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Decarbonization and EU ETS Reform: Introducing a price floor to drive low-carbon investments

Policy Paper

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Summary

The EU ETS is in a crisis. There is a fundamental concern that persistently low allowance prices will fail to incentivize the investments in low-carbon capital stock and technology research and development (R&D) required to achieve long-term European decarbonization targets in the context of the Paris Agreement. Attainment of these targets is at risk. Introducing a carbon price floor can re-affirm the role of the EU ETS as the central pillar in the European effort towards decarbonization. Such a price floor should start at an economically significant level and rise over time.

Many observers argue that it is misguided to focus on the EU ETS allowance (EUA) price, since the emissions cap determines environmental effectiveness and the allowance market works well in technical terms. Four interrelated considerations underpin our concern over the persistently low EUA price: First, the EU ETS cap is not cast in stone. It might be relaxed in the future if the costs of maintaining it become politically unacceptable. This could be the case if allowance prices escalate, which can be expected to result from a high-carbon capital stock building up in presence of persistently low allowance prices. Second, there is emerging scientific evidence that the EUA price is distorted as the carbon market does not operate cost-efficiently in a long-term perspective due to private sector short-sightedness and regulatory uncertainty. Third, the EU ETS has so far not allowed the effective expression of different climate policy preferences across EU member states. Without compensatory measures, voluntary unilateral emission reductions within member states (e.g. UK carbon price support, potential German coal power exit) dampen short-term allowance prices and shift emissions in space and time. Finally, all ambitious short-term climate policy measures required for embarking on long-term decarbonization pathways face significant political opposition. This opposition can be expected to come not only from reluctant EU member states, but also industry constituencies concerned about impacts on competitiveness, business models and jobs. These distributional challenges need to be tackled more effectively by strategically allocating allowance value, providing limited compensation to adversely affected constituencies, promoting low carbon R&D to reduce future costs of decarbonization, and fostering public support for ambitious climate policy.

The recent EU ETS reform effort offers an entry point to tackle these concerns, but does not sufficiently address the underlying problems. The magnitude and direction of its impact on the EUA price is highly uncertain. More fundamental change will be required to reaffirm the role of the EU ETS as the central pillar of European decarbonization efforts. In particular, a carbon price floor that rises over time can provide a clearer policy signal for guiding short- and mid-term capital stock and technology R&D investment decisions towards low-carbon options, and can thus enable cost-efficient achievement of long-term decarbonization targets. If designed accordingly, it allows member states with a higher preference for ambitious climate policy to effectively achieve additional emission reductions. In addition, targeted and transitory compensation models for particularly affected constituencies, and public investments into the development of new technologies and related business models will be required to ensure short- and long-term political support and reinforce policy credibility. Companion policies can play an important role in fostering low-carbon investment, but are

inadequate substitutes to effective long-term carbon pricing. Ideally, a carbon price floor will be implemented at the EU-level. An alternative is to start with a coalition of countries including Germany (also in view of attaining its 2020 climate targets), France and others, and to expand it over time.

1. Context

Carbon pricing is a key policy instrument for achieving cost-efficient decarbonization. The European Union has adopted the EU ETS as the central pillar of its policy mix to achieve ambitious short- and long-term greenhouse gas emission reduction goals. In 2015, the EU Commission initiated the current reform cycle of the EU ETS (EU Commission 2015) to incorporate lessons-learned into the design of the system. Following the adoption of the EU Council's and the Parliament's positions in the beginning of 2017, the trialogue negotiations between EU Council, Parliament and Commission have now been finalized.

In light of this ongoing reform process, the Mercator Research Institute on Global Commons and Climate Change (MCC) and the European Climate Foundation (ECF) convened an EU ETS Dialogue Forum among German stakeholders in 2017. In five meetings, these stakeholders discussed their perceptions of the fundamental challenges the EU ETS is facing, and response options considered effective to tackle them (see Annex for a description of the Forum). This policy paper is informed by the Forum discussions; however, it is not a consensus paper on behalf of the participants and expresses the views of the authors.

2. Why the low EUA price is a problem

The simple economic textbook characterization of a cap-and-trade (C&T) system is straightforward: the regulator sets a fixed cap on emissions, and an efficient market allowance price emerges via allowance auctioning and trading. This price reflects the marginal costs of achieving the cap. In this standard perspective, the economically barely relevant level of the EU ETS allowance (EUA) price of around 5-7€ in recent years is not necessarily a problem: it might simply reflect fundamentals of moderate market EUA demand given a fixed political supply (cap). Moderate demand might result e.g. from a downward shift in economic growth expectations and anticipation of technological innovations that will enable low-cost attainment of the EU ETS cap.

This traditional characterization, however, usually ignores two important and related features of real-world C&T systems: First, the cap is not determined exogenously but is an endogenous result of a continuous political bargaining process. It may be changed, e.g. if program costs become politically unacceptable. Second, given the long time horizons envisaged for EU decarbonization, the EU ETS has a lifetime of several decades and therefore, a static framework for analysis is misleading (Fuss et al. 2017). If the currently envisaged Linear Reduction Factor (LRF) which reduces the cap by 2.2% per year from 2020 on is maintained for the program lifetime, the cap will hit zero in the year 2057. Economic efficiency requires market actors to fully anticipate market and regulatory developments over these long time horizons (e.g. Rubin 1996; Kling and Rubin 1997; Leiby and Rubin 2001; Newell and Pizer 2003; Kalkuhl and Edenhofer 2014). Observation of the EU ETS market as well as recent scientific empirical evidence and theoretical analyses suggest that this is not the case, as discussed in the next section.

Recent scientific evidence suggests that the current allowance price is below its economic benchmark level. Figure 1 contrasts the empirically observed EUA allowance price (left panel) with benchmark prices from a range of economic models which calculate the prices required to achieve EU long-term emission reduction objectives at least cost (right panel). It shows that an economically optimal price would not only be higher than observed prices in the short

term, but also that prices should be continuously rising over time instead of dropping or stagnating as observed in the past years. Anticipation of a rising allowance price would incentivize a switching of long-lived capital investment decisions and technology R&D choices towards low-carbon options, which is essential for decarbonization.

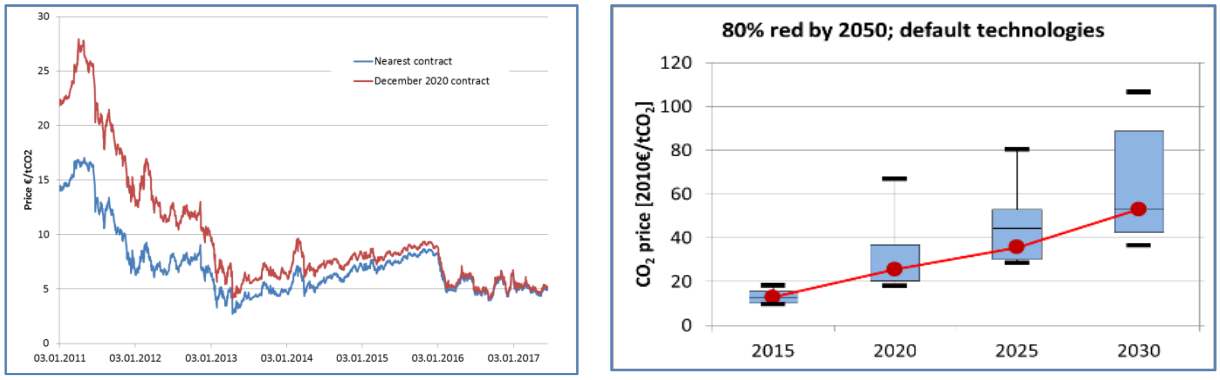

Figure 1: (Left) Observed EUA forward price 2011-2017. (Right) CO_2 price trajectories for a cost effective long-term pathway with an 80% reduction in GHG emissions by 2050 compared to 2005 within Europe with default technology setting. The blue box contains the 50% interval, the whiskers mark the 90% interval and the straight line marks the median over 12 different energy-economy models. The red line marks the values for the PRIMES model applied in the EU Commission's "Energy Roadmap 2050". (Sources: ICE 2017, Knopf et al. 2013, Edenhofer et al. 2014)

If it is correct that current EUA prices are below the economic benchmark, and if current reforms fail to remove the underlying distortions as we argue below, the following disturbing scenario can be anticipated: The EUA price observed on the market and expected by companies remains below its economical benchmark level for several years to come. Investments into high-carbon capital stocks for industrial production facilities continue to appear more profitable than low-carbon options, leading to a lock-in of high-carbon capital stocks. Investments into low-carbon technology R&D also remain below the economical benchmark level, which reduces the future availability of affordable low-carbon technologies. With the cap declining by 2.2% per year and a high continued demand for allowances, the remaining allowances in the Market Stability Reserve (MSR) will eventually be used up and prices will start to rise under the ever more stringent cap. However, given a lock-in of high-carbon capital assets and severe limitations to short-term abatement options in the future, market participants have reasons to doubt the credibility of the long-term cap already today. This expectation leads to a lower price path. More generally, when investors have a higher discount rate due to regulatory uncertainties because they expect a price drop with a positive probability, short-term prices are reduced and long-term prices will increase significantly in the future (see Salant 2016). Figure 2 offers a stylized illustration of the corresponding "EUA price hockey stick curve". In other words, the economic as well as political costs of sticking to the tightening cap schedule will rise steeply. This will put strong pressure on policymakers to eventually relax the cap e.g. by adjusting the LRF to avoid this price escalation. The long-term environmental effectiveness of the EU ETS is thus undermined.

What is more, the mere anticipation of this scenario can reduce incentives for private actors to invest into low-carbon capital stocks and R&D today: Given the risk that the cap will eventually be relaxed in face of escalating EUA prices, investors are even more reluctant to invest into costlier low-carbon options today. In fact, they may face an incentive to game the

system by withholding investments today and speculating on a future relaxation of the cap. A self-fulfilling prophecy may be the result.

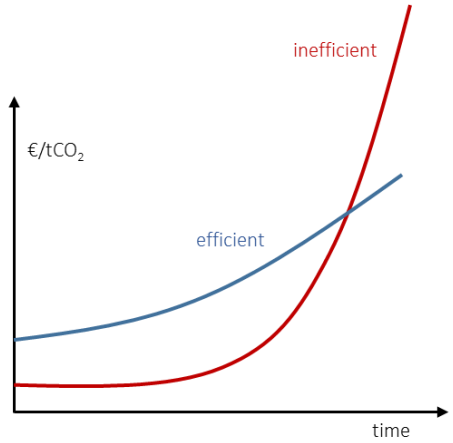

Figure 2: Stylized illustration of two EUA allowance price paths. The economically efficient benchmark path requires a significant carbon price today that will rise steadily over time (blue curve). If price formation does not work efficiently over time, a period of insignificant prices will be followed by a steeply escalating EUA price required to attain the same cap schedule (red curve). This will create political pressure to eventually relax the cap.

3. Mechanisms distorting EUA price formation

The scenario sketched in the previous section only then warrants further EU ETS reform if the current EUA price is too low compared to the economic benchmark, as outlined in the economic literature on long-term C&T systems (e.g. Rubin 1996; Kling and Rubin 1997; Leiby and Rubin 2001; Newell and Pizer 2003). If the current price resulted from an efficient interplay of market allowance demand and government supply, there would be no reason for concern.

Empirical scientific research finds that in contrast to conventional wisdom, carbon market fundamentals such as the negative allowance demand shock from the economic recession, the expansion of renewables, and the inflow of CDM credits explain only 10% of historical EUA downward price movements (Koch et al. 2014). Instead, recent scientific research has identified two interacting market and regulatory failures, and one additional distorting effect that work towards dampening the EUA price. These require careful characterization to be effectively addressed by future EU ETS reforms to avoid the scenario outlined above (Fuss et al. 2017; Acworth et al. 2017).

Market myopia (short-sightedness): Market participants have a systematically lower regard for long-term time horizons and policies than actors concerned about decarbonization (Kollenberg and Taschini 2016). Therefore, ETS prices are not in the first place determined by long-term allowance supply (cap) and allowance demand, but rather by short-term conditions. In other words, the unwillingness or inability of market participants to consider the long term leads to carbon prices that disregard expected future costs of compliance. When allowances are relatively abundant in the present compared to what is expected for the future, as is the case at the moment, myopia will induce prices that are too low to be cost-effective. The extent to which economic agents in the EU ETS are short-sighted is difficult to assess empirically.

Looking at power companies, their hedging in futures markets suggests planning horizons of maximally 5-6 years (maturities might be longer in non-public bilateral contracts). Similarly, liquid EUA futures markets do not extend beyond 2021. There is also anecdotal evidence from EUA market participants that trading is notoriously "thin" with very few financial market players being able and willing to hold significant amounts of EUA allowances and thus to speculate on rising allowance prices over longer periods of time (von Butler 2017). Taken together, these observations indicate that – in line with observations in other sectors in the economy – planning horizons of market participants are well below a multi-decadal foresight as assumed by the classical economic paradigm of long-term C&T systems. While it is true that strategy departments of companies preparing high- or low-carbon investment decisions into long-lived capital stocks need to make assumptions about long-term EUA prices beyond those observed on the trading market, these assumptions are subject to significant political uncertainty. It is unclear if these expectations are sufficient to drive investments into low-carbon capital stocks in line with cost-efficient decarbonization.

Regulatory uncertainty (lack of political credibility): The EU ETS is a government-created market. Scarcity is not set by the natural availability and by the production of a good within the economic system, but by political decisions concerning the stringency of the cap. In this respect, the EU ETS more closely resembles the market for money than the markets for standard goods such as oil or bread. A reliable and credible regulatory framework is vital to enable long-term investment decisions for decarbonization. The current regulatory situation, however, does not provide a sufficient degree of reliability (Expertenkommission 2015), and there is evidence that some energy-intensive German companies delay investments due to regulatory uncertainty (Bardt and Schaefer 2017). Market participants are exposed to an ongoing risk of regulatory intervention that could drastically affect ETS prices. In fact, the cap of the EU ETS for the period 2020-2030 is only about to be legislated as a result of the now completed reform process, with the cap (supply of allowances) beyond 2030 remaining subject to future political decisions. Most importantly from a decarbonization perspective, the political commitment to the long-term cap suffers from a lack of credibility. Any policy announcement that provides additional information on the overall stringency of the cap can trigger sharp price jumps, irrespective of whether the contemplated cap change actually happens. Thus, mere speculation about the political commitment to the envisaged long-term cap can become a decisive factor in determining the ETS price (Koch et al. 2016). If concerns about a relaxation of the cap in the future (or the long-run survival of the program in general) are prevalent, current ETS prices will be too low compared to their cost-efficient benchmark (Salant 2016).

Both distortions (myopia and regulatory uncertainty) are interdependent. For instance, substantial regulatory uncertainty is likely to encourage market participants to focus on the short-term and to discount the long-term carbon budget. Low EUA prices resulting from myopia in turn will lead to underinvestment in low-carbon capital stocks, thus increasing the need for future regulatory intervention to contain program costs. This prospect can intensify the problem of regulatory uncertainty. As argued in the previous section, the key threat of such mutually-reinforcing distortions is that the resulting ETS price might remain very low for several years and possibly decades. In the absence of other mitigation policies, such a situation will lead to a lock-in of carbon-intensive infrastructure such as high-carbon industrial production facilities. If the envisaged long-term cap remains in place, ETS prices must then rise steeply in the mid- to long-term to induce sufficient abatement, albeit at significantly higher societal costs ('hockey stick' ETS price curve, see above).

Waterbed effect: The problems identified above represent interrelated risks of political and market failures. Another major challenge for the EU ETS, adding downward pressure on current prices, is its interaction with state policies or voluntary action by non-state actors that reduce emissions from EU ETS sectors. Assuming that the cap is fixed (and that unilateral measures do not impact future political cap adjustments), emission reductions at facilities regulated by the ETS that result from additional policies or voluntary action will not lead to net additional emission reductions. Instead, due to the reduced allowance demand, the EUA price will drop and emissions will increase at other facilities. This 'waterbed effect' (Burtraw et al. 2017) is well-established in the scientific literature as a potentially serious problem (Böhringer et al. 2008; Goulder and Stavins 2011; IPCC 2014; Edenhofer et al. 2017). An empirical study suggests that the waterbed effect has been of limited relevance in the EU ETS so far, with additional mitigation efforts contributing only marginally to depressing allowance prices (Koch et al. 2014). This may be due to the fact that these additional policies have been considered in the EU's integrated climate and energy legislation when setting the 2020 target (Capros et al. 2011). However, if it is not adequately addressed the effect may become more relevant in the future as member states or non-state actors with a preference for more ambitious mitigation targets unilaterally pursue more ambitious actions, as they perceive EUA prices as being too low. This would put further downward pressure on allowance prices, undermining incentives for low-carbon investments in other sectors and countries.

While further empirical evidence on the precise magnitude of these effects would be desirable, and future analyses of their complex interactions will be useful, the existing evidence provides sufficient reason to assume that the current EUA price is too low compared to the economic benchmark. Regulatory reforms to effectively tackle these problems are required to avoid the carbon price escalation scenario outlined above.

The recently adopted reform is inadequate to effectively address all of these challenges (Perino and Willner 2016, 2017). Importantly, the new possibility for member states to unilaterally delete allowances in proportion to additional domestic policies would require full implementation by all member states to be effective (which seems very unlikely). It does not address the waterbed effect induced by emission reductions of subnational and private actors. Another key reform step is the cancellation of significant volumes of allowances in the MSR from 2023 on, when allowances in the MSR exceeding the volume of allowances auctioned in the previous year will be permanently deleted.

In view of the three challenges outlined above the overall magnitude and direction of the impact of these measures on the EUA price are highly uncertain. A small upward price effect might be expected from the envisaged significant deletion of EUAs in the MSR, but Perino and Willner (2017) find virtually zero impact of this measure on the allowance price until 2037 in their modeling study. A downward price effect may result from further exacerbating regulatory uncertainty as a result of the demonstrated unpredictability of EU ETS governance. In any case, structural regulatory uncertainty remains and the problems in intertemporal price formation resulting from market myopia remain unaddressed. There is no reason to expect that the reform will bring EUA prices in line with levels required for cost-efficient decarbonization.

More generally, no sound theoretical and empirical analysis establishing the relationship between the quantity of EUAs in circulation and the EUA price is publicly available – even though the MSR and the options adopted in the trialogue apparently rest on the assumption that such a relation exists. EUA price projections provided by some market analysts suggest an increase to significantly higher levels in the 2020s as a result of some other currently

considered reforms (such as the doubling of the MSR intake rate from 12 to 24%). However, these models lack transparency and external expert review and are apparently mainly based on a simplistic surplus-price relationship not anchored in economic theory. They do not provide a solid basis for public policy planning. As already mentioned, the scientific analysis by Perino and Willner (2017) finds virtually zero impact of the recently adopted MSR reform measures on the EUA price over the next two decades, and very limited impacts beyond. Against this background, more effective reforms need to be pursued in the years to come. Adopting a wait-and-see position to observe whether the new measures will be effective or not puts EU decarbonization efforts at risk.

4. Introducing a carbon price floor

We propose the introduction of a carbon price floor in the EU ETS to address all of the challenges identified in the previous section. It should start at an economically significant level and rise continuously over time to provide effective incentives for investments into low-carbon capital stocks and R&D. The main options are to start with a relatively high price that rises only slowly, or to start with a moderate price that rises more quickly. In addition, a ceiling for the allowance price that also rises over time could be adopted to avoid escalating costs. Since the main problem of the EU ETS has been a low allowance price, we focus on the price floor option in this paper.

Price management options have been implemented in many C&T systems outside Europe to address the problems outlined above, for instance in California, the RGGI (Regional Greenhouse Gas Initiative), Quebec, Ontario and some Chinese pilot systems (ICAP 2016). They also have been suggested and extensively analyzed by economists (e.g. Newell et al. 2005; Murray et al. 2009; Wood and Jotzo 2011; Fell et al. 2012; Edenhofer et al. 2014). Under uncertainty over costs and benefits of climate change mitigation a price-based or hybrid instrument combining quantity and price control is usually considered superior to other options (Roberts and Spence 1976; Newell and Pizer 2003).

Several methods for assessing appropriate levels and rates of increase of a carbon price floor are available. Existing economy-energy modeling studies indicate that benchmark carbon prices should be in the range of about 20-40€/tCO_2 in the year 2020 and rise thereafter in order to achieve EU long-term decarbonization targets (see Figure 1; Knopf et al. 2013). More recently, the Stiglitz-Stern Commission (Stiglitz et al. 2017) has employed several lines of evidence including technological roadmaps, analyses of national mitigation and development pathways, and global integrated assessment models to estimate carbon prices required at the global level to achieve the Paris agreement objectives. They find that 40-80$ per ton are needed by 2020, and 50-100$ by 2030.

While these methods and estimates provide a starting point, setting up an *expert commission* is necessary to assess options and develop recommendations for the level and rate of increase of an EU ETS price floor. This commission should explicitly take uncertainties into account. It would also develop proposals for robust rule-based governance mechanisms that could enable a transparent management of potential adjustments in the price floor (ceiling) rates so as to provide maximal regulatory predictability and credibility (Grosjean et al. 2016). This will be required given the inherent tradeoff between flexibility and commitment in long-term climate policy and carbon pricing. This tradeoff is inevitable due to uncertainty about future

technological developments, international climate policy, and advancing knowledge about the impacts of climate change (Jakob and Brunner 2014). The commission should also evaluate legal aspects of various price floor options.

A carbon price floor would address the three distortions identified above as follows (Fuss et al. 2017): Concerning *myopia*, the market failure in allowance price formation is directly remedied if the novel price path set by regulation is in line with social preferences, i.e. higher in the short-term (and lower in the long-term) than is currently the case. Any additional myopia or other externalities in relevant capital markets, however, are not directly addressed by the price floor and might require additional policy intervention.

A carbon price floor reduces *regulatory uncertainty* by introducing a much clearer short-term signal about the commitment of regulators to actually implement the announced long-term cap, and to avoid the "EUA price hockey stick" scenario that we outlined above. With a clear price trajectory set by regulators, individual investment projects will face less uncertainty over which assumptions to use in their internal investment planning e.g. when applying for bank loans. However, a carbon price floor will very likely become subject to regulatory changes as well. Clear process rules for revising carbon floor rates based on transparent assessments by dedicated expert bodies are thus needed (Brunner et al. 2012; Jakob and Brunner 2014). Delegating parts of the decision-making process to an institution resembling a central bank in monetary policy is another option that has been considered (Grosjean et al. 2016).

Concerning the *waterbed effect*, a carbon price floor can prevent the price from dropping below a certain level (Edenhofer et al. 2017), depending on implementation design (see below). Emissions can effectively be reduced if the price floor mechanism features a provision for withholding and possibly canceling allowances.

We briefly discuss three design options for implementing a carbon price floor, building on existing practice and literature, which differ in how they affect environmental effectiveness and other features of the system.

Auction reserve price: The general concept of an auction reserve price is widely known, e.g. from ebay auctions. The seller specifies a minimum level at which he/she would be willing to sell a good, with auction participants potentially offering bids higher than the reserve price. This option has been successfully implemented in the California and RGGI C&T systems, where the allowance price has remained at or above the reserve price for much of the duration of program operation (Burtraw et al. 2017). Notably, under this option the secondary market allowance price can fall below the reserve price. This was the case in California when doubts about the future of the system proliferated, putting the value of purchasing new allowances in question (Cullenward and Coghlan 2016). The impact on environmental effectiveness depends on design rules for non-auctioned allowances: If these are permanently deleted, low prices translate into a gain for the environment as overall emissions are reduced. If they are put into a market reserve and potentially re-issued in the future, this option can be cumulatively cap-neutral (e.g. allowances could be returned to the market when a price ceiling is triggered). While the price floor has been very low in the RGGI system and moderate in California (around 12$/t CO_2 and rising), they nevertheless offer valuable lessons and insights for designing and implementing such a provision in the EU ETS.

Another important feature of this approach is that if implemented unilaterally within a multilateral C&T system such as the EU ETS, the country that makes all or some of its auctioned allowances subject to an auction reserve price will forego sales revenues, as no market participant will buy allowances in this country when they are available at lower price

elsewhere. Thus, while an auction reserve price would be an elegant solution for the EU ETS as a whole, for individual countries other options that allow retaining or even increasing auctioning revenues appear fiscally more attractive. Also, the legal feasibility of a unilateral implementation and the interaction with the MSR need to be considered, specifically ensuring that this does not lead to fewer certificates being deleted from the MSR.

UK carbon price floor: In 2013, the UK unilaterally introduced a price floor for CO_2-emissions from UK power plants covered by the EU ETS (Ares and Delebarre 2016). It is implemented via a domestic carbon price support rate that scales with EUA prices to ensure the domestic price floor is always achieved. If e.g. the EUA price is 5€ and the UK carbon price floor is set at 20€/t, the carbon price support rate is 15€. If the EUA price exceeds the UK floor price, the domestic support rate would be zero. The mechanism deliberately aims at stabilizing the uncertainty around EUA prices and amends the Climate Change Levy (a tax on primary energy sources and electricity). It has been implemented outside the formal EU ETS framework. The UK government regularly publishes its decision on the level of the carbon floor price. In 2015/2016 and 2016/2017 the carbon floor price was equivalent to about 13€/tCO_2 and 16€/tCO_2 respectively. From 2016 to 2020, the Carbon Price Support rate is capped to a maximum of 19 €/tCO_2. Preliminary analyses suggest that the price floor has played an important role in driving the recent coal exit in the UK power system, alongside other factors such as the EU's Large Combustion Plant Directive regulation (IEA 2016; UK Committee on Climate Change 2017). Critical analysis of the UK carbon price support mechanism emphasizes that the waterbed effect is not being tackled. No allowances are removed, emissions simply shift in space and time, and the market EUA price is being depressed (Fankhauser et al. 2010). To achieve direct environmental impact, an additional mechanism for removing allowances is required.

In a fiscal perspective, a particularly attractive feature of unilaterally implementing the UK price support option is that it creates additional domestic revenues, unlike a unilateral auction reserve price (discussed above). These additional revenues could be used to make up for the financial loss from canceling allowances in domestic auctions to achieve additional emission reductions. Separate mechanisms would be required to calculate the volume of cancelled allowances, and the institutional implementation of such a provision.

Emissions Containment Reserve: The Emissions Containment Reserve (ECR) has recently been adopted in the RGGI, coming into effect in 2021 (RGGI 2017; Burtraw et al. 2017). The ECR will introduce an additional step into the RGGI allowance supply function (Figure 3d). RGGI already features an auction reserve price (floor price) of 2.15$ applying to all allowances. Allowances not auctioned due to this provision are cancelled. On the high cost side, the RGGI features a Cost Containment Reserve (CCR) that introduces additional allowances if prices rise above its trigger price. From 2021 the CCR will comprise 10% of the regional cap, with a trigger price of 13$ that will rise by 7% per year. The ECR will be introduced as an additional price step between price floor and CCR. In contrast to the price floor, it will apply only to a specified quantity of allowances (10% of all allowances), with the trigger price being 6$ in 2021, and rising at 7% per year. ECR allowances not auctioned will be permanently deleted.

By smoothing the allowance supply function, lower-than-expected allowance prices thus translate into additional emission reductions. The motivation underlying the ECR is to contain the waterbed effect in a situation where some states and actors take additional action, and to ease negative effects resulting from an uncertainty of price developments and from potential sudden extreme changes (Burtraw et al. 2017; a similar approach for the EU ETS is proposed

by Perino and Willner 2017). If implemented by only a subset of jurisdictions in a multilateral C&T system (as will be the case in the RGGI, see below), the costs of the measure will only be borne by those jurisdictions implementing the ECR in the form of reduced sales of allowances. Note, however, that in the RGGI this loss from not auctioning some allowances is expected to be overcompensated by higher allowance prices for those allowances still being auctioned (Burtraw et al. 2017). In the European context, the legal feasibility of this option would need to be clarified.

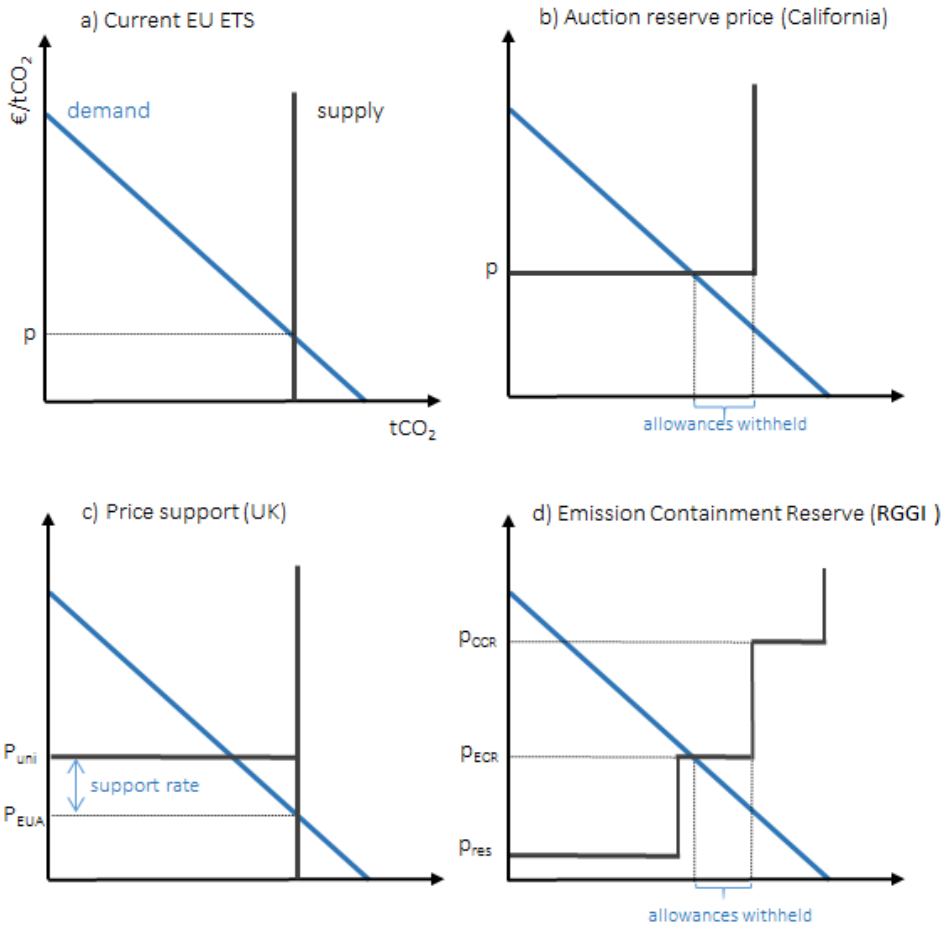

Figure 3: Three options for implementing a carbon price floor. (a) Current EU ETS supply rule (no price floor). (b) Auction reserve price as implemented in California. Compared to EU ETS supply rule, some allowances are not auctioned and withheld from the market. (c) UK carbon price floor. The domestic price support rate closes the gap between the unilateral UK carbon price (P_{uni}) and the EU-wide allowance price (P_{EUA}). Additional fiscal revenues result accordingly. An additional mechanism would be required to withhold allowances from the market. (d) Emissions Containment Reserve, approach adopted by the RGGI. Step-wise allowance supply function with minimum allowance reserve price for all allowances (P_{res}), an emissions containment reserve price applying to a share of allowances (P_{ECR}), and a Cost Containment Reserve price (P_{CCR}) triggering sales of additional allowances. Allowances not sold in the auction are withheld from the market (and cancelled in the RGGI).

5. Making it work

With the two-year EU ETS reform process being completed, there may be limited appetite for initiating another round of politically challenging reforms for now. Yet, as the current reform process will not tackle the root causes of the challenges the EU ETS is facing, only limited impact can be expected. More effective reforms need to be pursued now; otherwise, EU

decarbonization efforts are put at risk. This will become salient again in the upcoming facilitative dialogue of the Paris Agreement in 2018, an initial stocktaking of current NDCs (Nationally Determined Contributions) that is likely to trigger updates for a new round of NDCs by 2020. In the German context, the minimum price option is attractive also in the short term with a view towards the challenges of achieving the national 2020 greenhouse gas emission reduction targets. Previous modeling studies suggest that a minimum price of 30€ could reduce German power sector emissions at the order of magnitude of 30 Mt (Hecking et al. 2017, Loreck et al. 2014; see also Edenhofer et al. 2017); a multilateral implementation would be desirable to avoid emission leakage effects. This provides an opportunity to re-assess the effectiveness of domestic EU policies to achieve emission reduction commitments both at the German and EU level. The discussions about attainment of German policy goals as well as the European NDC review process next year can provide entry points for a more ambitious ETS reform that implements an economically significant carbon price floor.

Previous initiatives on introducing an EU ETS price floor, in particular those by the French government in 2015 (Szabo 2016), have failed due to a variety of reasons. Among these reasons were a lack of convergence in problem perception and reform preferences in the expert community, and a lack of political support from key member states including Germany. A price floor in the ETS would immediately raise the level of ambition of EU climate policy and make the attainment of long-term decarbonization targets more likely. This, however, will very likely trigger opposition from member states that are generally reluctant regarding climate policy, as well as from adversely affected industrial constituencies including companies, labor unions and regional governments.

Introducing a carbon price floor requires the support by different actors. Discussion and mutual learning within the expert community will be important and might lead to a convergence of views. The dedicated support of such an initiative by key governments in Europe, particularly Germany and France, as well as Scandinavian countries, the Netherlands, the Czech Republic and others, will be even more important. In addition, targeted compensatory policies will be required to bring reluctant member states and industries on board (Dorsch et al. 2017). Concerning member states, well-established bargaining mechanisms such as the distribution of allowances and investment funds can be harnessed (Edenhofer et al. 2017). Concerning industries, continuing targeted free allocation of allowances for an intermediate period will be essential. Free allocation rules should be revised to avoid overcompensation of sectors and companies not at risk of carbon leakage (Martin et al. 2014). These measures should be complemented by public financial support for private investments into low-cost transformative technology R&D that reduce the future costs of industrial sector decarbonization. Public technology R&D support is required from an economic perspective to tackle well-known market failures in innovation markets (Jaffe et al. 2005). Finally, public support for ambitious carbon pricing could be enhanced by using parts of revenues to reduce distortionary labor taxes (Franks et al. 2015), and by directly refunding auctioning revenues to households (Klenert et al. 2017).

EU-wide implementation of a carbon price floor would clearly be the preferable option, not least because it would show that ambitious and effective decarbonization is feasible in the context of the Paris Agreement. A common European approach would also avoid the complexities of adopting differentiated regulation under the EU ETS. However, if no European approach can be agreed upon over the next years, a coalition of climate leaders including Germany, France, and possibly Scandinavian and other countries could move ahead. The

participation of Benelux countries would be particularly desirable to avoid emission leakage effects in integrated power markets resulting from differentiated carbon prices (Loreck et al. 2014). In such a "multi-speed Europe" scenario, great care would need to be taken to enable other countries to follow later in time, for example by providing low-carbon investment incentives in relevant sectors. This should enable them to develop first-hand experiences with successful domestic emission reduction efforts as first steps towards more ambitious decarbonization pathways. In fact, a similar scenario is now being tested in the RGGI where New Hampshire and Maine have refrained from adopting the ECR mechanism.

6. Carbon pricing and companion policies for decarbonization

While this policy paper considers the EU ETS to be the central pillar in the European decarbonization effort, many have argued that driving long-term mitigation is actually not the main job of the EU ETS. According to this line of argumentation, other regulatory policies – in particular technology subsidies as well as standards such as banning the operation of coal power plants – should be implemented to guide long-term capital stock investment and R&D decisions towards low-carbon options.

In our view, companion policies can have important roles in the decarbonization policy mix. First, they can address additional market failures. It is well-established in economic theory that R&D in low-carbon technologies exhibits positive externalities in the form of knowledge spillovers that justify policies spurring technological change (Jaffe et al. 2005; Kalkuhl et al. 2013). Second, they can play an important role in stabilizing policy expectations. The technological requirements of regulatory policies can directly lock-in transformative changes in technology investment patterns. This temporal policy incentive structure is quite different from the case of long-term carbon pricing, where profitability of low-carbon investments depends on the inevitably uncertain future carbon price level. Third, different kinds of regulation can be first steps towards deep decarbonization pathways if these are understood as sequences of increasingly ambitious policy stages in gradually changing political environments. In this policy sequencing perspective, each policy stage prepares the ground for a more ambitious policy mix in the next stage, and a significant carbon price eventually has a key role to play (Pahle et al. 2017).

However, we argue that alternative policies cannot be adequate substitutes for significant and well-designed long-term carbon pricing. First, in the absence of a carbon price floor companion policies will be subject to the waterbed effect unless member states make use of the new provision enabling unilateral deletion of allowances. Second, a persistently low or inexistent carbon price will raise doubts about policymakers' commitment to long-term decarbonization targets. This will make private actors reluctant to embrace decarbonization as part of their broader company strategies. Third, regulatory policies will only affect the specific sectors, technologies and behavioral options that they are directly targeting, omitting others that can be incentivized by a more comprehensive carbon price (e.g. behavioral energy demand reductions). This will raise the costs of decarbonization, which will be increasingly problematic with rising levels of policy stringency.

Finally, ambitious unilateral decarbonization policies without related EU ETS reform will widen the gap between climate leaders and laggards within the European Union. This will make it increasingly difficult to converge towards common levels of climate policy ambition and to

succeed in the collective decarbonization effort that will also be required at the global level. The EU should instead aim for joint solutions, and continue to strive towards being the world's successful laboratory for multilateral design and implementation of ambitious climate policy.

7. Outlook

We propose establishing an expert commission to quickly develop more specific options for introducing a carbon price floor in the EU ETS. The commission should analyze appropriate levels of the price floor (and possibly price ceiling), based on modeling and other methods, taking uncertainties into account. It should also examine various implementation options in more detail, including their effects on emission reductions, fiscal revenue and other distributional implications, and legal considerations in the case of uni- and multilateral implementation in the European Union. The contribution of different levels of a short-term minimum price to attaining the German 2020 climate targets should be assessed as well. Governance mechanisms for transparently announcing and reviewing the long-term carbon price floor (ceiling) should be developed building on available analyses and experiences. The EU ETS expert community should actively participate in this process to enable convergence of views and clarification of diverging standpoints. First results could be made available within several months.

Within Germany and possibly other EU countries, introducing a carbon price floor can be part of a review and reform of energy taxes and levies in the broader context of environmental fiscal reform (Agora Energiewende 2017). Given the significant levels of energy tax income and the important allocative role of energy pricing in the context of climate and other policy fields (e.g. air pollution) this would be a worthwhile priority for the next German government.

Turning the EU ETS into a key driver of European decarbonization by introducing a carbon price floor can only succeed if Germany puts its political leverage behind this project. Building alliances with France (Pescia et al. 2017) and other countries and investing political capital in negotiations with reluctant member states and industries will be essential. Adopting ever-more ambitious climate policy targets may be less challenging politically than implementing short-term policies that can actually trigger the necessary pathway changes. Implementing a carbon price floor as outlined above puts Europe onto a credible decarbonization pathway, and restores the environmental and economic integrity of its long-term climate targets.

Annex: The EU ETS Dialogue Forum

This Policy Paper was written in the context of a stakeholder dialogue process convened by the Mercator Research Institute on Global Commons and Climate Change (MCC) and the European Climate Foundation (ECF) in 2017. The aim of the "EU ETS Dialogue Forum" was to facilitate a structured discussion within the German policy expert community on the future of the European Emissions Trading System (EU ETS) under Chatham House rules. The focus was on exchanging views about current problems of the system, and discussing potential reform options to ensure the EU ETS can effectively contribute to achieving mid- and long-term EU decarbonization targets.

Five meetings of the EU ETS Dialogue Forum took place between February and September 2017. The participants included key stakeholders from government, industry, NGOs and academia. During the five meetings, participants discussed issues related to EU ETS quantity and price interventions and their effects on allowance prices and investment decisions; and leakage, allocation and distributional issues. This policy paper does not communicate a consensus by the group, but aims at making an opinionated proposal for an EU ETS reform that takes into account the concerns and perspectives of different stakeholders, including those that participated in the Dialogue Forum.

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