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POLICY BRIEF

EUROPEAN CARBON MARKET: IMPACTS OF THE REFORM AND THE STABILITY RESERVE UNTIL 2030

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A policy package defining the operating rules of the European carbon market until 2030 has just been adopted. Based on a revised version of the ZEPHYR model, this Policy Brief provides an impact assessment of the reform on permit price and emission reduction paths. Four main messages emerge:

- **The coexistence of low carbon price levels and a large amount of unused permits** can be explained by an unanticipated decrease in permit demand between 2008 and 2017 that is attributable to both the economic slowdown and the achievements of complementary policies aimed at encouraging the deployment of renewables and, to a lesser extent, promoting energy efficiency. On the supply side, this is also due to the rapid and massive use of the maximum number of Kyoto credits allowed.

- In addition to the increase in the annual cap reduction rate (linear reduction factor), **the market stability reserve induces an additional decrease in permit supply over the period 2018-2030 (between 2.8 and 3.7 billion). In turn, this implies a sharp rise in the permit price** (on average €25 and €38 per tCO2 in 2020 and 2030 as opposed to €9 and €13 per tCO2 respectively absent the reform). This price increase will be more pronounced if liable firms anticipate the impacts of the reform from the start in comparison with the situation where they gradually adjust their anticipations over time.

- The implementation of **the reform should induce a decrease in emissions from the covered perimeter in the order of 50%** in 2030 relative to 2005. This is above the previously agreed upon objectives, which suggests that there is potential for reassessing Europe's climate ambition at relatively modest cost.

- According to the European authorities, one of the virtues ascribed to the stability reserve should be to make the EU ETS more resilient to external shocks such as those that have affected the market since 2008. Our modelling, however, suggests that **the MSR's responsiveness and dampening capacity would be limited.**

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A package of reforms defining the operating rules of the European carbon market until 2030 has just been adopted. The objective is twofold: on the one hand, to address system dysfunctions, a symptom of which is deemed to be the coexistence of low carbon price levels (€6/tCO_2 on average over the last five years) and a large amount of unused permits (1.7 billion, roughly equivalent to the annual volume of emissions from the covered perimeter); on the other, to ratchet up Europe's climate ambition in the wake of COP21. The reform thus aims at reducing the number of permits in circulation in the EU ETS by employing two supply-side management tools:

- an increase in the linear reduction factor (LRF) from 1.74% to 2.2%, which corresponds to an objective to reduce emissions by 43% in 2030 relative to 2005;
- as from 2019 on, the implementation of a stability reserve (MSR) that will automatically adjust the number of permits to be auctioned based on the quantity of unused permits in circulation. In the current juncture, the introduction of the reserve could lead to a large quantity of permits being withheld from auctions. The magnitude of MSR-induced permit withdrawals and associated impacts on price and emission paths need to be quantified.

Behind the explicit objective of reducing the quantity of permits in circulation put forward by the European authorities lies the implicit objective of leading to higher permit price levels. Another objective mooted by the Commission is to make the EU ETS more resilient to external shocks by an adequate response on permit supply through the MSR – hence its name.

This Policy Brief first describes the modelling framework we develop in ZEPHYR that allows us to simulate permit price and emission paths for the EU ETS in various situations. We then turn to the quantitative assessment the various aspects of the reform and finally analyse two situations involving significant external shocks on permit demand.

A modelling of permit supply and demand that accounts for past dysfunctions

Market demand for permits is crucially dependent on the evolution of baseline emissions, that is counterfactual emission levels absent a price on emissions. Building this scenario determines the volume of abatements that is implicitly attributable to the existence of a carbon price.

In order to build up this counterfactual scenario ex post and ex ante, we begin by decomposing past variations in emissions into three elements:

- the variations in industrial production from covered sectors;
- the development of renewable energies induced by ad hoc policies;
- the gains in energy efficiency assumed independent of the carbon price.

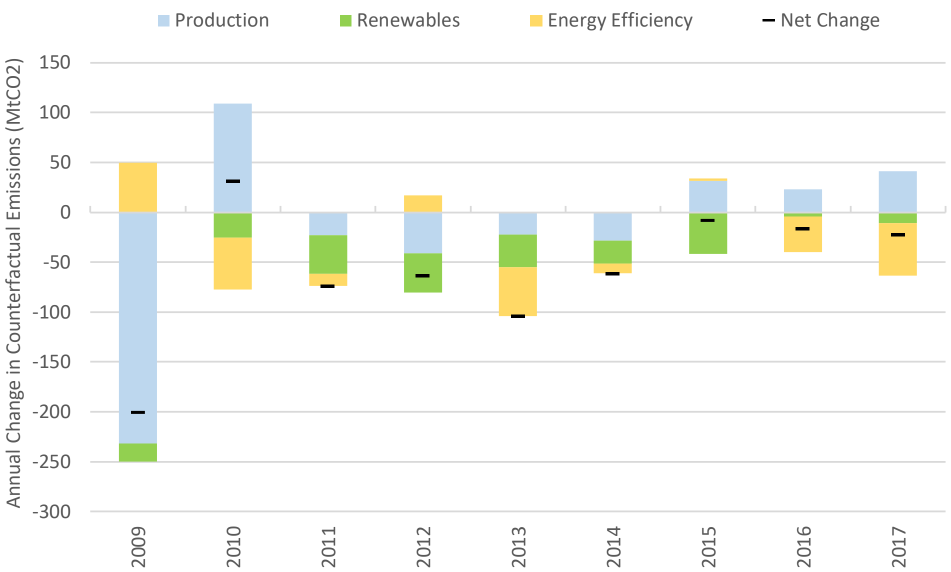


Figure 1 – Decomposition of annual variations in counterfactual emissions

Figure 1 indicates a downward trend in counterfactual emissions from the covered perimeter over the period 2009-2017. First, the economic downturn brought emissions to fall suddenly and drove a wedge in emissions as compared to expectations that became permanent. Second, the fast deployment of renewable energies (solar and wind mostly) and gains in energy efficiency (albeit to a lesser extent) also acted as an unanticipated drag on emissions growth. Third, on the supply side, there was an unexpectedly rapid and massive use of the maximum number of Kyoto credits allowed (more than 1 billion over 2008-2012, see Annex 1).

The protracted decline in the carbon price and the large number of unused permits, which are the main causes behind the reform, can therefore be explained by the combination of a sizeable and sustained drop in emissions from the covered perimeter together with a supply shock associated with the use of credits. This observation is widely shared in the related literature.[1]

In order to quantify the impacts of the reform ex ante, we assume that counterfactual emissions from 2017 on can be decomposed into the three same factors. Specifically, we hypothesize that

- annual growth in industrial production is of 1.8% (average growth for covered industries over the last three years; taken from Eurostat);
- the development of renewable power production is in line with Europe's objective and independent of the carbon price (20% of renewable energy in 2020, 27% in 2030);
- the recent trend in energy efficiency gains continues and is assumed independent of the carbon price (-0.7% per year on average over 2010-2015).

This set of assumptions is conducive to a downward trend in counterfactual emissions from the covered perimeter that amount to 1.5 $GtCO_2$ in 2030 (see Annex 1). Permit supply corresponds to the total supply as currently announced until 2020 and to the annual cap thereafter.

Equipped with these scenarios for permit supply and demand, we develop a model featuring an intertemporal permit market with compliance cost minimizing firms. The ZEPHYR model is a stylized representation of the EU ETS whose market equilibrium is solved in discrete time with an annual time interval and a representative agent with a finite time horizon. For a given year, the market equilibrium depends on the cumulated number of unused permits (banking) and the agent's anticipations of future permit supply and demand. Such anticipations can be adjusted annually based on effective supply as well as observed growth, renewable deployment, and gains in energy efficiency. The aim of the model is to determine price, emission and banking paths for the EU ETS in order to identify and compare the relative impacts of various policy proposals and market designs qualitatively. For more details on the model structure and calibration, see Box.

A large reduction in permit supply inducing a significant price rise until 2030

We first assess the impacts of the reform on permit price levels. To this end we compare model outputs over the period 2018-2030 with the increase in the LRF and the implementation of the MSR (scenario 'LRF 2.2 + MSR') relative to the case of continuation of Phase III rules (scenario 'LRF 1.74 No Reform'). Figure 2 below depicts simulated permit price paths ex post over the period 2008-2017 and ex ante thereafter in the two scenarios considered.

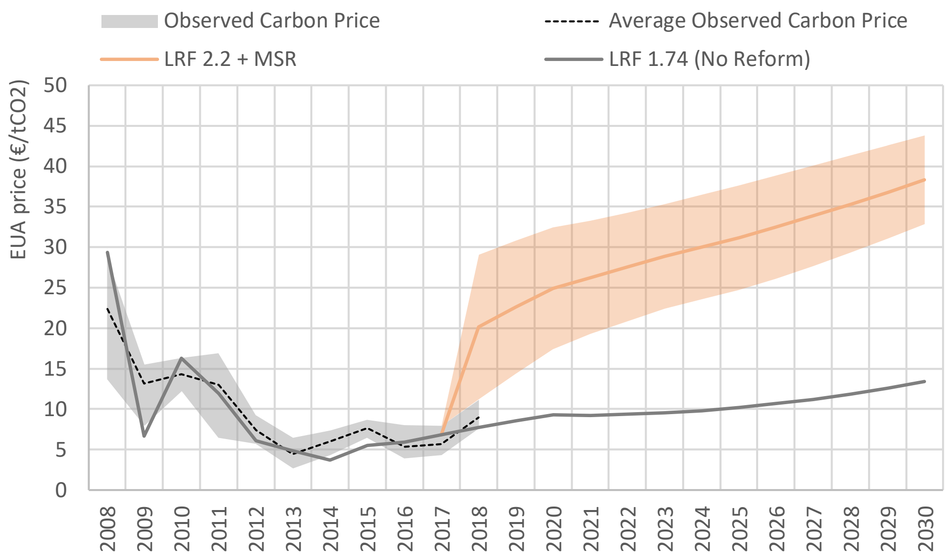


Figure 2 – Simulated permit price paths with and without reform

Relative to no reform, both the LRF increase and the introduction of the MSR reduce permit supply thereby inducing a substantial price rise over time. In fact, the MSR always withholds permits from auctions without re-injecting them into the market before 2030. In turn, this leads to an increase in prices from €9/tCO_2 in 2020 and €13/tCO_2 in 2030 without reform to €25/tCO_2 and €38/tCO_2 respectively on average with reform.

Note that there exists a continuum in the degree of firms' anticipation of the MSR impacts. Indeed, introducing the MSR modifies permit supply through time, which can be anticipated by market participants to different extents. On Figure 2, the price range in light orange shade is such that:

- the upper envelope corresponds to the situation where the MSR impacts are correctly anticipated by the market. That is, as from 2018 on, firms account for the MSR-induced shifts in permit supply over their time horizons;

- the lower envelope corresponds to the situation absent such an anticipation. That is, it is as though firms were discovering the MSR impacts each year (see Box for more details).

These two situations respectively yield the maximum and minimum possible prices. In particular, when the MSR-induced effects are correctly foreseen (upper envelope), the reduction in future permit supply is perceived as greater permit scarcity over the relevant period thereby triggering additional emission reductions. Prices can thus reach €32/tCO_2 in 2020 and €44/tCO_2 in 2030.

Another indicator of interest is the total number of permits in circulation (TNAC) whose evolution in time is shown in Figure 3. As might be expected, the MSR does reduce the number of unused permits. That said, this quantity never reaches the zone where the MSR is inactive (demarcated by the two dotted lines). Indeed, the additional MSR-induced permit scarcity entails additional abatements which in turn mitigates the decrease in the number of unused permits. Between 2019 and 2030, the MSR thus always withholds permits from annual auction schedules. In total in 2030, between 3.7 and 4.6 billion permits should be stored in the reserve or cancelled (including 0.9 billion backloaded permits, i.e. an effective withdrawal of 2.8-3.7 billion permits).[2]

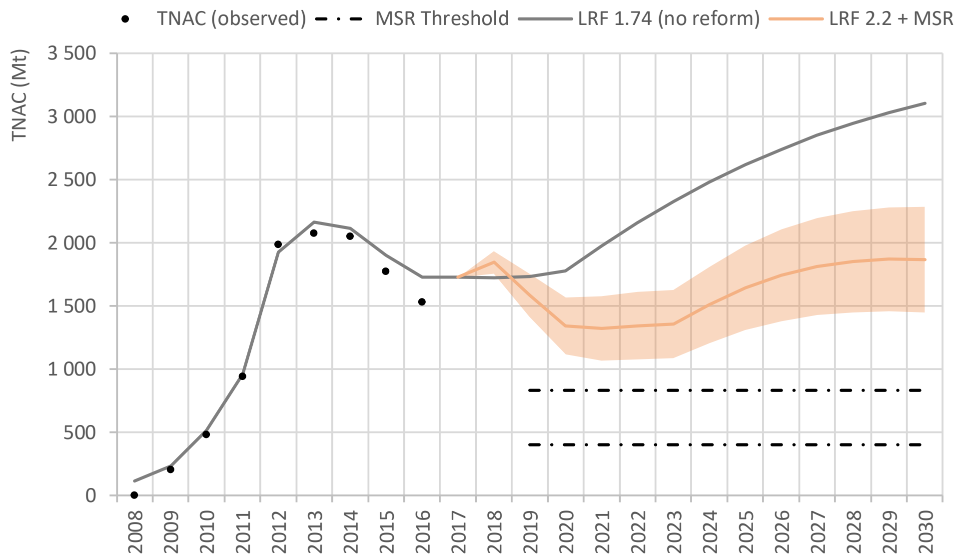


Figure 3 – Simulated market-wide banking paths (TNAC) with and without reform

Until 2030, permit withdrawals by the MSR are therefore tantamount to a reduction in the cap. In particular, Table 1 contains key figures from our modelling and shows that the introduction of the MSR can lead to a decrease in emissions from the covered perimeter of up to about 50% in 2030 relative to 2005 – recall that the announced objective is -43%.

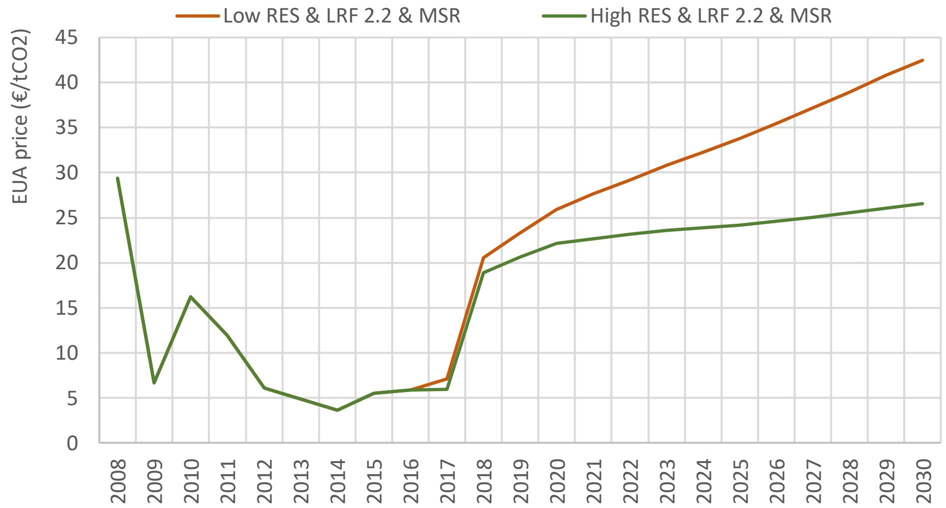
	LRF 1.74 No reform	LRF 2.2 & MSR (low)	LRF 2.2 & MSR (high)
EUA price 2020 (€/tCO_2)	9	17	32
EUA price 2030 (€/tCO_2)	13	33	44
Emissions in 2030 (% reduction / 2005)	-38%	-47%	-52%
Total EUAs cancelled or in MSR (MtCO_2)		3 700	4 600

Table 1 – Impacts of the reform: Key figures

In search of the stabilizing capacity of the reserve

According to the European authorities, one of the virtues ascribed to the stability reserve should be to increase the resilience of the system in the face of external shocks such as those that have affected the market since 2008 by adjusting permit auction volume promptly and adequately. We thus explore the MSR's potential to (1) increase synergies with other energy and climate policies and (2) improve the market's resilience to supply-demand imbalances.

Case 1: Sustained increase/decrease in permit demand. We first assess the impacts of a more or less marked renewables deployment in Europe present the MSR.



Note: We take the renewable shares (excluding hydro) in electricity production as given: (Low RES 20%, High RES 23%) in 2020 and (Low RES 24%, High RES 35%) in 2030 respectively.

Figure 4 – Simulated price paths with High and Low renewables deployment present the MSR

Figure 4 depicts the evolution of the permit price in these two situations with the MSR. For ease of legibility, the lightly shaded areas indicating the degree of firms' anticipation of the MSR are no longer represented and only average price paths remain. We observe that permit prices in 2030 differ significantly depending on realised renewable shares (€26/tCO_2 in Low RES as opposed to €43/tCO_2 in High RES) and that MSR cannot compensate for this divergence over time. In fact, the withdrawals by the MSR do not differ significantly in both cases, amounting to a difference of 200 million permits in 2030 (see Annex 2). The MSR's potential to buffer such a sustained difference in the evolution of permit demand is thus not apparent in our modelling.

Case 2: Short-term shock on permit demand. We now analyse the impacts of an external shock on economic growth from 2022 to 2030 that we calibrate based on observed growth variations in the aftermath of the 2008 economic recession between 2009 and 2017 (i.e., significant drop at first, stagnation in the following few years, and slight recovery thereafter).

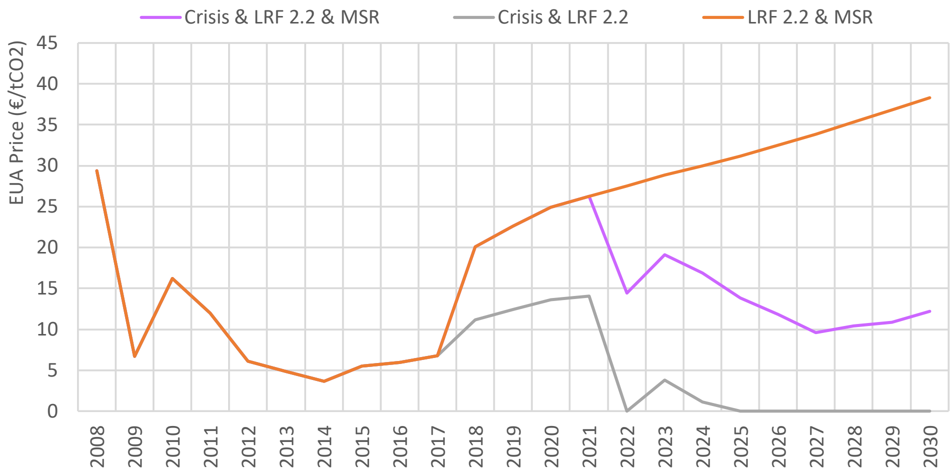


Figure 5 – Impacts of the MSR on the permit price in the event of an economic crisis in 2022

First, we compare the impacts of the crisis on the permit price in the presence of the MSR relative to the case without crisis (purple and orange lines on Figure 5, respectively). Not surprisingly, since economic growth is a determining factor of permit demand, a crisis of this magnitude entails much lower price levels (€12/tCO_2 in 2030 as against 38€ without crisis). The MSR thus appears ill-equipped to smooth out the induced price divergence that gradually settles in time. In fact, as in Case 1, the amount of permits withdrawn by the MSR are not significantly different in the two scenarios (about 260 million in 2030, see Annex 2).

Next, we compare the impacts of the crisis on permit price levels present and absent MSR (purple and grey lines on Figure 5). Two lessons can be drawn. First, the difference in level between these two price paths stems from the MSR-induced supply restriction prior to the crisis. Second, relative price variations at the peak of the crisis are similar with and without MSR. This indicates that, in addition to a limited dampening potential over the medium to long term, the MSR further exhibits restricted short-term responsiveness.

Box: Description of the ZEPHYR model

The ZEPHYR model features an intertemporal market for emission permits with banking but without borrowing that can incorporate the MSR as adopted in November 2017. It is a stylized representation of the EU ETS in discrete time with an annual time interval and a representative agent with a finite time horizon. The aim of the model is to determine permit price, emission and banking paths for the EU ETS in order to identify and compare the relative impacts of various policy proposals and market designs qualitatively.

Intertemporal optimization. We develop a partial equilibrium model of a competitive permit market where covered firms minimize their costs of compliance over time, which allows us to consider a representative firm (Rubin, 1996; Schennach, 2000). This is the dominant assumption in theoretical contributions on intertemporal permit trading (Kollenberg & Taschini, 2016; Perino & Willner, 2016, 2017; Richstein et al., 2015; Salant, 2016).[3] Over its time horizon, the firm determines its total abatement effort given its anticipation of both the total permit supply and its own permit demand. As it cost minimizes, the firm then distributes its anticipated total abatement effort through time cost-effectively, which in turn depends on the marginal abatement costs it faces and the interest rate it applies. Each year, the firm may revise its anticipations given the observed levels of growth, renewable development, energy efficiency gains and so forth.[4]

Market equilibrium. Each year, the firm's demand for permits consists of three sources: the compliance with the annual total cap, a strategy of medium-term hedging and an anticipation of the constraint restrictiveness over the long term. For each of these sources, the firm computes its present abatement effort as described in the above paragraph and the most binding at the margin makes the market price. We take hedging and long-term anticipation to be made, respectively, over time horizons of 3 and 15 years with interest rates of 2.5% and 5%.[5]

Model calibration. The model is solved from 2008 to 2050 with a yearly time step. We limit the presentation of our results up to 2030 to be in line with the current policy debate and avoid edge effects. We can thus conduct both an ex post analysis over the period 2008-2016 and an ex ante analysis thereafter. Ex post, anticipated versus actual of supply and demand were discussed on page 3. Since the market has turned out to be long over the short to medium term and the cap only becomes binding in the long term, it is the long-term anticipation that makes the price over the period.[6] The model allows us to reproduce the observed price *variations* in a satisfactory qualitative way (Figure 2) and we calibrate the marginal abatement cost so as to reproduce price *levels* as finely as possible.[7] Ex ante, anticipations are rational in our deterministic framework except at the end of document where we introduce exogenous shocks.[8]

Introduction of the MSR. As from 2019, the MSR will automatically adjust the volume of permits to be auctioned each year based on the previous year's total number of allowances in circulation (TNAC), i.e. the cumulated number of permits distributed but not yet remitted for compliance. At each date *t*, if TNAC of year *t-1* is above 833 million then 24% (for the first five years) or 12% (thereafter) thereof are withheld from being auctioned and placed in the MSR. If TNAC of year *t-1* is below 400 million and the MSR has enough permits in store then 100 million permits are added to the auction volume in year *t*. Otherwise, the MSR is without effect. When it starts in 2019 the MSR is filled with 900 million backloaded permits.[9] Also, as from 2023, on a yearly basis, the number of permits in the MSR in excess of the number of permits auctioned the previous year will be deemed void and thus assumed to be cancelled.

Anticipation of the impacts of the MSR. We consider the impacts of the MSR on permit supply can be anticipated by the market as from 2018 since the policy package was adopted in late November 2017. In the model, these impacts are determined adaptively. That is, for a given year and banking trajectory without anticipation of the effects of the MSR, the firm is able of computing the net impact of the MSR on supply over its time horizon. In turn, this leads the firm to revise its abatement and banking trajectories over the period, which again changes the anticipated net impact of the MSR, and so forth. Because the absorption rate of the MSR is less than a quarter, this process approaches a fixed point after a few iterations.

Annex 1 – Annual permit supply and counterfactual emissions

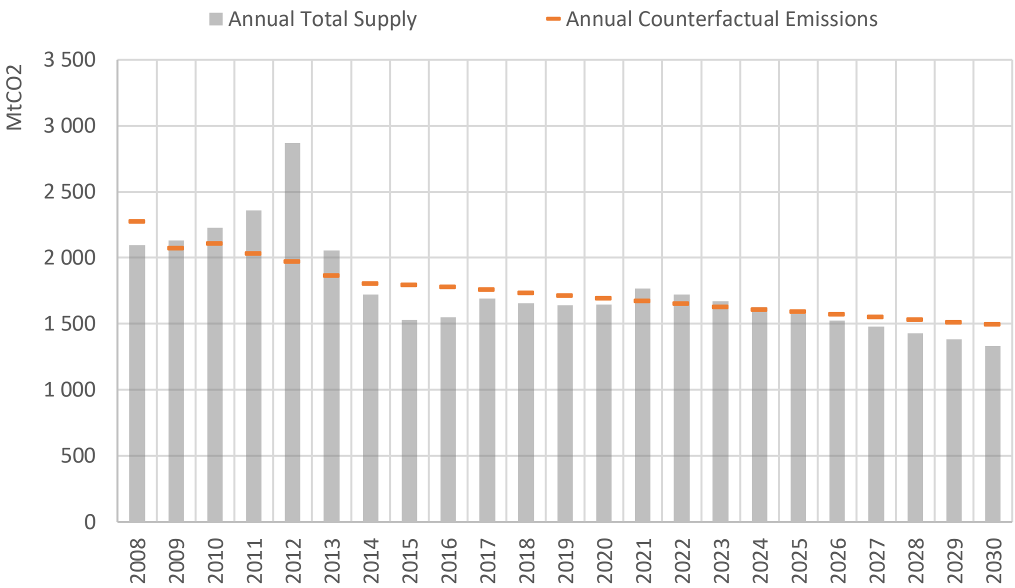
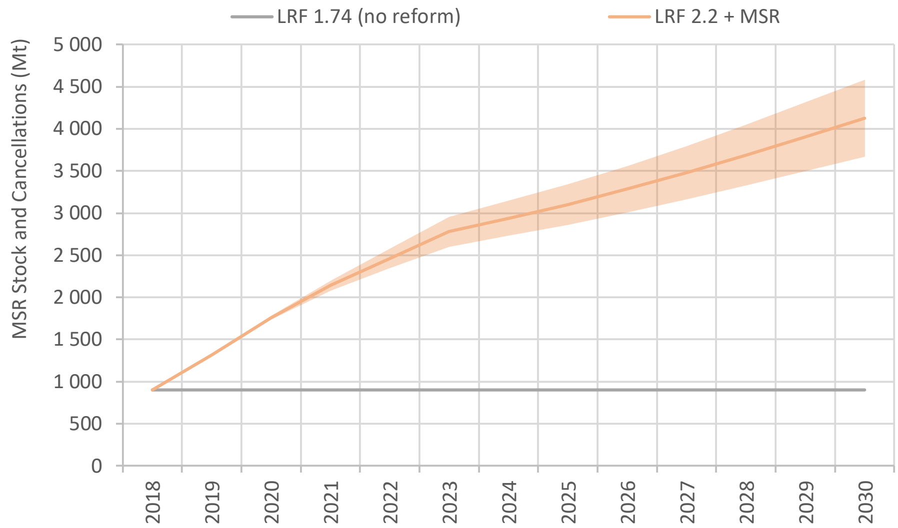
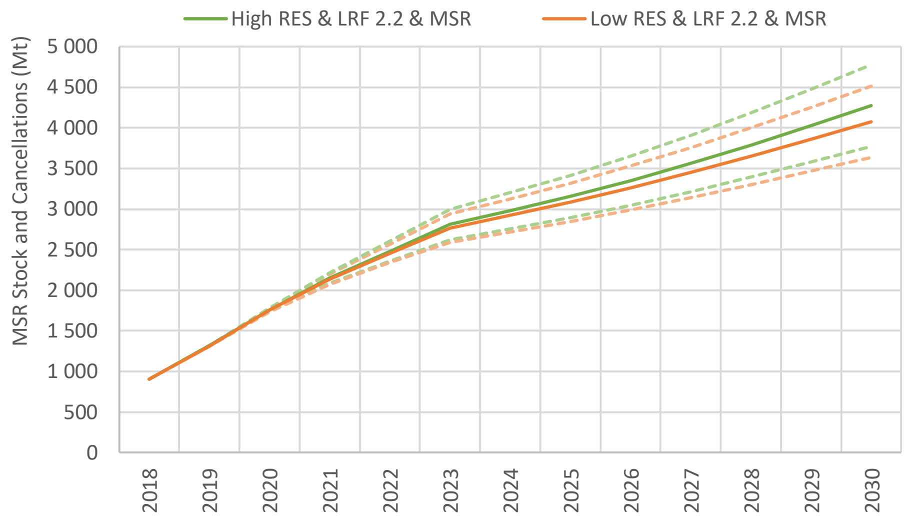


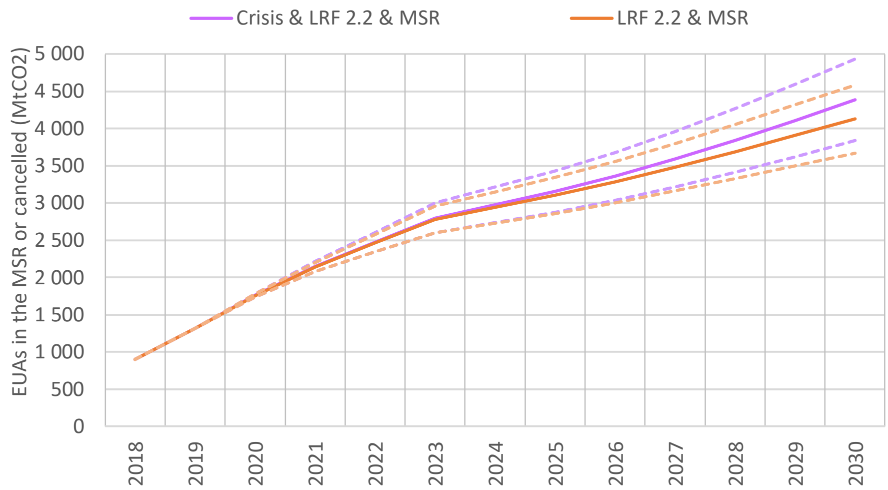
Figure 6 – Annual permit supply and counterfactual emissions

On Figure 6, the orange dashes demark the counterfactual emissions of the covered perimeter. In addition, the graph also displays the evolution of permit supply which consists of freely allocated permits, auctioned permits and surrendered offset credits. Total permit supply has greatly varied over the period 2008-2016 due to the massive use of credits between 2008 and 2012 (more than 1000 million) on the one hand and to the backloading of 900 million permits from 2014 to 2016 (that eventually reduced the auction volume) on the other.

Annex 2 – Permits withdrawn by the MSR (2019-2030)







Notes

1 Among others, the reader can refer to Borenstein et al. (2016), Ellerman et al. (2016), Fuss et al. (2018), Grosjean et al. (2016), de Perthuis & Trotignon (2014) and Tvinnereim (2014).

2 In all the scenarios we consider the MSR never re-injects permits. Thus, whether withdrawn permits are cancelled or not does not affect our results: in both cases, these quotas never return to the market.

3 See Chaton et al. (2017) for a treatment of the MSR with Cournot competition among firms.

4 Empirical studies indicate that covered firms adopt behaviours in line with cost minimization over time even though their degrees of optimization, levels of foresight and time horizons remain hard to elicit empirically (Hintermann et al., 2016; Koch et al., 2016).

5 An interest rate higher than the risk-free rate for long-term anticipation is way of incorporating limited farsightedness as well as risks of, say, a regulatory nature (Bredin & Parsons, 2016; Ellerman et al., 2015, Quemin, 2017; Salant, 2016). We note that our qualitative results are robust to variations in interest rates and that our quantitative results vary in foreseeable ways.

6 As long as the time horizon is less than 10 years, the model indicates nil prices for at least a few years. Thus, only long enough a time horizon can explain past prices. In particular, a time horizon of 15 years yields simulated price variations in line with observations.

7 Without loss of generality for our qualitative results, we assume the marginal abatement cost c is constant and fixed through time. In order to reproduce observed price levels satisfactorily we use the method of least squares to parameterize c and find c=1.10^{-7}€/$(tCO_2)^2$ approximately.

8 When anticipations are rational (Deaton & Laroque, 1992, 1996; Hotelling, 1931; Samuelson, 1971), either the price rises at the corresponding interest rate (that of hedging or long term) or the total annual cap is binding and, borrowing being proscribed, the price increases at a rate less than the interest rate.

9 Note that permits not distributed in Phase III, i.e. the difference between the cap and the total number of permits actually issued, whose magnitude is comprised between 500 and 1000 million, could also be placed in the MSR. We do not include these permits in the MSR but note that this does not affect our results.

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