RESOURCES FOR THE FUTURE

Pricing Carbon Effectively: Lessons from the European Emissions Trading System

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Report
November 2018

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About the Project

This issue brief was initially prepared as part of a workshop at Carleton University, with support of the Jean Monnet Network and funding from the Erasmus+ Programme of the European Union. All views in this document are strictly those of the authors. An earlier version of the issue brief and related publications can be found at **https://carleton.ca/caneunet/jean-monnet-network-publications/**.

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Summary

The EU Emissions Trading System (EU ETS) is the world's largest carbon market and has become a model for market-based approaches to reduce greenhouse gas emissions in other world regions. Evaluating and improving its effectiveness thus have been a concern not only for European policymakers but also for the success of carbon pricing policies at a global level.

Conventional wisdom is that the environmental effectiveness of a cap-and-trade system such as the EU ETS is guaranteed. This expectation is based on its design, which limits total emissions to a specific level (the emissions cap), and is supported by the observation that compliance with cap-and-trade programs is virtually 100 percent, meaning the emissions target is achieved. The recent recovery of prices for emissions allowances (EUAs) to moderate levels indicates that investors may have regained confidence in the bindingness of the cap.

Nonetheless, many observers have challenged the role of cap and trade. A major concern remains that the future price path could be too low to incentivize innovation and investment in low-carbon technology that is necessary to comply with the EU's long-term emissions reduction goals for 2030 and 2050. A second concern is that the emissions cap also serves as an emissions floor; that is, it not only sets a maximum level of emissions but also specifies the actual level of emissions that will result. This appears to hamstring the ability of independent actors or subsidiary jurisdictions such as member states in the EU to pursue emissions reductions beyond the EU's own goals. These challenges have led to calls for a thorough reform of the EU ETS.

In contrast, others object that the ETS price on carbon already imposes an unfair cost on EU industries, which must compete with unregulated industries in other countries. Even at present low prices, industry groups have stressed that the economic impacts of the trading scheme may undermine their ability to compete in international markets.

This policy brief begins with a review of the empirical evidence on the accomplishments of the EU ETS and concerns about industry competitiveness. We discuss various drivers of current and future EUA price development. While the EU ETS undeniably has had some success in reducing emissions and alleviating economic costs in the short term, the current policy design still raises concerns about its success in the long run. Allowance prices have been persistently low for most of the three trading periods, and despite recent increases, they could soon revert to this pattern. The uncertainty about the future supply in EUAs introduces the risk that high-carbon infrastructure and industrial assets will become locked in, making it expensive to achieve long-term carbon reduction goals.

To address these structural flaws, we argue for a comprehensive carbon price signal supported by a minimum price floor in the EU ETS. Such a measure would stabilize investors' expectations about the future price path and stimulate the demand for low-carbon technologies. This reform is also essential to mitigate the economic and political costs of carbon pricing, which may otherwise rise steeply in the future and become detrimental to achieving the climate goals under the Paris Agreement. A recent reform in the EU—the Market Stability Reserve—takes a step in the right direction; however, it appears insufficent to address our concerns fully. We look to the North American carbon trading programs, which all have a minimum price floor, as models that can influence the EU's program design. In this regard, the lessons obtained from the European experience have important implications for the functioning and expansion of carbon markets worldwide.

1. Reviewing the Evidence: How is the EU ETS Doing?

Since the inception of the EU ETS in 2005, European energy and manufacturing industries face a yearly decreasing cap on their total amount of greenhouse gas emissions. The trading scheme represents a central pillar of the European Union's effort to comply with its commitments under the Paris Agreement. For the year 2030, the EU's objective states that emissions are to be reduced by 40 percent compared with 1990 levels. In accordance with the 2030 Climate and Energy Framework, the EU ETS regulated sectors will contribute to this with a 43 percent reduction relative to 2005 levels, whereas non–EU ETS sectors, mainly heat and mobility, will provide a 30 percent reduction (EU 2018).

The trading program has gone through three phases and will begin a fourth in the next decade, each with various reforms aimed in large part at increasing the allowance price. Still, for most of this time span, the EU ETS exhibited EUA prices well below the levels that were originally anticipated. The recent surge in prices indicates that market actors have regained confidence in the trading program, but as structural design flaws remain, so does the possibility of subsequent price decreases.

At first glance, low prices should appear to be good news, because they imply that emissions reduction goals are not expensive to achieve. Also, from a technical point of view, the environmental effectiveness of a cap-and-trade system like the EU ETS is guaranteed: by design, the emissions can never be above the cap, and the reduction targets will be automatically reached. As long as the level of the cap is sufficiently ambitious, the policy will be effective. However, the low prices are a concern from a long-run perspective. It appears that the price level so far has not been sufficient to initiate innovation and investment that are necessary to achieve long-run goals, thereby undermining the credibility of those goals.

There is evidence of success in the short run. In recent years, emissions have fallen sharply in European industry and energy sectors. Empirical studies suggest that to a degree, this development can be attributed directly to the EU ETS.[1] Estimates based on aggregate data show that in the very moderate trial phase (2005–07), emissions decreased by about 3 percent (Anderson and Di Maria 2011; Ellerman and Buchner 2008; Ellerman et al. 2016). Microdata studies on German and French EU ETS firms suggest a 10–28 percent emissions reduction compared with nonregulated firms (Petrick and Wagner 2014; Wagner et al. 2014). Most of the effects found in these studies are directly related to the stringency in Phase 2 (2008–12), especially the early years of that period, when the EUA price was around €15. However, effects on innovation appear to have been more moderate; a mere 1 percent increase in total European low-carbon patenting can be attributed to the policy (Calel and Dechezleprêtre 2016).

In terms of total EU ETS emissions, reduction targets have in fact been overachieved. In late Phase 2 (2008–12) and the currently running Phase 3 (2013–20), total emissions have been consistently below the cap. Such an outcome might be consistent with banking of allowances at the beginning of the program to reduce the costs of compliance later. However, to an important degree, this development can be attributed to other emissions reduction factors such as the effect of the economic crisis and policies aimed at increasing the share of renewable energy and the degree of energy efficiency (Gloaguen and Alberola 2013; Bel and Joseph 2015).

2. Has the EU ETS Harmed the Competitiveness of Industry?

The transition toward a low-carbon economy will undeniably affect decisions on production, factor allocation, and investment. Unsurprisingly, these economic impacts of the EU ETS have received a lot of attention from economists, policymakers, and industry representatives. A major concern has been that during this adjustment, increased production costs might hinder regulated companies from competing successfully in international markets. Eventually, firms might even relocate their carbon-intensive production to countries with less ambitious carbon regulation—a process that could severely undermine the effort to curb emissions at the global level.

Empirical evidence suggests that until now, this threat has clearly been overstated. Regulated firms have not shown any indication of relocating their production. The average risk of European operations being downsized in response to the EU ETS has been low, with most firms reporting no plans to considerably cut production or employment (Martin et al. 2014). Companies are found to be comitted to their European asset bases and do not show any signs of downsizing (aus dem Moore et al. 2017). EU ETS firms instead increased their fixed assets (machinery, equipment) in the first two trading periods on average by 11 to 15 percent compared with a control group.

Empirical studies have also unequivocally rejected the idea of an increase of foreign direct investments (FDI) or a shift of emissions toward non-EU regions by regulated companies in response to the carbon policy (Koch and Basse Mama 2016; Dechezleprêtre et al. 2015). These studies also find some variation in the response to the EU ETS among sectors and firm types. Some multinational companies apparently did invest in their European asset bases to a lesser degree or notably increased their outward FDI. However, these firms represent a neglible share of the EU ETS emissions (less than 4 percent) and stem from comparatively clean industries that are more geographically mobile because of low capital intensities (aus dem Moore et al. 2017; Koch and Basse Mama 2016).

A recent study uses total factor productivity as a comprehensive measure of costs and benefits induced by the EU ETS and shows that the effect depends on the level of a firm's technological advancement (Themann and Koch 2018). Technologically more advanced firms are more likely to cope with the costs of a carbon price or even increase their productivity. In contrast, firms operating behind the technology frontier are more likely to face a productivity slowdown.

In an effort to mitigate any adverse effects, the EU has set up a program granting free allocation of EUAs to companies in energy- and trade-intensive industries that are perceived to be at considerable risk of downsizing or relocating their production.

However, the criteria currently used do not capture this risk well, leading to substantial overcompensation. An alternative, more cost-effective allocation scheme based on more refined criteria would reduce the aggregate risk of downsizing by more than half compared with the current practice—without increasing the public cost of compensation (Martin et al. 2014, 2015).[2]

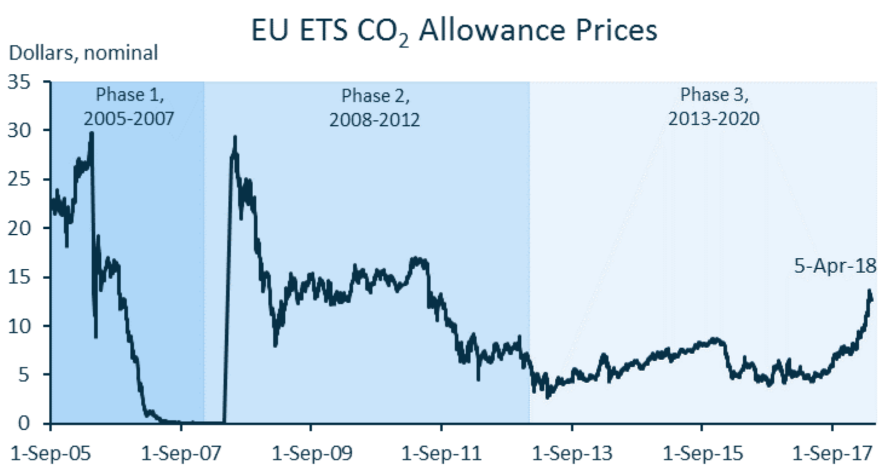
Overall, in the first two trading phases (2005–12), the EU ETS appears to have had some success in reducing emissions in accordance with EU reduction objectives while keeping adverse economic effects largely at bay. The reasons may be manifold: First, firms operating capital-intensive assets may prefer a carbon price over the high costs of relocating production. Second, the extensive compensation mechanism may have alleviated regulatory costs. Third, firms may have been able to pass down these costs to consumers (Fabra and Reguant 2014). And fourth, the economic recession and companion policies may have contributed to emissions reduction, thus easing the regulatory pressure stemming from the EU ETS.

3. Structural Design Flaws Put Decarbonization Goals at Risk

Despite some early successes in European climate policy, major uncertainties about the future of carbon pricing remain. Most prominently, many observers stress that until recently, the consistently low price of allowances indicated a severe lack of stringency that put the successful decarbonization of the European energy system at risk. As can be seen in Figure 1, from 2005 to 2017 the price of an EUA, the equivalent of one ton of CO2, traded on the European carbon market has fluctuated between US$0 and US$30, most of the time at the lower end of this range. This pattern changed completely in 2018, when prices increased sharply from US$9 in January to above US$25 in September.

Such a price path is surprising given the specific architecture of the cap-and-trade system. The reformed design of the EU ETS stipulates a yearly reduction factor of 2.2 percent, which would lead to a cap of zero emissions by 2057 (Edenhofer et al. 2017). Rational market participants, in apprehension of this scarcity, should have a strong incentive to continuously pursue more expensive mitigation measures and to purchase carbon allowances from others to build up a bank that would be available when the program is more stringent in the future. This rational behavior should be evident in a price path that increases steadily over time, roughly in line with the opportunity cost of holding financial resources tied up in the form of banked emissions allowances.

Figure 1. EUA prices in US$, 2005–17



Sources: Phases 1 and 2 OTC spot prices, Thomson Reuters; Phase 3 nearest future contract prices, ICE.

Instead, allowance prices remained stubbornly low for most of the three trading periods, only to increase sharply in a very short amount of time. One interpretation of this lack of continuity is that market participants are highly responsive to political events, and EUA prices are a mere reflection of their confidence in the current policy design and member states' commitment to the policy. Until recently, it appears that market participants had a severe lack of confidence that the program would be in place in the long run or that emissions allowances would be scarcer in the future. This outlook appears to have changed for the moment as a result of recent reform efforts.

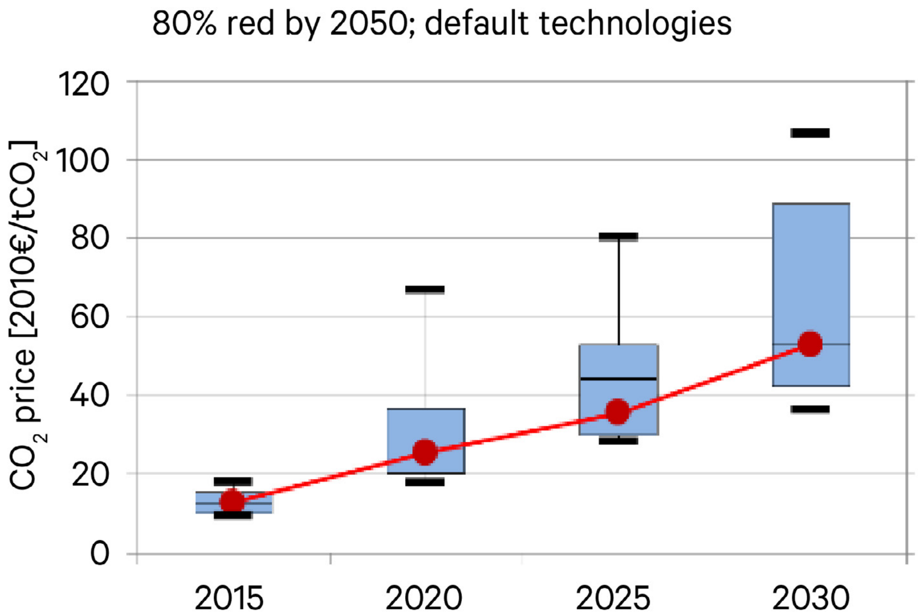
Such an experience is not unique to Europe. Every emissions market around the world, for every type of atmospheric resource, has witnessed price paths that are below expectations, including short-run exceptions where prices rose before falling again to low levels (Burtraw and Keyes 2018a).[3]

There are many reasons why prices in emissions allowance markets like the EU ETS frequently fall short of expectations. First, potentially overly generous initial allocation is common because the regulated parties are influential in the policy discussions that organize these markets. Second, the economic downturn in the last decade led to a reduction in energy use and associated emissions. Third, incentives associated with carbon pricing may in fact have their intended effect by accelerating a process of innovation that finds low-cost ways to comply with the emissions cap. However, in the EU, Koch et al. (2014) have shown these market fundamentals to explain only a fraction (10 percent) of historical EUA downward price movements.

Another potential explanation for relatively low allowance prices is the interaction of different market and regulatory imperfections (Edenhofer et al. 2017): (i) Market actors may be myopic and systematically disregard the long time horizon of decarbonization. EUA future markets cover a time span of only a few years, and market participants may have a low willingness to hold EUAs for longer periods of time. By itself, though, this explanation is not satisfying, because if prices are expected to rise in the future, there should be an opportunity for speculators to enter the market to capture substantial returns, and that speculation should drive up prices in the present. (ii) Studies have shown EUA prices to be sensitive to political events (Koch et al. 2015). This suggests that market actors perceive the cap not as an exogenous event, but rather as the result of a political process that is regularly adjusted. Low prices may indicate that market actors are not confident in the stringency of the future cap and bet on the possibility that policymakers might eventually relax the cap. High prices may point toward the opposite.

Without a thorough reform of the European carbon market, a combination of these factors may soon depress demand again, thus keeping EUA prices below the benchmark of a cost-effective price path toward 2050 over the next years. Figure 2 summarizes the results of different modeling studies and shows that the price should be increasing steadily for a cost-effective decarbonization to work.

Figure 2. CO2 price path for cost-effective long-term emissions reduction in Europe by 2050 (–80 percent relative to 2005)



Source: Edenhofer et al. (2017).
Note: Boxes: 50 percent interval; whiskers: 90 percent interval. The straight line refers to the median over 12 different energy-economy models. The red line refers to results from the PRIMES model used in the EU's "Energy Roadmap 2050."

If EUA prices indeed fell back to low levels, EU member states with more ambitious climate goals may choose to pursue national policies to curb carbon emissions. However, under a fixed emissions cap that gradually decreases, any additional reduction in one country or industry enables emissions increases in another without any change in overall emissions. This mechanism is called the "waterbed effect" because it leads to a rearrangement of where emissions occur but results in no change in total emissions (Burtraw et al. 2017).

Although the emissions outcome may not be affected by the actions of individual member states, the demand for allowances would be, and this puts downward pressure on allowance prices. In turn, the low prices caused by the waterbed effect creates the appearance that the ETS is not incentivizing actions necessary for long-term decarbonization and undermines confidence in the EU ETS as an effective way to reduce emissions. In turn, this may lead to calls for even more ambitious companion policies, creating a spiral that could severely impair the signal strength of the European carbon market for emissions abatement. The application of companion policies that directly or indirectly address greenhouse gas emissions in EU ETS sectors (such as renewable feed-in tariffs or air quality standards) has already become common practice among EU member states. Although the contribution of these policies to EUA price declines has been limited so far (Koch et al. 2014), this mechanism may pose an increasing threat to the effectiveness of carbon pricing under a scenario of continuously depressed prices.

In the EU and elsewhere, the possibility of falling prices is further amplified by the reinvestment of allowance value revenues in program-related activities. The EU provides guidance to each member state to invest at least 50 percent of the revenue from allowance auctions in climate- and energy-related projects (Löfgren et al. 2018). In the North American carbon markets, the share tends to be even greater (Burtraw and Keyes 2018a). Hence, these programs have a built-in design that exacerbates the trend toward low prices.

The European carbon market needs a relatively stable price trajectory very soon, and a sufficiently high price floor is one way to achieve that while leaving the actual determination of the price to market dynamics. If this is not achieved, it becomes likely that carbon-intensive assets would not be replaced by low-carbon technology, but rather would be locked in and reinforced by additional investments in high-carbon technology. Projections for Germany demonstrate that the risk of such a lock-in may increase critically within the next few years. Because of technical lifetimes and investment cycles, the year 2030 represents a critical juncture (acatech/Leopoldina/Akademienunion 2018). The threat of a lock-in is not limited to EU ETS sectors. The energy transformation requires substantial investments in renewable technologies in the heat and mobility sectors, potentially doubling electricity demand and increasing the need for renewable capacities by up to a factor of seven.[4]

In the absence of a more robust and comprehensive EU ETS that incentivizes a switch to low-carbon technologies, the economic costs of climate policy may otherwise increase dramatically in the future. Demand for EUAs could possibly drop again to previous levels, while the cap will continue to decline by 2.2 percent. In such a scenario, given the sustained investments in high-carbon assets, companies would be able to readjust toward abatement only at a high cost. Eventually, the economic costs of carbon trading would increase steeply, and a large part of asset portfolios would need to be devalued (Edenhofer et al. 2017). Such a crisis would clearly squander the relative success of the EU ETS in coupling emissions reduction with the mitigation of adverse economic effects. The economic dislocation and the threat of industrial relocation would likely increase the pressure on policymakers to relax the cap and put the European effort to curb emissions in jeopardy.

4. Recent Reforms in the EU ETS

The recent surge in allowance prices has been largely attributed to market actors anticipating the introduction of the Market Stability Reserve (MSR), one of several reforms aimed at boosting confidence in the EU ETS. Instead of constraining prices directly, the MSR adjusts the issuance of new allowances in response to the volume of unused allowances in circulation (the allowance bank). Beginning in 2019, if the allowance bank exceeds a specified ceiling quantity, the issuance of new allowances through auction will be reduced every year by 24 percent of the excess.[5] The withheld allowances will enter the MSR. The allowances will begin to reenter the market from the MSR through a subsequent auction when the volume of banked allowances falls below a threshold quantity.[6]

In November 2017, the EU augmented the MSR with an important provision allowing for the cancellation of some of the allowances held in the MSR. Starting in 2023, the number of allowances in the MSR must not exceed the number of allowances auctioned in the previous year—any remaining allowances will be canceled. Also, voluntary cancellations by member states are possible (FME 2017).

Despite the successful rebound, it is largely unclear whether EUA prices will indeed stabilize and continuously rise or the effect is only temporary. The main reason for concern is the considerable uncertainty as to how the MSR will perform. Various estimates suggest that in 2023, the MSR may cancel 1.7 billion to 2.4 billion allowances (Perino 2018; ICIS 2017). In contrast, emissions from covered sources in 2016 were 1.75 billion tons, declining each year thereafter.

The cancellation of this substantial volume of allowances in the MSR will likely continue to place some upward pressure on the allowance price. It will also temporarily puncture the waterbed effect, meaning that for the next few years, actions taken by member states to reduce emissions will lead to cancellations of allowances in the ETS. The waterbed effect is expected to return later in the next decade as the MSR is depleted (Perino 2018).

Overall, the effectiveness of the MSR is difficult to predict, and it is unclear whether supply restrictions will be enough to introduce a continuously increasing price path. The mechanism for allowance cancellations remains complex and not transparent. Soon, this could again lead to a lack of confidence in the EU ETS and depress allowance prices subsequently. While the MSR appears to be a valuable step in the right direction, it is unclear whether it will solve the problem.

5. Effective Carbon Pricing

We propose the introduction of a minimum price for emissions allowances as an approach to make the EU ETS more robust to the market and regulatory issues described above and to accelerate the decarbonization of the European economy (Burtraw et al. 2010; Grüll and Taschini 2011; Wood and Jotzo 2011; Fell et al. 2012). A price floor has been a feature since the inception of the North American programs—the Regional Greenhouse Gas Initiative (RGGI, involving nine northeastern US states) and the Western Climate Initiative (California, Quebec, and Ontario). The price floor is implemented through a reserve price in the auction of allowances, below which allowances will not sell (Burtraw et al. 2017).

The main contributions of a price floor to the stability and effectiveness of cap-and-trade systems are twofold. A price floor would be a partial remedy to the waterbed effect, because when the price is at the floor, as has been the case for some periods of time in the North American programs, measures by subsidiary jurisdictions yield real additional emissions reductions. This is because these local emissions reductions do not depress the price and thus provide no incentive to increase emissions elsewhere. However, when the price is above the price floor, the waterbed effect remains an influence on the emissions outcome.

Perhaps more important, the price floor would send a signal to market participants with respect to the minimum value of emissions reductions over time and increase the expected value of the future market price (Burtraw et al. 2010). Hence the introduction of a price floor helps avoid a lock-in of low carbon technologies and reduces the risk of escalating economic and political costs associated with it.

6. A General Approach to Managing Prices

We argue that the most transparent approach to addressing the problem of low prices would be to implement a price floor. However, as mentioned above, this does not address the waterbed effect when prices are above the floor.

The states involved in RGGI made progress toward a more general approach in their 2016 program review (finalized in 2017) with the implementation of a second price step, a minimum price that applies to 10 percent of the allowances. This price step is above the price floor, which applies to all the remaining allowances. If the price of those specific allowances falls below the price step, the supply of allowances sold in the auction is reduced by about 10 percent. However, if demand for allowances is very low, the price can fall below that price step until it finally reaches the price floor.

One appeal of this approach, which RGGI calls an "emissions containment reserve," is that as in other commodity markets, the supply of allowances responds to the price (Burtraw et al. 2018). In general, if a price of a good is less, one expects to see less of that good coming into the market. This helps the market achieve equilibrium and leads to less price volatility than in a market with a vertical supply curve with a fixed, unchanging supply of the good.

Another virtue of the price-responsive supply of allowances is that it addresses a concern of some observers that a minimum price would be used by governments to gradually convert a market into a tax. Because the price can fall below the price step if demand is low, the step cannot determine the market price. EU governments would not be able to steer the price in an attempt to maximize revenues from the auctioning of EUAs. A series of steps could easily approximate a continuous supply of allowances that responds when demand falls. In this way, this important reform can strengthen the role of markets in carbon mitigation.

7. Elements for Future Reform in the EU ETS

A minimum price or, better, a price-responsive supply of emissions allowances would introduce a valuable improvement to the EU ETS. This approach could be coupled with the MSR, which is already in place but would likely emerge as the more useful mechanism. A price floor or price schedule for the supply of allowances to be introduced to the market would provide substantial benefits through improved transparency and predictability.

A suitable level for the price floor to start could be in the range of €20–€40 (US$25–$50) per ton of CO2 equivalent in the year 2020, which is in line with most scenarios that model the EU climate objectives until 2050 (Knopf et al. 2013). Such a starting point is already being envisioned by the Pan-Canadian Framework, which aims at a price of around €32 (C$50) in 2022 (Government of Canada 2017). The High-Level Commission on Carbon Prices reviewed evidence from different mitigation pathways, technological roadmaps, and global integrated assessment models and concluded that a more ambitious range of US$40–$80 (€32–€65) in 2020 and US$50–$100 (€40–€80) in 2030 would be needed to drive abatement efforts (CPLC 2017).

However, we emphasize that differences of opinion about the price levels to be implemented should not preclude consideration of a minimum price or a price-responsive supply of allowances. The introduction of a price floor, or price schedule, is a strong positive feature of program design. Even at low levels, these features have the effect of censoring the range of potential price outcomes and thereby affect the expected price. The feature would boost confidence in the program.

Ideally, the reform of introducing a price floor would encompass all EU member states. A politically more viable approach could instead let states with ambitious climate goals agree on such a mechanism. In a second step, more reluctant members could be persuaded to join, such as by dedicating more revenues from EUA auctions to low-carbon investments in these regions (acatech/Leopoldina/Akademienunion 2015).

8. Other Recommendations

Several other reforms could also strengthen the EU ETS. One avenue to further improving policy outcomes is to blend in adequate support policies. Ideally, these policies should directly address market failures that are not properly resolved by carbon trading.

For instance, support for research and development policies could bolster the moderate impacts of carbon trading on innovation. This is especially fruitful, because innovations can produce positive spillovers for other branches of the economy. In a similar vein, measures with a focus on technology transfer could be applied. These policies would enable less technologically advanced firms to adopt more efficient technology and thus would distribute the benefits and costs of carbon regulation more evenly.

Other market failures may occur with respect to a lack of financing and access to infrastructure (e.g., grids). Also, certain technology standards may help instill confidence in market actors that policymakers are committed to achieving the international goals under the Paris Agreement. Further, more refined compensation methods (e.g., free allocation or border tax adjustments) based on more detailed data on actual relocation risk and economic vulnerability would provide a more cost-effective way of mitigating any threat of relocation.

The next big step for the EU to consider should be the extension of carbon pricing to non-ETS sectors of the economy. The non-ETS sectors currently face a similar threat of credibility because the cost of emissions reductions is expected to increase, and this may be difficult to defend politically. In an effort to avoid a lock-in of infrastructure in the mobility and heat sectors, the EU should consider extending the ETS to these sectors, ideally by stepwise converting it into an upstream system (acatech/Leopoldina/Akademienunion 2018).[7] The introduction of a cost-effective policy through carbon pricing could help improve the credibility of policy goals and incentivize innovation and investment that will help reduce costs, which is necessary to make these goals a reality.

Notes

1 See Ellerman et al. (2016) and Martin et al. (2016) for more comprehensive reviews.

2 For instance, many firms become eligible for free allocation because of trade intensity, although trade intensity per se is not related to relocation propensity. In contrast, emissions intensity, characteristics of firm size (e.g., output, assets), and trade intensity with respect to less developed countries are very good predictors. A more cost-effective approach would redirect resources to firms at actual risk based on these criteria.

3 This includes markets for sulfur dioxide, nitrogen oxides, volatile organic carbon, and carbon dioxide.

4 For instance, a scenario of 85 percent reduction in German emissions by 2050 could require an increase in wind and solar capacity by a factor of five to seven, mirrored by a doubling of electricity consumption. The scenario accounts for investments in energy efficiency.

5 After 2023, that amount is reduced to 12 percent.

6 An interactive infographic of how the MSR performs is presented in Burtraw and Keyes (2018b).

7 An upstream system would require businesses that extract, refine, and trade fossil energy sources (e.g., refineries), rather than the myriad of actors downstream (e.g., the millions of private car users), to hold EUAs.

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