shift consumption and production decisions, making new low carbon products more competitive and carbon-intensive products less so. Similarly, the growth of the green economy will create new interest groups, such as renewable energy or forestry lobbies, that benefit from, and therefore support, ambitious climate policies. Yet it will also mobilize powerful and organized interest groups that aim to maintain the status quo and keep their assets from becoming stranded.

Understanding and engaging with key stakeholders will be crucial for building lasting support, which in turn will reduce regulatory uncertainty. Following an inclusive, open, and transparent design process and maintaining communication during the operation of the system can help to manage stakeholder concerns and may even create private sector groups with an interest in the longevity of the system. For example, the New Zealand administration applied an inclusive approach by engaging experts and policymakers at an early stage in an interdepartmental working group. At best, extending cross-partisan cooperation on climate policy would help ensure that the policy survives electoral cycles unscathed.

Developing national Long Term Low Emission Development Strategies (LEDS), as stipulated under the Paris Agreement, might also provide important opportunities for building stakeholder consensus surrounding long-term mitigation strategies. Working with industry to determine the technical feasibility and cost of abatement options can foster collective ownership of long-term reduction goals as well as reveal information surrounding abatement costs. For example, by providing independent experts a role in long-term planning and allowing broad consultation, the United Kingdom Climate Change Committee is considered critical to improving consensus and public acceptance of UK climate policy.

Policymakers can also redistribute climate rents in a way that builds long-term support to compensate sectors exposed to emissions-intensive trade or adversely affected groups, to compensate consumers, to achieve tax swaps, to reinvest in low carbon research and development, or to deploy green technologies.

Finally, the political acceptability of an ETS will also depend on how co-benefits for public health, energy security, job creation, and natural resource protection are accounted for and communicated. One strategy to make clear the co-benefits from emission reductions is the very active display of benefits of revenue spending, as implemented by RGGI. Evidence from RGGI suggests that from 2009-2013, the reduction in hazardous pollutants in RGGI states has led to an estimated USD 10.4 billion in health savings from avoided illness, hospital visits, lost work days, and premature deaths.

Conclusion

A framework for understanding dynamic cost-effectiveness of allowance markets has been introduced and applied to show that myopia, excessive discounting, and a lack of political commitment might result in allowance prices that are too low in the short term and too high in the long-run, compared to a dynamically cost-effective price path. It is plausible that these market imperfections are present in operating ETSs. However, their impact on the allowance price is an empirical question for which little evidence exists. Indeed, overlapping ancillary policies, political lobbying and generous allowance supply in early phases of the ETS, as well as innovation and technological development that drives down the marginal cost of abatement, might also impact allowance price formation.

Policymakers in existing ETSs are applying a suite of approaches to reduce uncertainty and enable firms to better make investments that take full account of their carbon costs. For example, tools to adjust the allowance markets are now seen as good practice for an ETS. However, regardless of the approach taken, for market adjustment tools to function properly, they must also be embedded within a credible long-term policy architecture that reduces uncertainty for participants.

This paper explored a number of ways in which this might be done. First, stronger commitment to longer-term targets – for instance, by embedding them in legislation – will reduce uncertainty and improve the conditions for low carbon investment. Establishing long-term decarbonisation plans as prescribed in the Paris Agreement and aligning review cycles to the required ratcheting up of ambition might also bring further credibility to long-term targets. Finally, the distribution of “climate rents,” stakeholder engagement, and making co-benefits visible can assist in building constituencies that support ambitious climate policy, making it difficult to renege on future commitments.

1. Introduction

Emissions trading is now a well-established tool for reducing GHG emissions in an effort to mitigate global climate change. By the end of 2017, ETSs will regulate more than seven billion tons of CO_2e, with 19 systems operating worldwide (ICAP, 2017). This number is expected to grow as focus shifts from national pledges to reduce or stabilize emissions—in the form of Nationally Determined Contributions (NDCs)—to questions regarding how these are to be achieved.

Under an ETS, policymakers define a fixed quantity of GHG emissions (the cap) and create tradeable allowances. By allowing trade, an allowance price emerges, which in turn encourages a shift in consumption, production, and investment decisions toward low-carbon products and services. The allowance price spurs innovators to come up with better, cheaper, and faster ways of reducing emissions (Keohane et al., 2015).

Under classical assumptions -- that decision makers are rational and operate with perfect foresight, information is complete, and the program allows unlimited banking and borrowing -- an ETS achieves a given reduction target cost-effectively as marginal abatement costs are equated across the covered entities and discounted marginal abatement costs are equated through time. Under such conditions, a clear allowance price emerges that represents the intertemporal marginal cost of abatement and increases at the social discount rate (see Rubin, 1996; Hasegawa and Salant, 2015; Fankhauser and Hepburn, 2010; Leiby and Rubin, 2001). As a consequence, market participants have visibility over the expected future (long-run) carbon price and can make today's investment decisions with future carbon prices and abatement costs in mind.

However, markets do not operate under textbook conditions. This paper is concerned with market and regulatory imperfections in allowance markets that could prevent the emergence of a carbon price signal over the time frame relevant for low carbon investments (Hepburn et al. 2016; Koch et al., 2016; Grosjean et al., 2014; Neuhoff et al., 2015), and options to address them. Regarding such imperfections, Kollenberg and Taschini (2015) argue that participants might not have the information or the foresight to make the decisions required for low carbon investments and hence focus excessively on the short term.[2] Salant (2015) develops a theoretical model to show that even the expectation of a future regulatory intervention can result in price jumps and create inefficiencies that imply the achievement of the cap at needlessly high cost. Kollenberg and Taschini (2016) empirically illustrated this result in a dynamic simulation where actors are risk adverse. Finally, participants might have institutional or corporate constraints that prevent them from banking emission allowances beyond their short-term risk management requirements (Schopp et al., 2015; Neuhoff et al., 2012).

[2] This is not to suggest that policy makers could do any better. In fact, given the nature of the electoral cycle, policy makers are also expected to focus on the short-term at the expense of the long-term. See for example work on political business cycles and how elections, as mechanisms of accountability, generate a short-term bias on policy decisions (Nordhaus, 1975; Drazen, 2001; Eslava, 2011).

The impact of these market imperfections may be non-trivial with recent modelling studies indicating the EU ETS may be 30-90% less cost-effective in the presence of market imperfections compared to under conditions of perfect foresight, perfect competition, and unlimited banking and borrowing (Hepburn et al., 2016; Neuhoff et al., 2015).[3]

Helm et al. (2003), Brunner et al. (2012), and Grosjean et al. (2014) have focused on the extent to which climate policy is credible in the presence of scientific and technological uncertainties, as well as disagreement between political actors. Moreover, there may be political and financial advantages for some stakeholders to create, amplify, and propagate uncertainty. While some degree of flexibility for regulators is desirable so that they can react to new information or unforeseen developments, excessive regulatory uncertainty can cast doubt surrounding the expected stringency of future allowances caps and reduce the credibility of climate policy.

At least in part as a response to these market and regulatory imperfections, of the existing ETS, most systems include some mechanisms to adjust the allowance market based on predefined criteria. These mechanisms partially correct for market imperfections and/or provide flexibility to respond to unforeseen events, either via automatic adjustment rules or by delegating responsibility for such adjustments to a competent body. Providing certainty over the long-term carbon budget and the trajectory of the allowance cap can reduce regulatory uncertainty, therefore providing a more credible signal for investments in low carbon technologies and infrastructure. At the same time, pre-defined cap periods can provide a structured and transparent timeline for reviews and interventions, which provide flexibility for policymakers to respond to shocks while still maintaining confidence in the market. In addition, establishing and maintaining broad political support will help to ensure the perceived long-term legitimacy and viability of an ETS and therefore reduce concerns surrounding a lack of political commitment.

The aim of this paper is to provide structure to the debate surrounding the performance of emission markets in terms of their ability to establish an intertemporal carbon price signal. To this end, Section 2 discusses the objectives of an ETS and the role of the allowance price. Section 3 presents a framework to assess the intertemporal cost-effectiveness of an ETS and applies this framework to potential market and regulatory distortions that might hamper intertemporal performance, providing evidence where available. Section 4 discusses the different approaches that have been implemented to adjust the allowance market and relates these to dynamic cost-effectiveness. Section 5 discusses the cap setting process and how ETS policymakers have endeavoured to balance the need for political commitment with flexibility. Section 6 discusses the importance of political acceptance for

[3] The analysis is based on the results of an international model comparison exercise convened by Climate Strategies that brought together a research consortium involving researchers from twelve institutions across Europe, the United States and Australia. Each team brings a unique perspective on the EU ETS. For more details see Neuhoff et al. (2015), Hepburn et al. (2016) and the Journal of Environmental Economics and Management Special Issue vol 80.

the long-term viability of an ETS and ways in which constituencies can be formed in favor of an ETS. Section 7 concludes.

2. Objectives of an ETS and the role of the allowance price

The economic rationale for establishing an ETS to achieve emission reduction targets is well established (Baumol and Oates, 1988; Hasegawa and Salant, 2015; Fankhauser and Hepburn, 2010). By allowing flexibility over where emission reductions take place, least cost options are taken up broadly across the economy (referred to as **static efficiency)**. By providing flexibility as to the timing of investments -- whether to abate now or to compensate another firm for abatement now and schedule abatement at their own facilities at some point in the future -- intertemporal flexibility through banking and borrowing allows entities to abate when it is cheapest for them, minimizing the cost of emission reductions over the duration of the policy (referred to as **dynamic cost-effectiveness**).

While all ETSs that have been implemented to date state achieving emission reduction targets at least cost as an explicit objective (for example, EU ETS[45]; RGGI[6]; KETS[7]; NZ ETS[8]; Swiss ETS[9]; CC&T[10] and QC&T[11]), the question of what time frame should be considered when assessing the dynamic cost-effectiveness is mostly left unaddressed.

Some experts and stakeholders have argued for a short-term focus, suggesting that an ETS is achieving its cost-effectiveness goal as long as immediate targets are achieved (Tol 2009; Edenhofer, 2011). Where the focus is on attainment of short term compliance period (1-3 years) emissions caps with the given technology set, the level of the allowance price becomes secondary and merely reflects the current marginal cost of abatement. A low allowance price indicates that achieving the cap has not been particularly expensive, whereas a high allowance price suggests a dearth of available low-cost mitigation options. Either way, the emissions cap is guaranteed and the static efficiency goal attained.

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[4] Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low carbon investments, 15/07/2015, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52015PC0337

[5] Proposal for a Decision of The European Parliament and of the Council concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC, 20/02/2014 (?), http://ec.europa.eu/clima/policies/ets/reform/docs/com_2014_20_en.pdf

[6] RGGI Model Rule, http://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_FINAL.pdf, revised on December 23, 2013, originally issued on February 7, 2013

[7] Act on the Allocation and Trading of Greenhouse-Gas Emission Permits http://www.law.go.kr/DRF/lawService.do?OC=jaa806&target=elaw&MST=137271&type=HTML&mobileYn=

[8] New Zealand Emissions Trading Scheme Review 2015/16, Discussion Document, 24.11.2015 http://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/nz-ets-review-discussion-document-november-2015.pdf

[9] Swiss Federal Office for the Environment, http://www.bafu.admin.ch/klima/13877/14510/14719/index.html?lang=en, last accessed 06.07.2016

[10] Overview of ARB ETS Programm, http://www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf

[11] Gouvernement du Québec: A brief look at the Québec cap-and-trade system for emission allowances http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/in-brief.pdf

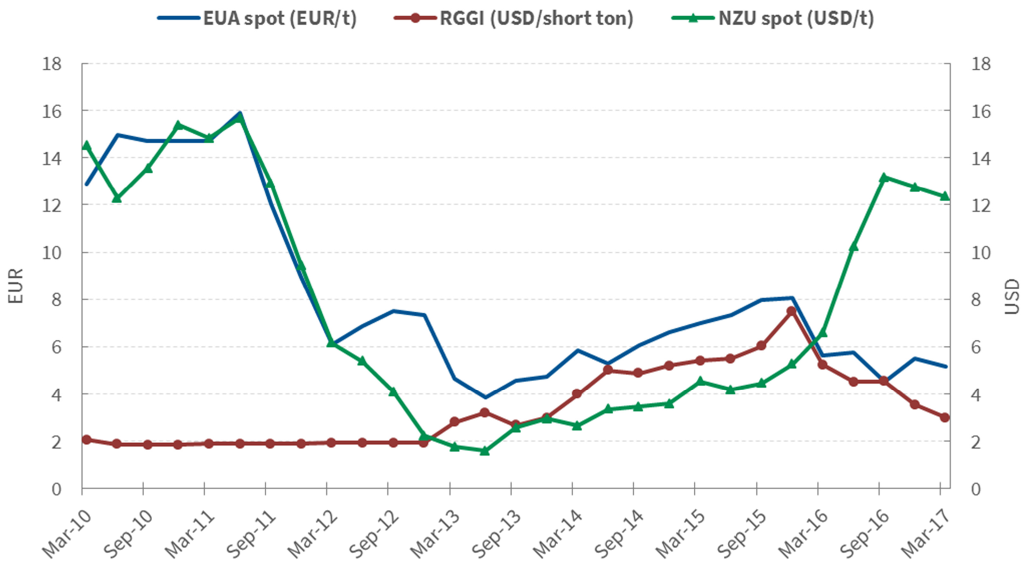


Figure 1: Allowance price development in three longest established ETSs

Source: own elaboration with data from Secondary Market Monitor Reports RGGI, the European Environmental Agency, the EEX, and Carbon Forest Services.

Taking a static perspective, low prices resulting from exogenous shocks would not be a concern as long as the annual caps are met. However, if attaining static efficiency was the main goal, ETS design should not feature temporal flexibility via banking and (at least limited) borrowing, enabling under- or over-compliance with annual caps. As all GHG cap-and-trade systems allow for some level of banking or borrowing[12] it seems unlikely that policymakers had only static efficiency in mind when implementing emissions trading. [13]

Low prices are of consequence for dynamic cost-effectiveness when other market and regulatory distortions interact with exogenous shocks hampering price formation in the allowance market and the intertemporal performance of the system.

Indeed, prices below levels initially anticipated have been common in most emission markets (see figure 1). However, it is difficult to ascertain whether low prices are associated with external demand shocks, or with inherent market and regulatory imperfections. Making such a distinction is important, as the associated policy response may differ depending on the cause of the low price. One study from the EU suggests that market fundamentals were only responsible for a small proportion of price variation (Koch et al., 2014). However, more empirical research is needed across different allowance markets to assess the presence and magnitude of market and regulatory imperfections.

[12] For an overview of intertemporal flexibility in operating ETSs see Step 5 of the ICAP-PMR ETS Handbook (ICAP-PMR, 2016).

[13] Banking and borrowing reduce price volatility, which was likely also a consideration of policymakers when allowing for banking and borrowing.

In the theoretical benchmark case specified by Rubin (1996), for long-run dynamic cost-effectiveness the current allowance price should reflect the net present value of the last allowance used in the system. The value of that final allowance should result from an intertemporal optimization process that minimizes abatement costs along the time path of the ETS and takes into account dynamic effects such as technological change and long-lived investments into the high- and low-carbon capital stocks covered by the system (Fuss et al., 2016). Hence compared to static efficiency, less focus is placed on the current carbon price and more on the price path that allocates abatement cost-effectively over time. In the short- to medium-term, a relatively low carbon price may be sufficient to encourage investment in proven energy efficient products and processes and, as price levels rise over time, emerging low-carbon technologies become competitive. In addition to promoting existing technologies, the long-term allowance price signal may also encourage innovation and new low-carbon patenting.

According to California and Québec policy documents, the role of the carbon price in spurring low carbon development and deployment was a core motivation for implementing their cap-and trade policies. For example, documents from Québec (Gouvernement du Québec, 2015) state that the ETS should set *"a strong carbon price signal to a wide range of economic stakeholders."* Similarly, official Californian sources (CARB, 2015) explain the ETS is implemented to *"…. establish a price signal needed to drive long-term investment in cleaner fuels and more efficient use of energy."*

This conceptual framework motivates the implementation of market-based programs with the expectation that prices will rise over time, thereby signalling long-run emissions reduction targets. However, in some jurisdictions, prices have been lower than expected by models of achieving targets cost-effectively over time, which has generated concerns about some markets (see, for example, Marcu et al. 2017, p. 13, for the case of the EU ETS). The following section explores theory and evidence for market or regulatory imperfections that could disrupt the dynamic cost-effectiveness and the related goals of an ETS.

3. What might preclude an ETS from achieving dynamic cost-effectiveness?

This section explores, through a simplified[14] demand-and-supply framework, three market or regulatory imperfections that might prevent the emergence of a long-run carbon price signal: myopia, factors that might result in excessive discounting, and lack of political credibility of the system. These effects are not mutually exclusive and may interact when multiple market and regulatory imperfections are present.

Conceptual framework

With limited intertemporal flexibility, the allowance price reflects the balance between current supply and demand. Unlike in other commodity markets, allowance supply in an ETS is largely determined by the number of allowances issued by the government, otherwise known as the cap.[15] Demand for allowances depends on a range of factors, including: business as usual emissions, current abatement costs, weather conditions, related commodity markets, and demand from linked systems. The allowance market will set the price that balances supply and demand at any one point in time.

In a market with banking and borrowing, a price path will emerge that values allowances not only at a single point in time, but also along the time path of the ETS. The price path is, under classical assumptions, derived from the value of the last allowance used for compliance, which is equivalent to the (marginal) cost of reducing one additional unit of emissions. The allowance price should reflect an intertemporal optimization process which minimizes abatement costs over time, such that a participant is indifferent between emitting another unit today, tomorrow, or at some future point.

[14] This is a simplified approach designed to highlight the potential effects of specific market imperfections. In doing so some factors that might be present in reality are ignored.

[15] Supply may also be affected by the availability of offsets, permits from linked systems, and any surplus of past allowances that are banked for future use.

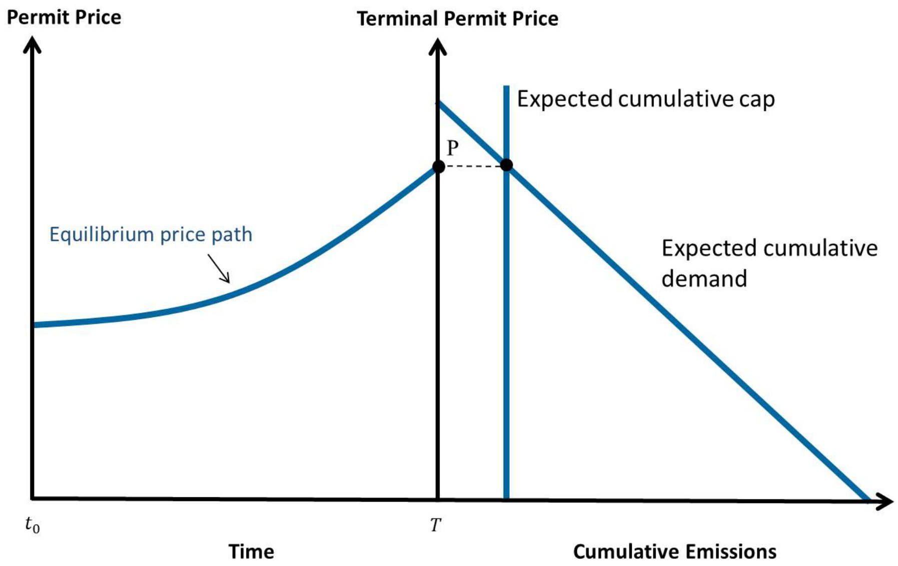


Figure 2: Allowance price path and emissions budget under the *"cost-effective pathway"*

Following Fuss et al. (2016), the dynamic cost-effective pathway is conceptually represented in Figure 2. The right-hand panel depicts the expected cumulative demand and cumulative supply curves on the x-axis, while the y-axis shows the price at terminal time T (i.e. when the trading program ends). The cumulative supply is fixed by the expected cumulative long-term cap in time T (it is shown as a vertical line on the axis of cumulative emissions). The cumulative demand for allowances derives from the expected aggregate marginal abatement costs across all regulated sources over time; for the sake of simplicity, it is assumed to be linear as a function of the price in period T. The intersection of cumulative supply and demand determines a unique price at the final period of the ETS, P (i.e. the value of the last permit surrendered in the system at time T). Given this terminal price, there is a unique equilibrium price path, which is depicted in the left-hand panel of the figure. The current allowance price in t_0 is then equal to the discounted value of the terminal price P.

Complementary policies and exogenous shocks

Exogenous shocks can create persistent shifts in demand resulting in prices that follow a lower (or higher) price path than the least cost schedule illustrated in Figure 2. Demand shocks might be caused, for example, by unforeseen economic recessions, innovations and technological developments or by ancillary policies. As illustrated by Fuss et al. (2016) a negative demand shock, such as an economic crisis, would decrease the aggregate demand for allowances and hence shift the price path downwards. The price path will remain efficient, given the unexpected events, if the slope of the price path is preserved and the curve shifts in parallel to the one illustrated in Figure 2.

The opposite is also true for positive shocks. For example, if expectations surrounding technological progress are not realised, overly optimistic expectations of future abatement technologies might result in a positive demand shock. In this case, more allowances will be required by participants in the future to ensure compliance, shifting the price path up. However, in the absence of market imperfections, the cap will be achieved at least discounted cost even if firm abatement costs change unexpectedly over time or are subject to random shocks (Salant, 2015).

Myopia

Myopia is present when participants display a limited time horizon (i.e. a time horizon that is shorter than the planning time horizon T) and has been put forward as a potential distortion to allowance markets. Kollenberg and Taschini (2015) argue that if participants have insufficient regard for long-term strategies, then the allowance price will not be determined by the overall carbon budget, but rather by short-term conditions. Hence, a short-term surplus could disproportionately depress current carbon prices if market participants have sufficient allowances to cover their emissions and do not bank allowances to cover future emissions, even though allowances are likely to become scarce over the long-term.[16]

In the supply-and-demand framework, Figure 3 displays the ETS equilibrium price path taking into account that myopic market participants would have a limited time horizon, here – arbitrarily, for the sake of illustration – depicted to run until T'. This means that the myopic demand schedule is shifted downwards compared to cumulative demand over the entire period. Also, the myopic cumulative supply of allowances is lower compared to the cumulative cap set by the regulator. The myopic price path in the left panel thus starts from a lower level than what would be cost-effective with perfect foresight and reaches the price of the last permit of the new supply and demand curves in T'.

[16] Assuming increasing marginal costs. If technological progress sufficiently reduces future abatement costs, allowances might be in surplus over the long-term.

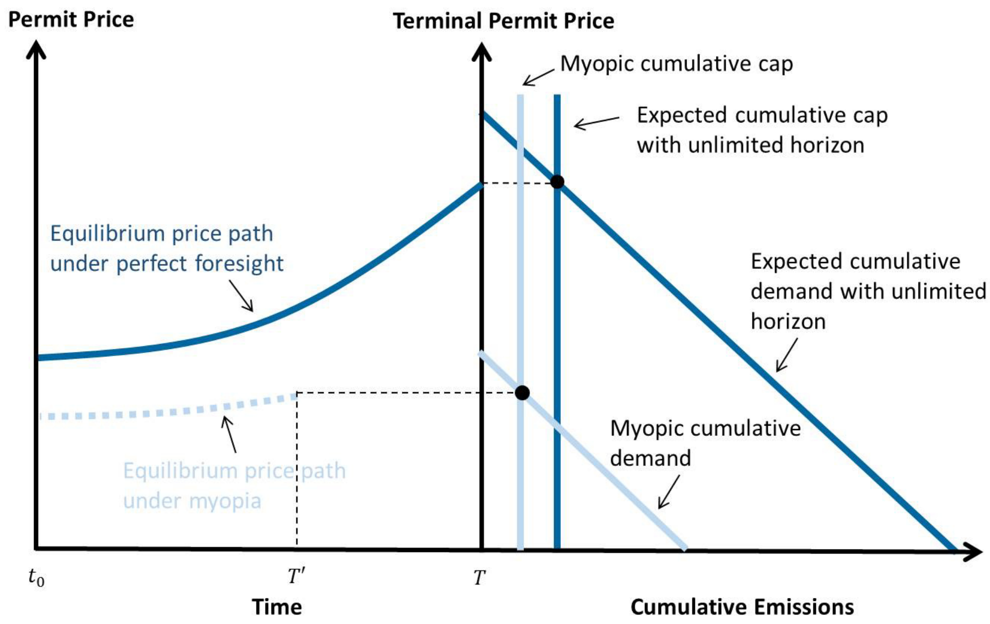


Figure 3: Demand and supply when market participants are myopic (adapted from Fuss et al. 2016)

If agents are myopic with respect to their planning, allowance prices in some ETSs could be lower than what would be optimal from a dynamic cost-effectiveness perspective.[17] If the short-term price signal is out of line with long-term objectives, investment decisions are made with disregard for long-term carbon budgets. This results in higher overall costs of achieving an emissions target as economies lock into carbon-intensive infrastructure, whose emissions have to be abated at higher costs in the future. Furthermore, lower prices[18] today slow down innovation and technological learning making future emission reductions more costly.

The extent to which economic agents are myopic is difficult to assess. Taking the EU ETS as an example and taking futures trading activity of European Emission Allowances (EUAs) as a proxy for market participants' foresight,[19] we can say that the maturity of EUA futures contracts ranges only until 2020 at the ICE exchange; however, transactions volume decrease rapidly within the nearest contracts (Fuss et al. 2016). Furthermore, looking at power companies, their hedging activity (electricity futures with maturity 2021 are traded at EEX) suggests planning horizons of maximally 5-6 years. Both imply that – in line with observations in other sectors in the economy – planning horizons of market participants are

[17] In a dynamic setting, myopic actors will continuously reassess T' as new information is revealed and will make abatement decisions accordingly, somewhat ameliorating the distortionary effect.

[18] While low current prices might communicate low costs for climate action and therefore allow policymakers to increase future ambition, delayed technological progress due to low price signals will make achieving these targets more costly and potentially unattainable.

[19] Futures markets can provide an indication of actors foresight but is not equivalent to it. The fact that futures only extend to 2020 does not necessarily imply that there is no planning beyond this point.

well below the assumption of multi-decadal foresight as assumed in the theoretical models underpinning dynamically cost-effective ETS design (Fuss et al., 2016).[20]

Excessive discounting

Another explanation concerns excessive discounting,[21] where investors and market participants feature higher (risk-adjusted) discount rates than would be socially optimal (assumed by some authors to be between 2-3% (Nordhaus, 2011)) (Fuss et al., 2016). If participants have higher discount rates due to perceived regulatory and other risks, then the value attributed to future allowances falls. This encourages less banking and more emissions today, compared to the cost-effective pathway.

While classic models of allowance markets assume that participants can bank an unlimited number of allowances now for future use at low discount rates, this may not hold in reality due to institutional or corporate constraints. Neuhoff et al. (2012) and Schopp et al. (2015) argue that participants require different risk premiums for distinct banking strategies. When they bank allowances as part of a hedging strategy, their discount rates are in line with the risk free cost of capital, however higher discount rates may be applied when actors pursue speculative banking strategies.

Statistical analysis and interviews with EU ETS participants find that utilities are the main actor holding surplus allowances in the EU ETS in order to hedge emissions from electricity production (Betz et al. 2015; Neuhoff et al. 2012). However, evidence suggests that they bank allowances only as part of their hedging strategies[22] when power is sold on forward contracts. As allowances can be banked at zero cost (no storage costs), discount rates associated with banked allowances should be in line with the cost of capital (Schopp et al., 2015). Due to internally established risk management requirements or, in the case of California, regulations such as holding limits,[23] utilities typically have limited capacity to bank beyond their hedging needs (Neuhoff et al., 2015).

Thus, where the allowance surplus is above that required for hedging, market participants will acquire allowances not for hedging but as speculative investment. Speculating in allowance markets involves an open position, with which participants are exposed to carbon price risk. Neuhoff et al. (2012) report that financial investors would, in principle, only be prepared to pursue speculative investments in carbon markets if annual rates of return exceeded 10-15%, significantly higher than that of a social planner. This is roughly in line with insights from other commodity markets which suggest that speculative investors

[20] Empirical examples in this section largely focus on the EU ETS, for the simple reason that most of the available evidence pertains to this longest-running ETS for greenhouse gases.

[21] Excessive discounting is closely related to myopia, in that myopic market participants apply an infinite (or very high) discount rate beyond a certain planning period. However, here market participants simply apply a high discount rate across all periods.

[22] EU power firms sell a significant share of their power one to three years ahead of delivery. Corporate risk management requires that contracts for fuel and carbon input are signed in parallel. This creates hedging needs for carbon emissions (Schopp et al, 2015).

[23] Under the California Cap and Trade Program, holding limits as well as a Californian Public Utilities Commission decision (12-04-046) prevent electric utilities from holding an excess of allowances.

become active where annual returns exceed 10% (Bessembinder, 1992; Wang, 2001). However, as pointed out by Salant (2015), there is no empirical evidence that European emission allowances are regarded as so risky or whether participants holding allowances in other emissions markets require such high rates of return. [24]

Kollenberg and Taschini (2016) also examine the impacts of excessive discount rates when market participants are risk averse. In their case, the discount rate is endogenous and they find that if firms are risk averse, even the possibility of regulatory interventions increases the discount rate; eventually, this results in less abatement in the short term compared to the cost-effective pathway.

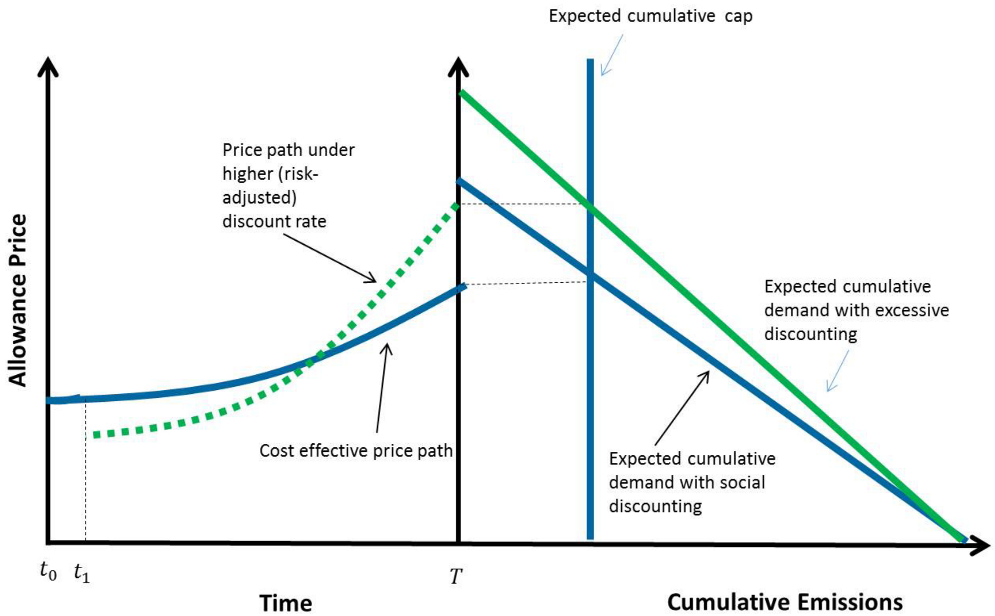


Figure 4: Price formation under (risk-adjusted) discount rate leading to lower short-term price and higher long-run price (assuming that the cumulative unregulated demand and intertemporal abatement cost schedule remain unchanged), based on Fuss et al. 2016

In Figure 4, with price-setting market participants applying a higher discount rate, the price path in the left-hand panel shifts downward in the short term and swivels in a way that the expected price in early periods is lower than the cost-effective price, and then rises more steeply until reaching a higher ultimate price at T (the higher future price is required to ensure the same cumulative allowance budget is met).

Regulatory uncertainty and political commitment

[24] The argument by Neuhoff et al. (2012, p. 6) builds on an observed increase of the risk-adjusted discount rate from about 5% to levels exceeding 10-15%. However, the observed time yields for EUA Futures have been consistently below 10% and mostly substantially so (Ellerman et al. 2016). This weakens the excessive discounting argument, as a price as low as observed in the EU ETS cannot be explained by discount rates below 10%.

Regulatory uncertainty is one possible driver of the market distortions discussed above. Substantial regulatory uncertainty is likely to encourage participants to focus on the short-term or alternatively increase the risk associated with banking allowances. Setting a clear reduction-trajectory and embedding an ETS within a transparent legislative framework can reduce such uncertainty (discussed below), but some uncertainty always remains as future governments have the ability to make new decisions in response to, for example, updated scientific understanding, technological progress, or changing domestic preferences (Hepburn et al. 2016).

Where regulatory uncertainty results in future price shifts (both up and down), the payoffs from low-carbon research and investments are uncertain. Lessons from real options theory (Dixit and Pindyck, 1994) suggest that investors may be better off waiting for additional information on the stringency and design of future climate policy than making costly, irreversible investments into low-carbon technologies (Blyth et al., 2007; Fuss et al., 2007). Hence, policy uncertainty creates a risk premium that acts as a barrier to immediate investment. The size of the risk premium (or option value) increases the closer investors are to an expected change in policy. With emissions trading, it is not only the stringency of the policy that might affect the pay-offs from low-carbon investments. Also important are decisions on the allocation of allowances and opportunities for future linking.

Regulatory uncertainty is directly linked to the question of political commitment and the long-term credibility of the system. Evidence from the EU ETS illustrates that, under regulatory risk, not only the announced cap will guide price formation, but speculation about the commitment embedded in this announced cap in itself may cause price shifts (Koch et al., 2016). Such speculation is often rooted in disagreement between political actors (e.g. the different member states in the EU, and energy-intensive industry lobby groups) that may cast doubt on the longevity of the envisaged cap trajectory.

Figure 5 shows the outcome of a regulatory event causing market participants to reduce their estimate of the expected cumulative cap (dotted supply curve). If the cap adjustment actually happens, this would lower the equilibrium price path (dotted price path). More importantly, however, we would also see a price shift if the contemplated cap change actually never happens. Indeed, when market participants sense an increase in the odds of a less stringent cumulative cap, the permit price will immediately fall and begin a new ascent. Nevertheless, because the actual cap and demand remain unchanged, the price must subsequently rise at a faster rate, eventually crossing the old equilibrium price path from below (solid price path). Steeply rising allowances prices would put significant pressure on policymakers to intervene either to relax the cap or implement alternative reforms in order to alleviate the resulting costs to society. Such dynamics might intensify market participants' focus on the short-term as they would feed any pre-existing regulatory uncertainty surrounding future targets.

Koch et al. (2016) provide empirical evidence for this model prediction first advanced analytically by Salant (2015), showing that regulatory events associated with potential cap adjustments can explain the precipitous downward price jumps that have occurred in the EU ETS.

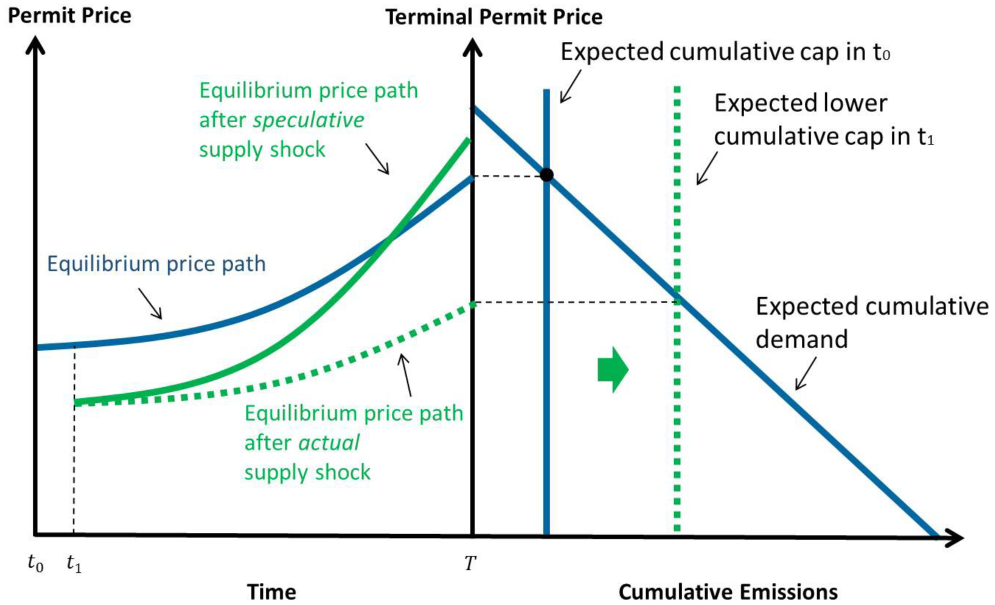


Figure 5: Deteriorating expectations of future cap stringency lowers today's price, adapted from Fuss et al. 2016

Regulatory uncertainty is an issue facing participants across different carbon markets worldwide. For the EU ETS, according to a Thomson Reuters Point Carbon market survey, in the year 2013 only 70% of respondents believed that the EU ETS would still be in place in 2020, with about 15% each responding either "no" or "don't know" (Dimantchev, 2014). Similarly in 2015, 35% of respondents were unsure whether the EU ETS would still be the main climate policy instrument to 2030 (Dimantchev, 2016). Likewise, the future of the Californian Cap & Trade program (CC&T) beyond 2020 is uncertain.

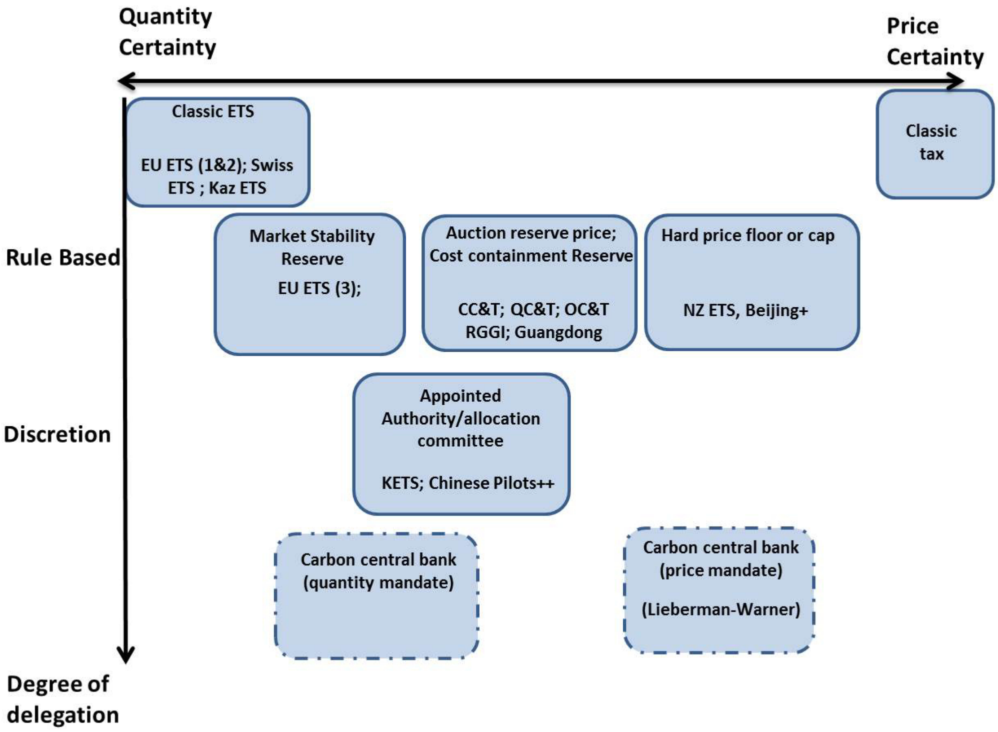
The following sections highlight the range of options that have been implemented to combat the market and regulatory imperfections identified above. Section 4 focuses on tools to adjust the allowance market. Section 5 examines the importance of embedding ETSs in a long-term policy framework and Section 6 discusses how constituencies can be built in support of an ambitious climate policy.

4. Addressing market and regulatory imperfections: tools to adjust the allowance market

Existing ETSs showcase a diverse array of design options, reflecting the different political and economic contexts within which they operate (Eden et al. 2016). However, across all systems policymakers have diverted from the ETS textbook model of fixed supply schedules and unconstrained allowance prices. This can, at least in part, be explained as a response to the market and regulatory imperfections that have been presented above.

This section focuses on the range of policy tools that have been implemented to adjust the allowance market. Following Grosjean et al. (2014), the theoretical set policy tools can be mapped in a two dimensional ETS governance space (Figure 6). The horizontal dimension represents the extent to which a design option targets allowance quantities or prices. A pure ETS where prices have no limits and the quantity of allowances is fixed is at one end of the spectrum, while a carbon tax is at the other end. Many different hybrid options are in between – for example, ETSs containing price floors, corridors, or cost containment reserves.

The vertical dimension refers to the degree to which institutions are involved in adjusting the market and the extent to which governance for the ETS has been delegated away from the government. In a textbook ETS, there is no delegation of governance: the government (legislative or executive, depending on the jurisdiction and the nature of the change) implements changes directly. However, the market could also be adjusted in part automatically via a rule-based mechanism or by an independent body.



Note: a box with a solid line denotes a governance model that has been implemented. A box with a dashed line represents one that has been proposed. + As the government is not required to maintain the price floor, this is not a strict hard price floor. ++The regional ETS in China are pilots with the main aim of testing options for the national system. As a result, they operate with more flexibility and less formal procedures. Details regarding the operation of delegated authorities are sparse.

Figure 6: ETS Governance Space – an empirical mapping of tools to adjust the allowance market, based on Grosjean et al (2014).

No or limited controls

A number of systems operate with no or limited tools to intervene in the allowance market and can be located in the top left hand corner of the ETS Governance Space, including the Swiss ETS, Tokyo C&T Program, Saitama C&T Program and Kaz ETS.[25]

For Phase I and Phase II, the EU ETS also operated with limited direct measures to intervene in the allowance market. Article 29a of the EU ETS Directive stipulates that if, for more than six consecutive months, the allowance price is more than three times the average price of allowances during the two preceding years on the European carbon market, then additional allowances can be auctioned from future allocations or from the New Entrants Reserve (European Union, 2009). However, Article 29a has never been triggered and the stringency of the criteria means it is unlikely to be triggered in the future. The EU ETS auctioning directive also provides provisions for an auction to be cancelled if the auction price is

[25] The Kaz ETS has been temporaily suspended to make adjustments to the leglislation, improve the monitoring, reporting and verification processes and adjust methods for allocation. It is scheduled to restart in 2018.

significantly below the secondary market price. Allowances from the cancelled auction would then be distributed over future allocations (European Commission, 2011).

Price-based controls
Design features that explicitly maintain allowances prices within a pre-determined range have been built into existing ETSs. In terms of responding to low prices, setting a **minimum (reserve) price at allowance auction** is a common feature of the ETSs operating in North America (California, Québec, Ontario, and RGGI) and has also been used as a trial in Chinese pilots (e.g. Guangdong). A reserve price constitutes the minimum bid that will be accepted in the auction; if there are no sufficient bids above that price to exhaust the supply of allowances, then some allowances go unsold. Under a reserve price, rules are required to set the minimum price and to reintroduce or retire allowances that are not initially sold. A reserve price at auction can also be introduced in a consignment auction, in which recipients of free allowances are required to sell all or some of those allowances but receive the revenues from these sales in return. Consignment auctions are important for price discovery and market efficiency in permit markets that are dominated by free allocation (Burtraw and McCormack, 2016). A consignment auction operating with a reserve price is in place in the California C&T Program for allowances directed to investors-owned electric utilities.

An alternative option to the reserve price is a **hard price floor**, where governments commit to buy back as many allowances as needed at a predetermined price. A hard price floor is a feature of the Beijing pilot ETS: if the price is lower than CNY 20 (EUR 2.67) per ton for ten consecutive days, the government can, but is not required to,[26] buy from the market at a fixed price. Shenzhen, Shanghai, Tianjin, and Hubei have similar policies, but without specific operational guidelines (For more details, see ICAP & PMR, 2016).

Policymakers have also defined an upper bound to the allowance price range through a number of mechanisms. The most common is a **cost containment reserve** which releases additional allowances from a reserve to the market when certain trigger prices are reached. Once the cost containment reserve is empty, prices can again rise above the trigger levels. California, Québec, Ontario, and RGGI have all adopted cost containment reserves. In California and Québec, allowances are allocated to the reserve from the allowance cap. In RGGI, if the cost containment reserve is triggered, allowances in addition to the original cap are released, resulting in an increase in total emissions. The NZ ETS operates with a **hard price cap** (NZD 25 /t CO_2e). In contrast to a cost containment reserve, a hard price cap guarantees the upper price level by releasing an unlimited number of allowances or charging a fixed fee for emissions when the allowance price is above a set price.

Lower and upper price controls can also be combined, as in the North American systems (California, Québec, Ontario, and RGGI). In its latest reform proposal, the California Air Resources Board (ARB, 2016) proposed a simplified mechanism, in which the upper trigger

[26] As the government is not required to maintain the price floor, this is not a strict hard price floor.

price increased in line with the auction reserve price such that allowance prices remained within constant band for the CC&T program after 2021. This would effectively establish a price collar, with a constant price corridor of USD 60 between the minimum and maximum price.

The **Emissions Containment Reserve** (ECR) is an alternative price-based mechanism that has been proposed recently as part of the 2016 RGGI Program Review. The ECR is triggered by a lower price threshold and can be implemented as a reserve price in an auction, just as a price floor, or by withholding allowances from a future auction. However, unlike the price floor, the ECR applies only to a limited number of allowances and the market clearing price could fall below the ECR trigger price. By automatically adjusting supply, the ECR would reduce the need for future bank adjustments which have previously been made through the RGGI review process. The ECR could be combined with a price floor set at a lower value. The ECR does not have an upper price trigger, so high costs would be controlled by the Cost Containment Reserve.

Impact on market and regulatory imperfections

The credible announcement of a price collar can guide price expectations of market participants. In this way, a price drop resulting from myopia, increased discount rates, and the shift in expected supply due to lack of credibility, and a combination of them, are contained by the price floor (also see Fuss et al., 2016 and Neuhoff et al., 2015).

Experience with auction reserve prices in existing ETS suggests that the lower bound is particularly important. In both the California-Québec and RGGI markets, the reserve price has been triggered and subsequently prices have risen above the price floor, and allowance prices have at times tracked closely to the lower bound. It is possible that trading prices fall below the reserve price if there is a sufficient surplus in the secondary market.[27] Thus, the price floor may be intended to deliver a minimum level of abatement, to protect investments in low-carbon technologies, to ensure the availability of program revenues, or to simply buoy the program in the face of potential exogenous shocks. Moreover, the price floor is likely to affect the expected allowance price (in a probabilistic sense) by censoring the distribution of possible prices and by signalling regulators' intent to defend the program.

A number of tools can assist policymakers in setting price controls. First, policymakers can look at choices in the fuel mix and set a minimum price that would guarantee that the most carbon-intensive fuels are no longer competitive. For example, one such trigger point would be the price that encourages a fuel shift from coal to gas. However, this trigger point fluctuates with coal and gas prices, making the selection of a stable floor price difficult. In any case, such an approach focuses on the current technology set and is more in line with achieving static efficiency goals than dynamic cost-effectiveness (Fuss et al., 2016).

[27] It should be noted that in a situation of such (expected) oversupply, bidders will likely not bid over the auction reserve price, in that sense the auction reserve price does not only operate as a price floor but – given specific market conditions – as a focal point for bidders.

Second, numerical intertemporal energy system optimization models can provide a quantitative assessment of the dynamic effectiveness of a given reduction target. They implicitly derive intertemporal marginal abatement cost curves and, given a reduction target, corresponding benchmark allowance prices. However, such models must contain assumptions regarding technological development and often do not account for market imperfections. Box 1 provides an overview of such modelling for the EU ETS.

In setting price controls, policymakers need to retain some flexibility to update price triggers in response to new information or market developments. Existing price controls in California and Québec apply automatic rule-based adjustments which dictate how price triggers will develop throughout a trading period (for example increase at a fixed rate on top of inflation). However, regulators maintain the right to update these rules between different cap phases, generally through a public rulemaking process that allows for stakeholders' input.

The ECR is justified with reference to imperfect foresight. If the allowance price fell beyond the trigger level this would be indicative of an overestimation of the cost of emissions reductions, thereby shifting the cost-benefit optimality to a higher abatement level. The considerations for the trigger point are therefore similar to those for a price floor. The price trigger could therefore be set based on modelling the emissions impact of different scenarios, for example, in line with a "low emissions scenario," which might eventuate due to lower technology costs, reduced economic activity, or complementary policies.

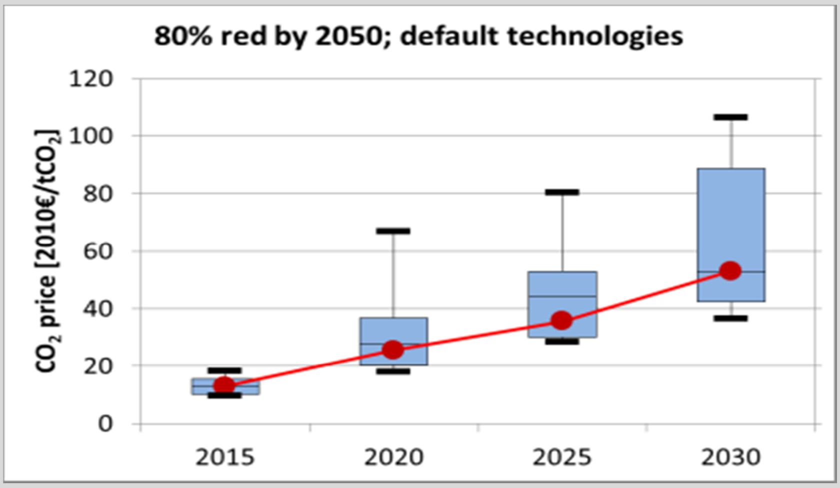
Box 1: Dynamic cost-effectiveness in the EU ETS

Benchmark GHG price calculations can be derived from different models. However, most of them ignore or do not appropriately address uncertainty and market imperfections, nor do they account for innovation and discovery, evolution of preferences, changing demographics, complementary policies, etc. As emphasized by Schopp et al. (2015), technological uncertainties complicate ex ante predictions of optimal price levels and regular modelling updates taking into account empirical changes in underlying parameters are recommended if model results are to be used in the policy process.

In the EMF-28 modelling inter-comparison study analysing the recent EU climate and energy policy package, the identified optimal economy-wide carbon prices were in the range of 20-70 €/t in the year 2020, rising to 38-110€/t until 2030. The PRIMES model indicates 25 €/t (2020) and 50€/t (2050). Additionally, Landis (2015) uses the PACE model, a Computable General Equilibrium Model (CGE), commonly applied by European Commission climate policy impact analyses, to identify reference EU ETS prices levels at 10€/t (2020) and 100€/t (2050).

More generally, carbon prices in accordance with the Paris Agreement's stated goal of at most 2°C warming have been found to be significantly higher than observed current or future prices. For example, the Report of the High Level Commission on Car bon Pricing (High-Level Commission of Carbon Prices, 2017) found, *with* supportive policies in place, 2020 prices of 40-80 US$/t (35 - 72€/t at current prices) in 2020 and US$ 50-100 (45-90€/t) in 2030 to be necessary to achieve the 2°C target.[28]

Applying the Marginal Abatement Cost Curves derived in Landis (2015) in a model comparison exercise, Neuhoff et al. (2015) also derive a range of EUA prices. Unlike other studies, the partial equilibrium models applied are designed to reflect market and regulatory imperfections. EUA prices ranged from around 10€/t in 2020 to between 20€/t and 40€/t in 2030.



Optimal economy-wide CO2 prices to achieve the EU 2050 objective of reducing emissions 80% below 2005 levels. Source: Knopf et al. (2013b).

[28] Note that the prices reported by the High Level Commission relate to prices required to achieve the Paris Agreement and therefore can not directly compared against allowances prices from an ETS.

Quantity-based controls

Quantity mechanisms add allowances to or subtract allowances from the market to maintain the allowances in circulation[29] stable within a predefined range. For example, the EU ETS will operate with a quantity-based control, the **Market Stability Reserve** (MSR), from 2019. The MSR aims for "scarcity pricing" by restricting the allowance surplus.

Impact on market and regulatory imperfections

In the absence of market imperfections, classical theory of emission trading mechanisms states that the temporary removal of allowances with an MSR would be anticipated by participants, and therefore either have no effect (when participants are risk neutral) or a potentially negative effect (when participants are risk adverse) on the dynamic cost-effectiveness of an ETS (Neuhoff et al., 2015; Fuss et al., 2016). With risk adverse market participants, Kollenberg and Taschini (2016) show that interventions such as an MSR create uncertainty as to if the regulator may intervene again and could actually decrease, rather than increase, abatement efforts. However, when myopia, excessive discounting or a lack of political commitment result in reduced banking by market participants, and sub-optimum allowance prices, studies show that an MSR could increase abatement and improve the functioning of an ETS (Neuhoff et al, 2015; Schopp et al. 2015; Kollenberg and Taschini, 2015).

As with price-based controls, applying a quantity supply mechanism requires choices surrounding the desired upper and lower bounds. If quantity thresholds are set too low, below hedging needs,[30] prices may be bid up beyond what is cost-effective or production levels reduced. Conversely, if the thresholds are set too high, they will likely be ineffective, not correcting for myopia and excessive discounting (Neuhoff et al., 2015). However, assumptions surrounding how many allowances are required for hedging purposes are difficult. Since data on power firms' hedging is only partially accessible and hedging needs can change over time with changes in power demand, carbon-intensity of power production as well as power market design choices and other factors impacting contracting strategies (Schopp et al., 2015).

Laboratory experiments have also illustrated the importance of parameterization for quantity-based instruments. Holt and Shobe (2016) demonstrate that, when upper trigger levels of a supply adjustment mechanism are set below the level of desired banking volume of market participants, then they are encouraged to build up their banks to ensure their hedging levels are met. This, in turn, increases the number of privately banked allowances (and therefore allowance surplus), while at the same time forcing the supply adjustment

[29] Allowances in circulation are the cumulative number of allowances issued in the period since 1 January 2008 and entitlements to use international credits exercised by installations under the EU emission trading system in respect of emissions up to 31 December of year x, minus the cumulative tons of verified emissions from installations under the EU emission trading system between 1 January 2008 and 31 December of year x, any allowances cancelled in accordance with Article 12(4) of Directive 2003/87/EC and the number of allowances in the reserve (Commission 2014).
[30] Hedging requirements evolve based on input prices and the composition of the energy mix.

mechanism to remove more allowances from the market. Such a pattern results in prices above the cost-effective pathway. All this points to the importance of reliable data regarding the evolution of firms' hedging needs as the basis for setting and updating quantity adjustment thresholds.

Delegation

Besides the instruments used to adjust the allowance market, the institutions which take control over those instruments are also relevant. The Republic of South Korea has established an Allocation Committee which, in a number of predetermined situations, has the right, but is not obliged, to intervene in the allowance market. Possible interventions include releasing allowances from a reserve, changing the limits on borrowing and setting a temporary upper or lower price (ICAP, 2016). In California, AB32 allows the Governor of California to suspend the CC&T program for a period of one year, which could, in theory, happen repeatedly.

In the Chinese pilot ETSs the management of the allowance market is the responsibility of the regional Development and Reform Commission (DRC).[31] In Beijing and Tianjin, the respective DRC can buy or auction allowance in case of market fluctuations; in Hubei, the provincial DRC holds the same right in consultation with an advisory committee. In Shenzhen, the Shenzhen DRC may sell additional allowances from a reserve at a fixed price, which can be used only for compliance. It can also intervene through buying back up to 10% of the total allocation.

In some cases, authority to intervene in the market, under strict guidelines, has been delegated to the local exchange. In Chongqing, the Chongqing Carbon Exchange has the right to introduce price stabilization measures. In Shanghai, the Shanghai Environment and Energy Exchange can take price stabilizing measures such as temporarily suspending trading or imposing holding limits if prices fluctuate more than 10% in one day. In the case of Hubei, the exchange also acted to change the rules, reducing the limit for price fluctuations from 10% to 1% in the face of continuously falling prices.

The Lieberman-Warner Bill (S. 2191), which proposed an ETS for the United States (US), but failed to gain a majority in the U.S. Congress in 2008, also suggested the creation of a Carbon Market Efficiency Board. The Board's proposed mandate would have been to achieve a price level that balanced emissions reductions and economic growth (Manson, 2009).

Impact on market and regulatory imperfections

A frequent analogy used when discussing delegation of climate policy is the role of central banks in monetary policy, where governments successfully created independent institutions shielded from immediate political pressure and partisan politics to ensure that

[31] Details regarding the operation of the Chinese ETS allocation committees are sparse. However, to the knowledge of the authors they have rarely intervened in the market.

monetary policy be guided by long-term considerations (Brunner et al., 2012; Grosjean et al., 2014). Applied to climate policy, the independence of the agency ideally: (i) shields it from short-term political pressures that are considered detrimental to welfare (thus, implying a broad consensus on what welfare would imply, e.g. in terms of climate policy ambition); and (ii) enables it to build a reputation for announcing and enacting its policy on the basis of a clear and transparent framework (Brunner et al., 2012). This is intended to enhance confidence that the independent regulator will ensure long-term targets are achieved, thereby addressing concerns regarding political commitment to climate goals.

When compared to rule-based interventions, an independent body with discretionary power has greater flexibility to respond to unforeseen events or new information. However, questions remain as to whether an independent body can build and maintain credibility required to guide low-carbon investments. Such a body also faces practical considerations: in order to provide the required certainty, it should only intervene under well-defined circumstances; these circumstances could be defined by the legislator or alternatively a degree of discretion might be provided to the independent body.

Commitments through financial options

While yet to be implemented,[32] a number of analysts have pointed to the potential of selling government-backed guarantees of future carbon prices as a means to restore long-term investor confidence and set a de facto minimum price (Ismer and Neuhoff, 2006; Helm et al., 2005; Pizer, 2011; Zachmann, 2013). Under the proposed mechanism, a government auctions contracts, which stipulate that it (the government) will be willing to buy a specified volume of allowances at a fixed price (the strike price) on a fixed date (the maturity) or before that date (Pizer, 2011).[33]

Once the options have been distributed, it is up to the holders of allowances whether they execute them or not. If allowance prices fall below the strike price, then the government is liable to purchase the volume of allowances covered by the option contracts at the strike price. If future prices are above the strike prices, then holders would rather sell their allowances in the secondary market and hence the government has no obligation. While revenues from the sale of the option contracts might be used to fund the purchase of allowances, treasuries may be reluctant to accept unpredictable and potentially large liabilities, creating a barrier to their adoption.

Impact on market and regulatory imperfections

Financial options can reduce uncertainty for investors that purchase them while, at the same time, introducing a quasi-minimum price. First, low-carbon investors significantly reduce their exposure to the future allowance market and therefore can make investments

[32] The World Bank's Pilot Autcion Facility has applied a financial options approach to guarantee a minimum price for offset credits flowing from specific Clean Development Mechanism projects. For more details see World Bank, 2016.
[33] This reflects a standard put option from financial markets.

with longer-payoff periods. Second, the government's liability is linked to the performance of the allowance market. If prices collapse below the strike price, the government then becomes liable to purchase the volume of allowances under contract. This potential liability introduces fiscal concerns for the government, were it to allow prices to fall too low. Hence, a sort of soft price floor is introduced, either because the government has an incentive not to let the price drop below the strike price,[34] or because once the price falls below the strike price, allowances will be removed from the market through legally binding government purchases.

[34] If intervention is expected to support the price above the strike price, this may introduce further uncertainties for market participants.

5. Enhancing political commitment: embed the ETS within a long-term policy framework

Providing certainty over the future carbon budget and the trajectory of the allowance cap can reduce regulatory uncertainty, thus supporting the emergence of a more credible signal for long-term investments in low-carbon technologies and infrastructure. To this end, early commitment to mid-term reduction targets that are consistent with long-term mitigation objectives is important. Also important is the institutional framework within which allowance caps and mitigation objectives are set, as well as the perceived commitment to these caps.

However, regulatory uncertainty is inherent and impossible to eliminate, not least because new governments are free to make new decisions (Hepburn et al., 2016). Therefore, all systems will need a politically accepted process to respond to new information and to the evolving local and global circumstances.

The cap setting process is one element through which policymakers can balance the commitment-flexibility trade-off in an ETS. Choices include the time period for which the cap is set, the relationship of the cap to long-term targets, and the institutional context within which the cap is set. Table 2 provides an overview of the cap setting process across ETS jurisdictions.

Time periods for cap setting

The "cap period" refers to the number of years for which the cap is fixed in advance. The cap period normally aligns to the commitment period or ETS phase, under which other key design parameters are also fixed. In general, cap periods range from three years in Korea to 10 years for Phase IV of the EU ETS. While never implemented, in the United States the Waxman-Markey Bill would have established annual caps from 2012 to 2050, providing certainty regarding the allowance supply for 34 years in advance. Finally, before its repeal in 2014, Australia[35] implemented a "rolling cap" process (see Box 2 for further details).

[35] The rolling cap was part of the "Carbon Price Mechanism" which has since been repealed.

Box 2: The Rolling Cap Mechanism in the Australian Carbon Pricing Mechanism

The rolling cap mechanism was part of the design of the Australian Carbon Pricing Mechanism (CPM), which was repealed in 2014 after a change in government, two years into its initial phase. The CPM started with a three-year fixed-price period and would have transitioned into an ETS as of July 2015. Plans for the CPM foresaw fixed five-year caps with rolling annual updates for the N+5th year. The five year fixed period was intended to provide the market with certainty, while the ability to change the cap annually allowed the regulator flexibility to respond to economic and technological circumstances.

The rolling cap updates would have operated in parallel to a price collar, with ceiling prices at AUD 20 above the international carbon price for 2015-16 and floor prices at AUD 15. Lower and upper margins were to increase annually at a rate of 5% and 4% respectively.

The Carbon Pollution Reduction Scheme (CPRS), an ETS proposal by an earlier government under Kevin Rudd that was abandoned in 2010, had also included elements to enhance long-term planning. It proposed a gateway – a range within which the cap could be set - for the 10 years beyond each defined five-year cap. The goal was to enhance certainty over the cap trajectory for the next 15 years (Australian Government, 2008).

Table 2: Cap setting in selected ETSs

	Cap (in $MtCO_2e$)	Years set in advance	Jurisdiction wide climate targets	Institutions involved in decisions on cap-setting
EU	2013: 2,084.00 The linear reduction factor (LRF), which annually declines by 1.74%, does not expire; LRF of 2.2% adopted from 2021	Phase 3: 8 years Phase 4: 10 years	By 2020: 20 % below 1990 levels (leg.) By 2030: at least 40 % below 1990 (leg.) By 2050: 80-95 % below 1990 (asp.)	European Commission; Relevant authorities of the participating countries; European Parliament
Switzerland	2013: 5.63	8 years for current phase	By 2020: 20 % below 1990[a] (leg.) By 2030: 50 % below 1990[b] (asp.)	Federal Office for the Environment; Swiss Federal Council
RGGI[b]	2014: 82.80[c] 2020: 56.30[c]	5 years	By 2020: 50 % below 2005 (asp.)	RGGI Inc.; RGGI Staff Working group; Statutory and/or regulatory authority of each RGGI state
California	2015: 394.50 2020: 334.20 (2020 cap adjusted[d]: 322.6) 2030: 200.5 (proposed)	8 years for current phase	By 2020: return to 1990 GHG levels (leg.) By 2030: 40 % below 1990 (leg.) By 2050: 80 % below 1990 (asp.)	California Air Resources Board (ARB); California State Legislature
Québec	2015: 65.30 2020: 54.74	8 years	By 2020: 20 % below 1990 (leg.) By 2030: 37.5% below 1990 (leg.) By 2050: 80-95 % below 1990 (asp.)	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (Ministry of Sustainable Development, Environment and Fight against climate change); Office of Climate Change; Western Climate Initiative; Québec National Assembly

Table 2: Cap setting in selected ETSs (Con't)

	Cap (in $MtCO_2e$)	Years set in advance	Jurisdiction wide climate targets	Institutions involved in decisions on cap setting
Korea	2015: 573.00 2017: 551.00	3 years	By 2020: 30 % below BAU (asp.) By 2030: 37 % below BAU (asp.)	Ministry of Environment; Ministry of Strategy and Finance; National Assembly
New Zealand	The NZ ETS has no fixed cap	-	By 2030: 30 % reduction (below 2005 level) (asp.) By 2050: 50 % reduction (below 1990 level) (asp.)	Ministry for the Environment; Environmental Protection Authority; Ministry for Primary Industries; New Zealand Parliament; Emissions Trading Group: Officials from the Ministry for the Environment, the Treasury, the Ministries of Economic Development, Transport, Agriculture and Forestry
Tokyo	An absolute cap is set at the facility level that aggregates to a Tokyo-wide cap	4 years	By 2020: 25 % below 2000 (asp.)	Bureau of Environment (Tokyo Metropolitan Government); Tokyo Metropolitan Assembly
Saitama	An absolute cap is set at the facility level, which aggregates to a Saitama-wide cap	4 years	By 2020: 21% below 2005 (demand side) (asp.)	Saitama Prefectural Government

Notes: Leg. stands for target adopted through legislation. Asp. stands for aspirational (political) target.

[a] Domestic reductions only; [b] At least 30% compared to 1990 domestic reductions, at most 20% reductions using international offsets; [c] In million short tons; [d] emissions are expected to be lower in 2020, which would lead to an adjusted cap.

Sources: ICAP, 2017.

Alignment with long-term targets

As low-carbon investments often require payoffs beyond the cap period, some jurisdictions have attempted to provide additional policy certainty. One option is to define a long-term cap trajectory that signals the direction and rate of change (possibly linear) and is aligned to long-term jurisdiction-wide GHG reduction plans. In the EU ETS, this is referred to as the Linear Reduction Factor. Under this general approach, a benchmark year serves as starting point of a trajectory, the end point of which is defined in alignment with the jurisdictions mitigation objectives for the capped sectors. A straight line can then be drawn between the starting and ending points which defines the cap level in each year (ICAP-PMR, 2016). In this way, ETS caps must be set with consideration of the mitigation activities in the uncapped sectors, and may not reflect jurisdiction-wide targets but rather the specific mitigation target for the capped sectors.

Furthermore, ETS caps must also consider the role of complementary policies that will drive emission reductions in the covered sectors. Given that the cap fixes emissions, the effect of complementary policies will to some extent determine how much mitigation effort will be required by the ETS, with implications for the allowance price. The ARB provides for one example of how this can be done in their 2030 Draft Target Scoping Plan. Specifically, they formulate two estimates of the emission reductions required from the ETS based on two different set of assumptions surrounding existing measures and complementary policies (See Figure 7).

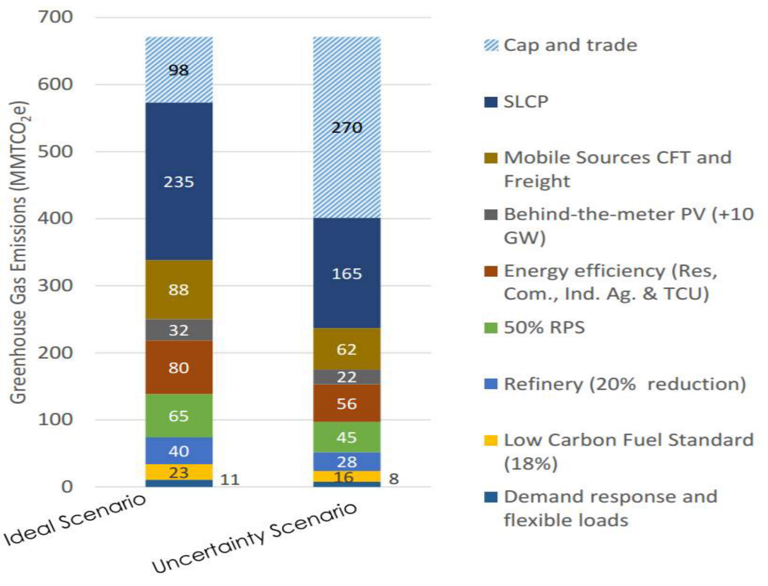


Figure 7: Draft Californian 2030 Target Scoping Plan Scenario – Estimated cumulative GHG reductions by Measure 2021-2030

Long-term Low Emission Development Strategies (LEDS) are also an important tool for linking short term polices with longer-term decarbonisation plans. LEDS can explore the implications and risks of short-term policy decisions for the longer term transformations required for deep decarbonisation (Waisman et al., 2016). Hence, they provide a framework for understanding the adequacy of proposed short- to medium-term measures. The importance of LEDS at the national level is expected to increase with the Paris Agreement requirement to develop LEDS (IDDRI, 2016).

The institutional context for changing the cap

Apart from the cap trajectory, also the process and the institutions involved in updating or changing the allowance budget will affect the perceived credibility of future emission targets.

All ETS-jurisdictions, with the exception of most Chinese pilots, have adopted a legislation/regulation which sets the allowance budget for the current cap period. Beyond the current cap period, policymakers have taken different approaches. The EU ETS's LRF does not expire at the end of a given cap period, hence setting in legislation a default reduction path. In RGGI, the cap remains fixed beyond 2020, until a future reduction path is set through the review process.

The complexity of the cap setting process also hinges on the number of actors involved in decision-making, resulting in a relatively higher – or lower – number of veto points. In the EU, the 28 Member States represented in the Council and the European Parliament jointly decide on cap-setting, on the basis of a legislative proposal of the European Commission. A large degree of coordination is also required in the decision-making process of RGGI as all nine RGGI states need to decide jointly on system design. In contrast, single-jurisdiction ETS (for instance, South Korea) may have relatively more flexibility to adjust the cap and other policy features if the government considers this necessary. This resulting high (or comparatively lower) complexity can roughly be linked to the time and effort it takes to alter the cap or to decide on future caps. As a result, a higher degree of complexity may insulate the cap to future changes but makes changing path (for instance, to ratchet up ambition) more difficult.

6. Building constituencies in support of ETS

Broad political support helps ensure domestic legitimacy and long-term viability of an ETS, by reducing concerns around a lack of political commitment. Yet, building political consensus around ETSs can be challenging as the interests of climate constituencies are multiple and often conflicting, with the benefits and costs of action falling differently, and shifting over time (Keohane and Victor, 2011). In turn, climate constituencies will also organize and conceive their interests differently as climate policy develops. Distributional aspects are particularly important as perceived unfairness by different affected interest groups can create strong and potentially destabilizing opposition.

In this section, we discuss how policymakers can increase support for ambitious policy and in doing so enhance the durability of an ETS. Specifically, engagement with stakeholders, distribution of climate rents, and role of co-benefits are discussed.

Engagement with key stakeholders

The introduction of an allowance price will shift consumption and production decisions, making new low-carbon products more competitive and carbon-intensive products less so. Similarly, the growth of the green economy will create new interest groups, such as renewable energy or forestry lobbies, that benefit from and therefore support ambitious climate policy. Yet it will also mobilize powerful and organized interest groups that aim to maintain the status quo and keep their assets from becoming stranded.

Understanding and engaging with key stakeholders will be crucial for building long-lasting support. ETS stakeholders include: government stakeholders, regulated entities and other affected firms, market service providers, financial intermediaries, offset project promoters, civil society and non-governmental organizations, academics, the general public and the media (ICAP & PMR, 2016). Following an inclusive, open and transparent design process can help to manage stakeholder concerns, resulting in an ETS design that is more robust and resilient to future uncertainties. Identifying and providing a voice to interest groups in favor of ambitious climate policy will be important for fostering enduring support. Furthermore, mobilising “ETS champions” outside of government can be a powerful tool to garner support. Finally, the way in which the ETS is communicated will play an essential role in building understanding and acceptance, particularly among the public.

Developing LEDS might also provide important opportunities for building stakeholder consensus surrounding long-term mitigation strategies. Working with industry in determining what is technically possible, achievable and at what cost can develop collective ownership of long-term reduction goals as well as reveal information surrounding abatement cost. By providing independent experts a role in long-term planning and allowing broad consultation, the United Kingdom Climate Change Committee is considered critical to improving consensus and public acceptance of UK climate policy (IDDRI, 2016).

Building strong political support for ETS within and beyond government enhances the political long-term credibility of emissions trading which in return may have positive impacts on private sector commitment. Interdepartmental coordination can be a critical point in ETS legislation, especially since effective climate policy is usually prioritized quite differently across ministerial departments and might run counter to the objectives of some departments. Inter-ministerial collaboration and effective communication facilitates political decision-making processes and ETS implementation. For example, the New Zealand administration applied an inclusive approach by engaging experts and policymakers from the departments of Environment, Treasury, Economic Development, Transport and Agriculture and Forestry at an early stage in an interdepartmental working group (ICAP & PMR, 2016). At best, extending cross-partisan cooperation on climate policy cooperation would help ensure that the policy survives electoral cycles unscathed.

ETS can also be designed in a way that creates private sector groups with an interest in the longevity of the system. For example, allowing the banking of allowances creates stakeholders with a vested interest in the integrity of the program, favoring rigorous monitoring and enforcement, as well as more stringent future targets in order to protect the value of their allowance assets (ICAP & PMR, 2016).

We have described previously that ancillary policies that promote specific technologies may affect the price path and undermine the role of prices in signalling the value of innovation and investment. Nonetheless, such policies have various justifications and one effect is that the introduction of new technology brings an economic constituency that has a stake in the new technology, which may counter the protests against climate policies by constituencies with an interest in carbon-intensive technology (Keohane and Victor, 2011). Meckling et al. (2005) argue that most carbon pricing initiatives have been enabled by previous green technology policies, following a process that they describe as policy sequencing. The strategy of policy sequencing may be useful in overcoming a number of other barriers to policy, but it is not guaranteed that they will evolve into pricing since ancillary policies may create a lock-in that diverts policy away from pricing (Pahle et al., 2017).

Distributing climate rents

By establishing a cap, scarcity for allowances is created that in turn generates value or a “climate rent.” The ability of emissions trading to compensate those affected without impairing environmental integrity has often been touted as a central feature of cap-and-trade vis-à-vis a carbon tax. The relatively more visible redistribution has the political advantage of stipulating competition for benefits (such as free allowances) rather than joint opposition to a tax (Goulder and Schein, 2013). Here, five options are discussed for distributing climate rents in a way that builds long-term support for climate policy.

Energy-intensive trade-exposed sectors

The long-term competitiveness of industry and the broader economy will have a large influence on the political acceptability of ambitious climate policy. As long as carbon prices differ across jurisdictions, emission-intensive industries will remain concerned about their ability to compete in international markets. While there is little empirical evidence to suggest that carbon pricing affects sector level competitiveness at current prices

(Arlinghaus, 2015), the threat of increasing allowance prices in the face of more stringent targets suggests that competitiveness concerns will remain.

Energy-intensive industries have proven to be powerful, well organized lobbies that can destabilize ambitious climate goals if ignored. All ETSs to date have included transfers (usually in the form of free allocation) to lessen the impact on energy-intensive, trade exposed industries and quell opposition to climate policy (ICAP & PMR, 2016). Over time this approach has evolved from allocations based on historic emissions to allocations based on benchmarked performance standards.

Low-carbon Research and Development

Given current technologies, sectors that heavily invested in coal infrastructure and/or industries with high marginal abatement costs might feel threatened by ambitious climate policy and hence aim to destabilize support for an ETS. In some cases, government support for research and development into breakthrough low-carbon technologies might demonstrate a commitment to these sectors in a way that alleviates concern and builds support. For example, there may be a role for strategic investment by governments in the development and demonstration of breakthrough technologies such as Carbon Capture and Storage (CCS). As pointed out by Neuhoff et al. (2015), such innovation is unlikely to be consumer-led, especially if the innovation does not improve the properties of the resulting product. Furthermore, risk sharing arrangements between industry and government may help in the demonstration phase of new breakthrough technologies.

This approach has, for example, been followed by the New Entrants Reserve (NER 300) of the EU ETS, which has funded several demonstration projects for carbon capture technologies designed to reduce the stranded assets from coal infrastructure.

Green growth and low carbon deployment

ETS revenues may also be used to support low-carbon technology deployment such as renewables, energy efficient buildings or public transport, which are highly visible to constituents, stimulate the local economy and create green jobs. Furthermore, such programs contribute to the green economy and create new interest groups that benefit from ambitious climate policy.

RGGI allocates approximately 80% of their auction proceeds to strategic energy and consumer programs. For example, programs funded with RGGI investments have provided benefits and improvements to private homes, local businesses, low-income housing, industrial facilities, community buildings, and retail customers (RGGI, 2016). RGGI has been successful in accounting for and communicating the benefits of these programs. Beyond quantitatively accounting for all benefits from auctioning, “RGGI Inc. also publishes an ongoing set of ‘Success Stories’ portraying individual families or organizations that have benefited from RGGI auction support” (Rabe, 2016).

Compensate adversely affected groups

Emission costs passed through to consumer prices will have welfare impacts on households, particularly where there are few low-carbon alternatives. Rising energy, fuel, and product prices may cause some households to abandon support for ambitious climate policy, particularly if costs rise above what households are willing to pay. Governments have a number of options to offset or even reverse the effects of an ETS on low-income households, for example, per capita payments and lump sum transfers, tax reform (see below), or social security payments.

Per capita payments have the potential to have progressive impacts across the income distribution. Depending on how these payments are taxed and the proportion of carbon revenue that is withheld, per capita payments can make roughly two thirds of households strictly better off, including those with relatively lower income (Boyce and Riddle, 2007; Burtraw et al., 2009; Burtraw and Sekar, 2013). Furthermore, analysts argue that per capita payments might in fact be politically reinforcing, potentially perceived as environmental justice, and the receipt of a payment may make climate policy popular for many voters (Burtraw and Sekar, 2013).

In the case of RGGI, around 15% of revenues are given as rebates to electricity consumers, mostly through small credits on electricity bills. In California the majority of allowances associated with emissions in the electricity sector are to be consigned to an auction, and the revenue is to be used for the benefit of ratepayers, with approximately 60% given to residential customers as an equal semi-annual bill credit (climate dividend) for each residential account (Burtraw and Sekar, 2013). The credit is semi-annual so that for five months out of six consumers see electricity bills rise, signalling the cost of the program. In addition, at least 25% of total revenues raised through auctions (including allowances associated with the transportation sector) have to be used to the benefit of disadvantaged communities. An even stronger rebate mechanism, dedicating over 50% of (low-income) household compensation was contained in the now repealed Australian Carbon Pricing Mechanism (Eden et al., 2016).

In addition, some communities reliant on fossil fuel industries will inevitably lose jobs as carbon-intensive infrastructure shuts down. These jobs may not involve the same skill set required for employment in the green economy. Carbon revenues might be used to compensate these communities, for example, through expanding unemployment and health benefits, providing job search assistance and job training, supporting community development and infrastructure projects, and providing direct monetary assistance (Kaufman and Krause, 2016).

Tax or fiscal reform

Beyond spending related to the compensation of directly and indirectly affected constituencies, or related to other climate change objectives, ETS revenues could also be directed towards broader public spending, such as general deficit reduction or to enable lower taxes.

Deficit Reduction – as a government deficit raises the future tax burden necessary to finance and repay debt, using carbon revenue to reduce government debt can also increase the overall efficiency of climate policy. Reducing the deficit obscures the “winners” versus “losers” debate as those that benefit from a lower government deficit are determined by the tax system as a whole rather than specified by the ETS design.

Tax reform – if auctioning revenue is “recycled” to reduce existing distortionary taxes (in particular labour and capital taxes), it is possible that emissions trading can reduce GHGs while at the same time reducing the overall cost of the tax system. Economists have speculated that if the efficiency improvements from revenue recycling outweigh the cost of carbon pricing, emissions reductions could be achieved at zero or negative cost. This idea is often referred to as the “double dividend” hypothesis and is still widely debated (Goulder, 2013; Parry, 1997, Heine et al., 2012).

Make co-benefits explicit, visible and politically salient

The political acceptability of an ETS will also depend on how the economic, social and environmental co-benefits are accounted for and communicated. The range of these benefits is diverse, and depending on the ETS design and context for implementation, an ETS is likely to create positive outcomes for public health, energy security, job creation, and natural resource protection. In particular, the long-term health benefits from a reduction in local air pollution through climate mitigation policies have received much attention (Eden et al., 2016).

One strategy to make clear the co-benefits from emission reductions is the very active display of benefits of revenue spending, as implemented by RGGI, which “pioneered auctioning and has very effectively utilized revenues to build and sustain supportive constituencies” (Rabe, 2016). Evidence from RGGI suggests that from 2009-2013, the reduction in hazardous pollutants in RGGI states has led to an estimated USD 10.4 billion in health savings from avoided illness, hospital visits, lost work days, and premature deaths.

7. Conclusions

This paper has discussed the market and regulatory imperfections that could disrupt the dynamic cost-effectiveness of an ETS and options in which policymakers can respond. A framework for understanding dynamic cost-effectiveness of allowance markets has been introduced and applied to show that myopia, excessive discounting and a lack of political commitment might result in prices that are too low in the short term and too high in the long-run, compared to a dynamically cost-effective price path. Furthermore, regulatory uncertainty might also encourage participants to delay irreversible investments until there is more clarity surrounding the future design and stringency of climate policy.

Based on the research findings, it is plausible that these market imperfections are present in operating ETS. However, their impact on the allowance price is an empirical question for which little evidence exists. Indeed, overlapping ancillary policies, political lobbying and resulting over allocation and innovation and technological development that reduces the marginal cost of abatement might also be driving allowance price formation.

Under a static perspective, low prices resulting from exogenous shocks are of no concern as long as the annual caps are met. Alternatively, adjusting discount rates upwards or delaying irreversible investments might be an appropriate response to uncertainty. However, to the extent that excessive discounting, myopia, and a perceived lack of political commitment depress allowance prices, then emission targets will not be met cost-effectively. Moreover, when depressed allowance prices are the result of ancillary policies promoting specific technologies under the sources covered by the cap, the effect is to erode the additionality of those policies, undermining cost-effectiveness even further. Where the short term price signal is out of line with long-term objectives and investment decisions are made with disregard for long-term carbon budgets, economies might lock into carbon-intensive infrastructure, whose emissions have to be abated at higher costs in the future. Furthermore, lower prices today slow down innovation and technological learning, making future emission reductions more costly.

In light of the above, policymakers are exploring options to reduce uncertainty and allow decision makers to make investments that take full account of their carbon costs. For example, tools to adjust the allowance markets are now seen as good practice for ETS. Policymakers are experimenting with different approaches. In North America, reserve prices at auction and cost-containment reserves have been implemented. Consensus surrounding the ambition of climate policy in these jurisdictions as well as the role of the ETS within the broader policy mix seemed important for adopting price-based controls and agreeing where trigger levels are set.

After ten years of operating without market management tools, the EU has now agreed to implement a quantity based automatic-adjustment mechanism – the Market Stability Reserve. A quantity-based approach is considered advantageous as it avoids the need to define upper and lower price bounds (within which the price is free to move) – which is considered contradictory to the market based approach by some European policymakers – and the MSR could be passed without unanimity voting as it is not fiscal in nature.

Korea has adopted an Allocation Committee that can draw on a range of intervention tools once certain triggers are met. The committee has made use of this flexibility in 2016, holding an additional auction for allowances, increasing the borrowing limits for covered entities and releasing more Korean Certified Offset Credits to the market. Chinese provinces are also experimenting with similar approaches.

Clearly, different approaches are possible. However, regardless of the approach taken, for market management tools to function properly, they must also be embedded within credible long-term policy architecture that reduces uncertainty for participants. This paper explored a number of ways in which this might be done. First, stronger commitment to longer term targets – for instance by embedding them in legislation – will reduce uncertainty and improve the conditions for low carbon investment. Establishing long-term decarbonisation plans as prescribed in the Paris Agreement and aligning review cycles to the required ratcheting up of ambition might also bring further credibility to long-term targets. California's 2030 Target Scoping Plan also provides a useful example of how long-term planning might be done. Finally distribution of "climate rents," stakeholder engagement and making co-benefits visible can assist in building constituents that support ambitious climate policy, making it difficult to renege on future commitments.

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