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Adjusting supply in the EU ETS

Significantly higher emissions barely lower energy costs

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Summary

This report evaluates the adjustments to the supply of emission allowances within the EU emission trading system (EU ETS) recently proposed by the European Commission. Specifically, we analyse the impact of the proposed relaxation of the emissions cap and the reform of the Market Stability Reserve (MSR), including the elimination of the rule stipulating that surplus allowances in the MSR can be permanently invalidated (the 'invalidation mechanism'). In this analysis, we examine the effects of these measures on the total CO_2 emissions within the EU-ETS, the price of emission allowances, and market stability in the period through to 2050.

According to our calculations, the adjustments could lead to 2.9 Gt of additional emissions within the EU ETS through to 2050, which is an increase of 33%. If the rate at which the new emissions cap decreases between 2036 and 2040 continues after 2040, a total of 2.3 Gt in additional allowances will be issued by 2050. Of this amount, 1.3 Gt is generated through the purchase of international credits (after 2036) and permanent carbon removals within the EU (between 2031 and 2040). On top of the extra issuance of 2.3 Gt in allowances, 0.6 Gt of additional emissions will become available because allowances, which would otherwise become invalid, remain in circulation. Most of these extra emissions are an indirect consequence of the expansion of supply, since this results in fewer allowances entering the MSR. Consequently, the proposal to stop the invalidation mechanism, in combination with other adjustments, only has limited influence on total emissions up to 2050.

The decrease in emission price, resulting from these adjustments, is marginal compared to the energy price increases of the recent years. Businesses and traders are anticipating an increase in supply in the future, which, according to our analysis, will cause the price of emission allowances to fall by 14%. Converted into natural gas prices, this is comparable to a cost reduction of €2 per MWh for businesses, which constitutes approximately 3% of the current gas price. This decrease stands in stark contrast to the price increases of the gas market in recent years.

The proposed adjustments result in reduced price stability within the EU ETS. By no longer invalidating allowances in the short term, the EU ETS loses an important stability mechanism. Due to the future expansion of supply and the lower emission price today, businesses will use more emission allowances and thus reduce their stock of allowances in the short term. Consequently, fewer allowances are flowing into the MSR, reducing the duration of its stabilising effect. Our study calculates the impact of the proposed adjustments for price stability based on a 10% negative demand shock in 2029. The effect is clear: without adjustments, our analysis shows that the price will decrease by 3%; with the proposed adjustments, this decrease will be 5%.

Additionally, the proposals by the European Commission make other forms of support for the industry less effective. An earlier CPB/PBL study (Olijslagers et al., 2026) examined whether the industry's competitive position can be effectively improved through subsidies, and what the consequences of this would be for CO_2 emissions in the EU. The study shows that the invalidation mechanism plays an important stabilising role, because it ensures that fewer allowances are invalidated and, consequently, more allowances remain in circulation when lower costs for the industry (as a result of increased production) lead to additional demand for emission allowances. The invalidation mechanism therefore mitigates the upward pressure that subsidies exert on the emission price. Without this mechanism, subsidies would lead to a *higher* emission price, which would, in turn, weaken the intended improvement in the industry's competitive position.

1. Introduction

To strengthen the competitiveness of European industry against the backdrop of persistently high energy costs (Draghi, 2025), the European Commission (EC) has recently proposed to ‘modernise and update’ the EU ETS for phase 5, which runs from 2031 to 2040. The proposed changes include measures to increase total market supply, expand the free allowance allocation, set up a fund for additional investments in decarbonisation (reducing CO_2 emissions), and a broader scope for the EU ETS (European Commission, 2026a). In this report, we focus on the consequences of a slower reduction of the emissions cap starting in 2031 and the reform of the Market Stability Reserve (MSR). We do so using a model that incorporates the key features of the current emission allowance market, including the MSR with permanent invalidation of allowances.

We find that the decline in price of emission allowances resulting from the proposed expansion of supply, will only marginally contribute to the competitiveness of European industry. This is especially true when we take into account the recent energy price increases. Furthermore, this limited price decline is accompanied by a significant increase in cumulative emissions through to 2050. Finally, the aforementioned adjustments are damaging to price stability within the EU ETS, both due to the elimination of the invalidation rule, and due to the lower expected price of emission allowances, which reduces the quantity of accumulated allowances and, ultimately, the MSR stock.

2. Current operation of the EU ETS

The emissions pathway towards net zero in the EU ETS is determined by the annual linear reduction factor (LRF). This factor determines the rate at which the emissions cap decreases over time. The most recent adjustment to the emissions cap via the LRF was part of the 'Fit for 55' reform adopted in 2023, and resulted in a stricter cap for the rest of phase 4 by increasing the LRF to 4.3% until 2027 and 4.4% starting in 2028.

Additionally, since 2019, the EU ETS also contains a market stability reserve, the so-called MSR, which removes emission allowances from the market in the event of a surplus, and reintroduces them when there is a shortage. The goal of the MSR is to promote long-term price stability. Its introduction was a direct response to the oversupply of emission allowances in phase 3. This oversupply led to low prices for emission allowances during that period (Brink et al. 2016; Perino, 2018). Since 2023, allowances in the MSR above a certain threshold have been invalidated each year. As a result, the total volume of emission allowances is no longer fixed but also depends on market conditions.

Both the (announced) stricter emissions cap and the MSR with invalidation have contributed to a significant increase in the price of emission allowances since 2017 (Starz et al., 2024). Whereas the price in 2017 was still well below €10 per metric tonne of CO_2, the price has been consistently higher than €50 per metric tonne of CO_2 since 2021. The price has remained relatively stable despite the significant economic turbulence, such as the COVID-19 crisis and the increases in fossil fuel prices caused by the wars in Ukraine and Iran. The MSR likely played a key role in this: such negative demand shocks prompt businesses to reduce their emissions, resulting in a larger stockpile of unused emission allowances. This, in turn, leads to a greater inflow into the MSR the following year and, consequently, more invalidations. Since 2023, more than 3 billion emission allowances from the EU ETS have been invalidated (European Commission, 2026b).

3. Current operation of the EU ETS

In its recent proposals, the European Commission has introduced several measures that affect the total supply of emission allowances in the EU ETS:

- Direct adjustments to the supply of emission allowances through various measures:
    - Adjustment of the linear reduction factor (LRF) to 3.7% between 2031 and 2035, and 1.7% between 2036 and 2040, to align the cap with the new 2040 target in the amended European Climate Law;
    - This new LRF, which will be effective from 2036, is contingent upon the European Commission's purchase of 260 million 'high-quality, credible, and cost-effective' international carbon credits between 2036 and 2040; if such credits are unavailable, the emissions cap will be reduced by the number of projected international credits by setting the LRF starting in 2036 at 2.7% instead of 1.7%;
    - Additional emission allowances above the emissions cap through the integration of 250 million extra allowances via domestic permanent carbon removal.
- Adjustments that indirectly affect the supply of emission allowances, i.e. via the MSR:
    - Termination of the invalidation mechanism by 2027;
    - An adjustment to the rules governing in- and outflows from the MSR, using dynamic parameters in line with the shrinking cap.

It is important to note that the July 2026 proposal for the revision of the EU ETS also includes several other changes, such as extending the period of free allocation of emission allowances, expanding the scope of the ETS (international aviation, small vessels, and waste incineration), and an investment fund for decarbonisation, which includes the reallocation of 800 million allowances from the 'free allocation buffer' and the 'new entrants reserve'. Even though these adjustments are also important for the competitiveness of European industry, they have little to no impact on the total supply of emission allowances. As a result, they will also have less impact on the emission price than direct changes in supply via the LRF and the MSR. For this reason, we exclude these adjustments from our analysis.

4. Method

We use an extension of a simple model for price formation in a cap-and-trade system (Ellerman and Montero, 2007; Olijslagers et al., 2026), to better understand the effects of the aforementioned adjustments. In the model, businesses and traders behave rationally and form rational expectations based on supply and demand in the emission allowance market. Emission allowances can be kept fully in reserve if so preferred. Businesses and traders optimise the costs and benefits of allowances over the entire planning horizon up to 2050. Consequently, price formation for the market as a whole follows Hotelling's rule with a 'risk-free interest rate'. In our analyses, we assume an interest rate of 5%.

The annual supply of emission allowances is determined by the emission cap set by the European Commission, in combination with MSR flows and the invalidation rule. We assume that the LRF applicable in 2040 will remain in effect after this date. Demand follows an exogenously declining path to reflect long-term technological changes, adjusted for emission reductions by businesses based on the emission price. The latter is modelled using an aggregated marginal emission reduction cost curve that incorporates not only technical adjustments (as in McKinsey, 2025), but also all other reduction options (though implicitly). The cost curve is calibrated using observed emissions and the price of emission allowances for the period 2024-2026.

Our baseline scenario reflects current regulations, that is, prior to the implementation of the adjustments proposed by the European Commission. It indicates an inflow into the MSR through 2034 and an outflow starting in 2040, consistent with a recent analysis by Olijslagers et al. (2026).

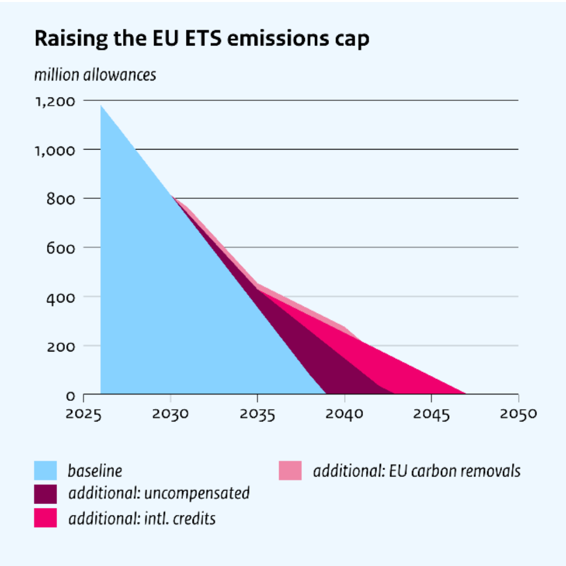
To evaluate the combined effect of these proposals by the European Commission, we implement the proposed changes that directly or indirectly affect the supply of allowances in our model.[1] We compare our estimates for the baseline scenario with these adjustments, keeping initial demand (i.e. the emission level without reduction) constant across all scenarios. This allows us to analyse the effects of these adjustments on emission price, total emissions, and price stability, including the interactions among the proposed adjustments.

[1] In our analysis, we assume that allowances can be invalidated until January 1, 2027. In reality, the implementation date for the phase-out depends on how quickly the European Parliament and the Member States can come to agreement on the proposal. For the other adjustments, we follow the implementation dates communicated by the European Commission. The model analysis assumes that businesses will already be factoring in the proposed adjustments from early 2026 onwards, meaning that their emissions could change as early as 2026 as a result of the proposal. The fact that the emission price did not drop after the proposal in July is an indication that businesses and traders were indeed already factoring in the proposed increase in supply within the EU ETS. See also Chapters 5 and 6 for a perspective on the development of the emission price over the past few months.

5. Direct consequences for supply

In this chapter, we examine the impact of direct adjustments to the supply of emission allowances, without taking into account the indirect effects on supply via the MSR. The proposed adjustments to the cap result in a clear increase in the total amount of emissions, particularly after 2035 (see Figure 1). As indicated, the underlying assumption here is that the trend in the supply of allowances and international credits during the years 2035-2040 will continue into the period after 2040. If we include the 0.25 Gt of emission allowances that will be added to the emissions cap during the period 2031-2040 through the integration of (domestic) permanent carbon removals, these ETS adjustments, taken together, will result in a total of 2.34 Gt of additional domestic (EU) CO_2 emissions compared to the baseline path; this is a relative increase of 28%. The adjustments mean that the year in which the cap reaches zero, is postponed by eight years to 2047. Of the additional emission allowances within the cap, 0.96 Gt is created by the integration of international credits starting in 2036 (less than one-third of which occurs in the years 2036-2040). This is because the procurement of international credits starting in 2036 allows for a less steep reduction path, based on an LRF of 1.7% instead of 2.7%.

Figure 1. Emissions cap in the baseline scenario after the proposed adjustments



Part of the additional emission allowances is the result of the integration of international credits (below the cap) and permanent carbon removal within the EU (formally above the cap).

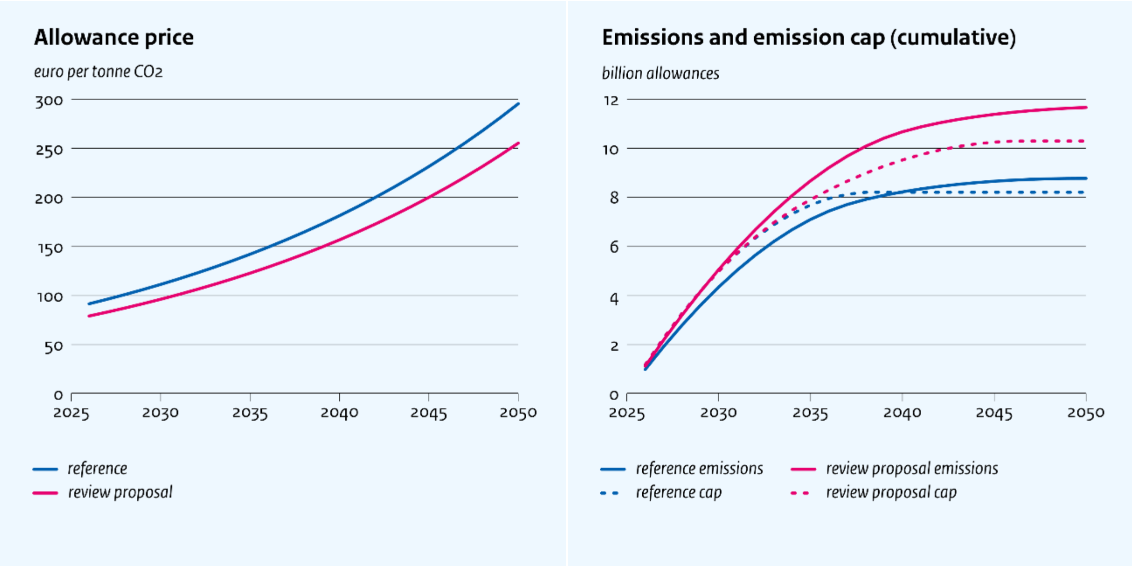
A larger future supply of emission allowances will result in less scarcity in the market. This will lead to a lower price for emission allowances, even in earlier years. At a lower price, businesses will reduce their emissions to a lesser extent. This affects not only the demand for emission allowances, but also the surplus of emission allowances, and thus the in- and outflow to the MSR and the invalidation of allowances. As a result, the overall effect on emissions may be greater than the direct increase in supply, and is therefore also sensitive to the changes to the MSR and invalidation proposed by the European Commission. In the following section, we describe the overall effect of adjustments using our EU ETS market model, which also accounts for the indirect effects on supply via the MSR.

We note that the price effects calculated by our model, and reported below, primarily provide insight into the expected direction of the consequences of certain proposals. The calculated figures should therefore be regarded primarily as indicative. The actual price observed on the EU ETS market is, in fact, determined by many more factors than the supply adjustments to the EU ETS that we examine in our calculations. Changes in, for example, energy prices, other elements of the Commission's proposal, or production volumes also play a role in determining the final price on the emission allowance market (Olijslagers et al., 2026; Schure and Vethman, 2020).

6. Overall effects

The proposed adjustments to the emissions cap and the MSR have a limited downwards effect on the price of an EU ETS emission allowance (see Figure 2). This is because businesses and traders immediately adjust their expectations downwards regarding future scarcity of emission allowances in the market. In our analysis, this causes the allowance price to fall by 14%.[2] A direct consequence of the lower allowance price is that business reduce their mitigation efforts, which explains why the new cumulative emissions trajectory lies above the reference line, even well before the adjustment to the emissions cap starting in 2031. The total increase in emissions up to 2050 amounts to 2.89 Gt, representing a 33% increase compared to the baseline scenario. This difference is visible on the right side of Figure 2.

Figure 2. Allowance price (left) and cumulative supply and demand for emission allowances (right)



The emissions cap is shown for reference. The total amount of emissions may exceed the cap due to allowances already accumulated and to allowances being released that are currently stored in the MSR. Moreover, the additional allowances resulting from carbon removal in the EU are formally excluded from the emissions cap.

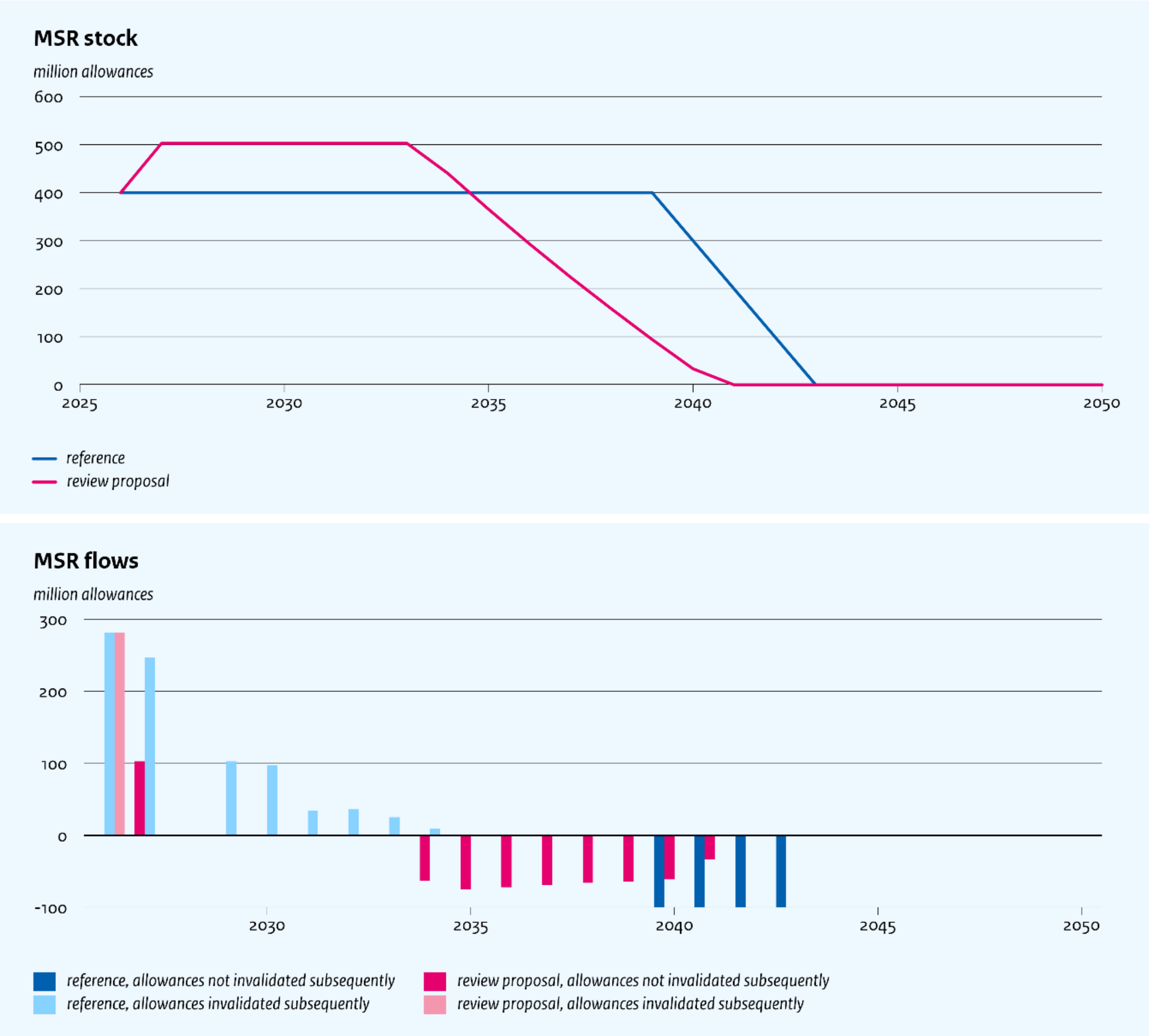
The immediate increase in the number of emission allowances used has clear implications for the functioning of the MSR, and, due to the removal of the invalidation rule, also for the total supply of emission allowances. The rise in demand driven by the lower allowance price is significantly outpacing the actual increase in supply. After all, the cap will not become less stringent until 2031. As such, the reduced emissions reduction prior to

[2] As noted, this outcome should not be viewed as a prediction of how the price of emission allowances will actually develop on the market. Various factors play a role here, including the expectations that market participants already had regarding the Commission's proposal. For example, since the beginning of 2026, the price has fallen from over €85 per tonne in January to significantly lower levels in February and March. It is possible that expectations regarding potential easing of regulations in the EU ETS (driven by discussions about the competitiveness of European industry) played a role here. Other developments, such as the closure of the Strait of Hormuz, likely also played a significant role in the price increase that occurred in subsequent months. Even after the European Commission published its revision proposals on July 17, 2026, the price rose again. The uptick in industrial output during the second quarter may have contributed to this.

2031 will be entirely at the expense of the quantity of accumulated allowances, the so-called 'TNAC'.[3] It is important to note that the TNAC ultimately determines the in- and outflows to the MSR.

Specifically, our analysis shows that, following the proposed adjustments, the MSR's intake threshold will only be exceeded in 2027 (Figure 3), whereas in the scenario without adjustments, this would remain the case until 2034. After 2027, the TNAC will have decreased to such an extent that it will remain permanently below the threshold value, and no new allowances will flow into the MSR. This will occur despite the declining MSR thresholds proposed in the revision. Furthermore, the low threshold value that determines the issuance of allowances will now be exceeded as early as 2034, which is six years earlier than in the baseline scenario. As a result, the MSR stock will also be completely depleted in 2041, which is two years earlier than in the baseline scenario.

Figure 3. MSR stock and flows following the proposed adjustments



[3] The Total Number of Allowances in Circulation (TNAC) is the total number of emission allowances in circulation within the EU ETS. This figure is published annually by the European Commission. In the economic literature, the practice of saving emission allowances for future use is referred to as 'allowance banking' (Ellerman and Montero, 2007). For this reason, the TNAC is also sometimes referred to as the allowance *bank*.

Regarding inflows, we make a distinction between allowances that remain valid (dark) and those that are ultimately invalidated (light).

The reduced inflow of emission allowances into the MSR also means that the removal of the invalidation rule has a smaller effect when this measure is combined with the other proposed supply-side adjustments. Although the supply-side adjustments result in 0.55 Gt fewer emission allowances being invalidated, this is primarily due to the lower inflow into the MSR resulting from reduced reduction efforts by businesses, rather than as a direct result of the removal of the invalidation rule itself.

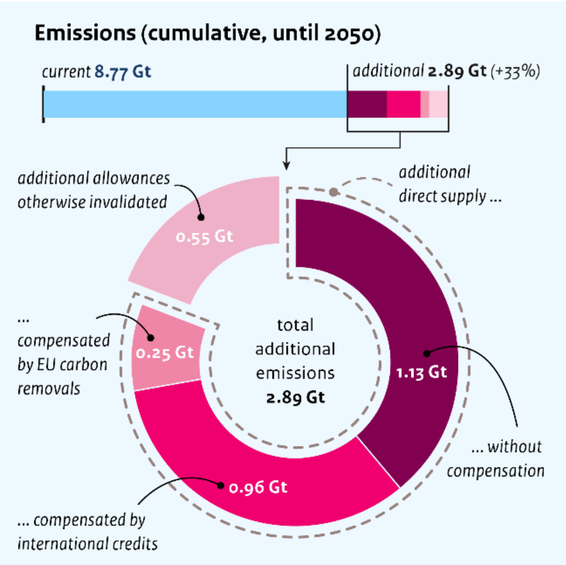
Finally, we note that the adjustments to the cap and the MSR could possibly jeopardise price stability. This is precisely at odds with the objective of the European Commission's proposal. The discrepancy between the immediate response of demand and future adjustments on the supply side (though not until 2031) reduced market liquidity in the short term and, in the long term, the MSR's ability to absorb imbalances between supply and demand. Furthermore, without the invalidation mechanism, the market loses an important stabilising feature: when demand for emission allowances falls unexpectedly, e.g. as a result of sharply rising energy prices, and the allowance bank (TNAC) consequently increases, the invalidation mechanism can reduce future supply, thereby limiting downwards pressure on the price.

To test this conclusion, we used the model to simulate an unexpected one-time 10% decline in 'business-as-usual' demand for emission allowances in 2029, without a full recovery to the original demand trajectory. We found that, with the proposed adjustments, the price decline resulting from this demand shock amounts to 5.3%. This is significantly higher than the 3.1% price decline we observe for the same demand shock in the baseline scenario. This indicates a less robust and, therefore, less stable market.

7. Discussion

Our analysis demonstrates that the proposed adjustments to the emissions cap and the MSR result in 2.89 Gt of additional CO_2 emissions in the EU through to 2050 (Figure 4). Of these additional emissions, 0.55 Gt can be attributed to previously issued emission allowances that remain in circulation and would otherwise have been invalidated. Incidentally, only 0.11 Gt of this amount is actually the result of the removal of the invalidation rule itself. The remaining 0.44 Gt is caused by the reduced absorption into the MSR as a result of the reduced reduction effort. The directly created additional supply of emission allowances (a total of 2.34 Gt) is offset by 0.96 Gt of international credits and 0.25 Gt of domestic carbon removal. Ultimately, this means that the proposed adjustments to the EU ETS will result in a *global* net increase of 1.68 Gt of CO_2, of which 1.13 Gt is due to the higher emissions cap and 0.55 Gt is due to reduced invalidation of allowances.

Figure 4. Extra emissions within the EU ETS through 2050, resulting from the proposed adjustments



The extra emissions relative to the baseline scenario are primarily the result of a direct expansion of supply, but also from the fact that, due to the adjustments, fewer already issued allowances (in the MSR) are invalidated. The figure also shows what portion of the (direct) expansion of supply is offset by the procurement of international credits or by permanent carbon removal within the EU.

In addition to this significant increase in emissions, the proposed adjustments jeopardise price stability within the EU ETS due to faster depletion of the bank and the MSR, as well as the termination of the invalidation mechanism.

One crucial question is whether the competitive advantages of a lower emission price for EU industry justify this significant cost in terms of higher emissions and reduced stability. Our estimated decline in the allowance price of approximately €12.50 per metric tonne of CO_2 compares to a cost saving of just over €2 per MWh of natural gas. This corresponds to about €3 of the current gas price and is negligible compared to the energy price increases of recent years.

An earlier CPB/PBL study showed that the competitiveness of European industry would benefit most from policy directly aimed at reducing production or energy costs, for example by lowering energy tax rates. In particular, reducing the cost of electricity appears to be effective and feasible (Olijslagers et al., 2026). Additionally, that study found that the existing rules for invalidating emission allowances in the MSR already make the EU ETS less restrictive in this case of overlapping instruments, such as a subsidy combined with an emission allowance system. Without invalidation, the total volume of emissions below the cap is completely fixed, which means that a reduction in electricity costs will lead to a higher price for emission allowances. As a result, support measures in the form of subsidies are less effective at reducing industry costs under the new EU ETS rules.

We want to emphasise once more that our analysis focuses exclusively on those changes in the revision that affect the total supply of allowances. For example, the establishment of a decarbonisation investment fund of more than €100 billion (which is part of the revision) also lowers the price of emission allowances because this fund reduces the costs of CO_2 reduction.

Finally, we note that in an 'artificial' market such as the EU ETS, the credibility of the policy instrument is of critical importance. Reinforcing the EU ETS in 2018 and 2021 sent a clear signal to the market that reductions would be necessary to comply with the available supply of future emission allowances. This reinforcement has therefore contributed to a price for emission allowances in recent years that was significantly higher than in previous years (Sitarz et al., 2024). Weakening the EU ETS undermines this credibility, while the benefit to competitiveness is very limited.

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Appendix 1. Model description

Price formation in a market such as the EU ETS

In this appendix, we describe the model we used for the analyses provided in this report. As indicated in the main report, we build on an extension of a simple model for price formation in a cap-and-trade system (Ellerman and Montero, 2007; Olijslagers et al., 2026). This model assumes that businesses and traders act based on (rational) expectations regarding developments in supply and demand in the emissions permit market. This means that they take into account anticipated future emissions and prices in this market given their assessment of other economic developments, such as fossil fuel prices. The supply of allowances is determined by the government through the (annual) release of a specific amount of allowances via auctions or by distributing them free of charge to registered users. Demand for allowances arises as a result of the actual CO_2 emissions for which businesses must hand over allowances.

In particular, our model incorporates the important role of banking emission allowances. The banking provision in the EU ETS enables businesses and traders to hold emission allowances for future use. This allows for flexible use over time, significantly increasing market liquidity compared to a trading system without a bank. Note that the 'bank' in any given year therefore actually consists of all unused allowances from that year and previous years.

Although demand for emission allowances among market participants is, in principle, uncertain, this applies to a much lesser extent to the supply side. After all, the supply side is determined by the government. Thus, it is, in principle, already evident how many allowances will be available in total in the future, assuming the rules remain unchanged in the meantime. The total number of allowances over the entire time horizon is therefore also known, and businesses and traders will base their expectations on this when deciding whether or not to purchase and hold allowances in the emissions trading bank. It is precisely this behaviour that determines the price of emission allowances that is established in the market (taking expected demand into account).

Today's price formation is therefore ultimately determined not only by the expectations that businesses and traders have regarding what will become available in the current year, but also by the addition or removal of allowances in the future. Hence, in our model, we assume that market participants base their decisions on their current views regarding the entire time horizon covered by the EU ETS. This time horizon also includes the scenario in which no new allowances will become available after a certain date.

In the current EU ETS market, however, the supply of allowances no longer solely depends on the initial allocation of allowances through auctions or free allocation. The Market Stability Reserve (MSR), and in particular the invalidation mechanism, also influences total supply over time. After all, total supply depends in part on specific market conditions, i.e. the demand for allowances. Under the current regulations, these conditions indirectly determine future supply. The MSR ensures that in times of oversupply (when there are relatively many allowances in circulation within the system), a portion of the allowances is placed in a reserve. Allowances from that reserve are, in principle, returned to the market in times of scarcity. The MSR thus ensures greater price stability. In our model with perfect foresight, however, this is not the case, since the total number of allowances remains unchanged.

Of greater importance to the absolute level of the price, are the invalidation rules. These rules were announced back in 2019 and have been in effect since 2023. Under these rules, allowances in the MSR are invalidated if the size of the MSR exceeds a certain threshold. This means that once the size of the MSR reaches this threshold, all allowances that then flow into the MSR (on a periodic basis) are permanently removed from the market. Consequently, fluctuations in demand also affect the total number of available allowances over time. The de facto cap in all future years not only depends on the predetermined supply of allowances through auctions and free allocation, but also on the indirect effects of changes in demand resulting from adjustments made by the bank. If an unexpected shock occurs, such as higher fossil fuel prices, fossil fuel consumption (and therefore CO_2 emissions) will decrease immediately, reducing the demand for allowances while supply remains constant. This, in turn, will increase the amount of accumulated allowances (the bank), resulting in a larger number of allowances being added to the MSR in the following year. Once the MSR reaches maximum capacity, this additional inflow will be immediately invalidated, and the total supply of allowances will thus decrease over time.

It should be noted that, in reality, there is a delay between determining the number of allowances in the bank at the end of the year and reducing or increasing supply via the MSR. This is because the European Commission needs time to determine the number of allowances in circulation ('TNAC'). Our model, however, treats each year as a single time step, in which changes in the number of allowances in circulation in a given year are fully reflected in the in- and outflows of the MSR in the following year. That is faster than what actually happens. In reality, the number of allowances in circulation at the end of a given year determines the MSR flows from September of the following year through August of the year after that.[4]

In our model, investors generally understand how the system works and have expectations regarding future emissions demand. Based on those expectations, they make their decisions, and a price is established. We explicitly limit ourselves to the supply adjustments proposed by the European Commission and keep the demand function constant. This enables us, given that demand, to examine how adjustments to specific rules in the EU ETS affect price formation and total supply of allowances over time (specific rules like the initial supply based on the Linear Reduction Factor (LRF), the MSR's inflow and outflow rules, and the invalidation mechanism). This approach allows us to analyse these effects not only for each individual component of the proposal, but also for combinations of components, taking their interactions into account.

[4] Because the inflow to the MSR in our model analysis responds more quickly to a decline in the TNAC, the number of invalidated allowances when the inflow is declining is also smaller than it would be in reality. However, we expect this assumption to only have limited consequences for the results of our analysis. First, because the annual MSR flows are limited compared to the total supply through 2050, which also serves as the basis for price formation in our model. Second, because the number of allowances flowing in and out of the MSR each year generally evolves gradually, as the bank of accumulated allowances also only changes gradually.

Consequently, price formation for the market follows the so-called Hotelling's rule. The Hotelling's rule defines the net price trend so that the real return on the use of a renewable resource remains the same across different time periods, and thus no further efficiency gains can be achieved by deploying it earlier or later. In our model, we also treat the EU ETS as such a resource, albeit an artificial one because the government imposes restrictions here. Based on the assumption of rational expectations, our model assumes efficient exploitation of the resource. Therefore, the percentage change in the net price per unit of time must equal the discount rate in order to maximise the present value of the use of allowances over the available period of use. Because financial market participants always have the option to switch to other investment opportunities, the discount rate is, in principle, determined in the capital market. In our analyses, we assume an interest rate of 5%.

According to Hotelling's rule, the price of emission allowances in year *t* is then determined by:

$$p(t) = p(0) \cdot 1{,}05^t$$

To determine the price in our case, the price of emission allowances in the first year, $p(0)$, is chosen by finding the lowest starting price at which the emission allowance bank, based on Hotelling's rule described above, never becomes negative through the final year of the analysis. This ensures that in no year, the cumulative consumption of allowances (up to that year) greater than the total number of emission allowances issued up to that point.

Demand for emission allowances

As described above, the analysis we outlined is based on a fixed demand function. The total demand for emission allowances is the result of a combination of an (exogenous) emission path over time, assuming a constant price, and a function that determines the extent to which demand for emission allowances responds to price. The price-dependent part of the demand function is determined by the marginal cost of emission reduction as a function of the emission reduction percentage.

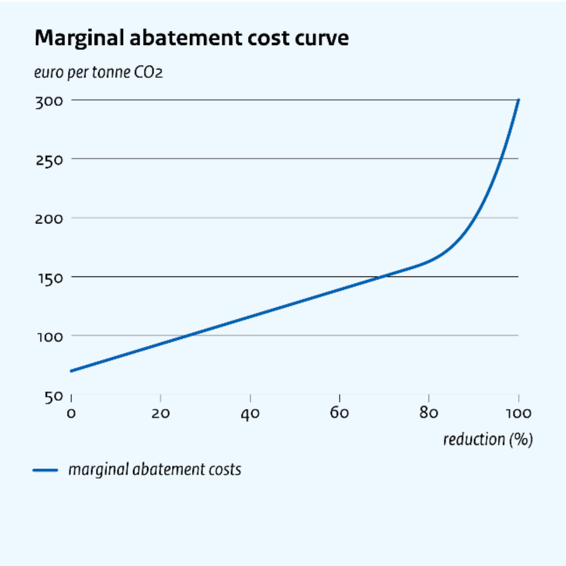
Total demand thus primarily reflects an assumption about emission trends without taking into account the changes in emission price. This trend accounts for exogenous changes in production volumes, as well as in emission intensity of production through e.g. substitution and technological change. Various factors in both the energy markets and international trade play a role here, as shown by the development of the baseline scenario by Olijslagers et al. (2026). For our model analysis, we assume that the decline in emission intensity exceeds the increase in production volumes over time. Overall, we assume that, at a constant price, demand for emission allowances decreases by 1% per year.

Relative to this baseline path, we assume that the demand for emission allowances is determined each year by the so-called marginal abatement cost curve. This curve reflects the extent to which businesses are willing to reduce emissions more or less than this exogenous path in response to a change in the emission price in a given year (Figure 5). In this scenario, emissions will be reduced to the extent that the price of emission allowances in a given year equals the marginal cost of that reduction percentage. This means that it is equally cost-effective for companies to reduce emissions as it is to procure additional emission allowances. Consequently, it is not efficient for them to adjust their emission reductions upwards or downwards.

The assumed marginal abatement cost curve reflects the costs of all reduction options, ranging from technical adjustments to changes in production volumes, relative to the existing autonomous baseline (which already included some exogenous emission reductions). It is generally assumed that the marginal cost of emission reductions increases as reductions become more extensive.[5] In this study, we use a reduction cost function that roughly mimics existing estimates of such cost curves, such as those from McKinsey.

For the baseline scenario, we assume a linear increase in marginal costs up to a reduction rate of 75%. The first possible additional emission reductions relative to the baseline, occur at a cost of €70 per tonne of CO_2. We then assume that the increase in marginal abatement costs in the linear portion of the reduction function amounts to €1.15 per metric tonne of CO_2 per percentage point of emission reduction. Starting at a reduction rate of 75%, the reduction function is convex up to marginal abatement costs of €300 per metric tonne of CO_2 when reducing the final emissions. The parameters mentioned have been calibrated using the emission price for the period 2024-2026. Appendix 2 further analyses the sensitivity of the results to these parameters.

Figure 5. The calibrated marginal abatement cost curve

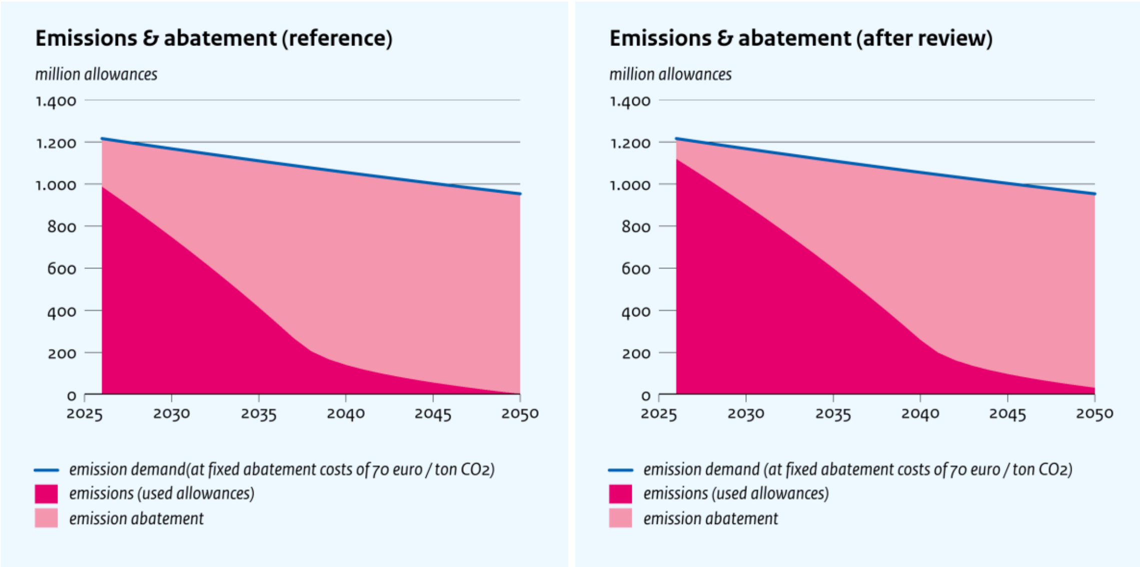


This refers to (additional) reductions relative to emissions at a fixed abatement cost of €70 per metric tonne of CO_2.

Figure 6 illustrates the development of the assumed exogenous emissions path (i.e. at a constant price of emission allowances) and the development of emissions, taking into account emission reductions based on the price of emission allowances in the baseline scenario and under proposed adjustments to the EU ETS.

[5] The effect of technological development on emissions intensity is thus broken down into an autonomous trend that leads to overall emission reductions, without taking into account the additional effect of an instrument like the EU ETS, and a separately operating effect through additional reduction options that can be utilised each year and are dependent on the emission price.

Figure 6. Emissions and emission reductions under the EU ETS in the baseline scenario (left) and after the proposed adjustments (right)



This figure shows the exogenous emissions demand path assuming fixed abatement costs of €70 per metric tonne of CO_2. For the baseline scenario and the scenario with the proposed adjustments, it illustrates which portion of this demand, at the prevailing emission price, results in the use of emission allowances and which portion does not result in emissions, since emission reduction is more cost-effective than procuring emission allowances.

Appendix 2. Sensitivity analysis

Exogenous emissions path

In the baseline scenario, business-as-usual emissions (i.e. emissions at an emission price of €70) decrease by roughly 1% per year, as a result from the combination of assumed production growth by ETS sectors and a reduction in emissions per unit of production due to technological progress. We analyse two alternative scenarios for this exogenous emissions path: a *High* scenario, in which business-as-usual emissions increase by 1% per year, and a *Low* scenario, in which business-as-usual emissions decrease by 3% per year. Table 1 presents the results of this sensitivity analysis.

Table 1. Sensitivity of results to changes in the exogenous emissions path

	Reference (-1%)	*High* (+1%)	*Low* (-3%)
Increase in emissions 2026-2050 due to proposed adjustments (Gt)	2.89	2.90	2.82
Price effect from proposed adjustments (%)	-13.6%	-11.7%	-15.9%

Table 1 shows that different assumptions regarding the exogenous emissions path in our model analysis have a limited impact on the effects of the proposed adjustments in the ETS revision. It is notable that particularly the magnitude of the increase in total emissions resulting from the proposed changes is hardly affected by different assumptions regarding the baseline path. The price effect of the adjustments is more sensitive to the development of the exogenous emissions path, but the results are as expected: if the demand for emissions is higher (lower) due to stronger (weaker) autonomous growth, then the price falls less (more) than in the baseline path. This is because the absolute reduction cost per unit (metric tonne of CO_2) in the scenario with high (low) exogenous emissions demand is relatively low (high), since there are more (fewer) total emissions to reduce. The expansion of supply therefore leads to a more limited (sharper) decline in the price of emission allowances.

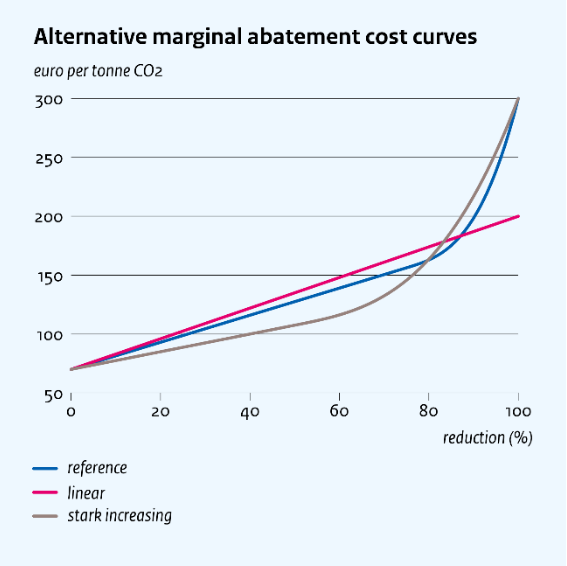
Marginal abatement costs

Due to the invalidation mechanism, the total supply of emission allowances in the current EU ETS is endogenous (see also Olijslagers et al., 2026). As a result, total emissions within the EU ETS depend on the trajectory of emission reductions over time. If there are significant reductions in the short term, more allowances flow into the MSR, and more allowances may also be invalidated. If there is little reduction in the short term, fewer allowances may be invalidated. The trajectory of emission reductions over time depends on the evolution of marginal abatement costs relative to the evolution of the emission price; i.e.

how expensive emission reductions are in the short versus the long term. For this reason, it is important to assess the sensitivity of our results to these relative reduction costs.

We test this sensitivity using two alternative marginal emission abatement cost curves, shown in Figure 7, assuming a constant interest rate of 5% as in the baseline scenario. We test a linear marginal abatement cost curve in which reductions relative to the baseline abatement curve are initially relatively expensive, but become relatively inexpensive as reductions become more extensive. We also test a reduction curve in which the marginal abatement costs for limited reductions are lower than in the reference case, but where the increase in marginal costs begins at a lower reduction percentage compared to the baseline curve, making deep reductions relatively expensive (Figure 7). The two alternative marginal abatement cost curves represent a good illustration of the range of additional emissions and the decline in the emission price resulting from supply adjustments in the EU ETS.

Figure 7. Marginal abatement cost curves in the analysis



Both alternative abatement curves, like the reference abatement cost curve, are calibrated to the starting price. The marginal costs of reduction at 0% reduction are the same in all cases, based on the observed price of emission allowances around 2024. Other parameters for the abatement cost curves are also calibrated to the price of emission allowances in 2024. The results of the sensitivity analysis are presented in Table 2 below.

Table 2. Sensitivity of results in the marginal abatement cost curve

	Reference	*Linear*	*Curvier*
Cumulative emissions 2026-2050 without adjustments (baseline, Gt)	8.77	8.95	7.26
Increase in emissions 2026-2050 due to proposed adjustments (Gt)	2.89	2.22	3.54
Price effect of proposed adjustments (%)	-13.6%	-10.5%	-17.0%

Table 2 shows that the amount of emissions in the scenario without policy adjustments, as well as the additional emission resulting from the proposed adjustments, does depend on the shape of the marginal abatement cost curve. With a linear abatement cost curve, we first observe higher emissions throughout the entire EU ETS period. With this curve, reducing emissions at low reduction rates is slightly more expensive, but deeper reductions are actually relatively inexpensive compared to the reference case. This means that, as a result, fewer emissions are reduced in *the early years* than in the reference case. Consequently, fewer allowances are saved in the short term. As such, the size of the bank of saved allowances will be smaller in the scenario without policy adjustments. This also means fewer allowances in the MSR and, thus, reduced invalidation of allowances. If the European Commission's proposed adjustments are then implemented, and no allowances are invalidated at all starting in 2027, fewer allowances will be added to the market, as is indicated by the total of 2.22 Gt. Since fewer additional allowances will enter circulation overall due to the changes, the price decline will also be less significant in this case.

As expected, we observe opposite effects on the marginal abatement cost curve, which is initially lower and then rises more steeply (and is thus more curved). Because costs are somewhat higher at the start, there will be a more limited (stronger) reduction in the early years compared to a less extensive reduction in later years. This results in a larger bank of saved allowances, and therefore larger inflow into the MSR. Under the current rules, this would lead to more invalidations. If the proposed measures are implemented in this situation, it will result in more additional emissions because more allowances remain in circulation (since they are not invalidated). This partly explains the large number of additional emissions (3.54 Gt) shown in Table 2. In percentage terms, the price decline along this abatement curve is also greater because the measures result in a relatively much larger increase in emissions compared to the adjustments in the reference case.

The sensitivity analysis provided above, which examines the shape of the relative marginal abatement costs, primarily illustrates their impact on cumulxative emissions. If costs are somewhat higher (lower) at the outset, there will be a more limited (stronger) reduction in the early years compared to a (less extensive) reduction in later years. In the scenario without policy adjustments, this results in a relatively large difference in cumulative emissions. The implementation of the Commission's proposals therefore also has a different, albeit counterintuitive, effect. If it is somewhat more expensive (cheaper) at the outset, the reduction will be smaller (larger), resulting in relatively less (more) invalidation, and thus a smaller (larger) increase in additional emissions compared to the scenario with adjustments in the reference case. The relatively smaller (larger) change in the emissions relative to these new baseline paths consequently results in a proportionally comparable, less pronounced (more pronounced) decline in the emissions price.

In the analysis provided above, we kept the interest rate constant. A lower or higher interest rate will shift emissions over the years in a similar way. At a lower interest rate, the price of emission allowances increases only slightly. As a result, it becomes relatively expensive to reduce emissions further into the future (compared to procuring emission allowances). At a high interest rate, the opposite is true, and emission reductions are actually postponed because emission allowances are relatively inexpensive in the short term. However, testing the sensitivity to the interest rate is complicated because it is linked to the calibration of the marginal abatement cost curve to the starting price. Without adjusting this curve, a different interest rate would lead to a lower or higher starting price. Otherwise, cumulative demand would not equal cumulative supply. Since the effect of changes in the relative abatement costs over time can already be adequately assessed based on the shape of the abatement cost curve, we have chosen to not separately examine the sensitivity of the interest rate (in combination with the abatement cost curve).

Appendix 3. Individual instruments

To analyse the effect of individual adjustments in the EU ETS revision, we analysed scenarios in which the various adjustments were combined in different ways. We distinguish the following four measures:

1. *StopInv*: Scrapping the invalidation mechanism
2. Adjustment of the Linear Reduction Factor (LRF)
    a. *LRFwith*: when using international credits: 3.7% starting in 2031, 1.7% starting in 2036
    b. *LRFwithout*: without the use of international credits: 3.7% starting in 2031, 2.7% starting in 2035
3. *CDR*: Additional emission allowance through the use of permanent carbon removal (250M in 2031-2040)
4. *MSR*: Adjustment of MSR parameters

Table 3 shows the most important indicators in our analysis for a number of different combinations. Using these scenarios, we can determine the individual effect of each of these instruments.

Table 3. Effects of (combinations of) individual instruments

	A	B	C	D	E	F
Measures	*StopInv*	*StopInv* + LRFwith	*StopInv* + LRFwith + CDR	*StopInv* + LRFwith + CDR + MSR	*StopInv* + LRFwithout + CDR + MSR	LRFwith + CDR + MSR
Meaning	Proposal to stop invalidation (April 2026)	Proposal to stop invalidation and adjust LRF	Total package without MSR adjustments	Total package	Total package without international credits	Total package without stopping invalidation
Increase in emissions 2026-2050 due to proposed adjustments (Gt)	0.55	2.64	2.89	2.89	1.67	2.78
Price impact of proposed adjustments (%)	-2.8%	-12.5%	-13.6%	-13.6%	-8.2%	-13.1%

According to our analysis, the standalone proposal to scrap the invalidation mechanism (column A in Table 3) results in a 0.55 Gt increase in emissions within the EU ETS. The corresponding decrease in the price of emission allowances is 2.8%. If we add to that the adjustment to the LRF (including the use of international credits), total emissions through 2050 will increase much more sharply, by 2.64 Gt. The emission price will also fall more sharply, by 12.5% (see column B). The inclusion of carbon removal (column C), on the other hand, has a limited effect on emissions, namely exactly the additional emission allowance created by this measure: 0.25 Gt. This results in an even greater decline in the emission price: 13.6% instead of 12.5%. The proposed adjustments to the MSR parameters, in addition to the three adjustments mentioned earlier, have no effect whatsoever on total emissions and the emission price (column D, compared to column C) because these adjustments only affect the timing of the MSR flows, and the role of the MSR in our analysis was already worked out early on.

Column E in Table 3 shows the results for the total package, but without the use of international credits. In that case, the increase in emissions resulting from the adjustments amounts to 1.67 Gt. This is significantly lower than the 2.89 Gt resulting from the implementation of the total package. It is noteworthy that the additional emissions in the EU resulting from the use of international credits (1.23 Gt) exceed the amount of international credits procured (0.96 Gt; see Figure 4). This is because international credits increase the supply of allowances and thus lower the initial emission price (13.6% instead of 8.2%). As a result, fewer allowances will be invalidated in the short term (i.e. before the repeal of the invalidation rule takes effect).

Finally, we examine the effect of the invalidation rule within the total package, i.e. in combination with other instruments. We find that the effect of repealing that rule (column F compared to column D) is smaller than when it is the only adjustment being implemented (column A). This is because the other adjustments already limit the number of allowances that can be invalidated. As noted earlier, the lower emission price will lead to significantly higher demand for allowances early on, which will also result in the MSR filling up less. Consequently, the effect of discontinuing the invalidation rule in combination with the other adjustments amounts to only 0.11 Gt in this case (from 2.78 Gt to 2.89 Gt), whereas it would have been 0.55 Gt if considered in isolation. As part of the total package, the discontinuation of the invalidation rule therefore results in only an additional price decrease of 0.5 percentage points (from 13.1% to 13.6%). When considered in isolation, this measure still results in a price decrease of 2.8%.