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## The European Emissions Trading System (EU ETS): Ex-Post Analysis, the Market Stability Reserve and Options for a Comprehensive Reform

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**Summary**

The central pillar of European climate policy, the European Emissions Trading System (EU ETS), is currently under scrutiny, as the allowance price is persistently low at around 5€/tCO2. The cap was met and emissions actually declined in recent years, ensuring the environmental effectiveness of the scheme. However, the low price may affect the long-term cost-effectiveness of the instrument by reducing the incentive for investment and deployment of low carbon technologies. No significant increase in the allowance price is expected before 2020, and probably not beyond, without reform. While the reasons for the price decline are controversial, empirical analysis shows that only a small portion of price fluctuations can be explained by factors such as the economic crisis, renewable deployment or international offsets. Therefore, it is likely that political factors and regulatory uncertainty have played a key role in the price decline. As a consequence, any reform of the EU ETS has to deliver a mechanism that reduces such uncertainty and stabilizes expectations of market participants. The Market Stability Reserve proposed by the EU Commission is unlikely to address the current problem of price uncertainty and insufficient dynamic efficiency. The key element of the alternative reform proposal described in this paper is to set a price collar in the EU ETS with lower and upper boundaries. This is likely to reinforce the long-term credibility and reliability of the price signal. In addition, a price for GHG emissions not covered by the EU ETS has to be set. If additional market failures prevent the market from functioning efficiently, specific policy instruments related to innovation and technology diffusion should be implemented in addition to carbon pricing. Carbon leakage could be addressed through tailor-made trade policies. In parallel, increasing the coalition of countries included in the carbon pricing should remain a priority. This reform package would bring the EU ETS back to life, while avoiding a relapse into potentially costly and inefficient national climate and energy policies.

**Keywords:** EU ETS, Emissions Trading, Carbon Price, Price Collar, Market Stability Reserve, Credibility
**JEL Classification:** Q42, Q48, Q54, Q58

*This paper draws on the discussions at the Euro-CASE Workshop "The European Emissions Trading System (EU ETS) - Taking stock, looking forward: Options for reform", February 2014 http://www.euro-case.org/index.php/the-european-emissions-trading-system-eu-ets-taking-stock-looking-forward-options-for-reform.html. The authors are thankful for valuable input provided by the workshop participants. The paper also benefited a lot from suggestions by a number of reviewers.*

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# The European Emissions Trading System (EU ETS): ex-post analysis, the market stability reserve and options for a comprehensive reform[1]

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## Abstract

The central pillar of European climate policy, the European Emissions Trading System (EU ETS), is currently under scrutiny, as the allowance price is persistently low at around 5€/t$CO_2$. The cap was met and emissions actually declined in recent years, ensuring the environmental effectiveness of the scheme. However, the low price may affect the long-term cost-effectiveness of the instrument by reducing the incentive for investment and deployment of low carbon technologies. No significant increase in the allowance price is expected before 2020, and probably not beyond, without reform. While the reasons for the price decline are controversial, empirical analysis shows that only a small portion of price fluctuations can be explained by factors such as the economic crisis, renewable deployment or international offsets. Therefore, it is likely that political factors and regulatory uncertainty have played a key role in the price decline. As a consequence, any reform of the EU ETS has to deliver a mechanism that reduces such uncertainty and stabilizes expectations of market participants. The Market Stability Reserve proposed by the EU Commission is unlikely to address the current problem of price uncertainty and insufficient dynamic efficiency. The key element of the alternative reform proposal described in this paper is to set a price collar in the EU ETS with lower and upper boundaries. This is likely to reinforce the long-term credibility and reliability of the price signal. In addition, a price for GHG emissions not covered by the EU ETS has to be set. If additional market failures prevent the market from functioning efficiently, specific policy instruments related to innovation and technology diffusion should be implemented in addition to carbon pricing. Carbon leakage could be addressed through tailor-made trade policies. In parallel, increasing the coalition of countries included in the carbon pricing should remain a priority. This reform package would bring the EU ETS back to life, while avoiding a relapse into potentially costly and inefficient national climate and energy policies.

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# 1. Introduction

The EU implemented the EU ETS as the central cornerstone of EU climate policy. It is the first large-scale $CO_2$ emission trading system in the world, offering the world community a unique opportunity to distill empirical lessons for the operation and design of an emissions trading system. This is particularly salient, as trading schemes for GHG reductions are currently in the process of being adopted in many other world regions including California, Quebec, and several Chinese cities and provinces. At the same time, however, the performance of the EU ETS is under great scrutiny. Many believe that the carbon price it sets is far too low to incentivize long-term investments in low-carbon technologies.

To progress beyond a narrow discussion of the adequate allowance price level, this paper evaluates the performance of the EU ETS and the different EU ETS reform options along the three criteria of environmental effectiveness, cost-effectiveness and political feasibility. Our analysis concludes that the environmental effectiveness of the EU ETS is given (in fact, the emission target has been overachieved), but that the EU ETS lacks dynamic efficiency. The EU Commission has suggested addressing this problem by introducing a reform that manipulates the supply of EU allowances (EUAs), i.e. the Market Stability Reserve. However, we show that this reform proposal does not address the problem of dynamic efficiency, mainly because the interplay between the magnitude of the EUA surplus and the EUA price formation seems incomprehensible from an inter-temporal perspective. It also fails to address the problem of overlapping policies arising from the existence of supplementary policy instruments at the EU Member State level that could undermine the overall performance of the EU ETS. By contrast, our analysis clearly shows that instead of a narrow reform of the EU ETS focusing on the EUA surplus, a comprehensive reform addressing a several aspects of carbon pricing is required. This includes (i) setting a price collar within the EU ETS, (ii) expanding the EU ETS to other sectors (e.g. transport, buildings) (iii) addressing additional market failures through other policy instruments and (iv) addressing the possible problem of carbon leakage by expanding the group of countries that adopt comparable carbon prices.

The paper is structured as follows. Section 2 will give an ex-post evaluation of the performance of the EU ETS in terms of environmental effectiveness and allowance price formation, while section 3 evaluates the cost-effectiveness. Section 4 provides an overview of the different reform proposals and analyses the Market Stability Reserve in detail. Section 5 describes a comprehensive reform of the EU ETS in view of establishing the long-term credibility of European climate and energy policy. Section 6 concludes and addresses political feasibility.

# 2. The EU ETS: ex-post analysis

Pricing carbon is essential for climate policy. It directly addresses the market failure related to Greenhouse Gas (GHG) emissions and harmonizes the price signal indicating the level at which internal GHG reductions are more cost-effective than purchasing and surrendering EU Allowances (EUAs). If implemented properly, this promises to simultaneously meet the objectives of environmental effectiveness (the permitted emissions given by the cap) and economic efficiency (all organizations have an incentive to implement internal abatement options cheaper than the allowance price).

The EU aims to reduce all GHG emissions by 80-95% by 2050. This long-term vision is grounded in a 2020 mid-term strategy with 20% GHG reduction by 2020, as agreed in the "EU climate and energy package" in 2007[2]. To achieve this, the EU Emissions Trading System was implemented in 2005, covering the power sector, the energy-intensive industrial sector and commercial aviation which, together, are responsible for about 45% of all GHG emissions originating in the European Union. In particular, the 2003 EU ETS Directive states that the trading scheme aims to "promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner." However, the time frame for assessing efficiency is not specified in the Directive. However, it is fair to assume that the EU ETS must enable the development and deployment of low-carbon technology in order to keep the promise of cost-effectiveness in the long-term. Achieving emissions reductions exclusively through output reductions rather than through a shift to new technologies would not be economically efficient. Therefore, this paper evaluates the EU ETS against its capacity to foster first R&D and then investment in new technologies.

The EU ETS is the first, and to date the largest, system for trading GHG emission allowances in the world[3]. A complex and functioning market infrastructure has emerged including periodic auctioning of permits, trading amongst regulated entities and financial intermediaries, a centralized emission registry, and a system of monitoring, reporting and verification of emissions.

Since 2013, the EU ETS directive foresees that emissions within the EU ETS will decline by a Linear Reduction Factor (LRF) of 1.74% p.a., so that emissions will be reduced by 21% between 2005 and 2020[4]. In volume this means a reduction from 2,501 Mt $CO_2$ in 2005 to 1,904 Mt $CO_2$ in 2020[5], giving an approximate reduction of allowances of 38 Mt CO2 per year. If the LRF of 1.74% p.a. is continued until 2050, a 71% reduction will be achieved by 2050 within the EU ETS sector (long-term cumulative cap). An increasing share of emission allowances will be auctioned (starting with 40% in 2013), but free allocation is retained in order to address concerns about competitiveness (see section 5.4).

## 2.1. Evaluating the environmental effectiveness of the EU ETS

In order to evaluate the environmental effectiveness of the EU ETS, emission reductions within the EU ETS sectors have to be analyzed to determine, in particular, whether these reductions can be attributed to the EU ETS or whether other factors such as the economic recession, or renewable and energy efficiency policies are more relevant. According to an overview of studies, emissions within the EU ETS[6] reduced by around 3% of estimated business-as-usual emissions in Phase I and during the first two years of Phase II. As the annual cap is observed, and non-compliance faces severe penalties, the EU ETS ensures that environmental effectiveness, as indicated by the legally binding cap, is delivered. However, between 2009 and 2013, actual emissions stayed below the annual cap (see Figure 1). This means that *temporarily* the annual cap was not binding. Thus, the emission target has in fact been overachieved. In this situation, a study by Gloaguen and Alberola[7] evaluate the drivers behind the cumulative emission reductions in EU ETS sectors between 2005 and 2011 (compared to a business-as-usual scenario), which they find to be between 1,152 and 1,324 Mt $CO_2$.

[2] European Commission (2014a)
[3] European Commission (2014b)
[4] Until 2008 the ETS was in a pilot phase and the emissions cap remained constant.
[5] European Commission (2013)
[6] Martin et al. (2013)
[7] Gloaguen and Alberola (2013)

The study attributes relative shares of the different factors that contributed to these reductions by applying econometric methods. They find that policies from the EU climate and energy package for 2020 (GHG reduction, renewables, energy efficiency) might have contributed to a reduction of around 766-805 Mt $CO_2$. The main contribution was from the expansion of renewables energies (60%-80%), followed by energy efficiency measures (20%-30%), while the impact of the carbon price signal was relatively small (only 0-10%)[8]. In addition, according to the study, the economic crisis led to an emissions reduction of around 296-346 Mt $CO_2$ and fuel price variations to another 262 Mt $CO_2$ (compared to a business-as-usual scenario). To sum up, while the annual cap of the EU ETS has been achieved for each year of its operation – and in fact, has been overachieved, as depicted in Figure 1, leading to the accumulation of an emission "surplus"– the main reasons for these emissions reductions were factors other than the EUA price. This does not imply that a $CO_2$ price does not lead to emission reductions. Although the analysis shows that the economic downturn and the development of renewables have been the main drivers of the fall in emissions, the combination of these two factors has made it unnecessary for market participants to undertake additional abatement. However, it is important to note that - as long as the allowance price is positive - factors and measures in addition to the carbon price simply provide different ways of abating emissions (e.g. renewables or energy efficiency); they do not lead to additional reductions of total emissions as the cap remains unchanged and banking, i.e. the possibility to use EUA certificates in a later period, is allowed. In the following we refer to this problem as "overlapping policies".


**Figure 1: Historical developments of EU ETS annual cap (Cap), annual verified emissions from sources covered by the EU ETS (Emissions), annual offsets surrendered for compliance (Offsets) and average December future prices ($CO_2$ price). Source: Grosjean et al. (2014).**

[8] Gloaguen and Alberola (2013), presented at the Euro-CASE workshop, see footnote **Errore. Il segnalibro non è definito.**.

While EU ETS emissions were *de facto* reduced in 2012 and 2013, a structural reform of the EU ETS began to be debated. This debate was mainly triggered by the marked and persistent drop of the EU allowance (EUA) price (see next section for details). As a short-term measure, in 2014, the Commission introduced the so-called "backloading" that postpones the auctioning of 900 million allowances from 2013-2015 until 2019-2020. During 2014 the auction volume will be reduced by 400 million allowances, in 2015 by 300 million, and in 2016 by 200 million. However, this temporary measure does not change the overall cap during the third trading period of the EU ETS. In 2014, with its new proposal for a climate and energy framework for 2030, the EU Commission has proposed a structural reform of the EU ETS for the period beyond 2020.

## 2.2. Evaluating the price drivers in the EU ETS

The EUA price has experienced a sharp decline during the second phase of the EU ETS and has remained relatively low since then. In particular, it dropped from 30€ per ton of $CO_2$ in mid-2008 to as low as 3€ in April 2013. Several factors are widely assumed to be behind the deterioration of the EUA price[9]: (i) the deep and lasting economic crisis in the European Union[10], (ii) the large influx of CDM credits[11], and (iii) overlapping EU member state policies, e.g. renewable supporting schemes[12]. Only a very few studies, however, provide a fully-fledged empirical analysis of the price drivers. This is especially relevant because the annual emission cap in the EU ETS currently does not constrain the emissions. As discussed above, the latter are indeed driven down by lower economic activity and the renewables deployment. Prices in this regime, on the other hand, reflect expectations of *future* scarcities, which are inter alia subject to the credibility of the long-term political commitment of the cap in the EU ETS. The positive allowance price indicates that the cumulative cap (as determined by the linear reduction factor) is still binding but at the same time the low price level reflects that market participants anticipate only a modest long-term scarcity of allowances in the market.

Before reviewing the literature, it is helpful to clarify the main pricing mechanism in an emissions trading scheme such as the EU ETS. According to economic theory, the allowance price should reflect market fundamentals related to marginal abatement cost, i.e. the cost of abating an additional unit of $CO_2$, over the entire duration of the EU ETS if the cap is binding[13]. In the power sector, the most important short-term abatement channel is through switching of input fuels, the prices of which should be reflected in EUA prices if the market is efficient. Other price fundamentals include, for example, economic activity and weather conditions, since they determine baseline emissions and therefore the demand for abatement[14]. It is important to note that from an inter-temporal perspective, even if the cap in the current trading phase is non-binding today, expectations of future scarcities (or the long-term cumulative cap) in coming trading phases should still be reflected in future allowance prices. While movements in the demand for EUAs are influenced by marginal abatement costs, the supply is determined to a large extent by political decisions such as adjustments to the linear reduction factor or backloading. Thus, current and future supply and demand paths are at the heart of the price formation process in the market and essential for ensuring dynamic efficiency of the mitigation strategies chosen over time.

[9] de Perthuis and Trotignon (2013)
[10] Aldy and Stavins (2012), European Commission (2013) (p. 33)
[11] Newell et al. (2012)
[12] Fankhauser et al. (2010), Van den Bergh et al. (2013), Weigt et al. (2013)
[13] Rubin (1996)
[14] Hintermann (2010), Delarue et al. (2008)

Empirical evidence relating to these theoretical expectations is limited to Phase I (2005-2007) and the early stage of Phase II (2008-2012) of the EU ETS when the EUA price was still around 15€ / $tCO_2$[15]. The common finding for this period of relatively high carbon prices is that the identified marginal abatement cost drivers had only a limited influence on EUA price formation and that different dynamics were at work as the EU ETS market design evolved and matured [16]. Yet, evidence as to the causes of the EU ETS price drop over the period 2011-2013, which led to the persistently low EUA price level today, is just emerging.

A recent study[17] expands existing research by conducting a first *ex post* analysis for the entire Phase II of the EU ETS and the first year of Phase III. In particular, the study empirically examines whether and to what extent monthly EUA price changes are driven by three factors identified above (economic recession, international credits, and renewable policies). The overall finding is that demand-side fundamentals explain very little (see Figure 2) and fuel prices (coal and gas) in particular, no longer have the highly significant impact they had in Phase I. Instead, expectations of future economic development are positively and significantly correlated with the EUA price, which is in contrast to Phase I, where this relationship was weak[18]. Variations in economic activity indeed prove to be the most important abatement-related determinant of EUA price changes.

The study also assesses the relative importance of the substantial use of Kyoto credits, especially in 2011 and 2012. This influx might be attributed to the collapse in credit prices, but also to the European Commission's decision to exclude credits originating from hydrofluorocarbons (HFC) and adipic acid nitrous oxide ($N_2O$) projects from Phase III. In addition, they only allow new Certified Emission Reductions (CERs) if they originate from least-developed countries[19]. Large amounts of cheap credits were surrendered in the second half of phase II as a result. Even though the study finds a statistically significant negative influence of the issued CERs, the impact on the EUA price is minute. On the one hand, this could be because the maximum use of offsets was anticipated when setting the cap and only the timing has changed. On the other hand, it could mean that the data available for the analysis were limited and the result should be interpreted with some caution.

Finally, the study finds a statistically significant correlation between changes in renewable generation and EUA prices, but the magnitude of the impact is small. In fact, the development of renewables was expected based on the implementation of the 2020 package and so this effect should have been factored in, unless market participants did not believe in the possibility of achieving the renewables target[20].

[15] Mansanet-Bataller, Pardo, and Valor (2007), Alberola et al. (2008a), Alberola et al. (2008b), Hintermann (2010)
[16] Bredin and Muckley (2011), Creti et al. (2012), Koch (2014)
[17] Koch et al. (2014)
[18] Hintermann (2010), Chevallier (2009)
[19] Kossoy and Guigon (2012)
[20] Koch et al. (2014)

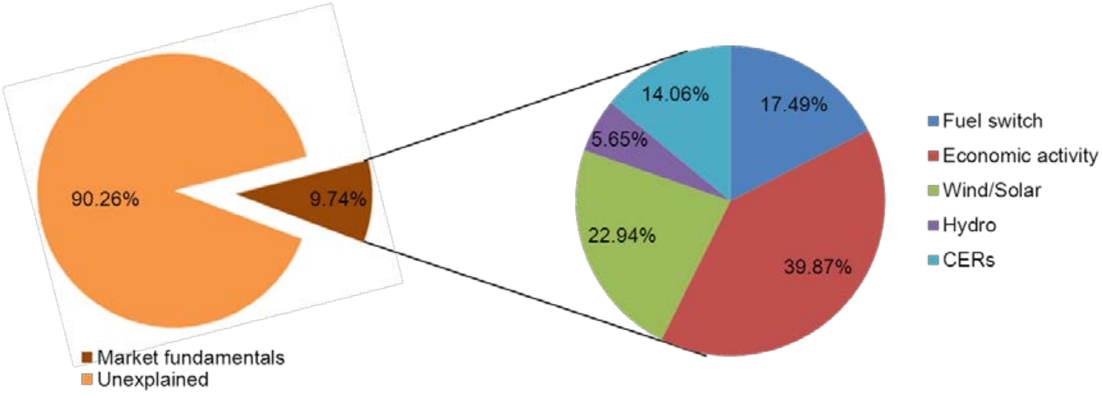


**Figure 2: Only about 10% of the price fluctuations can be explained by market fundamentals (left). The right part shows the different contributions of the different drivers. Source: Koch et al. (2014)**

The bottom line of the study is that 90% of the variations of EUA price changes remain unexplained by the abatement-related fundamentals on the demand side (see Figure 2). Consequently, the quantitative analysis does not support the widely-held view that negative demand shocks (economic crisis, renewables, Kyoto credits etc.) are the main cause of the weak carbon price signal. It should again be noted, that this finding is based on a thorough empirical analysis, which has also been called for by previous studies [21]. In particular, the finding for the role of the economic downturn is in line with the common intuition reflected in the current debate. However, the magnitude of its explanatory power is more limited than expected. Combined with previous findings for Phase I, this indicates that marginal abatement only weakly explains price changes in an EU ETS regime with non-binding annual caps.[22]

If demand-side fundamentals explain so little of the price decline in the EU ETS, it is necessary to have a closer look at the supply side. This is mainly influenced by political decisions. Regulatory announcements concerning the cap should have a major impact on prices – either through changing expected supply or, if they are not credible, by creating uncertainty and further depressing the price. The above-mentioned study gives indicative evidence that such policy events (e.g. the announcement of the backloading proposal) and the lack of their credibility could be alternative explanations for the low price, which is a key issue for future research.

It is clear that any discussion of policy reform, and an evaluation of the menu of options available for this, needs to be informed by a thorough understanding of market behavior and the dynamics of price formation. The economic crisis, and overlapping policies (and more specifically support of renewables) did reduce emissions (cf. section 2.1), but the above study finds that they are not solely responsible for the EUA price changes. This may, in particular, be the case because market participants do not expect a strict 2020 cap, as signaled by low futures prices.

## 3. Evaluating the dynamic efficiency of the EU ETS

In view of the low EUA price since early 2013, the key concern regarding EU ETS performance is its dynamic efficiency. Dynamic efficiency relates to the ability of the EU ETS, and in particular its

[21] Ellerman et al. (2014), Grosjean et al. (2014)
[22] Mansanet-Bataller et al. (2007), Alberola et al. (2008a), Alberola et al. (2008b), Hintermann (2010)

carbon price signal, to achieve its cumulative cap, as determined by the Linear Reduction Factor, at least cost. This can be done by optimally incentivizing mitigation efforts, investments, and research and development (R&D) into low carbon technologies over time. Evidence suggests that this is a broadly shared concern in the current debate over EU ETS reform[23], and is exemplified in the following EU Commission statement prompting its January 2014 reform proposal: "A large surplus hence strongly confounds the signal for investments, which are necessary for the transition towards a low-carbon economy, including energy supply. It is a problem as it is expected to result in locking the EU into high carbon capital and investment, in particular considering the currently high gas to coal price ratio"[24]. This indicates that the Commission is concerned about inefficient investment patterns creating a lock-in of carbon-intensive infrastructure investments today (such as in coal power plants) that might make future ambitious mitigation efforts, as indicated by the long-term EU decarbonization objective, disproportionally expensive.

In a perfect market (and perfect regulation) the EU ETS would incentivize a dynamically cost effective allocation of all available mitigation options over time. This section addresses the problem of how to evaluate the effectiveness of the actual EU ETS market outcome. It reviews three interrelated reasons for concern over the dynamic efficiency of the EU ETS: the low EUA price, significant uncertainty, and the potential proliferation of unilateral Member State policies.

## 3.1. Is there a problem with the low EUA price?

Figure 3 shows the actual near-future (blue line) and far-future (red line) price for EUAs. Both reference price series have declined in the past. An interesting feature of the figure is that the far-future 2020 price is always higher than the near-future price. However, this price spread shows a strong decrease over time. Currently, futures contracts for prompt EUA delivery trade at around 5€ / $tCO_2$, and futures contracts for delivery in the year 2020 are only slightly higher at around 7-8€ / $tCO_2$. It is important to note that the 2020 price is not zero because market participants expect at least some scarcity in the future. This is in sharp contrast to Phase I, where zero prices did indeed occur.[25] However, the 2020 price level is relatively low reflecting moderate expectations of future scarcity. The key concern regarding the dynamic efficiency of the EU ETS is rooted in the perception that these actual EUA prices (specifically, the far-future 2020 price) are 'too low'. However, such a judgment raises the question of what an adequate EUA price path would look like over time.

Economy-energy models construct stylized representations of relevant economic and technological processes, and offer benchmarks for assessing dynamic efficiency of actual observable market outcomes. In fact, they offer the only reliable benchmark available for judging whether EUA prices are 'too low' or 'too high' from this perspective. Alternative approaches for judging 'the right' EUA price, such as focusing on whether specific technologies such as CCS, certain renewables, or coal-to-gas switch in the power sector are triggered, only consider a subset of the available options of the models. Despite the caveats discussed below, economy-energy models are the only available tools providing integrated and systemic views on the diverse relevant factors (available abatement options, plausible technological change rates, allowance demand etc.) that need to be taken into account in an informed assessment on whether the EU ETS is on the right trajectory.

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[23] Grosjean et al. (2014)
[24] European Commission (2014c)
[25] Phase I was isolated from future trading phases, as banking was not allowed. Thus, the initial EUA oversupply resulted in a non-binding Phase I cap.

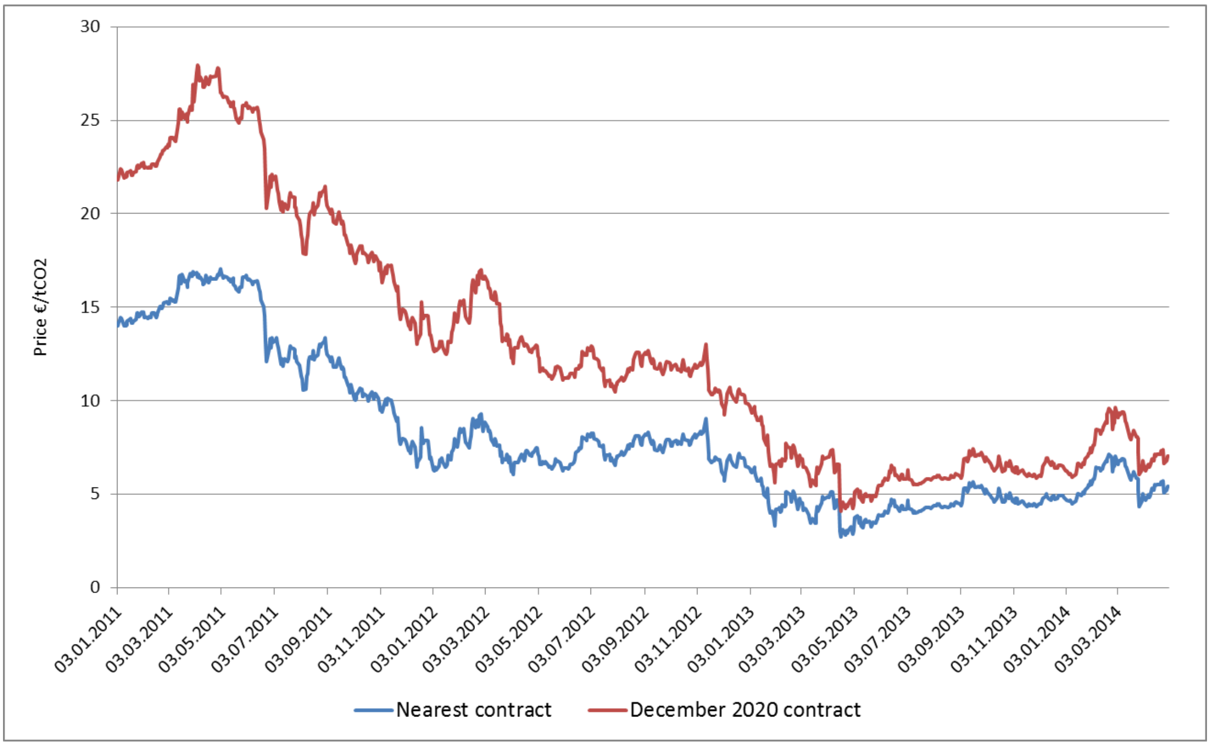


**Figure 3: EUA price for nearest futures contract and for December 2020 futures contract traded on the ICE ECX platform for the time span 2011-2013. Source: ICE Futures Europe[26].**

These economy-energy models reveal that current price paths in the EU ETS are not in line with socially optimal $CO_2$ price paths[27]. $CO_2$ prices from a recent model comparison exercise[28] in fact show that prices increase over time which is in sharp contrast to the declining trend in observed EUA prices. For 2015 the socially optimal $CO_2$ price paths, calculated by the models for the default case, range from about 10 to 20€ / $tCO_{2,}$ and for 2020 the optimal price range across models spans from 20 to 70€ / $tCO_2$ (see Figure 4, left panel). Comparison with the 2020 futures contract, which currently trades at around 7-8€ / $tCO_{2,}$ suggests that actual 2020 prices deviate substantially from the socially optimal price and that actual EUA prices are too low relative to these dynamic efficiency benchmarks. Clearly the EU ETS is not currently on a dynamically cost-effectiveness pathway. The reasons for this could be two-fold. On the one hand, the problem could be rooted in lower business-as-usual expectations of market participants compared to energy-economy models; for example expectations of a slower economic recovery or technological breakthroughs. On the other hand, the lack of credibility of the long-term cap could be the driver of the divergence.

[26] www.theice.com

[27] The “optimal price” refers to the carbon price trajectory for achieving a given climate target at least cost over time, and "social" refers to the overall welfare perspective on these costs in contrast to costs of individual market participants.

[28] The EMF28 Study on Scenarios for Transforming the European Energy System (Knopf et al., 2013b).

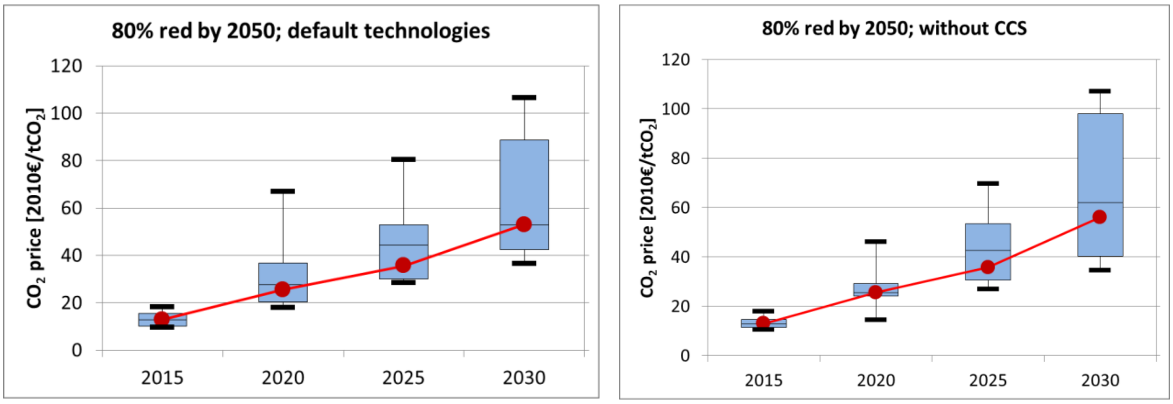


**Figure 4: $CO_2$ price trajectories for a cost-effective long-term pathway with an 80% reduction in GHG emissions by 2050 within Europe. Left: with default technology setting; right: without CCS. The blue box contains the 50% interval, the whiskers mark the 90% interval and the straight line marks 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". Source: EMF28 model comparison, Knopf et al. (2013b).**

It is certainly necessary to treat the $CO_2$ prices indicated by models with care. First, the scenarios indicated in Figure 4 are optimal economy-wide carbon prices. However, EU Commission modeling indicates that actual policies should generate roughly harmonized implicit carbon prices across sectors[29]. Also, earlier studies from academia indicate that the actual carbon price in the EU ETS tends to be too low relative to the implicit price in non-EU ETS sectors. This re-enforces the indication that actual EUA prices are too low relative to the dynamic efficiency benchmark. Second, there are strong differences in optimal $CO_2$ prices across models reflecting different assumptions in the operation of energy, the economy, and EUA markets, as well as different assumptions about the future development of key parameters such as GDP growth, energy efficiency improvements, renewable and fossil cost developments, and additional and overlapping policies. Uncertainty in these estimates and their relevance for policy design are discussed in the subsequent paragraphs. What will be stressed here is that the significant divergence between actual market prices and the benchmarks indicated by modeling, raises concerns as to whether the futures price signal of the EU ETS guiding investments today, and locking in potentially GHG intensive infrastructures (such as coal power plants) for decades, is in line with what long-term dynamic efficiency considerations would suggest it should be.

The reasons for the divergence between actual prices and model results are not well understood in the literature and minimally discussed so far. In the following section we will examine significant uncertainties both on the allowance demand side and allowance supply side as potential explanations for this divergence.

## 3.2. Uncertainties in the EUA price development

As discussed in the previous section, the formation of current futures prices hinges critically on the perceived supply-demand balance in the EU ETS market over the next few decades. These significant uncertainties are an important reason for the divergence between actual prices and socially optimal prices and further impede the dynamic efficiency of the EU ETS.

[29] The Impact Assessment (European Commission, 2014d) shows that that the (implicit) carbon prices within and outside the ETS sectors are virtually the same, i.e. in both cases a price of 22 €/$tCO_2$ by 2030 for the GHG40 scenario.

Demand-side uncertainties are a primary potential driving force behind the divergence. If market agents expected lower future GDP growth and thus lower future business-as-usual emissions than assumed in the modeling exercises, the EUA market price would be below the modeled efficient price trajectory. This uncertainty can be further exemplified by considering modeling sensitivity studies which find that price formation is indeed particularly sensitive to economic development. A sensitivity analysis for the EUA price in the PRIMES model for different GDP growth path assumptions shows a divergence of expected optimal prices between 6-50€ / $tCO_2$ in the year 2030[30]. Furthermore, the uncertainty over technological development is a crucial determinant for the price path. The EMF28 model comparison shows that without CCS availability, the optimal price path shows a slightly higher $CO_2$ price and specifically a much more robust picture across the models for 2020 (see Figure 4, right panel).

Another explanation for the divergence could be that market agents expect more lenient supply, i.e. they do not find the cap announced by policymakers credible and they expect it to be relaxed in the future. Both the uncertainty of future targets and the credibility of long-term commitment might therefore push the market EUA price below that in the cost effective modeling projections. Yet another explanation might be that the uncertainties over both supply and demand are so large that private agents resort to discounting long-term supply-demand balances in the EU ETS and the expected scarcity of allowances several decades away, putting more weight on the current (over)supply-demand balance in the market, thus depressing prices.

The myriad of uncertainties may not only drive a wedge between actual market prices and the socially optimal benchmarks, they may also present direct challenges to the investment planning of regulated companies. 'Too much' uncertainty can further hamper dynamic efficiency by halting investment activities altogether. Real options studies[31] show that the value of information, measured by the willingness of investors and producers to pay for information on the correct $CO_2$ price path, is high when the supply of allowances is frequently adjusted. In addition, the larger the price uncertainty, the larger the cumulative $CO_2$ emissions over the forthcoming century, as the transition to less $CO_2$-intensive technologies is increasingly postponed. This indicates that both environmental and dynamic efficiency will be negatively affected by uncertainty in the policy process and a consequent uncertainty in the supply. In general, such studies show that climate change policies that are stable over a certain length of time outperform frequently changing policies both in terms of emissions savings and cost effectiveness. It is worth noting that this challenge to investors might prevail even if current and future EUA prices are higher than they are now.

In summary, supply-demand uncertainties create significant policy design challenges for policymakers aimed at ensuring dynamic efficiency. This critical aspect will be central to the discussion of the EU Commission reform proposal for a market stability reserve (see section 4.2) as well as the alternative EU ETS reform package (see Section 5) below.

## 3.3. Overlap with unilateral Member State policies

The overlap of policy instruments between the EU ETS and individual nations causes further concern regarding the dynamic efficiency of the EU ETS. In view of the currently low EUA price (section 3.1) and the indicated uncertainties (section 3.2), some Member States might increasingly resort to

[30] Capros (2014), presented at the Euro-CASE workshop, see footnote **Errore. Il segnalibro non è definito.**.

[31] E.g. Fuss et al. (2009)

national mitigation policies in order to achieve their more ambitious domestic mitigation goals. However, reliance on domestic policy instruments would create an inefficient pattern of regulation across the EU and would add to the factors working towards reducing the EUA price. The EU ETS is embedded in a multi-level governance structure, with Member States having diverging preferences over their technology mix and level of climate policy ambition. The EU ETS is not the only instrument for climate and energy policy, but based on the national sovereignty of the energy mix, Member States can implement additional measures, such as renewable support schemes, energy efficiency measures, or additional domestic carbon prices (UK) that interact with the EU ETS. This is likely to intensify asymmetries in marginal abatement costs across Member States and thus increase overall policy cost. In addition, these policies also do only reallocate but not on net reduce emissions and can add to an even stronger reduction of the EUA price by exogenously reducing the allowance demand through channels identified in section 2.2, thus intensifying the problems of the EU ETS. At the same time, given the differences in envisaged levels and timing of climate policy targets across Member States, the question arises as to whether the EU ETS can be adjusted to help guide these divergent national preferences towards mutually beneficial outcomes. These points are revisited in the discussion of reform options in the next sections.

# 4. Reform options for the EU ETS

## 4.1. Overview of reform options

As described in section 2.2, various factors may explain the current low price: (i) the economic crisis, (ii) the inflow of international credits, (iii) the overlapping policies, and (iv) the low credibility of commitment. Table 1 summarizes the categories of factors and the mechanisms which influence the price. As discussed in the previous sections, whether the EU ETS needs reform, and the type of reform warranted, depends on the factors that are considered to be the drivers of the low price. Therefore, problems with different price drivers will need to be addressed for different reforms and the third column of Table 1 categorizes the reform proposals currently under debate.

| Factor | Mechanism | Possible reforms |
|---|---|---|
| Economic crisis | Reduced production by companies within the EU ETS leading to lower permit demand: excess supply of permits | Backloading, market stability reserve, adjustment of target or linear reduction factor, price collar |
| Inflow of international credits | Higher than expected use of CDM credits depresses demand for permits. | Restriction of offset use, options addressing surplus (see quantity- and price-based options above) |
| Overlapping policies | Support for renewables leading to displacement of $CO_2$ emissions within the EU ETS and through this lower EUA demand and price | Improved coordination between overlapping policies, sectoral expansion, options addressing surplus (see quantity- and price-based options above) |
| Low credibility of commitment | Demand for EUAs adjusted downwards due to changes in expectations/uncertainty | Price collar, carbon authority |

Table 1: Price formation process in the EU ETS and currently discussed reform proposals

The generic reform options shown in Table 1 have been detailed in a number of scientific studies. They can be broadly categorized as instruments addressing the price either directly (e.g. through a price floor) or indirectly through the supply of permits, leading to more certainty on price or quantity. In such a framework, various combinations of hybrid schemes exist. The other dimension of reform is institutional and pertains to the degree of delegation that is embodied in a reform. Delegation is understood as in a monetary policy context: the extent to which the governance of the carbon market (in this case the supply of permits) is relinquished to a rule-based mechanism or an independent body.

A rough classification of the different reform proposals in the two-dimensional space of price/quantity certainty and degree of delegation is given in Figure 5. A variety of alternatives are proposed in the literature, including rule-based permit supply adjustment based on economic and energy indicators[32] or price triggers[33]. An independent carbon authority is also put forward to adjust a price corridor[34] or to ensure the compatibility of the cap with other climate and energy policies as well as to monitor the import of carbon offsets[35]. In common with central banks in monetary policy, this authority would have a mandate enabling it to make adjustments in the supply of allowances either through a rule or based on discretionary power[36].

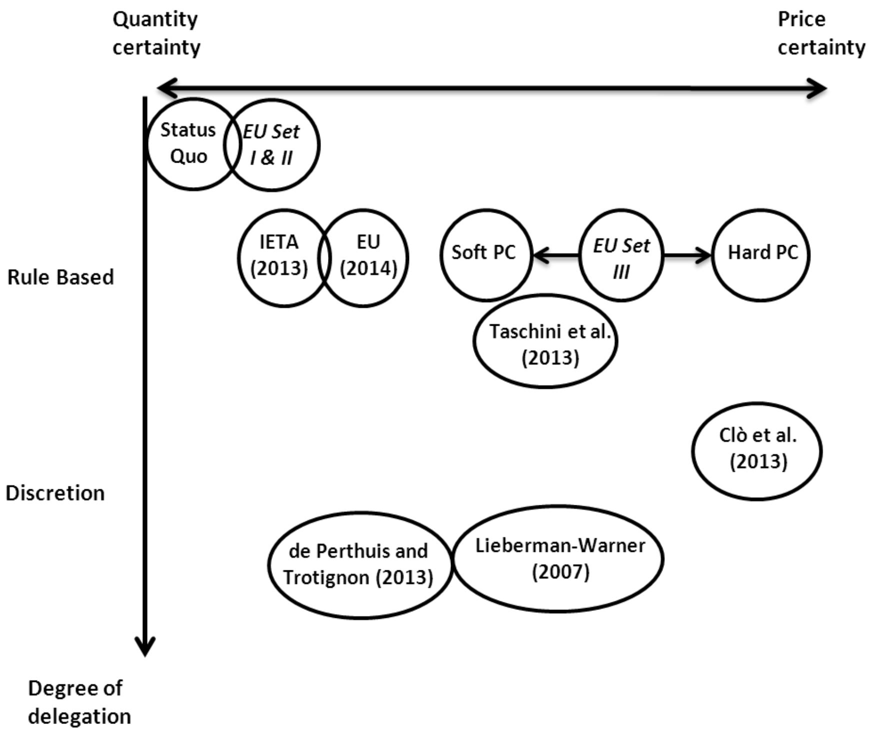


**Figure 5: Overview of different reform proposals. Soft PC: soft price corridor; Hard PC: hard price corridor[37]. Source: Grosjean et al. (2014).**

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[32] IETA (2013)
[33] Taschini et al. (2014)
[34] Clò et al. (2013)
[35] de Perthuis and Trotignon (2013)
[36] U.S. Congress (2007)
[37] A soft price collar refers to a trading scheme with an auction reserve price and an allowance reserve that can be called upon when the price reaches a specified upper limit. A hard price collar represents a design with a strict price floor and price ceiling.

Within the existing debate, the European Commission proposed a set of six concrete reform options in November 2012. These options, initially intended to prop up the price, can be broadly divided into three sets (see Table 2)[38]. Set I includes options aimed at a one-off reduction of permits. Set II foresees an adjustment of the scope of the EU ETS through sectoral expansion or offset restrictions and set III includes discretionary price management options.

| **EU Set I: Reduce permit surplus** | **EU Set II: Adjust scope** | **EU Set III: Reduce Price Uncertainty** |
|---|---|---|
| • Increase the EU emissions reduction target to 30% by 2020<br>• Retire a number of allowances in phase three<br>• Early revision of the linear reduction factor | • Expand the EU ETS to other sectors<br>• Restrict the number of usable offsets | • Discretionary price management, e.g.:<br>➢ Price floor<br>➢ Soft price collar (allowance reserve) |

**Table 2: Overview of reform options proposed by the EU Commission.**

Set I entails a change of environmental ambition, or at least an adjustment of the current legislation affecting the 2020 targets, and should increase current price levels to reflect an expected increase in scarcity of allowances. Set II is likely to have an impact on the price but assessing its net impact requires further investigation. Set III resembles classical hybrid structures with either a price floor or an auction reserve price. In the case of the latter, unsold allowances would be placed in a reserve that could be called upon in case of price hikes.

These reform proposals were discussed in a number of workshops and in stakeholder seminars organized by the Commission. In January 2014, the European Commission finally proposed a reform framework of the EU ETS along with broader climate policy targets for 2030. The proposal is a rule-based adjustment mechanism, called "Market Stability Reserve" (MSR), which regulates the permit supply based on the size of the surplus of allowances in circulation in the market[39]. The MSR will be evaluated in detail in the next Section.

Along with the proposal of a Market Stability Reserve, the Commission also suggested a tightening of the linear reduction factor (LRF) within the EU ETS sector. This is currently set at 1.74% up to 2020 and beyond (see section 2). The LRF is not part of the legal proposal and it is also not a structural reform instrument; it mainly addresses the question of environmental ambition. The annual reduction rate of 1.74%, which is currently agreed, is consistent with an overall reduction of about 73% by 2050. The Commission has proposed an LRF of 2.2% from 2020 onwards, leading to a reduction of 87% by 2050 (relative to 2005) in the EU ETS sector. This is consistent with an 40% overall reduction in GHG emissions by 2030 or 80% by 2050, according to their own calculations. In our analysis of reform options, we take the LRF as given i.e. independent of the level that will be applied after 2020. All reform options might, in principle, be implemented before 2020. However, given the constraints and the time such a political process normally takes (even for minor changes) - the backloading, for example, took around 20 months to be finalized - it is not realistic that a full-

[38] Grosjean et al. (2014)
[39] Similar to the IETA (2013) proposal

fledged structural reform could be implemented much before 2020. Despite this, it is worth noting that although the reform implementation will take several years and might be delayed to Phase IV (2021-2030), market expectations and prices are likely to adjust in anticipation, factoring in expected changes.

In the following, we will discuss the Commission's proposal of a pure quantity-based instrument in detail as it is currently the most important reform proposal already in the legislative procedure and yet the mechanism is not very transparent. We evaluate whether the proposal addresses the lack of dynamic efficiency within the current EU ETS.

## 4.2. Evaluation of the Market Stability Reserve

The proposed Market Stability Reserve (MSR) is designed to adjust the short-term auction supply without affecting the long-term cap by establishing a reserve of non-auctioned allowances. The MSR is based on pre-defined rules on (i) when to feed allowances into the reserve and when to release them (triggers), and (ii) how many allowances to reserve and how many to release (adjustment size). When the total allowance surplus[40] is higher than 833 million allowances, 12% of the surplus is removed from future auctions of the following year and placed in the reserve (i.e. at least 100 million allowances). If the total surplus is below 400 million allowances, 100 million allowances are released from the reserve and added to future auctions. 100 million allowances will also be released if, for more than six consecutive months, the allowance price is more than three times its average price during the two preceding years (additional "safeguard" trigger). The reserve can be carried over multiple periods, ensuring that the MSR is neutral to the overall cap.

The first key design aspect of the MSR is the focus on a *quantity-based trigger* based on the size of the cumulative allowance surplus (see also Figure 6). The aim is to maintain the total surplus within the pre-defined target range of 400 and 833 million allowances. The second key design aspect is the *asymmetric adjustment size*. While the release of allowances is limited to 100 million allowances, the withdrawal can be much higher depending on the size of the total surplus (e.g., 240 million allowances for the current surplus of 2,000 million). The asymmetry reflects the EC's aim to remove the surplus of allowances that has built up without releasing them too quickly.

These design features also reflect the underlying concerns and objectives of the European Commission which are outlined in the Impact Assessment of the MSR[41]. The problem definition focuses mainly on "market imbalances" caused by the rigid auction supply. The main concern is that the resulting large "structural surplus" negatively affects the long-term cost-effectiveness of the EU ETS in the short-term and beyond. Thus the increasingly high allowance surplus, rather than the persistently low allowance price, is identified as the main problem. To restore the functioning of the EU ETS, it is assumed that reducing the surplus to a certain band level will restore the "signal" that guides low-carbon investments[42]. The signal is most likely influenced by the allowance price because in an ETS it is the price that incentivizes dynamically efficient investment. In this sense, it is implicitly

[40] The total allowance surplus, or more specifically the "total number of allowances in circulation", is defined as the difference between all allowances issued plus international credits used since 2008 up to the end of each year, and verified emissions recorded since 2008 plus allowances in the reserve at the end of that same year.

[41] European Commission (2014c)

[42] "A large surplus hence strongly confounds the signal for investments, which are necessary for the transition towards a low-carbon economy, including energy supply." European Commission (2014e)

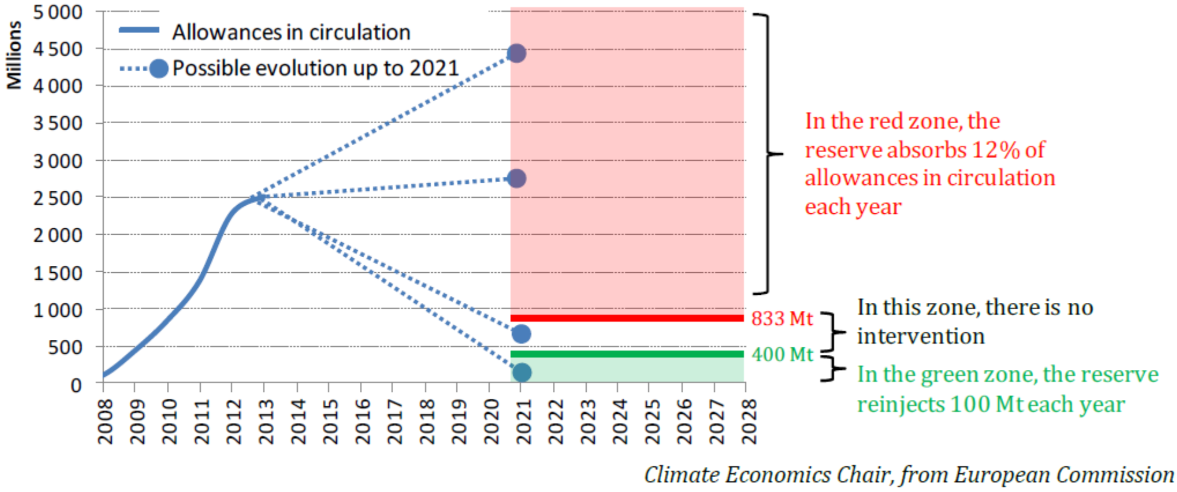


**Figure 6: Stylized representation of projected allowances in circulation: the MSR triggering mechanism. The figure shows a stylized representation of projected allowances in circulation (size of the cumulative allowance surplus) that serves as the basis for intervention conditional on two quantity-based triggers (red and green line). Source: Trotignon et al. (2014).**

assumed that a surplus size in the range of 400 - 833 million allows market prices to remain undisturbed. Some argue that such a surplus level may be justified by the needs of regulated entities to hedge their forward sales of electricity. Thus, the MSR can be considered as an instrument to (temporarily) reduce the volume of unused allowances in situations where the allowance surplus grows beyond the hedging demand. However, if the volume within the MSR, set between 400 and 833 million allowances over the period to 2030, should decline with total emissions over time, then the hedging demand will also decline. It is also problematic that there could be a significant time lag before any intervention occurs. This is because the trigger is based on an indicator – i.e. the total surplus – for which timely data is not available. It can only be calculated based on data (for verified emissions and surrendered allowances/credits) relating to the situation two years previously. This inflexibility sheds doubts on the ability of the MSR to encourage supply flexibility in the EU ETS.

Moreover, it remains unclear whether the surplus band of 400 – 833 million allowances in the MSR was actually informed by hedging demand estimates. Indeed, the European Commission only states that "the upper and lower boundaries of the range were determined following consultations with stakeholders and reflect a range where experience shows that the market was able to operate in an orderly manner"[43]. Thus, the exact rationale behind the triggers is opaque. That may be exactly because getting the quantities "right" seems impossible given (i) the diverging views on the order of magnitude required, (ii) the way that hedging will evolve over time, (iii) the risk posed by strategic reporting of companies about their hedging behavior, and (iv) the limited possibilities of verifying the data. As a result, the European Commission seems to have adopted a trial and error approach with respect to the choice of quantity triggers since they are due to be revised by 2026 at the latest in order to correct potential failures in their setting. The expected revision may herald a continuous adjustment phase of the EU ETS (with unforeseeable consequences) for the next decade, which is unlikely to contribute to stabilizing the expectations of market participants. In particular, experience has shown that a revision of EU ETS legislation is a complex process characterized by high transaction costs and large regulatory uncertainty.

[43] European Commission (2014f)

In addition, it is questionable whether the central assumption of the MSR – that a temporary reduction of the allowance surplus will cure the price decline – is justified. In fact, even the Commission's impact assessment acknowledges that the price impact of the MSR cannot be anticipated[44]. This is precisely because the MSR only changes the timing of auctioning - in this sense constituting a long-term backloading proposal - and as such does not provide a clear price signal. When the reserve builds up, the number of allowances accessible to market participants at auctions in the short-term will decrease. However, the allowances are supposed to come back to market auctions in the mid to long-term.

According to standard economic theory, such a cap neutral adjustment of the auction timing should have a minimal or zero impact on the allowance price due to inter-temporal price smoothing. In fact the MSR may have some effect if the quantity of allowances withheld in the reserve is sufficiently large to ensure that companies with an allowance shortage (e.g. the power sector) cannot meet their compliance needs by buying them in auctions. Only then might short-term prices increase to a level that motivates surplus owners (e.g. industry) to sell allowances. However, rebound effects would occur when the allowances return to the market, resulting in depressed prices in the mid to long-term. *Ex ante*, the extent to which market participants will anticipate the inter-temporal impact of the reserve and adapt their behavior is uncertain. Moreover, the allowance price evolution should depend on whether market participants expect the allowances to be returned to the market as currently proposed. As a matter of fact, it is possible that a number of allowances could be permanently retired after a certain period of time, or if the reserve exceeds a certain size. Such a hypothetical adjustment would no longer be cap-neutral and should drive up the price.

According to inter-temporal pricing theory the interplay between the magnitude of the allowance surplus and the allowance price formation seems incomprehensible. The picture might be slightly different however, if market failures prevent the occurrence of inter-temporal price smoothing. For instance, once the surplus in the market exceeds the hedging demand from power producers, speculative investors may be needed to provide balance. Yet, speculators may require high rates of return, and can only secure such returns if the allowance prices are highly discounted relative to expected future prices. In such a setting, with hedge market failure and suboptimal discounting, a reduction of the allowance surplus by means of the MSR could be adequate to stabilize the allowance price[45]. However, it remains to be empirically determined whether discount rates of future prices increase *de facto* with increasing surpluses. The current implied interest rate of the EUA futures curve indeed suggests that discount rates decrease when the surplus builds up[46].

In summary, from a theoretical perspective, the central assumptions of the MSR on the allowance surplus are not upheld; an allowance price link is incompatible with inter-temporal price formation in a dynamic ETS incorporating banking, unless market failures prevent price smoothing. Given the weak impact on the price signal, the MSR should also have a very uncertain impact on investment in R&D as well as on low-carbon investments. In a similar vein, several public statements on the MSR also reflect the difficulties of stakeholders in anticipating the impacts of the mechanism. These have

[44] European Commission (2014c)
[45] Schopp and Neuhoff (2013)
[46] Based on futures price data for (i) the nearest contract and (ii) eight December contracts with expiration in Phase III (2013-2020) obtained from ICE Futures Europe (www.theice.com).

been labeled as “paper-tiger” and “backloading-de-luxe” amongst others.[47] Most strikingly, several market participants (e.g., BDEW, OPG, IETA) call for additional clarification on the mechanism’s effect, corroborating the above conclusion. In view of these major uncertainties, it is unlikely that the MSR can cure the problem caused by a lack of dynamic efficiency and prevent a lock-in into carbon intensive technologies. It also does not address the problem of overlapping policy instruments at Member State level. A broader reform is therefore required.

# 5. A comprehensive reform of the EU ETS

In Section 3 we have identified the major problems of the current EU ETS in terms of cost-effectiveness and the related problem of additional unilateral policy instruments at Member State level. In Section 4.2 we have argued that the proposed MSR will not address and cure these problems. Therefore, instead of a narrow reform of the EU ETS, a comprehensive reform addressing several aspects of carbon pricing is required. This includes (i) setting a price collar within the EU ETS, (ii) expanding the EU ETS to other sectors (e.g. transport, heat) (iii) addressing additional market failures by policy instruments in addition to carbon pricing and (iv) addressing the possible problem of carbon leakage by expanding the group of countries that participate in the EU ETS or by linking it to other regions.

## 5.1. Setting a price collar

While the MSR is a purely quantity-based instrument that indirectly aims to stabilize the allowance price, setting a price collar directly addresses price certainty. A price collar is a two-sided price instrument that combines a price floor (minimum price) with a price ceiling (maximum price). Within the auctioning system of the EU ETS it is possible to implement a minimum price as an auction reserve price. This means that the allowances in the auction are only released when the auction price is beyond a pre-defined minimum price. A price ceiling could be implemented by releasing additional emission allowances for auctions from a reserve if the auction price hits a specified maximum price[48]. This design has already been implemented successfully in the US Regional Greenhouse Gas Initiative.

In general, implementing a price collar in the EU ETS would generate three different potential outcomes: (i) when allowance demand is low, the price is set close to the floor level, and emissions are below the annual cap; (ii) when demand is moderate, the price is somewhere between the floor and ceiling, and the emissions are determined by the cap; and (iii) when demand is high, the price is set at the ceiling, and emissions are above the cap. Thus, the hybrid price-quantity mechanism reduces the price uncertainty arising on the demand side, e.g. due to uncertain future GDP growth or future technological development. Accordingly, this mechanism represents a compromise between concerns about environmental outcomes (cap on emissions) and concerns about cost uncertainty (allowance price volatility)[49]. Moreover, it would address the industry’s concern of prices that are so high that they might threaten EU competitiveness. However, while it directly addresses the problem of the weak price signal, it does not solve the underlying problem of lacking long-term credibility.

[47] e.g. Bellona Europe (2014)
[48] Wood and Jotzo (2011)
[49] Murray et al. (2009); Fell et al. (2010)

This section outlines the two main advantages of a price collar: first, and in contrast to the MSR, it directly addresses dynamic efficiency. Specifically, it can deliver a stable and sufficiently high allowance price and address the crucial question of how to manage expectations of long-term prices. Second, it can facilitate the environmental effectiveness of unilateral climate policy measures (e.g. renewable supporting schemes) in the EU Member States with heterogeneous costs and preferences, as long as the price operates at the floor level.

### 5.1.1. Addressing the problem of dynamic efficiency

As outline above (see Section 3.2), the concern about the dynamic efficiency of the EU ETS is largely underpinned by (i) the current low EUA price and (ii) the significant supply and demand uncertainty, which can distort optimal private sector decisions over mitigation, investment, and R&D. Setting a price floor is probably the clearest way to correct the current low price signal and achieve EUA prices that are high enough to drive dynamically efficient investment. In fact, the implementation of a price floor via an auction reserve price would immediately increase the current price of allowances (even if the price corridor is not introduced before the next trading phase in 2021). This inter-temporal price effect is due to the fact that market participants would anticipate the future scarcity created by the unsold allowances held back from auctions below the reserve price[50]. If the implemented price floor was also credible, the introduction would immediately impact company investment decisions. In combination with the price ceiling, the specified price corridor truncates the possible range of EUA prices in times of low and high demand and, hence reduces the significant uncertainties on the demand side. The increased allowance price certainty could help overcome the investment backlog arising from 'too much' uncertainty. By reducing demand-side uncertainties, on top of implementing a sufficiently high EUA price, a price collar may incentivize the investment in the innovations that are required for cost-effective long-term decarbonization. While the floor price is justified in terms of cost-effectiveness, the argument for a price ceiling is different. It is needed because prices can also increase substantially through shocks. When a ceiling is set, this risk is reduced symmetrically, which is important for investors, as for them both directions of the risk (prices that are substantially higher or lower) are important. So setting a price collar gives a level of confidence. In addition, a price ceiling prevents costs becoming politically infeasible. However, it is worth noting that uncertainties regarding the supply side of allowances (e.g. future changes in the cap), in particular with regard to credibility problems of long-term commitments, still exist in an ETS with a price collar (see below).

In addition to delivering a stable and sufficiently high allowance price, a price collar addresses the important question of how to manage expectations for long-term prices. It has been shown that in order to achieve dynamic efficiency, current prices should reflect (discounted) long-term price expectations. An ETS with banking can achieve that result *if* market participants have sufficient foresight and capacity to form rational expectations about the longer term[51], and *if* they do not significantly discount future prices and quantities due to uncertainty in supply and demand. However, it is not clear whether the requirement for rational expectations in the EU ETS, as well as discounting in line with social preferences, is ensured in practice. Indeed, in the absence of the necessary foresight, the price collar is a useful way for the European Commission to signal the

[50] By contrast, if the floor price was implemented through the payment of a minimum tax (while maintaining the allowance release) a full price drop of EUAs between now and 2020 would probably result, since the oversupply would become permanent and thus their scarcity value zero.

[51] Newell et al. (2012)

socially desired levels of current and future prices in line with the long-term cap of the EU ETS. This can further induce incentives to invest in low-carbon technologies and avoid a lock-in into a carbon intensive infrastructure, e.g. in power capacities and grid.

However, the latter hinges heavily on the question of whether the price signal is credible because the price collar is set within the political sphere and can be revised and even overhauled over time. In fact, policy revision is necessary, precisely because a fundamental feature of climate change is uncertainty about its impacts. In particular, as new information about the benefits, costs and global commitment arise, expectations about long-term emission levels and prices will evolve and this makes revisions to the EU ETS policies essential[52]. Transparent and orderly policy revisions can minimize credibility problems to provide an institutional setting that secures long-term credibility[53].

Besides the legislative procedure already available, some propose the creation of an independent authority with a degree of discretionary power to make adjustments, see Section 4.1. Various designs for an independent carbon authority have been put forward in the literature[54] with the hope of giving the process credibility, in a similar vein to delegation in monetary policy. An independent group of experts, protected by long-term mandates, would be in charge of reacting to new information and making sure that the signal sent by the EU ETS is consistent with the long-term goals of climate policy. While such an institutional design is appealing, the major challenges would be defining the exact mandate of such an institution and preserving its democratic legitimacy. It should also be noted that the question of the institutional design is not specific to the option of setting a price collar, but is a question for every reform option, as outlined in Section 4.1.

### 5.1.2. Addressing the problem of unilateral policies at Member State level

The second – and so far often overlooked – advantage relates to the aspect of environmental federalism and the concern that Member States (MS), due to their diverse preferences towards the technology mix and level and timing of climate policy targets, might increasingly implement domestic policy instruments that impact the objectives of the EU ETS[55]. Under the current, purely quantity-based EU ETS, any effort to reduce emissions by one MS does not affect the overall level of emissions. In other words, the adoption of any unilateral measure is not environmentally effective[56]. For instance, assuming that there are no additional market failures, a renewable supporting scheme for electricity at the Member State level does not lead to any additional abatement – it only leads to a lower EUA price[57]. This situation becomes even worse if the resulting low allowance price motivates the MS with more ambitious domestic mitigation goals to implement further unilateral measures, which would further exacerbate the problem of falling allowance prices. By contrast, an EU ETS with a price floor would allow Member States to adopt their own policies and, most importantly, the unilateral measures could actually contribute to an overall emissions reduction at the EU level. More specifically, if the EU ETS operated a floor price, every national tax, renewable

[52] Newell et al. (2012); Murray et al. (2009)
[53] Grosjean et al. (2014)
[54] U.S. Congress (2007) , McKibbin (2009), de Perthuis and Trotignon (2013), Clò et al. (2013)
[55] Knopf et al. (2013a), Edenhofer et al. (2013)
[56] Burtraw and Shobe (2009)
[57] Only in the extreme case of an allowance price close to zero the unilateral measures would be environmentally effective.

supporting scheme or efficiency standard would lead to additional abatement, i.e. the unilateral policies would be environmentally effective. During times in which national policies are in a phase of revival (e.g. the carbon floor price in the UK)[58] it is of vital importance for the EU ETS as a European instrument, to take this into consideration. An auction reserve price could therefore address both the politically economic constraints of the multi-level government and the overlapping of EU and MS policy instruments. It would allow national preferences to be addressed, for example those with high ambitions for mitigation, without undermining the environmental effectiveness of such additional policies. The floor price would guarantee that a stable and sufficiently high allowance price is delivered. However, evidence suggests that national emissions reduction measures, such as the deployment of renewables, have a higher marginal abatement cost than those induced by the EU ETS. In other words the unilateral measures are not (statically) cost effective[59]. Also, it is clear that the environmental effectiveness argument only holds when the EU ETS operates at the floor price. If the allowance price is above the floor, national policies lead to an allowance price reduction without additional abatement. Moreover, it is important to note that a floor price implemented at the national level, such as in the UK, would not be an environmentally effective way to reduce emissions[60]. Only an EU-wide minimum price would have an effect on emissions.

There are certainly some challenges in introducing a price collar. The first problem is to determine the “right” dynamic EUA price collar. As discussed above (Section 3.2), economy-energy models provide integrated and systemic views on socially desired $CO_2$ price levels. Specifically, these models enable the required $CO_2$ price paths to be determined to achieve a given cumulative cap at least cost. Based on different key parameter assumptions about – such as GDP growth, energy efficiency improvements, renewables and fossil cost developments – model comparisons can deliver optimal price ranges for a given cumulative cap. This price range could then guide decisions on the price collar. For instance, the recent EMF28 comparison exercise shows a minimum price of 20€ / $tCO_2$ across models for scenarios after 2021 (see Figure 4). Existing economy-energy models could certainly be extended and dedicated to determining a dynamic price collar. In addition, current estimates for the social cost of carbon (SCC) can be useful in determining a price corridor. The SCC is a standard indicator for the economic damages associated with climate change; it reflects the present monetary value of damage that would be avoided by a marginal reduction in $CO_2$ emissions. Most recent analyses suggest that the expected global cost of one ton of $CO_2$ emitted in 2020 is between \$12 and \$64 (with \$43 as the central value)[61]. It should be noted that the models used to estimate the SCC, known as integrated assessment models, probably understate future damages. The greatest problem however, might be political feasibility and the multi-level governance character of the EU ETS; it is likely that a price floor, even if it is implemented as an auction reserve price, will be interpreted as an (EU) tax. Taxes however, as all fiscal measures, are subject to the unanimity rule of the EU and it seems to be difficult to get an agreement of all 28 Member States on an adequate price level. In this context, the lesson learned from the Californian ETS is that an auction reserve price does not necessarily constitute a tax in the legal sense. Instead, it was considered to be a fee not subject to supermajority requirement. Another disadvantage concerns

[58] Sartor and Berghmans (2011)
[59] However, the unilateral measures may in principle be dynamically cost effective, if they generate technology spillovers.
[60] Fankhauser et al. (2010)
[61] U.S. Government (2013)

environmental effectiveness. If prices hit the ceiling, and the price cap is applied, then fewer emissions would be reduced in the ETS sector than desired and more emission reductions would have to be delivered by sectors outside the ETS. Investing in offset projects to compensate for the increase of emissions could be one way to overcome this problem[62]. Revenues from EUA auctioning could be used to finance these offset projects (see Section 5.3). The second way to address this problem is the adoption a soft price corridor instead of a hard corridor. With a hard price collar, an unlimited number of additional allowances would be introduced if the allowance price hit the price ceiling. In such a situation it could become impossible to meet the emission reduction target of the EU ETS. In contrast, a soft price collar places an upper limit on the number of additional allowances in a given period when the price ceiling is hit. In this case, emissions cannot exceed the cap plus the allowance reserve. Thus, a soft price collar implies more quantity certainty than a hard price corridor. However, with a soft price collar the price ceiling will only be maintained as long as additional allowances are available in a reserve.

## 5.2. Expanding sectoral coverage

The EU ETS currently encompasses 45% of total EU GHG emissions. It covers the electricity sector, parts of the industry sector, and EU-internal aviation. In order to achieve long-term decarbonization targets, substantial emission reductions are also required in the other sectors, i.e. road transport, buildings and agriculture. The most cost-effective way to achieve reductions across all these sectors would be to equalize the sector marginal abatement costs. Establishing asymmetric sectoral GHG prices risks compromising cost-effectiveness by potentially generating very different levels of climate policy ambition across the sectors (different explicit and implicit marginal carbon prices). However, if the carbon price is to be uniform across all sectors, it has to be nuanced.

First, emission standards complementing carbon pricing can be justified because there are other market failures in the different sectors. Some studies have shown that emission standards are able to overcome the behavior "failures" of energy saving potentials[63], such as lack of and asymmetry of information, principal-agent problems, split incentives, hidden costs or bounded rationality. However, while the current regulatory standards can help address market failures such as split incentives between landlords and tenants or informational transaction costs in vehicle purchase decisions, these standards fail to incentivize all available abatement options, e.g. demand-side abatement options that would result from increasing the price of GHG emissions.

Second, another strand of literature has analyzed emissions standards as a temporary substitute for carbon pricing, when reliable carbon prices are not feasible due to short-term distributional consequences[64]. Emission standards for newly installed capacities protect owners of existing capital stocks from the depreciation of their assets and the under-utilization of their capital stock. In this way, efficiency standards can potentially reduce short-term costs (and increase the long-term costs) making the introduction of mitigation and the implementation of a carbon price politically more feasible. Despite the advantage of emission standards as a temporary substitute for carbon pricing, carbon pricing remains crucial in the long-term because of the rebound effect. Standards also risk causing a lock-in into fossil-fuel infrastructure without incentivizing investments into low-carbon

[62] Stavins (2008)
[63] Parry et al. (2014)
[64] Rozenberg et al. (2013)

technologies[65]. A basic drawback of climate policies based on standards is that they do not generate all of the available mitigation options.

A third reason arguing against a comprehensive coverage is that pre-existing regulation, distortionary taxes and subsidies are not perceived as removable in the short-run. Standards currently form the main policy instruments achieving emission reductions in the road transport and building sectors (e.g. EU vehicle $CO_2$-intensity standards at the EU-level, building codes at the national level). In addition, in the transport sector for example, different tax burdens applied for budgetary reasons or for internalizing factors other than the climate externality, currently lead to implicit carbon taxes between 130 € / $tCO_2$ (Spain) and 230 € / $tCO_2$ (Greece)[66]. Including all existing sectors in the EU ETS would therefore lead to different tax burdens across the sectors. In addition, specific dynamics in each sector might have to be considered; these would include inertia, risk aversion and discount rates of consumers or producers, the need for new technology deployment or demand elasticities. So, a dual price system, with an ETS for large industries and a carbon tax for diffuse emissions in the heat sector or road transport, might generate the best results in terms of incentivising investments in low carbon technologies, without overburdening industry. At least this could be a pragmatic step, which would not lose sight of the long-term perspective of a uniform carbon price and a full sectoral coverage of the EU ETS. In this context, it is important to note that the sectoral expansion is not meant to be an instrument for stabilizing short-term EUA prices, but it is meant to complement the price collar in order to achieve the decarbonisation in a cost-effective way.

## 5.3. Revenue recycling

In general, the carbon price interacts with the tax system[67]. It is an implicit tax on factors of production which can exacerbate distortions from pre-existing taxes. In addition, carbon pricing generates a new revenue stream for governments. The income stream of revenues can in principle be used for different purposes, e.g. reducing the burden from other taxes. Smart revenue recycling policies can potentially reduce net policy costs (double dividend) and improve the acceptance and the effectiveness of carbon pricing. GHG pricing policies generate government revenues in a cap and trade system, if allowances are auctioned, and in GHG tax systems.

Currently, within the EU ETS, about 40% of allowances are auctioned, while the larger proportion of allowances is still issued at no cost. About 70% of all allowances will be auctioned up until the year 2020, when the transitional free allocation to some sectors in a few countries will be phased out. 88% of all auctioning revenues are distributed back to the Member States according to the grandfathering principle based on their proportional emissions in the period 2005-2007 (taking whichever year in which emissions were highest), while 12% of auctioning revenues are returned primarily to the least wealthy countries, i.e. the new Member States. The EU directive on the EU ETS recommends spending at least 50% of the auction revenues on mitigation and adaptation. This is only followed by some Member States; some incorporate it directly into the general budget (25%)

[65] Bertram et al. (2013)
[66] Vivid Economics 2012.
[67] Goulder (2013)

and for some the use is simply unknown (41%)[68]. Altogether a revenue stream of 3.55 bn€ was generated in 2013.

A higher proportion of auctioning would allow Member States to raise more revenues for different purposes. A simple thought experiment gives an idea of the order of magnitude of revenues from an ETS with a broader sectoral coverage and increased auctioning; introducing a rising price collar with minimum price of 20€, expanding EU ETS sector coverage to 90% and increasing the auctioning shares to 80% would *ceteris paribus* yield total EU revenues of about 64bn€. This is a factor of 18 above the revenue in 2013.

These revenues could be used to lower labor and capital taxes, thus reducing net policy costs and potentially compensating for increased energy costs of households (e.g. by preferentially lowering income taxes or increasing social benefits for poorer households). Another option is to forego auction revenue value and lower policy costs of industries threatened by competiveness concerns by allowing inframarginal exemptions[69]. Lowering costs to particular industries can, under a cap and trade system, be achieved by free allocation of allowances for a certain fraction of company emissions, and by inframarginal tax exemptions under a carbon tax. In both systems public revenues are foregone to effectively finance specific exemptions for industry. This underlines that the aspect of revenue recycling and its proper use is of vital importance for the acceptance and political feasibility of pricing carbon.

## 5.4. Stimulating innovation: policy instruments in addition to carbon pricing

Innovation is crucial for developing the required low carbon technologies. To trigger innovation, dynamically efficient carbon prices are needed. As we argued above, it is difficult to establish dynamic efficiency within a cap and trade system. A price floor, as a hybrid instrument, could solve this problem because it establishes a long-term credible price signal.

Even a reliable price signal might not be enough to stimulate innovation. This is because there are market failures in the innovation and diffusion of technologies, besides that of the climate externality, that provide a strong rationale for policies that foster the development and adoption of low-carbon technologies[70]. The main market failure associated with innovation is knowledge spillover, i.e. firms cannot receive full benefit from their innovations. The main market failures associated with adoption are learning and network externalities. Moreover, both stages are also characterized by market failures related to incomplete information.

There are different policies to address the market failures specific to both stages. R&D policies support technological development until the technologies are ready for commercialization[71]. As empirical evidence for innovation spillovers is very high and as knowledge market failures are higher in clean technologies[72], there is substantial agreement among economists that R&D polices should be part of the portfolio of policy instruments. In general, several instruments exist to support R&D

[68] Flachsland (2014)
[69] Goulder (2014)
[70] Jaffe e al. (2005)
[71] Goulder and Parry (2008); Aldy et al. (2010)
[72] Dechezleprêtre (2014)

including subsidies to private R&D, strengthened patent rules, and technology prizes. It is important to note that different policy instruments become relevant at different stages of the innovation process[73]. However, as the outcome of innovation processes, i.e. market success, cannot be anticipated in advance, and the exact effects of innovation policy are unknown, policy learning requires some experimentation and a large variety of policies.

Support during the adoption and diffusion stage is accomplished by deployment policies which create a market pull for certain technologies. Typical instruments used to support, for example, renewable energy sources are feed-in tariffs or renewable portfolio standards. Whether such policies are warranted is a controversial issue, mainly because solid empirical evidence is lacking and the seriousness of the underlying market failures cannot be determined[74]. Proponents, however, argue that the potential positive technological externalities are sufficient to ensure respective policy efforts are maintained. Moreover, historical experience with technological transformations in other sectors, suggests that the use of deployment policies will be needed[75].

A comparison of the social return on investments of R&D policies with that of deployment policies would be necessary for the design of these policies. Unfortunately, empirical evidence is limited. Public support for R&D in new climate friendly technologies, incentives for market development of ripe technologies and stable long-term market conditions that guarantee investor security are all important aspects for innovation. In those areas where spending on deployment measures has exceeded public R&D investments (such as wind and PV), the market should be strengthened and public support schemes should be gradually cut back when technologies become competitive. The newly available resources may then be used to expand research in areas where more research is still needed, such as storage, grids or (smart) demand-side options. In these areas it seems reasonable to reallocate government investment flows from deployment to R&D.

Innovation policy encompasses science and technology policy and goes beyond mere support of R&D. Policy instruments target various stages of the innovation process ranging from supporting basic science to market deployment. The choice of the most suitable policy instrument depends on the maturity of the technology.

It is important to bear in mind that successful innovation policy needs to allow private businesses to exploit market opportunities. Therefore, setting standards, market development, and legal framework conditions are as important as financial R&D support. Private actors are able to mobilize considerably higher R&D budgets than public bodies, which is underlined by the differences in business vs. government expenditures on R&D. It may well be argued that innovation efforts by private companies are hindered because of a non-existent commonly agreed long-term framework for European energy and climate policies.

Innovation energy policy should focus on strengthening the overall performance of the innovation chain and capacity of its stakeholders for innovation. While the definition of climate targets and research agendas by EU institutions certainly contributes to streamlining otherwise dispersed

[73] IRENA (2013)
[74] Aldy et al. (2010)
[75] Jaffe (2012)

research efforts, systemic policies geared towards strengthening the overall performance of innovation systems are hardly ever to be found.

## 5.5. Addressing carbon leakage

A long-standing issue in the debate on unilateral climate policies is the concern that some fraction of the emission reductions achieved might be offset by increasing emissions in regions with no – or less ambitious – climate policies[76]. Addressing carbon leakage is important for political feasibility because if the burden for the home industry is perceived to be too high, a reform of the EU ETS will not be agreed upon. In addition, if emissions are outsourced to other world regions, it questions the environmental effectiveness of the instrument.

Depending on a large array of assumptions, including the desired stabilization goal and how industrial structure and international trade are modeled, the literature finds a broad spectrum of leakage rates in the regions subject to binding emission targets (i.e. the fraction of unilateral emission reductions offset by leakage)[77]. For instance, a recent comparison of 12 computable general equilibrium models finds leakage rates between 5% and 19%, with a mean value of 12%[78]. For the scenarios assuming unilateral action by the EU to cut emissions by 20% and 30% below years 2004 and 2020 respectively, the study finds respective leakage rates of 15% and 21%. More recently, several contributions have indicated that leakage rates could become negative, i.e. more abatement in the EU would also reduce emissions in other countries. This may arise either from fuel switching within energy markets[79], through technology diffusion to non-abating countries, or from crowding out of capital accumulation in third party countries as a result of rising capital demand in countries engaging in abatement[80]. In addition, it has been demonstrated that technology spill-overs to non-abating countries can significantly reduce leakage rates[81].

One robust insight that emerges from the literature is that leakage rates are lower where participation in international mitigation efforts is broader [82]. For this reason, harmonizing carbon prices via policy coordination, or even linking the EU ETS with other emerging emission trading systems could 'level the playing field'[83]; carbon leakage with regards to trade with these regions could be eliminated or alleviated when all or some sectors are covered by the EU ETS. When linking such systems without full coverage, the overall effects on leakage are ambiguous and depend on the sectors covered in the system with which the EU ETS is to be linked[84]. This is because linking not only eliminates one economic distortion (different carbon prices between the capped sectors), but also increases another (the difference in carbon prices between the capped and the uncapped sectors in one region). Hence it is necessary to carefully analyze the effects of linking on carbon leakage.

[76] Branger and Quirion (2013)
[77] Jakob et al. (2014)
[78] Böhringer et al. (2012)
[79] Bauer et al. (2013) and Arroyo-Currás et al. (2013)
[80] Baylis et al. (2013), Carbone (2013) and Winchester and Rausch (2013)
[81] Bosetti et al. (2008), Golombek and Hoel (2004) and Di Maria and van der Werf (2008)
[82] Boeters and Bollen (2012)
[83] Houser et al. (2008)
[84] Marschinski et al. (2012)

Free allocation of emission permits is another way to reduce carbon leakage. This can be achieved by 'grandfathering' (i.e. allocation of emission permits in proportion to past emissions[85]), which provides an incentive to remain in business for firms that are subject to a carbon price if their potential losses are covered by the value of free emission permits[86]. As demonstrated in a study for the US[87], giving away 13% of emission permits to energy-intensive industries would be sufficient to maintain their profits, and it seems reasonable to assume that for the EU a roughly similar figure would apply. In addition, if future emission permits are assigned by grandfathering, using today's emissions as a basis, companies will have fewer incentives to reduce their production in order to receive more of these permits at a later date[88], such that there is less incentive to increase imports in these sectors and carbon leakage is reduced[89]. However, this also means that more abatement has to be performed in other sectors, where it may come at a higher cost, thus increasing total mitigation costs. Output-based rebates (OBRs) that give emission permits to companies free of charge in proportion to their output relative to an industry- or sector-specific benchmark on emission-intensity (i.e. emissions per unit or per monetary value), are an alternative to grandfathering. As OBRs only incentivize a switch to cleaner technologies, rather than a reduction in production or consumption, the price signal for emission-intensive products is not fully passed through to final consumers. This raises the economic costs of achieving a certain level of emission reductions above those of grandfathering[90]. As a consequence, no unambiguous conclusion can be drawn regarding the preferred policy in terms of welfare (including issues such as consumption losses, distributional consequences and employment effects) or reducing leakage. Rather, the total effect of both policies depends on the interplay between creating additional domestic emissions and avoiding emissions abroad[91].

Finally, tailor-made trade policies are an appropriate means of addressing leakage. In this context, it should be noted that the popular concept of full 'border tax adjustment' (BTA) which would subject imports from regions with less ambitious climate polices to a price on 'embedded emissions' equal to the one prevailing in the EU ETS, does not constitute an optimal policy and can even increase carbon leakage[92]. This is due to the fact that faced with tariffs, the EU's trade partners would readjust their production structure towards goods for the domestic market instead of exports; it might well be the case that the former are more carbon-intensive than the latter, which would then cause emissions to increase. Furthermore, full BTA would be subject to considerable uncertainty and imply substantial costs to determine the carbon content of imports at a product level. As carbon leakage predominantly concerns energy-intensive and heavily traded products, a scheme that focuses on a few key sectors could substantially reduce leakage. For instance, one study determined that the application of EU border taxes on imports of steel, aluminum, and cement would reduce leakage in these sectors to practically zero[93]. In order to decrease complexity and alleviate concerns related to discriminatory treatment, carbon contents could be calculated on the 'best available

[85] Clò (2010)
[86] Demailly and Quirion (2008)
[87] Goulder (2013)
[88] Weitzman ( 1980)
[89] Demailly and Quirion (2006)
[90] Quirion (2009)
[91] Fischer and Fox (2012)
[92] Jakob, Steckel, and Edenhofer (2014)
[93] Monjon and Quirion (2011)

technology approach' which assumes that trade partners use production technologies comparable to the EU[94]. As a mechanism to make such an arrangement politically feasible, the EU should negotiate agreements with its main trading partners in which the latter agree to levy taxes on their most carbon-intensive exports[95]. This would have the identical effect on carbon leakage as import tariffs, but would permit the exporting countries to retain the associated tax revenues. An interesting example of such an approach are the voluntary export restraints put into place by Japan to protect the US car industry in the 1980s. That taxation of energy-intensive exports is feasible is shown by China, which already has such an export tariff in place (allegedly to reduce domestic energy consumption)[96].

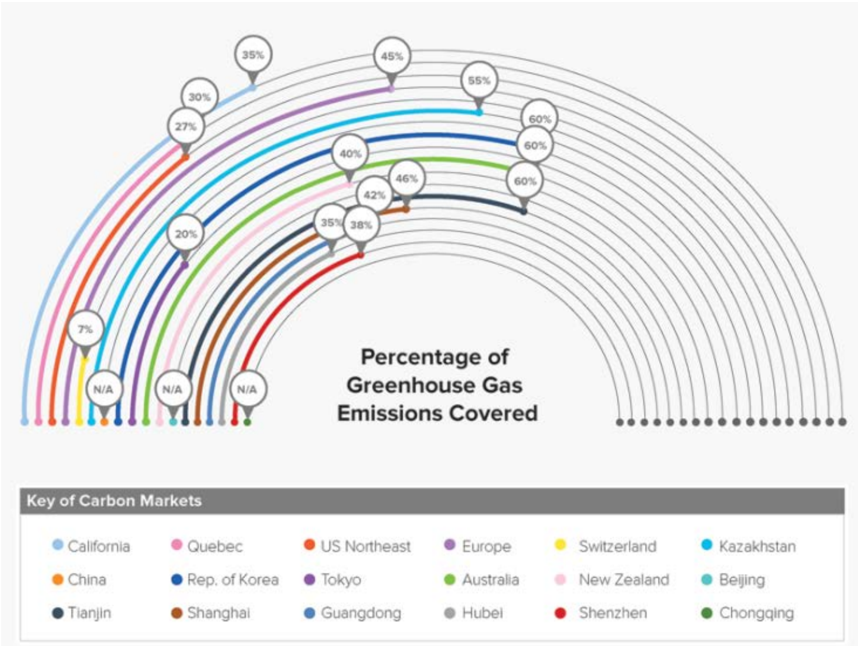


**Figure 7: The emergence of global carbon markets. The biggest emitters can make the biggest difference. Source: World Bank (2013).**

However, certainly the best way to tackle carbon leakage and the most efficient way to reduce global emissions is for the number of countries that apply carbon trading schemes, or that implement a carbon tax, to increase. Carbon markets are already being established worldwide (see Figure 7). The new World Bank Report on "States and trends of carbon pricing" concludes that a growing number of countries and regions are putting a price on carbon and that "together these carbon pricing instruments cover almost 6 $GtCO_2e$ or about 12% of the annual global GHG emissions"[97]. It is obvious, however, that this coalition must grow substantially in order to effectively address climate change . So far the effect of carbon leakage has been rather small, but for the future there is the danger that without stronger international endeavor, Europe's aspirations will get stuck in a cul-de-sac, contributing little to emission reductions but compromising European competitiveness. In this respect a price collar might be a good instrument when taking the linking and the compatibility to other emission trading systems into account. One proposal for the

[94] Ismer and Neuhoff (2007)
[95] Jakob et al. (2014)
[96] Wang and Voituriez (2009)
[97] Ecofys (2014)

international negotiations, for example, suggests[98] that all major economies should signal a floor price in addition to an emission target to prevent targets from being unexpectedly lax. Introducing minimum GHG prices worldwide would probably be the best way to address carbon leakage.

## 6. Conclusions

This paper presents and reflects the discussion surrounding the current performance of the EU ETS and specifically the persistently low price of EUAs. It analyses the performance of the EU ETS in terms of environmental effectiveness and cost-effectiveness, and examines the reform options additionally in terms of political feasibility. Our analysis concludes that the environmental effectiveness of the EU ETS is given (in fact the emission target has been overachieved), but that the EU ETS lacks dynamic efficiency. The EU Commission has suggested addressing this problem by introducing a reform that manipulates the supply of EUAs, i.e. the Market Stability Reserve. However, we show that this reform proposal does not address the problem of dynamic efficiency, mainly because the interplay between the magnitude of the EUA surplus and the EUA price formation seems incomprehensible from an inter-temporal perspective. It also fails to address the problem of overlapping policies arising from the existence of supplementary policy instruments at the Member State level that could undermine the overall performance of the EU ETS. By contrast, our analysis clearly shows that instead of a narrow reform of the EU ETS focusing on the EUA surplus, a comprehensive reform addressing a series of aspects of carbon pricing is required. This includes (i) setting a price collar within the EU ETS, (ii) expanding the EU ETS to other sectors (e.g. transport, buildings) (iii) addressing additional market failures through policy instruments in addition to carbon pricing and (iv) addressing the possible problem of carbon leakage by expanding the group of countries that adopt comparable GHG prices.

Evaluating the reform proposals of the EU ETS currently being discussed, it is important to understand how prices are formed In particular in a situation with non-binding annual caps, it is unclear how price formation works. In theory and in a situation not characterized by a temporarily non-binding cap, abatement-related fundamentals affect the price through the demand side (e.g. support for renewables raises their deployment and thus decreases the demand for EUAs). Political decisions have an impact on the price through the supply side (e.g. by adapting the cap).

Latest research indeed shows that in a regime with temporarily non-binding annual caps, the abatement-related fundamentals working through the demand side are generally only able to explain a minor share of the observed price decline in the EU ETS. One explanation is that market participants do not seem to believe in the (long-term) cap announced by policymakers. The lack of credibility thus results in further downward pressure on the EUA price and very likely impedes cost-effective investment by failing to provide the incentive to innovate and deploy clean technologies.

The widely-held view is that the cumulative surplus of EUAs in the EU ETS needs to be addressed. This is the reason why the EU Commission has proposed the MSR. However, the outcomes of the workshop and our analysis identify the stabilization of price expectations as the main problem. The MSR is not able to address this problem. It is also unlikely that the MSR can cure the problem of a lack of dynamic efficiency and prevent a lock-in into a carbon intensive infrastructure. This is

[98] McKibbin et al. (2009)

because the MSR is a quantity-based and cap-neutral set aside that only changes the timing of auctioning - in this sense constituting a long-term backloading proposal - and as such does not provide a clear price signal. Instead, we propose to set a price collar with an upper and lower level for the EUA price, which would be the ideal policy instrument to judge cost-effectiveness criteria. It would help to reduce uncertainty over supply and demand now and in the future and thus stabilize expectations. This could address market failure in the sense that in a political market like the EU ETS, the future is much more exposed to uncertainties and regulatory changes, with potentially tremendous impacts, than in other markets. The ability of an EU ETS with a price collar to achieve environmental effectiveness depends to a great extent on the specific design of the collar.

It is important to note that a price collar does not come without challenges. First, considering political feasibility, quantity-based reforms are preferred to the price collar, which is perceived to be similar to a tax. Second, there are implementation challenges of a price collar: while modeling seems to be the most straightforward way to determine the relevant price range, there is significant uncertainty between models, even when their underlying assumptions are harmonized. Careful implementation will need to factor this in and find ways to determine a price range which is robust across the spread of model outcomes. In addition, unforeseen events might change the conditions on which the price collar was modeled, so it needs to be flexible enough to be adapted under such circumstances without losing credibility. Arbitrary adjustments should be avoided and any changes should be made transparent and performed on the basis of previously specified rules.

| **Reform options, instruments and measures** | **Environmental effectiveness**[99] | **Dynamic efficiency** | **Political feasibility**[100] |
|---|---|---|---|
| Market Stability Reserve | o | o | + |
| Price collar | At max price: -<br>At min price: + | + | - |
| Expanding sectoral coverage | o | + | - |
| Addressing carbon leakage | + | + | + |
| Additional instruments for inducing innovation | o<br>(+ if enables more ambitious cap in the future) | + | + |

**Table 3: Evaluation of considered reform options. Evaluation of environmental effectiveness and dynamic efficiency relates to changes relative to the status quo of EU ETS design. The reform proposal by the EU Commission is marked in blue and the reform package proposed in this paper is marked in orange. Legend: "+" means high, "-" means low and "o" means indifferent. Smart revenue recycling policies have the potential to facilitate the expansion of the sectoral coverage and of addressing carbon leakage by compensating industry for additional burdens.**

Table 3 summarizes the evaluation of the reform proposals by the EU Commission and the reform package proposed in this paper, according to the three different criteria introduced above. Our analysis clarifies that in addition to the setting of a price collar, a comprehensive reform proposal is

[99] Defined as (i) achievement of target and (ii) level of ambition

[100] Defined as anticipated support by powerful interest groups (different industries, NGOs and governments).

required. The sectoral expansion is an equally important cornerstone of a reform, as the associated policy instruments will help stimulate innovation if there are additional market failures. Last, but not least, expanding the group of countries that participate in the EU ETS or by linking the ETS to other regions can address the concern of carbon leakage. All options differ in terms of political feasibility (see Table 3). The proposed reforms could in principle be implemented before 2020, but given the long lead-times, this does not seem to be politically feasible. The linear reduction factor is independent of the concrete reform proposal and should be adjusted to be in line with an EU-wide GHG target for 2030, once it is agreed upon.

We conclude that although setting a price collar might seem politically infeasible, it might be the best way to tackle different problems at the same time. Or put it differently: the MSR might be a politically feasible reform option but will most probably, in the end, turn out to be a “toothless tiger” and no more than “backloading-de-luxe”.

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