*Documentation*

# MSR through 2030: impact on market liquidity and considerations for the 2026 reform

## Input material and takeaways from a workshop in Brussels

*December 6, 2023*

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# Content

## Workshop: goal and set-up

This document presents the main takeaways and insights from a workshop organised by the Ariadne Project in Brussels on 6 December 2023. Following up on the workshop we conducted last year on the evolution of EU-ETS prices through 2030 and beyond, in this year's event we wanted to take a closer look at the functioning of the Market Stability Reserve (MSR) - also with a view on its upcoming review in 2026. The focus of the model-based discussion was the years until 2030, but we also considered effects post 2030 in the discussion if they impacted MSR behaviour in this decade. The workshop convened experts from six organisations that operate carbon market models – academic institutions as well as carbon market analysts (see Figure 1).

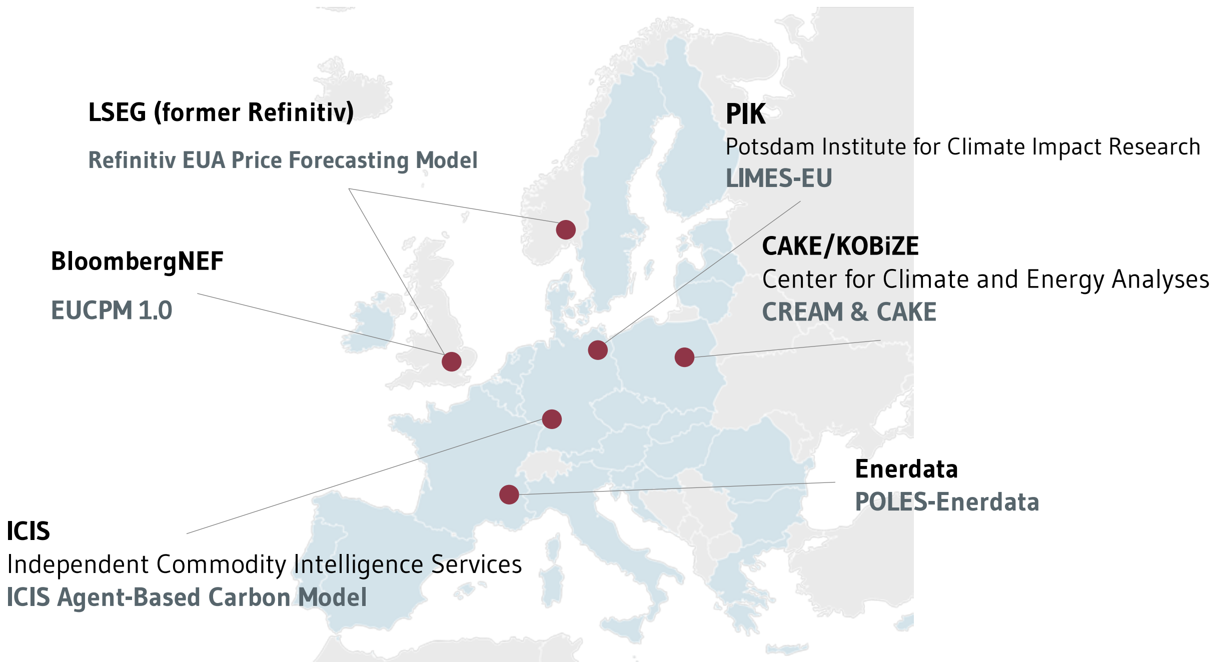



*Figure 1. Participating organizations and models.*

The goal of the workshop was twofold: First, we wanted to discuss important updates of the models, implementation details as well as core assumptions that happened since the last workshop. Second, we wanted to look into and discuss results of the different models for the evolution of the total number of allowances in circulation (TNAC) and the operation of the MSR.

Such as last year, all participants responded to a questionnaire and provided a short model fact sheet, information about EUA prices and MSR operation in their default "Green

Deal/FF55 COM" scenario. They also elaborated on the main price drivers in 2030, and provided their views on the future role of the MSR and how to reform it -if any- in the 2026 revision. The completed questionnaires can be found in the Appendix C.

## The participating models

All six models participating in this comparison study simulate the functioning of the EU ETS by capturing the supply and demand dynamics of emission allowances. Table 1 summarizes the most important methodological aspects of the models.

*Table 1: Categorization of models along different features and methodological aspects.*

| Modeling group | MSR | Detail of modeling sectors | Foresight | Market imperfections |
|---|---|---|---|---|
| **LSEG** | ✓ | **Detailed**<br>-<br>**MAC curves**<br>electricity, heating, industry<br>**Emission projections**<br>aviation, maritime | **Limited**<br>3-5 y | - Limited foresight<br>- Probabilistic approach to represent uncertainties about policies |
| **BNEF** | ✓ | **Detailed**<br>-<br>**MAC curves**<br>electricity, industry<br>**Emission projections**<br>aviation, maritime | **Limited**<br>1-5 y | - Limited foresight<br>- Banked EUA from non-compliance actors |
| **ICIS** | ✓ | **Detailed**<br>electricity, heating<br>**MAC curves**<br>industry<br>**Emission projections**<br>aviation, maritime | **Limited**<br>1-10 y | - Limited foresight<br>- Banked EUA from non-compliance actors |
| **PIK** | ✓ | **Detailed**<br>electricity, heating<br>**MAC curves**<br>industry<br>**Emission projections**<br>aviation, maritime | **Perfect**<br>50 y | **x** |

| | | | | |
|---|---|---|---|---|
| **Enerdata** | ✓ | **Detailed** electricity, heating, industry, aviation, maritime, other<br>**MAC curves**<br>**-**<br>**Emission projections**<br>- | **Limited**<br>3-10 y | - Limited foresight<br>- Banked EUA from non-compliance actors |
| **CAKE** | ✓ | **Detailed** electricity, heating, industry, aviation, maritime, other<br>**MAC curves**<br>**-**<br>**Emission projections**<br>- | **Limited** | - Limited foresight |

Each model features a detailed representation of the MSR, including its various thresholds, enabling the determination of MSR intake rates and invalidation levels endogenously. However, the models vary in their approaches to estimating certificate demand from different sectors, showcasing differences in modelling detail. Some models employ a detailed, bottom-up representation of technologies and investment decisions, while others use exogenous Marginal Abatement Cost (MAC) curves for a more simplified approach. The representation of the aviation and maritime sectors tends to be the most simplified, with four out of six models relying solely on emission projections.

The models diverge in their representation of potential market imperfections, with PIK's model being the only one aiming to establish benchmark trajectories, hence assuming perfect foresight by anticipating developments up to 2050 and beyond. In contrast, other models prioritize projecting the market's near-future landscape, accounting for various imperfections like myopic compliance actors, the influence of non-compliance actors, and policy uncertainty.

## Main takeaways and insights from workshop discussions

### EUA price projections up until 2030 – little movement initially, but rapid rise in the second half of the decade

Putting the price projections side by side shows some divergence in the long run, but much less so in the short run. The projections range from 80 to 132 EUR2023/tCO2 in 2025 and from 91 to 188 Euro EUR2023/tCO2 in 2030 (see Figure 3), with ICIS reporting the lowest expected price and Kobize the highest in 2030. Overall, EUA price estimations are higher, but prices remain below 100 EUR2023/tCO2 by 2025. ICIS and Enerdata both expect rather flat prices. Compared to the EUA price estimation from the survey in 2022 (see Appendix A), this represents a return to normal: back then, the models had shown remarkable convergence towards 2030, but more divergence in the short term. This situation has now been reversed.

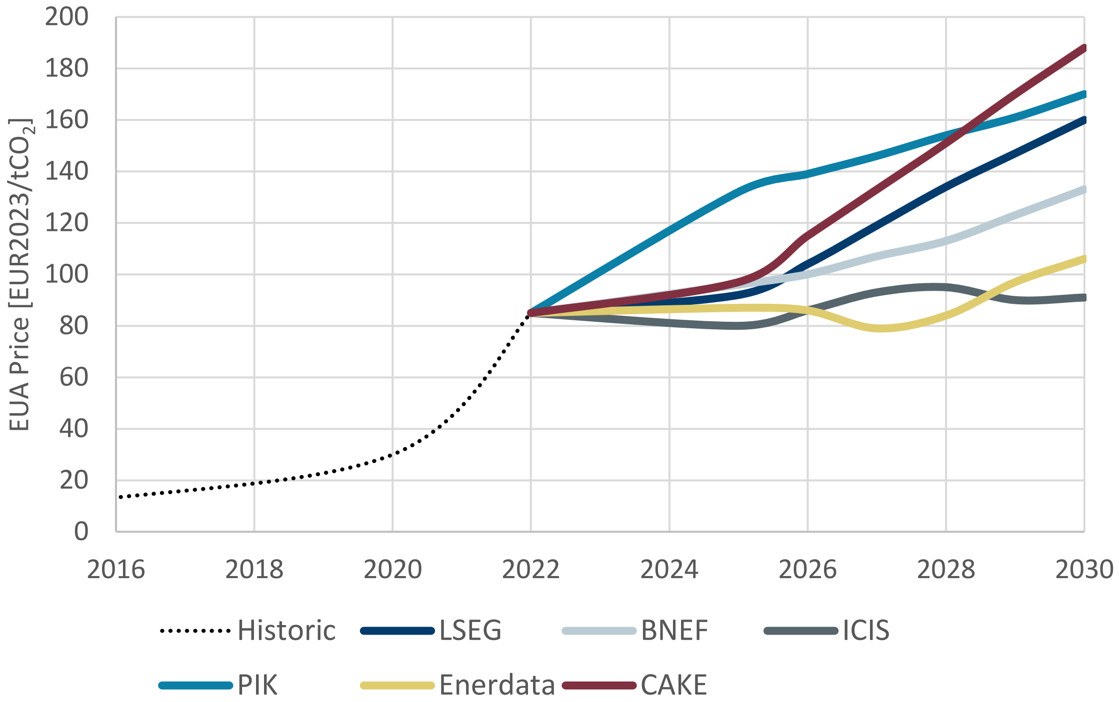



*Figure 2. Modelled EUA price path towards 2030.*

**Scarcity drives prices up – but increase is slowed by the expansion of renewable energy, uncertainty about industrial development**

One of the lowest projections comes from ICIS. Drivers of this trend include the structural trend towards decarbonisation of industry, where they account for the contribution of overlapping policies to reducing emissions; but also an allowance supply in excess of the cap as unallocated allowances are returned to the market. The cross-sectoral correction factor is not triggered in the ICIS scenario.

In the case of Enerdata, the low-price projection is the result of a significant downward revision. Their updated long-term scenario now reflects more decarbonisation objectives and a stronger role for non-price-based tools that take over some of the decarbonisation effort. Similarly, Bloomberg reported revising their price projection downwards, marking one of the first times ever that this has occurred. Drivers for Bloomberg included the additional allowance supply for REPowerEU, a dampened outlook for industrials, as well as strong growth of renewable energies, and thus lower-than-expected emissions from the power sector.

Other teams, such as Kobize, have revised their price projections upward for the second half of the 2020s. Compared to the 2022 projection, the new scenario includes the additional auction volumes used to finance RePowerEU, which increase supply in the short term, but exacerbate the shortage after 2026. As a result, Kobize reports one of the highest expected prices, with EUAs approaching 188 Euro by 2030. in later years, the existing scarcity is exacerbated by greater hedging needs.

The release of RePowerEU volumes, together with the dampening effect from increased renewable energy production, are also among the main new drivers in the modelling by the London Stock Exchange group, explaining the downward revision compared to last year’s projections.

**Market Stability Reserve stops taking in allowances by 2030**

By 2030, almost all models see the Market Stability Reserve (MSR) entering the range where it turns inactive (see Figure 4), i.e. where it neither takes in nor releases allowances. Enerdata sees the MSR intake ending as early as 2024, Bloomberg one year later. Kobize sees the upper threshold for intake reached only in 2028.

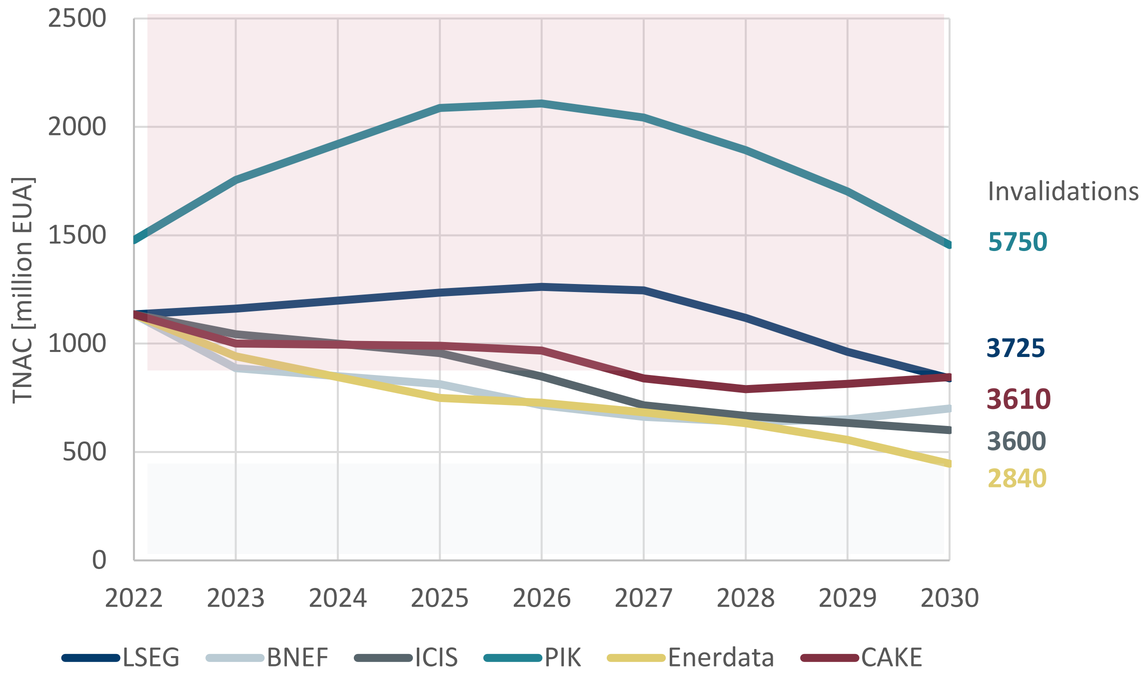



*Figure 3. TNAC evolution until 2030 and cumulative invalidations over time.*

By 2030, the models estimate that a cumulative total of 2.6 - 5.7 billion allowances from the MSR will have been invalidated. The difference in estimates is explained by how quickly the models see the TNAC fall below the upper threshold, meaning that models with a higher TNAC estimate a greater volume of cancellations.

**Foresight as a key determinant for the dynamics of the Market Stability Reserve**

A recurring discussion revolved around the question how much the market really anticipates future scarcity of allowances. In practice, the experience is mixed – often, market participants do not appear to apply a lot of foresight, meaning that they either do not believe the projections, or at least do not act in accordance to them, their behaviour being guided by shorter-term motivations.

The different models represented in the discussion assume quite different levels of foresight, which partly explains their divergence. The PIK model marks the most extreme case by assuming perfect foresight, which is related to a change in paradigm where agents take a longer-term view due to enhanced policy credibility. This means that agents in the model – knowing where the price will go – hold on to more allowances and have greater hedging needs. As a result, this model also yields the highest TNAC. As a result, the MSR remains active for longer, and a larger number of allowances is invalidated from the MSR. If the assumption of perfect foresight is relaxed and more limited foresight assumed, the projections for TNAC and the resulting MSR activity is closer to that of other models. In a more limited way, the models by ICIS and LSEG also make stronger assumptions about foresight (five years in the case of LSEG), resulting in a TNAC that is lower than for PIK, but above other models.

**The economic outlook influences projections, behaviour - and the political commitment**

One possible explanation of the (very) limited foresight by some market participants is the economic outlook and the overall state of the economy. Simply put, several businesses are more concerned if they survive into the next year, and therefore cannot afford to look into 2030 and plan accordingly. For instance, some firms find themselves forced to sell allowances because they need liquidity, even where they would be better advised to hold on to them. Likewise, the balance sheet can be an issue where companies lack sufficient liquidity to hedge against price swings.

Investment funds are a group of market actors that are not constrained by liquidity, but instead can (and do) move quickly to exploit arbitrage opportunities. In general, their market behaviour is more forward-looking and attentive. In this case, however, they have gone back to short positions overall.

That said, while carbon was quite volatile in recent years, it was not nearly as volatile as other commodities (in particular oil, gas). As a pseudo-commodity, there is always some expectation of political interventions to dampen prices. Yet while there was plenty of discussion around price containment interventions, at the end of the day interventions remained few and far between – and limited in extent. Given the unprecedented pressure from the skyrocketing energy prices, this finding is itself remarkable, and speaks to a relatively strong and robust commitment. Going forward, this experience of a "non-intervention" even amid extreme price developments may strengthen participants' trust in the market and the long-term commitment of the regulator.

**Market structure: industrial abatement more uncertain than the power sector**

A common theme from all the projections is that they see the market lingering around initially – until 2025, calm waters prevail, while after 2026 stormier waters are ahead. All projections see the crunch point for this trend in the mid-2020s, as fundamental tightness in the market increases: as the extra volumes from the RePowerEU run out and the ambitious linear reduction factor kicks in, scarcity (and in its wake prices) are bound to increase rapidly.

Notably, the power sector is not the key source of uncertainty in this process: for power, the path ahead towards full decarbonisation and 100% renewables is fairly clear, with diverging views only on the necessary expansion pace, and whether it will be under- or over-achieved. More important, but also more uncertain, is what happens in industry. Increasingly, as power sector emissions go down, abatement in industry will become decisive for the carbon market dynamics and price.

For industry, one complication is that the industries comprised in the EU ETS are very heterogenous in terms of the abatement options, and that different types of abatement can happen in parallel. Here, some models distinguish between abatement induced by the forecasted $CO_2$ price, which captures emission reductions available along the MAC curve, and planned abatement, which captures publicly announced investments into industrial transformation projects implemented independently of the forecasted carbon price. While the latter can deliver very large emission reductions, they also carry much larger risks. And, crucially, most depend on public support in the form of subsidies for transformative investments and infrastructure – which in itself is risky in times of constrained public budgets. Added to this could be a third mode – unmanaged abatement through de-industrialisation, as energy-intensive processes are scaled down in Europe as they are no longer viable. Those analysts that included industrial decarbonisation projects in their models noted that they had found themselves continuously revising expectations downward, as planned and announced projects turned out not be viable, and technologies not as mature as needed.

Hedging behaviour, by contrast, is currently not seen as very important for industrial players. This may still change in the second half of the 2020s as scarcity increases. Likewise, CBAM has limited effect on the EUA market: proxy hedges by CBAM-covered importers are conceivable, and apparently have raised interest from Chinese companies exporting to the EU. Yet they would be a fairly complex strategy and instrument, and are therefore unlikely to play a significant role in the short to medium term. They might be more relevant post-2030 as the CBAM is phased in at an increasing pace.

**In the near term: quick fixes to MSR parameters to improve its functioning**

With reference to the upcoming review of the market stability reserve in 2026, numerous questions emerge whether the MSR in its current form is still fit for purpose, and for how long it can continue to function as the EU ETS moves toward net zero.

In the foreseeable future, some scope for improvement remains by adjusting key parameters of the MSR. This concerns the level of the thresholds for intake and release and the procedure for adjustment. At current, the thresholds were determined based on the hedging needs of the power sector. Yet as the power sector is decarbonised, its hedging needs will decline, as will the cap itself. At the same time, new hedging needs may arise e.g. from maritime or from CBAM proxy hedging. Therefore, a new and better definition of the thresholds and their calculation is needed (and ought to be communicated). Rather than a one-off adjustment, this might take the form of a continuous function of the thresholds – e.g. by applying the linear reduction factors to the MSR thresholds.

A further potential to improve the MSR without changing its fundamental structure would basing it on a different indicator than the TNAC, or finding better ways to calculate it. Thus, for instance, the TNAC calculation will exclude historic (2013-2023) EUA demand from aviation operators (ca. 180 million tons as of 2023). This means that the TNAC is artificially higher than the actual surplus, and that the MSR may therefore remain inactive longer than needed. Furthermore, Member States may cancel up to 100 million tons from auction volumes and use these as flexibility towards their ESR. Again, since these are not reflected in the TNAC, if and when realised, they will further increase the wedge between surplus and TNAC.

**Going forward: do we need different mechanisms to stabilise the market?**

Yet recalculating parameters such as TNAC and thresholds does not resolve another fundamental weakness of the MSR: expectations about future scarcity lead to more stockpiling behaviour, these lead to a higher TNAC, which in turn leads to more invalidation, and thus exacerbates scarcity. In this way, the MSR creates cyclicality and increases volatility.

The injection of the RePowerEU volumes is a case in point: by bringing forward future volumes, the injection introduces quantities of EUAs that will then be syphoned off by the MSR and subsequently invalidated. In that sense, the mechanism is effectively cap-tightening.

In this way, the MSR was good at what it was designed to do – to reduce the surplus and improve the system's resilience to major shocks by adjusting the supply of allowances. Especially during the COVID shock, it served to restore / maintain confidence in the EU ETS. However, it is not suitable for actually living up to its name, and to stabilise the market. And particularly as the EU ETS approaches zero, much stronger stabilisation methods will be needed.

In terms of fundamental changes to the MSR, a price trigger would be a logical alternative. This, however, is not without problems either. First, it raises the question of who sets the prices, and how to shield the process from undue political interference. The experience with existing price corridors and stabilisation mechanisms at national-level is not necessarily encouraging (as in the German national ETS price corridor or the UK floor price). As a result, such a change could remove one uncertainty by introducing another one, i.e. from market uncertainty to political uncertainty. Second, there is the legal risk that an ETS must not look like a tax in the EU system – or else require unanimity. The ETS2 though does include some sort of price-based trigger for its MSR (albeit limited in time and volume), demonstrating that this appears to be feasible without unanimity. Finally, from a market oversight perspective, there is the technical risk that a price trigger risks creating odd market dynamics around the price threshold.

An even more ambitious option would see the introduction of a Carbon Central Bank charged with ensuring price stability. Yet for this, the political feasibility seems even more questionable. While an institution outside would make the design more technocratic and shield the ETS from the political process, it also raises questions on its governance and faces the challenge of earning trust in very short time. Overall, rather than a new institution, the Commission needs to ensure the functioning of a rule regarding how to stabilise the market while maintaining the integrity of the EU ETS.

**Market stability (and integrity) on the way to net zero: how to ensure a soft landing?**

Yet more questions on market dynamic arise after 2030, as the MSR changes from inactive mode and begins to release allowances into the market. But what if MSR is depleted and there is simply no supply left? The current release rate means that this point could be reached sooner rather than later. To avoid a quick depletion, it might be expedient to link the release volumes to the amount of allowances remaining in the MSR. But irrespectively, as the MSR runs out, questions are bound to come up regarding making the cap flexible (or to put it more simply: watering down the cap). To pre-empt this, thinking is needed on how such a safety valve mechanism could function in a rule-based way. It could involve access to international credits (Article 6), the use of removal credits (e.g. backed by the state, or built up in the form of a strategic reserve of carbon credits). By contrast, any consideration of returning invalidated allowances to the market would be a serious blow to the integrity of the market and the expectations of market participants: invalidations should clearly be considered as cancellations.

Yet even so, while the ETS has shown its worth in reducing emissions in bulk, it may be questioned if it is still the right tool for the last stretch as the EU approaches net zero. This also concerns how a soft landing could be engineered – for instance with a declining LRF for the final approach to net zero.

In any case, the key is to create market confidence and robust expectations. This requires clear direction, including what to do with residual emissions without compromising environmental integrity. In particular, this includes the issue of integrating carbon direct removals (CDR) into the overall architecture: eventually, any supply of remaining emissions will need to be backed by CDR – and as the EU enters net negative terrain, would even require overcompensation with removals for any remaining emissions.

# APPENDIX

## *A. EUA price estimation from Ariadne Workshop in 2022*

Below we reproduce the EUA price estimations from the Workshop in 2022. The prices are further adjusted to 2023 prices for comparison purposes. Figure A1 shows a remarkable convergence between the different modelling approaches in the modelled price path towards 2030. It was deemed that there are fewer abatement technology choices in the medium to long term than there are in the short-medium term. Also, in the medium to long term, backstop technologies are quite clear (renewables, eventually negative emission technologies), and their prices can be estimated with reasonable confidence. In this sense, the convergence of carbon prices can also be an expression of the convergence of expectations about future developments – or simply a case of group thinking

This was counterintuitive result since normally one would expect to have greater confidence in predictions of models about short term developments, as price drivers are better known and understood, whereas socio-economic uncertainties increase in the long term. Yet, as the carbon budget is shrinking, the path also becomes clearer – as all available options for decarbonisation will need to be implemented.

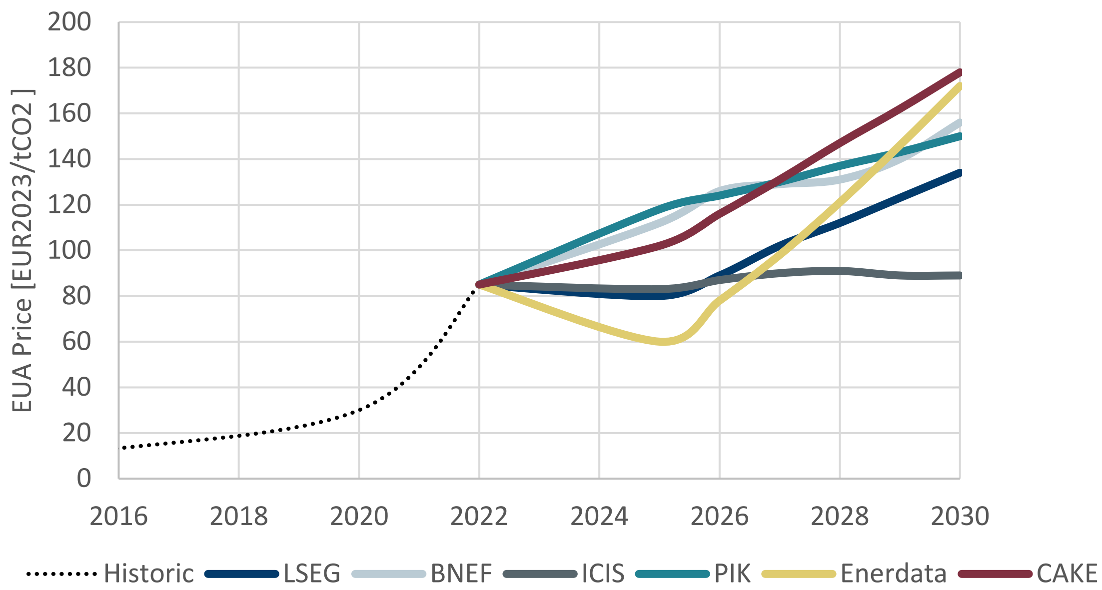



*Figure 4. EUA prices in default "Green Deal/FF55 COM" scenarios from Ariadne Workshop in 2022.*

*B. Completed questionnaires*

# Questionnaire ETS workshop

| | |
|---|---|
| **Responding organisation** | **LSEG (former Refinitiv)** |

## Model fact sheet

| | |
|---|---|
| **Model (suite) name** | Refinitiv EUA price forecasting model |
| **Short description** | The EUA price forecasting model is a linear optimization model projecting yearly EU ETS prices to 2030 (2035). It consists of three modules. Module 1 is an econometric model projects future carbon price based on ETS balances forecast. The balances forecasts are based on emissions separately for power and industry (incl. Aviation) sectors and supply forecast for EU ETS including auctioning and free allocation. Market Stability Reserve is modelled in this module too. The second module simulates the interaction between the future EUA price expected by the market and the amount of abatement in the EU ETS. It uses a feedback loop to estimate the impact of abatement on the carbon price and to forecast the future carbon prices and abatement levels, based on in-house marginal abatement cost curves for the power and industry sectors. The third module provides a constraint, which specifies that market participants cannot be short of EUAs for their annual compliance needs. The module simulates the market's reaction to a potential future shortage by calculating companies' abatement assuming they aim to minimise costs. Market participants are assumed to begin to cover shortages by beginning to abate emissions five years in advance. Power sector emissions forecast is based on a least cost dispatch optimization model, which is then used to calculated power sector's EUA demand profile with assumed three-year ahead forward hedging rates. Industry emissions forecast is based on econometric model and in-house analysis of production and CO2 intensity and assumed four-year ahead forward-looking horizon. The model documentation is available in Refinitiv Eikon. |
| **Approach**<br>Bottom-up, Top-down, Hybrid | Bottom-up |
| **Geographical coverage** | EU ETS coverage (EU27, Norway, Iceland, Liechtenstein) |

<table>
<tr><td>Sectors covered and modelling detail</td><td>
<table>
<tr><th>Sector</th><th></th><th>Level of modelling detail</th></tr>
<tr><td>Electricity generation</td><td>☒</td><td>Bottom-up dispatch model with detailed assumptions on power demand and installed capacity by technology of each EU27 country. Fuel prices are based on latest traded price and forward curves of TTF and API2 coal. Renewables capacity assumptions are based on the EU 2030 renewables target and national energy plans.</td></tr>
<tr><td>Centralized heat generation</td><td>☒</td><td>Same as the electricity generation model with assumptions on power to heat share for countries that are applicable.</td></tr>
<tr><td>Industry</td><td>☒</td><td>Bottom-up model using econometric modules to forecast emissions based on historical emissions, production growth rates, macroeconomic forecasts by Oxford Economics and assumed CO2 improvement emissions intensities. Stationary industry is categorised into five sectors – Oil & Gas, Pulp & Paper, Metals, Cement, Lime & Glass, and Other (includes Chemical sector).</td></tr>
<tr><td>Buildings</td><td>☐</td><td></td></tr>
<tr><td>Road transport</td><td>☐</td><td></td></tr>
<tr><td>Aviation</td><td>☒</td><td>Using Eurocontrol projections of EU aviation growth and historic yearly emission intensity.</td></tr>
<tr><td>Maritime</td><td>☒</td><td>Yearly emissions provided by Siglar Carbon using vessel tracking data</td></tr>
<tr><td>Forestry</td><td>☐</td><td></td></tr>
<tr><td>Waste</td><td>☐</td><td></td></tr>
<tr><td>Other sectors</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Representation of foresight</td><td>Default: limited foresight for 3 to 5 years depending on the sector</td></tr>
<tr><td>Representation of non-compliance trading (NCT)</td><td>Default: Not represented</td></tr>
<tr><td>Representation of market imperfections</td><td>This is captured via the econometric model based on historic balances, most importantly ‘perceived balances’ considering market participants’ behaviour changes and probabilistic approach of uncertainties regarding ETS policies.</td></tr>
<tr><td>Linkage to other ETS?<br>If yes, please briefly elaborate</td><td>no</td></tr>
</table>

| | |
|---|---|
| **Representation of CDR**<br>If yes, which technologies | no |
| **(International) Offsets and credits included?**<br>If yes, please briefly elaborate | no |

## 'Default' scenario results: EU ETS and MSR operation (from a recent run in line with the 'Fit for 55 package')

| | |
|---|---|
| **Short description of scenario**<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)? | • Reform of ETS according to Final Fit for 55 package<br>• EU ETS Cap with 4.3% and 4.4% LRF and two one-off rebasing<br>• REPowerEU sales of EUAs as of July 2023, and auction regulation as of September 2023<br>• Model maritime sector exogenously for now (will include into market balance soon) |
| **Representation of the MSR**<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post? | Yes we have modelled MSR as the set up in the regulation. MSR is endogenously modelled in the price model. Changes in emissions and supply assumptions will affect TNAC/market balances with MSR calculation embedded too. Hence the MSR intake/outtake projections will also change if underlying assumptions change. MSR cancellation is now modelled exogenously. |
| **Result highlights**<br>3-5 points; please include figure showing TNAC and MSR intake/outtake (see LIMES example) | • TNAC has fallen to 1135 Mt in 2022 and is close to the 1096 Mt threshold triggering dynamic intake rate (below 24% to avoid excess intake causing TNAC below 833 Mt)<br>• Our latest model run with our latest emissions forecast still gives a TNAC higher than 1096 Mt and 24% intake. However, we have had some scenario runs with intake rate falling to 20% in 2023 and remaining at the level until 2025. This is to highlight that the MSR intake rate would deviate from the 24% level in the years 2023-2025 depending on the level of emissions. |

| MSR figures | 2022 | 2023 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total number of allowances in circulation (TNAC) [million EUA]** | | 1162 | 1235 | 1262 | 1246 | 1118 | 962 | 840 | | |
| **Cumulated MSR cancellations as of 2020 until (including) year x [billion EUA]** | | 2515 | 2758 | 3042 | 3341 | 3599 | 3724 | 3724 | | |
| **Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA]** | **2795** | 3097 | 3339 | 3624 | 3923 | 4224 | 4513 | 4735 | | |
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

*Notes:*

1. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
2. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | | | | 92 | 104 | 119 | 134 | 147 | 160 | 432 | |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal [ X] real [ ]<br>• Base year: 2023 | | | | | | | | | | |
| **Real discount rate assumed** | 2% | | | | | | | | | | |

| **EUA prices** | **2015** | **2020** | **2022** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | **1.00** | **1.06** | **1.19** | 1.06 | 1.08 | 1.10 | 1.11 | 1.13 | 1.15 | | |
| **Source of your inflation rates assumptions (if applicable):** | ECB | | | | | | | | | | |

*Notes:*

1. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/t$CO_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
2. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
3. *For the workshop we will harmonize price data to $EUR_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | **Average of inflation rate %** | **2015 real** |
|---|---|---|
| 2015 | 0.12 | 1.00 |
| 2016 | 0.19 | 1.00 |
| 2017 | 1.56 | 1.02 |
| 2018 | 1.79 | 1.04 |
| 2019 | 1.43 | 1.05 |
| 2020 | 0.68 | 1.06 |
| 2021 | 2.91 | 1.09 |
| 2022 | 8.54 | 1.19 |
| 2023 | | 1.26 |

## Relevant price drivers

Please select the <u>three most important drivers</u> for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply - allocation vs. auction, policy credibility, shocks | ☒ | +/-20 |
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☐ | |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☒ | +/-30 |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☒ | +/-20 |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☐ | |

| |
|---|
| **Please provide a short description/explanation for the level of banking you expect for 2030**<br><br>I think roughly equal to one year of emissions in industry sectors (excluding CBAM sectors), 500 Mt |

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

I think the MSR as supply-adjustment mechanism is fulfilling its purpose and functioning well. Since its implementation in 2019, it has been able to inject confidence into the market and absorb exogenous shocks (such as tackling surplus due to covid lowering energy consumption and industrial activities). I think the current design with TNAC quantity as trigger works better than using price as trigger. Regarding the current MSR parameter, the lower and upper thresholds might need to be reviewed. The current 400 and 833 Mt are mainly linked to the hedging needs of power sector which will see its emissions declining rapidly. On the other hand, with the expansion of ETS to more sectors (maritime, ETS2 etc.), I agree that MSR threshold need to consider the enlargement of EU ETS too. It maybe worth to pin the criteria determining the levels of MSR thresholds (hedging needs, allowance demand, allowance inventories over a given period etc. )

# Questionnaire ETS workshop

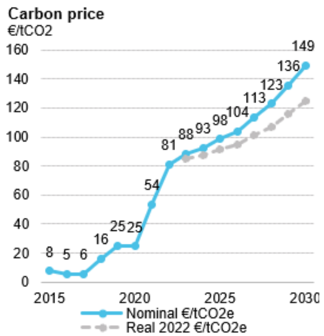
| | |
|---|---|
| **Responding organisation** | **BloombergNEF** |

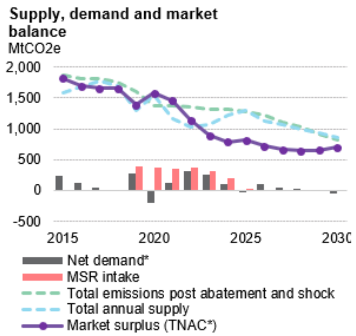
## Model fact sheet

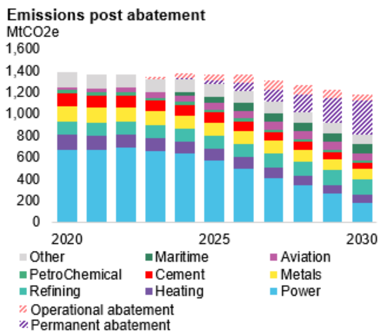
| | |
|---|---|
| **Model (suite) name** | EU ETS Carbon Pricing Model (EUCPM 1.0) |
| **Short description** | The carbon price model forecasts the EU ETS market balance and EUA prices given emissions forecasts, a marginal abatement cost curve, and user-defined rules for the Market Stability Reserve.<br>The model projects hedged holdings and allowances in circulation given price levels and abatement volume solved for in the previous year. It subsequently calculates the reserve injections or ejections and anticipates any upcoming scarcity using a market horizon. The pricing algorithm then minimizes the costs at which abatement is provided.<br>Users can adjust assumptions for the key parameters of the Market Stability Reserve including start date, absorbed volume, injection/ejection rate, fixed or variable reserve ejections, and others. The model comes pre-configured with several key sets of assumptions, and users can save their combination of settings for later use. The model differentiates between operational abatement (such as fuel switching), which can be scaled down if prices fall below levels incentivizing its use, and permanent abatement (like investment-driven decisions) which, once implemented adjust the emissions trajectory. |
| **Approach**<br>Bottom-up, Top-down, Hybrid | Bottom-up |
| **Geographical coverage** | EU |

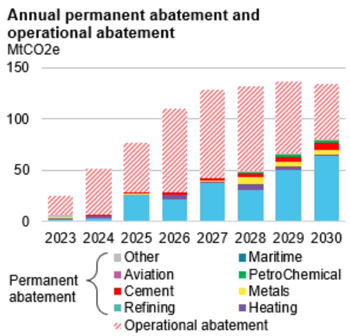
<table>
<tr><td>Sectors covered and modelling detail</td><td>
<table>
<tr><th>Sector</th><th></th><th>Level of modelling detail</th></tr>
<tr><td>Electricity generation</td><td>☒</td><td>Emissions, marginal abatement cost curves</td></tr>
<tr><td>Centralized heat generation</td><td>☐</td><td></td></tr>
<tr><td>Industry</td><td>☒</td><td>Emissions, marginal abatement cost curves</td></tr>
<tr><td>Buildings</td><td>☐</td><td></td></tr>
<tr><td>Road transport</td><td>☐</td><td></td></tr>
<tr><td>Aviation</td><td>☒</td><td>Emissions</td></tr>
<tr><td>Maritime</td><td>☒</td><td>Emissions</td></tr>
<tr><td>Forestry</td><td>☐</td><td></td></tr>
<tr><td>Waste</td><td>☐</td><td></td></tr>
<tr><td>Other sectors</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Representation of foresight</td><td>Base case (default) assumes one full year of foresight and five ‘decay years’ of declining foresight. Optional: users can adjust the number of years of full and declining foresight.</td></tr>
<tr><td>Representation of non-compliance trading (NCT)</td><td>Assumes ‘speculative’ demand as a portion of TNAC</td></tr>
<tr><td>Representation of market imperfections</td><td>Not represented</td></tr>
<tr><td>Linkage to other ETS?<br>If yes, please briefly elaborate</td><td>No</td></tr>
<tr><td>Representation of CDR<br>If yes, which technologies</td><td>No</td></tr>
<tr><td>(International) Offsets and credits included?<br>If yes, please briefly elaborate</td><td>No (after expiry of allowed offsets in the EU)</td></tr>
</table>

## **‘Default’ scenario results: EU ETS and MSR operation** (from a recent run in line with the ‘Fit for 55 package’)

<table>
<tr><td>Short description of scenario<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)?</td><td>• All legislated policies are included (fit for 55, REPowerEU).<br>• All included sections Power, Heating, Refining, Metals, Cement, Petrochemical, Aviation, Maritime, Other</td></tr>
<tr><td>Representation of the MSR<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post?</td><td>Yes</td></tr>
<tr><td>Result highlights<br>3-5 points; please include figure showing TNAC and MSR intake/outtake (see LIMES example)</td><td>








</td></tr>
</table>

| **MSR figures** | **2022** | **2023** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total number of allowances in circulation (TNAC) [million EUA]** | | 887 | 813 | 716 | 663 | 639 | 650 | 701 | | |

| MSR figures | 2022 | 2023 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cumulated MSR cancellations as of 2020 until (including) year x [billion EUA]** | | 2,602 | | | | | | | | |
| **Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA]** | | 1,415 | 1,651 | | | | | | | |
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | | - | - | - | - | - | - | - | | |

*Notes:*

3. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
4. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | | | | 98 | 104 | 113 | 123 | 136 | 149 | | |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal<br>• Base year: 2022 | | | | | | | | | | |
| **Real discount rate assumed** | | | | | | | | | | | |

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | | | | 1.08 | 1.10 | 1.12 | 1.15 | 1.17 | 1.19 | | |
| **Source of your inflation rates assumptions (if applicable):** | Bloomberg terminal | | | | | | | | | | |

*Notes:*

4. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/t$CO_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
5. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
6. *For the workshop we will harmonize price data to $EUR_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | Average of inflation rate % | 2015 real |
|---|---|---|
| 2015 | 0.12 | 1.001167 |
| 2016 | 0.19 | 1.003086 |
| 2017 | 1.56 | 1.018717 |
| 2018 | 1.79 | 1.036969 |
| 2019 | 1.43 | 1.051746 |
| 2020 | 0.68 | 1.058933 |
| 2021 | 2.91 | 1.08973 |
| 2022 | 8.54 | 1.182841 |
| 2023 | | |

## Relevant price drivers

Please select the <u>three most important drivers</u> for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply - allocation vs. auction, policy credibility, shocks | ☒ | +/- 15 |
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☒ | +/- 10 |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☐ | |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☒ | +/- 5 |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☐ | |

**Please provide a short description/explanation for the level of banking you expect for 2030**

This encapsulates several important price-driving variables. On the supply-side, the linear reduction factor will determine the overall supply in the market to 2030, which will also be affected by the MSR. Given that our model expects an undersupplied market balance towards 2030, this balance will likely have a large bearing on the price. Furthermore, the timing of supply will also shape the price trajectory throughout the decade. For example, we see a need to reshuffle less allowances to raise the REPowerEU target than the Commission proposal.

**Power sector:** The power sector has a large impact on EUA prices for 2025 and 2030 on the demand side, because it makes up the largest share of emissions in the EU ETS, the least free allocation, and the most available abatement options (which is the price-setting mechanism in our CPM). Our marginal abatement cost curve shows a large amount of renewable capacity coming online gradually between 2025 and 2030, which impacts the prices in both years.

**Behaviour:** Hedging is also an important component of our model. So far, we have seen utilities/power sector players taking part in EUA hedging, and expect this to be increasingly adopted by industrials in the latter half of the decade as their free allocation starts to get phased out.

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

More dynamic threshold values – not based on price (we already have Article 29a in an attempt to control price).

# Questionnaire ETS workshop

| Responding organisation | ICIS – (Independent Commodity Intelligence Services) |
|---|---|

## Model fact sheet

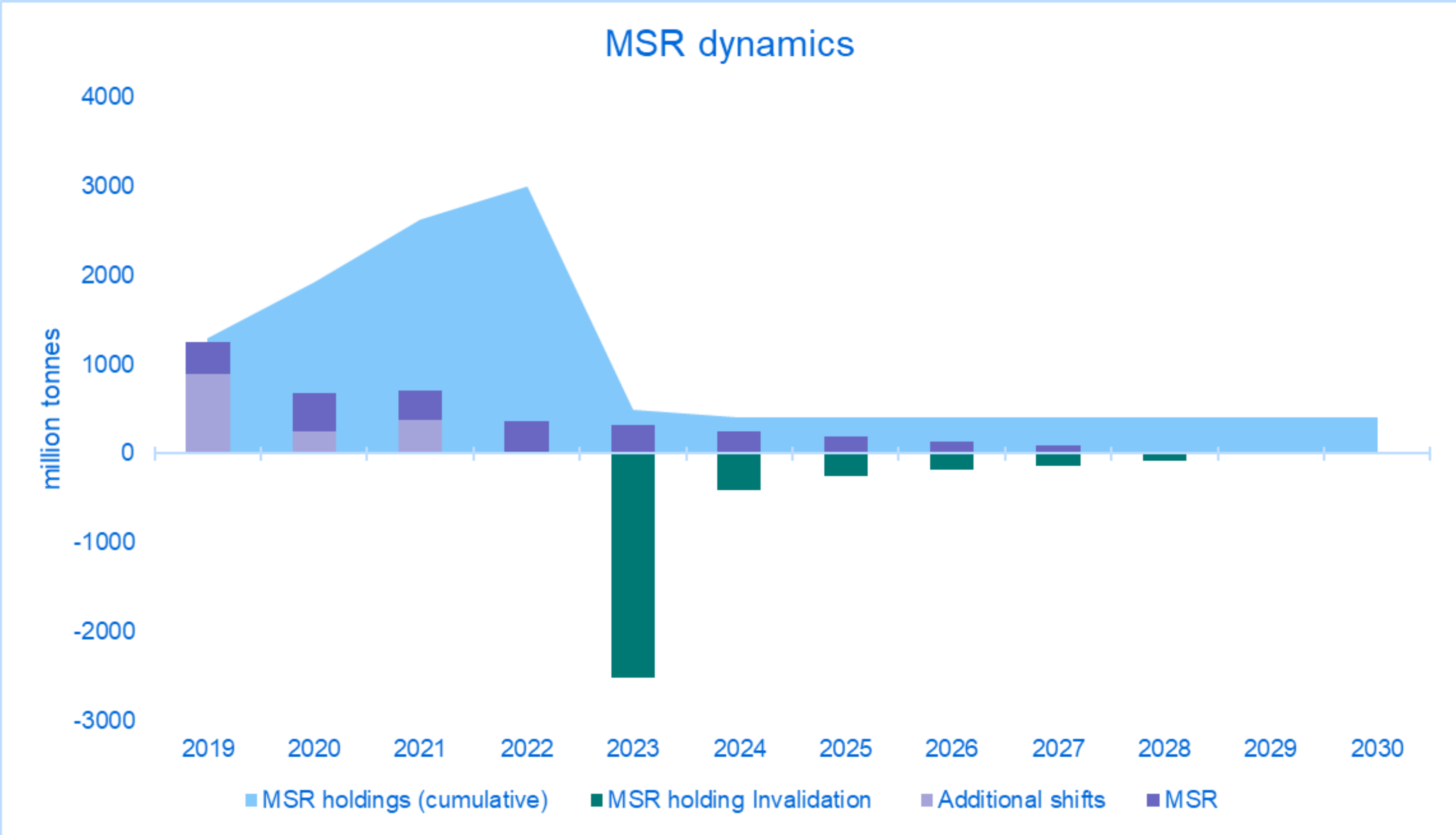
| Model (suite) name | ICIS Agent-Based Carbon Model |
|---|---|
| **Short description** | The ICIS EU ETS Carbon Model is an agent-based fundamental model that includes a detailed representation of allowance supply and demand in the EU ETS and the EU power sector. The model iterates from quarter to quarter which allows it to reflect different behavioural strategies and the impact of the Market Stability Reserve.<br><br>The model in the short-term creates a supply and demand equilibrium based on reversible emission reductions (e.g. fuel switching), price dependent hedging, banking and future price expectations of market participants. In the long-term the model endogenously determines price-driven industrial abatement and power sector investments.<br><br>The power sector is reflected by the fully integrated ICIS Power Horizon Model which is a linear dispatch optimisation and iterative investment simulation. The model considers fuel costs, capacity, and interconnector constraints, investment-, financing- and operating costs, lifetime, load factor assumptions, investor hurdle rates and natural resources.<br><br>ICIS power modelling can capture the relationship between policies, technology costs and demand developments, with internally consistent scenarios reflecting different pathways for the European power sector out to 2030.<br><br>The model is constantly adjusted to new market realities and assumptions and scenarios are updated on a monthly basis. |
| **Approach**<br>Bottom-up, Top-down, Hybrid | Hybrid |
| **Geographical coverage** | EU ETS (EU27 + NO + IS + LI) |

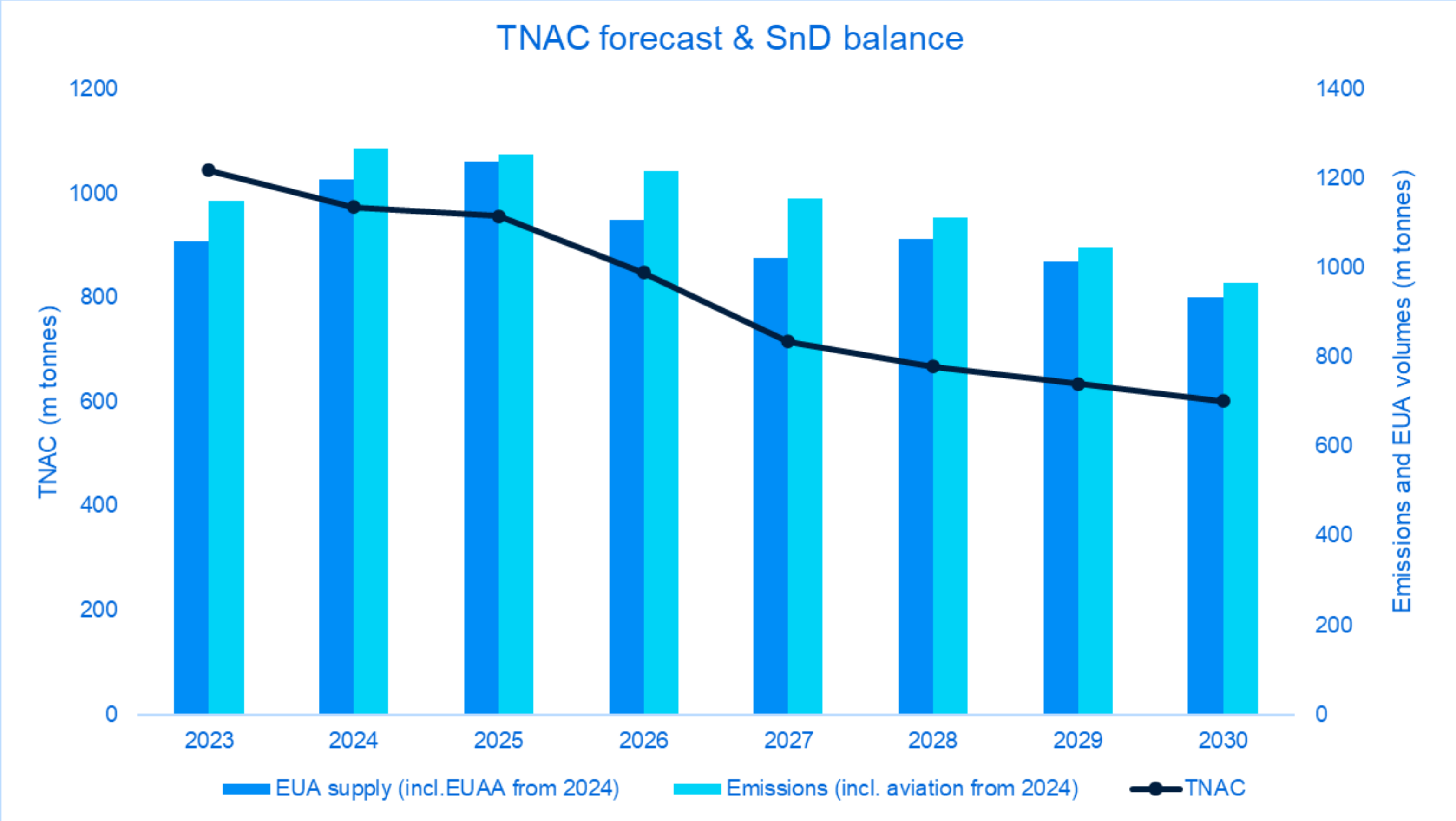
<table>
<tr><td>Sectors covered and model-ling detail</td><td>
<table>
<tr><th>Sector</th><th></th><th>Level of modelling detail</th></tr>
<tr><td>Electricity genera-tion</td><td>☒</td><td>Dispatch and investments per technology; detailed representation of techno-economic constraints</td></tr>
<tr><td>Centralized heat generation</td><td>☒</td><td>Dispatch from CHP plants, do not include heat-only plants</td></tr>
<tr><td>Industry</td><td>☒</td><td>Price-induced investments from energy-intensive industry based on regional marginal abatement costs for different technologies. In addition, baseline emissions include emis-sion reductions derived from abatement projects already announced by ETS participants.</td></tr>
<tr><td>Buildings</td><td>☐</td><td></td></tr>
<tr><td>Road transport</td><td>☐</td><td></td></tr>
<tr><td>Aviation</td><td>☒</td><td>Exogenous emissions, based on fuel demand forecast (incl. SAF)</td></tr>
<tr><td>Maritime</td><td>☒</td><td>Exogenous emissions, based on activity level forecast and emission intensity aligned with IMO 2030 target</td></tr>
<tr><td>Forestry</td><td>☐</td><td></td></tr>
<tr><td>Waste</td><td>☐</td><td></td></tr>
<tr><td>Other sectors</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Representation of foresight</td><td>Limited foresight depending on agent 0-10 years.</td></tr>
<tr><td>Representation of non-com-pliance trading (NCT)</td><td>We can represent NCT by either modelling them as a form of static demand or as an agent with limited foresight that looks at a BAU market balance and long-term abatement costs for a given horizon to form a “fair value” for the present that impacts buying and selling patterns.</td></tr>
<tr><td>Representation of market imperfections</td><td>Limited short-term abatement in a world of static banking by industrial players, buy-and hold strategies of NCT, represen-tation of “hedge books”</td></tr>
<tr><td>Linkage to other ETS?<br>If yes, please briefly elaborate</td><td>No</td></tr>
<tr><td>Representation of CDR<br>If yes, which technologies</td><td>No</td></tr>
</table>

| | |
|---|---|
| **(International) Offsets and credits included?**<br>If yes, please briefly elaborate | No |

## ‘Default’ scenario results: EU ETS and MSR operation (from a recent run in line with the ‘Fit for 55 package’)

| | |
|---|---|
| **Short description of scenario**<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)? | • Model parameters are aligned with the EU ETS framework, including all changes adopted under the Fit-for-55 reforms. The stationary cap (incl. maritime in 2024) is set at 12.294Gt in TP4 and by 2030, achieves a -62% reduction vs. 2005. The 4.3% LRF is applied (2024-2027) and 4.4% applied (2028-2030). The cap is reduced by -90mt in 2024 and -27mt in 2026 (rebasing).<br>• In line with the REPowerEU package, 247m allowances which were originally scheduled to be auctioned between 2027-2030 are frontloaded in 2023-2026. The redistribution of supply keeps the TNAC elevated in the mid-term and triggers increased MSR withdrawals.<br>• Our base case scenario sees ETS emissions drop steadily towards 2030 driven by a combination of a rapid build-out of renewables assets, closure of coal plants across member states and coal-to-gas fuel switching in the power sector. By 2030, 80mt/year of industrial abatement is required to balance the EU ETS (vs. baseline forecast). The scale-up of low-carbon industry faces limited headwinds due to the high fossil-fuel price environment, and a policy mix of carbon prices and financial support for energy intensive industrials. |
| **Representation of the MSR**<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post? | • The ICIS EU carbon model includes a simulation of the MSR where withdrawals/injections are determined endogenously |

| | |
|---|---|
| **Result highlights**<br>3-5 points; please include figure showing TNAC and MSR intake/outtake (see LI-MES example) | <br>• **MSR dynamics:**<br>o In total, we see cumulative MSR withdraws reach 1,685mt in TP4 (2021-2030). The frontloading of REPowerEU volumes in addition to low emission trend in 2023-2026 keep the MSR active for longer.<br>o The TNAC falls below the upper threshold in 2027 and last MSR withdrawal occurs in 2028, between 1 Jan-31 Aug, based on the 2026 TNAC.<br>o Allowances held in the MSR are invalidated from 1 Jan 2023. At first, allowances held in the reserve above the previous year's total auction volumes are invalidated. From 2024, holdings in the reserve above 400m (lower threshold) are invalidated at the start of each year. As a result, from 2024, MSR holdings remain at 400mt with annual cancelations based on the previous year's MSR volumes. |

| | |
|---|---|
| | o In line with the REPowerEU legislation, 27m allowances (that otherwise would have been invalidated) are transferred from the MSR holdings to the Innovation fund.<br><br><br>• **TNAC dynamics:**<br>o The TNAC remains elevated in 2024/24 due to low emissions trajectory driven by demand destruction. A strong MSR in the mid-term sees the TNAC decline rapidly from 2025 until MSR withdrawals stop in 2028.<br>o Rapid decarbonization in power sector + industry abatement avoids a situation where the TNAC falls below the 400mt threshold in TP4. |

| **MSR figures** | **2022** | **2023** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total number of allowances in circulation (TNAC) [million EUA]** | 1135 | 1044 | 956 | 848 | 715 | 667 | 635 | 601 | | |
| **Cumulated MSR cancellations as of 2020 until (including) year x [billion EUA]** | 0 | 2515 | 3176 | 3363 | 3498 | 3585 | 3594 | 3594 | | |
| **Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA]** | 1112 | 1435 | 1874 | 2008 | 2095 | 2105 | 2015 | 2105 | | |
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

*Notes:*

5. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
6. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| **EUA prices** | **2015** | **2020** | **2022** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | | | | 79.7 | 85.7 | 93.2 | 95.1 | 89.8 | 90.5 | | |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal [ ] real [x]<br>• Base year: 2023 | | | | | | | | | | |
| **Real discount rate assumed** | 2% | | | | | | | | | | |

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | **1.00** | **1.06** | **1.19** | | | | | | | | |
| **Source of your inflation rates assumptions (if applicable):** | | | | | | | | | | | |

*Notes:*

7. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/Tco$_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
8. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
9. *For the workshop we will harmonize price data to EUR$_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | Average of inflation rate % | 2015 real |
|---|---|---|
| 2015 | 0.12 | 1.00 |
| 2016 | 0.19 | 1.00 |
| 2017 | 1.56 | 1.02 |
| 2018 | 1.79 | 1.04 |
| 2019 | 1.43 | 1.05 |
| 2020 | 0.68 | 1.06 |
| 2021 | 2.91 | 1.09 |
| 2022 | 8.54 | 1.19 |
| 2023 | | 1.26 |

## Relevant price drivers

Please select the three most important drivers for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply – allocation vs. auction, policy credibility, shocks | ☒ | +/-10€ |
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☐ | |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☒ | +/- 30€ |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☒ | +45€/-10€ |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☐ | |

**Please provide a short description/explanation for the level of banking you expect for 2030**

Our model considers banking of ‘spare’ EUAs through behaviour of a speculative agent and industrials that receive excess free allocation.

The model is given Limited foresight through a speculative agent which banks allowances when the forecasted price is below a discounted fair value (in anticipation of future higher prices). The speculative agents sell their banked volume when EUA price is above the discounted fair value. These agents do not look beyond 2030. Cumulative banked allowances reach max in 2025 before being rapidly depleted towards 2030 to balance the supply deficit.

In our model, market actors bank a fixed portion of any excess free allocation volumes which can be used to meet future compliance obligations. This fixed assumption is based on historic trading behaviours and is not price sensitive. Cumulative banked allowances (from excess free allocation) are forecasted to stand at 80mt in 2030.

In 2030, the lion's share of liquidity demand is attributed to hedging activity associated with forward purchases of EUAs based on future emission expectations. Liquidity demand from the power sector falls significantly towards 2030 due to the closure of coal plants and build-out of renewable capacity. We see increased hedging activity from industrials, who receive less free allocation due to CBAM, partially offset the reduced liquidity demand from power sector. Hedging demand from the international transport sectors (maritime/aviation) remain relatively stable at ca. 140mt /year in 2030.

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

The 2026 review will focus on how the MSR should evolve to facilitate effective market functioning in a 'net zero aligned' EU ETS. As it stands, the MSR has been successful in addressing the historical surplus of allowances and under the revised ETS framework, we are unlikely to see a repeat of the excess supply build-up observed in TP3. Going forward, the primary role of the MSR will be to provide stability to major demand shocks. However, based on its current parameters, we see risk that the MSR will no longer be fit for purpose towards 2030 and beyond.

Rapid decarbonization of the power sector leads to a significant reduction in EUA liquidity demand for hedging purposes (-67% in 2030 vs. 2022). This is only partially offset by increased liquidity demand from industrial players. As a result, the MSR will become less responsive to supply/demand imbalances driven by exogenous market shocks. For example, based on our TNAC forecast and the current 833m upper threshold, emissions could decrease by -25% (vs. base case) in 2030 and still avoid triggering an MSR withdrawal. To put this into perspective, ETS emissions dropped by -11% y/y 2009 (financial crisis) and 2020 (Covid-19).

In that context, we see a strong case to provide the MSR parameters with more <u>flexibility</u>. Reform options will need to account for continued evolution of liquidity needs (e.g. speed of decarbonization) and market size (linkage, new sectors) for the MSR to maintain its effectiveness in the long-term.

Based on this, we see simple reform options for the quantity-based mechanism:

- One-off adjustment of upper/lower threshold based on updated assessment of liquidity needs
- LRF applied to upper/lower thresholds to align MSR with ETS cap trajectory (market size)

We should also consider the composition of the TNAC calculation since this is what the MSR is based on. Currently, the TNAC does not represent the 'actual' ETS surplus since the calculation excludes historic (2013-2021) EUA demand from aviation operators (ca. 200mt as of 2023). Not accounting for cumulative net EUA demand from aviation sector (current legislation) keeps MSR withdrawals active for longer but in parallel reduces likelihood of the TNAC falling below 400mt threshold. Note, if lower threshold of TNAC was set below 200mt level, we would never see MSR injection triggered as TNAC will always be ≥ cumulative 2013-2023 net EUA demand from aviation sector. This is particularly relevant since triggering the lower threshold will be the focus point for the ETS post-2030.

In general, we favor quantity-based over price-based mechanisms. The EU ETS is a quantity-based system. Appropriate price thresholds are challenging to identify (especially from a political perspective). Furthermore, a price-based mechanism could be incompatible with future linkage between EU ETS and other systems (e.g. ETS 2) since abatement cost are unlikely to be aligned. On price-based mechanisms, the EU ETS has already got Article 29a which responds to excessive EUA price increases. However, under its current parameters, it is extremely unlikely to be triggered and thus does not serve as an effective mechanism to respond to market shocks. Furthermore, this mechanism is not designed to address impact of negative price shocks and would need to be adapted before representing a suitable replacement for current MSR.

# Questionnaire ETS workshop

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| **Responding organisation** | **Enerdata** |

## Model fact sheet

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|---|---|
| **Model (suite) name** | POLES-Enerdata (Enerdata's version of the POLES model) |
| **Short description** | The POLES-Enerdata model is originally an energy system model, which enable to derive endogenous full energy balances for contrasted scenarios, up to 2050. It has been complemented by a module enabling to model the EU ETS market.<br><br>POLES[1] (Prospective Outlook on Long-term Energy Systems) is a recognized multi-issue, partial equilibrium and a simulation energy model that relies on national energy balances combined with economic, policy and technological scenarios to withdraw energy production, consumption and greenhouse gas (GHG) emission projections up to 2050, with yearly results. |
| **Approach**<br>Bottom-up, Top-down, Hybrid | The POLES-Enerdata model has a bottom-up approach. |
| **Geographical coverage** | POLES-Enerdata covers the world energy systems, with details for individual countries or regions. Each EU27 Member State is modelled individually. |

[1] The POLES model has been initially developed by IEPE (Institute for Economics and Energy Policy), now GAEL lab (Grenoble Applied Economics Lab).

<table>
<tr><td>Sectors covered and modelling detail</td><td>
<table>
<tr><th colspan="2">Sector</th><th>Level of modelling detail</th></tr>
<tr><td>Electricity generation</td><td>☒</td><td>Representation of capacities and generation with a load curve module, a capacity planning module and a dispatch module</td></tr>
<tr><td>Centralized heat generation</td><td>☒</td><td>Representation of district heating, fueled by different inputs: fossils, biomass, electricity</td></tr>
<tr><td>Industry</td><td>☒</td><td>Endogenous representation by industrial sectors : steel, chemicals, non-metallic minerals (for instance cement, lime, glass, ceramics) and other industries (for example other manufacturing, mining and construction). Endogenous specific electricity and heating consumptions, fuel mix, etc.</td></tr>
<tr><td>Buildings</td><td>☒</td><td>Representation of demand split by use: space heating, space cooling, water heating, cooking, appliances and by sector (residential, services, agriculture)</td></tr>
<tr><td>Road transport</td><td>☒</td><td>Endogenous representation of traffic (pkm), vehicle stock and sales per motorization (cars, trucks, buses), vehicle efficiency, energy consumption per fuel</td></tr>
<tr><td>Aviation</td><td>☒</td><td>Representation of fuel consumption per fuel such as decarbonization solutions (biofuel, hydrogen)</td></tr>
<tr><td>Maritime</td><td>☒</td><td>Idem aviation</td></tr>
<tr><td>Forestry</td><td>☐</td><td>Exogenous database for energy potential and costs</td></tr>
<tr><td>Waste</td><td>☐</td><td>Exogenous database for energy potential and costs</td></tr>
<tr><td>Other sectors</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Representation of foresight</td><td>Limited foresight by actors, with an adjustable anticipation period</td></tr>
<tr><td>Representation of non-compliance trading (NCT)</td><td>Represented using an exogenous additional EUA demand, including EUA banked by industrials and financial actors.<br>Hedging by power utilities is also represented as an endogenous additional demand, relying on simple exogenous assumptions of hedge ratios.</td></tr>
<tr><td>Representation of market imperfections</td><td>Some imperfections represented: banked EUA from industrials & financial actors, limited anticipation of actors (rolling compliance period).<br>The model assumes no political interventions on price.</td></tr>
<tr><td>Linkage to other ETS?<br>If yes, please briefly elaborate</td><td>No, but the method can be adapted to other regions</td></tr>
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| **Representation of CDR**<br>If yes, which technologies | Yes, we represent all CCS technologies for power generation (on coal, gas and biomass plants), in industrial sector and for hydrogen production. They are considered in the EUETS scope in our study.<br>Direct air capture (DACCS) is also represented. |
| **(International) Offsets and credits included?**<br>If yes, please briefly elaborate | No |

## ‘Default’ scenario results: EU ETS and MSR operation (from a recent run in line with the ‘Fit for 55 package’)

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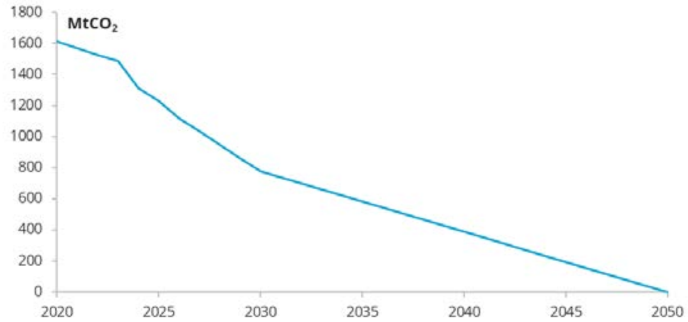
|---|---|
| **Short description of scenario**<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)? | • The scenario is designed with ETS and ESR targets from the FF55 package, but RES and EE targets not strictly implemented. MSR is designed as proposed by the EU commission.<br>• The EU ETS cap has the following trajectory<br><br><br>• We assume political support, notably for renewable technologies. The decarbonization effort is not sustained only by the ETS price.<br>• We considered the allowances from innovation fund measure as well as the RePowerEU allowances |

| | |
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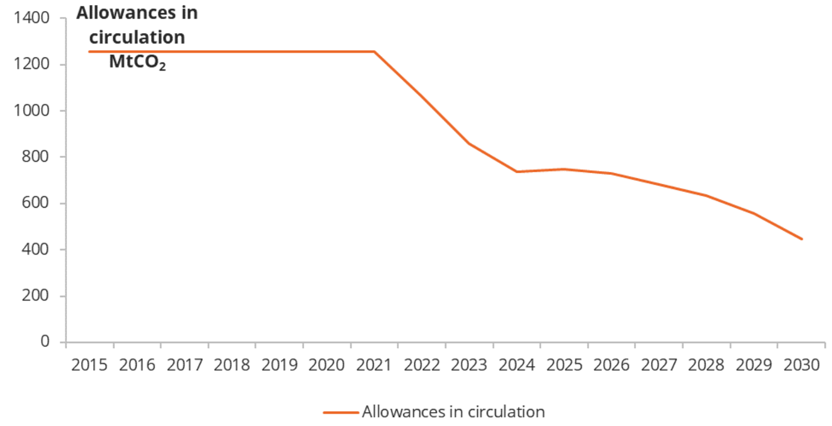
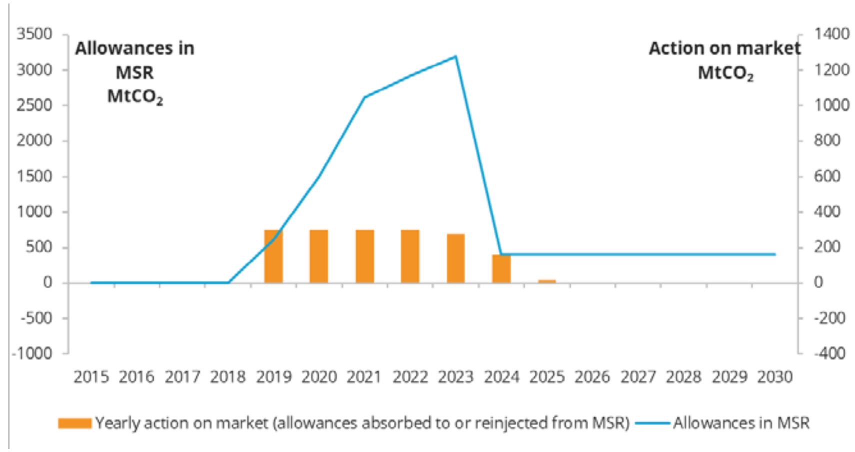
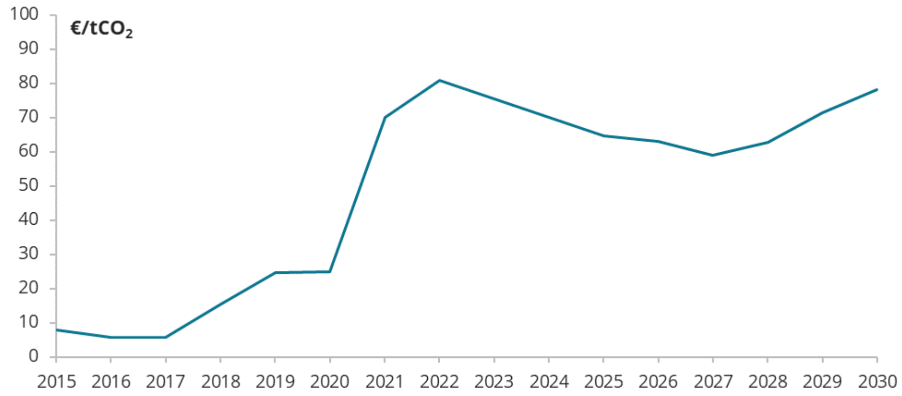
| **Representation of the MSR**<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post? | Our EU ETS market modelling methodology enables to project the EU ETS price based on allowances supply and demand equilibrium. The module relies on:<br>• endogenous variables characterizing the state of the market (e.g. allowances in circulation, allowances in circulation as perceived by the MSR criteria, allowances banked by industrials, allowances hedged by utilities, MSR stock, etc.)<br>• an optimization process, enabling to compute through multiple runs of the model, the $CO_2$ price leading to a supply-demand equilibrium for allowances, on a yearly basis.<br><br>The optimization process works as follows. For each year between 2021 and 2050, iteratively, a rolling carbon budget period is defined on which the supply-demand equilibrium for allowances will need to be respected. The horizon of this period can be chosen between 3 to 10 years, and corresponds to the represented period of anticipation of agents. On each rolling budget period, the carbon price is calculated using an optimization method and impacts the ETS emissions in order to comply with a constrained budget. The budget to comply with is composed of several components: the cumulated ETS cap on the period, the effect of the MSR anticipated over this period (whether allowances will be removed or added to the market), the surplus of allowances available on the market at the initial year. The methodology also models the impact of banking and hedging of allowances.<br><br>• Sensitivities can be done on several assumptions or parameters of the methodology, including for instance the cap, the parameters of the MSR, etc. |

**Result highlights**

3-5 points; please include figure showing TNAC and MSR intake/out-take (see LIMES example)






The CO2 price would remain quite stable during the period

| MSR figures | 2022 | 2023 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total number of allowances in circulation (TNAC) [million EUA] | | | 749 | 728 | 683 | 633 | 556 | 446 | | |
| Cumulated MSR cancellations as of 2020 until (including) year x | 0 | 0 | 2840 | 2840 | 2840 | 2840 | 2840 | 2840 | | |
| Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA] | 1205 | 1481 | 1641 | 1658 | 1658 | 1658 | 1658 | 1658 | | |

| **MSR figures** | **2022** | **2023** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

*Notes:*

7. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
8. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| **EUA prices** | **2015** | **2020** | **2022** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | | | | 69 | 68 | 63 | 67 | 77 | 84 | | |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal [ ] real [X]<br>• Base year: 2015 | | | | | | | | | | |
| **Real discount rate assumed** | | | | | | | | | | | |
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | **1.00** | **1.06** | **1.19** | | | | | | | | |

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Source of your inflation rates assumptions (if applicable):** | Not considered | | | | | | | | | | |

*Notes:*

10. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/t$CO_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
11. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
12. *For the workshop we will harmonize price data to $EUR_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | Average of inflation rate % | 2015 real |
|---|---|---|
| 2015 | 0.12 | 1.00 |
| 2016 | 0.19 | 1.00 |
| 2017 | 1.56 | 1.02 |
| 2018 | 1.79 | 1.04 |
| 2019 | 1.43 | 1.05 |
| 2020 | 0.68 | 1.06 |
| 2021 | 2.91 | 1.09 |
| 2022 | 8.54 | 1.19 |
| 2023 | | 1.26 |

## Relevant price drivers

Please select the three most important drivers for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply - allocation vs. auction, policy credibility, shocks | ☒ | |

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☒ | Sensitivity on power decarbonization reached by non CO2 price instruments<br>- 30€/tCO2 in 2030.<br><br>Sensitivity on power decarbonization reached only by CO2 price instruments<br>+110€/tCO2 in 2030. |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☐ | |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☒ | |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☐ | |

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| **Please provide a short description/explanation for the level of banking you expect for 2030** |

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

A robust and relatively certain price signal can be quite effective to encourage actors to invest in renewables, by limiting uncertainty. Besides it can avoid prices to reach increasingly high levels and to produce a lack of competitivity of European actors.
An increasing price corridor (or MSR based on price criteria with both an upper and lower limit) can therefore be a great alternative in order to limit the effects of high and low prices, while being an higher constraint with time to reduce GHG emissions.

For the moment, it is maybe too premature to think about a coupling with ETS2 for 2 many reasons. The first reason is that we do not know yet how the ETS2 will be designed, will work. A return on experience of several years will be required to have a better idea of how the market will work, and if it is relevant to think about connecting these two markets. Second is that there is already some design to be improved concerning the ETS1 perimeter, and that should be prioritized first, before linkage with other markets, such as ETS2.

# Questionnaire ETS workshop

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|---|---|
| **Responding organisation** | **Potsdam Institute for Climate Impact Research (PIK)** |

## Model fact sheet

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|---|---|
| **Model (suite) name** | LIMES-EU |
| **Short description** | LIMES-EU is a linear dynamic cost-optimization model with a focus on the electricity sector. It simultaneously optimizes investment and dispatch decisions for generation, storage and transmission technologies in five-year time steps from 2010 to 2070. Each year is modelled using six representative days, comprising eight blocks of three hours. The representative days are estimated using a clustering algorithm, which enables the short-term variability of supply (namely, wind and solar) and demand to be captured. The model covers 32 generation and storage technologies, including batteries, hydrogen electrolysis and re-electrification. The energy-intensive industry is also covered and represented by a step-wise linear marginal abatement cost curve for each country. Depending on the model version, centralized heat provision is either included in full detail or in a simplified aggregation via a step-wise linear marginal abatement cost curve similar to energy-intensive industries. The EU ETS is implemented in line with the recent 2018 reform, including the MSR and cancellation of allowances. Additional overlapping policies that influence prices by reducing the demand for allowances (coal phase-out and RE measures at the EU member state level) are also considered in the model.<br>A comprehensive description of the LIMES-EU model, including parameters, equations and assumptions, is provided in the documentation available from the model's website: https://www.pik-potsdam.de/en/institute/departments/transformation-pathways/models/limes |
| **Approach**<br>Bottom-up, Top-down, Hybrid | Bottom-up |
| **Geographical coverage** | EU27 (excluding Cyprus and Malta) + UK + CH + NO + aggregated Balkan |

<table>
<tr><td>Sectors covered and modelling detail</td><td>
<table>
<tr><th>Sector</th><th></th><th>Level of modelling detail</th></tr>
<tr><td>Electricity generation</td><td>☒</td><td>Dispatch and investments per technology; detailed representation of techno-economic constraints</td></tr>
<tr><td>Centralized heat generation</td><td>☒</td><td>Dispatch and investments per technology (CHP and heat-only plants); detailed representation of techno-economic constraints for each country (simplification)</td></tr>
<tr><td>Industry</td><td>☒</td><td>Marginal abatement cost curve for energy-intensive industry comprised within ETS</td></tr>
<tr><td>Buildings</td><td>☒</td><td>Partially, to capture the shift of emissions to ETS due to electrification and district heating expansion (not included in the results reported here)</td></tr>
<tr><td>Road transport</td><td>☐</td><td></td></tr>
<tr><td>Aviation</td><td>☒</td><td>Exogenous emissions</td></tr>
<tr><td>Maritime</td><td>☒</td><td>Exogenous emissions</td></tr>
<tr><td>Forestry</td><td>☐</td><td></td></tr>
<tr><td>Waste</td><td>☐</td><td></td></tr>
<tr><td>Other sectors</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Representation of foresight</td><td>Default: Perfect foresight (benchmark approach)<br>Optional: limited foresight via rolling horizons</td></tr>
<tr><td>Representation of non-compliance trading (NCT)</td><td>Default: Not represented<br>Optional: Indirectly represented (additional demand/supply, simulation mode)</td></tr>
<tr><td>Representation of market imperfections</td><td>Not represented (benchmark approach)</td></tr>
<tr><td>Linkage to other ETS?<br>If yes, please briefly elaborate</td><td>Optional to the UK ETS.<br>When linked, the UK ETS cap is added to the EU ETS cap. This and the emissions are considered within the TNAC estimation and thus used for the MSR simulation.</td></tr>
<tr><td>Representation of CDR<br>If yes, which technologies</td><td>Yes, from BECCS</td></tr>
</table>

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|---|---|
| **(International) Offsets and credits included?**<br>If yes, please briefly elaborate | No |

**'Default' scenario results: EU ETS and MSR operation** (from a recent run in line with the 'Fit for 55 package')

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|---|---|
| **Short description of scenario**<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)? | • By default, we assume the climate policy ambition represented by the recent EU ETS reform. That is, we assume a cap set to reach a reduction of 62% by 2030 with respect to 2005. Moreover, we deduct the one-off reductions in 2024 and 2026 from the annual caps (rebasing). We additionally extrapolate the cap reductions beyond 2030 by assuming the then LRF (4.4%). Accordingly, the cap for the stationary sector reaches zero in 2039.<br>• MSR parameters are set according to the most recent reform, e.g., continued intake of 24% through 2030, the adaptive upper threshold to avoid oscillatory effects, and cancellation so that maximum 400 million EUA remain in the MSR<br>• In line with the goal of climate neutrality by 2050, we assume that certificate trading is only allowed until that year, and thus net emissions from ETS need to reach zero as of that year. Furthermore, we assume that the scope of the EU ETS as per current regulation will not change.<br>• Additional policies in REPowerEU are not considered, but one could describe the model assumptions about possible upscaling speeds and resource potentials of wind and solar to be representative of a world where regulations are streamlined as proposed by REPowerEU<br>• Banking is allowed until 2050, i.e., net zero emissions are to be achieved that year. |
| **Representation of the MSR**<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post? | LIMES-EU is coupled with a simulation of the MSR and solved in an iterative approach. Hence, MSR cancellations are determined endogenously. |

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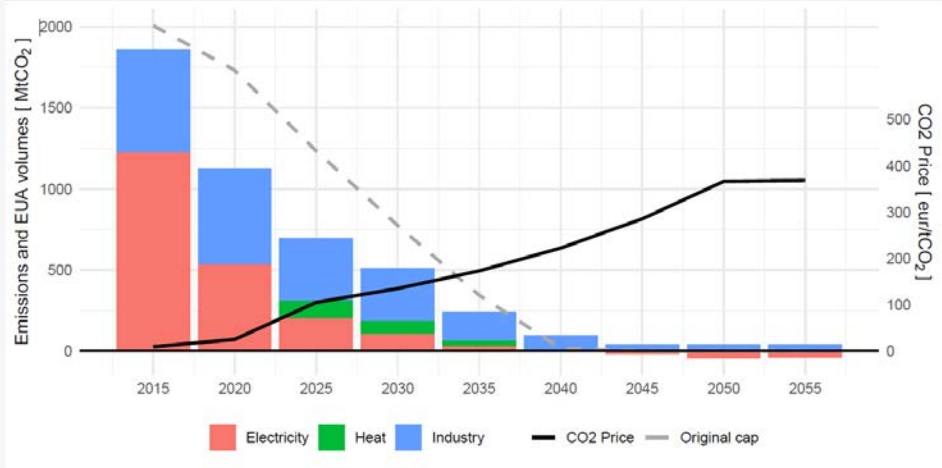
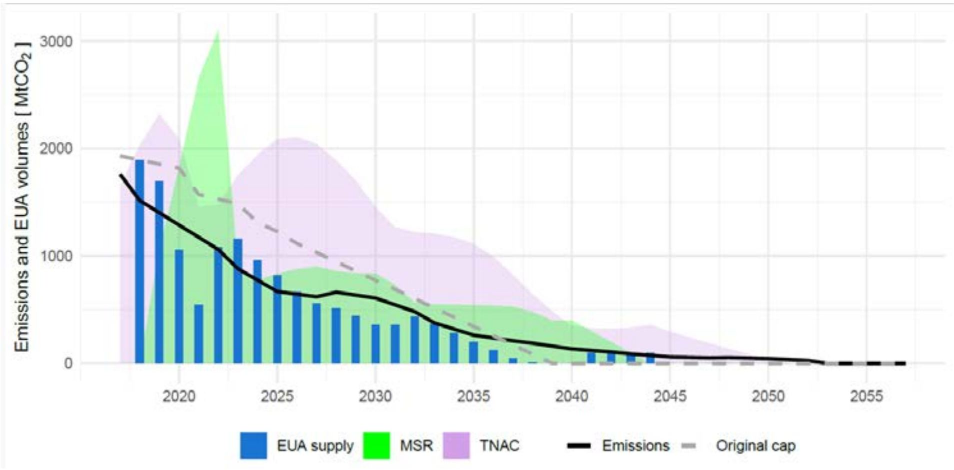
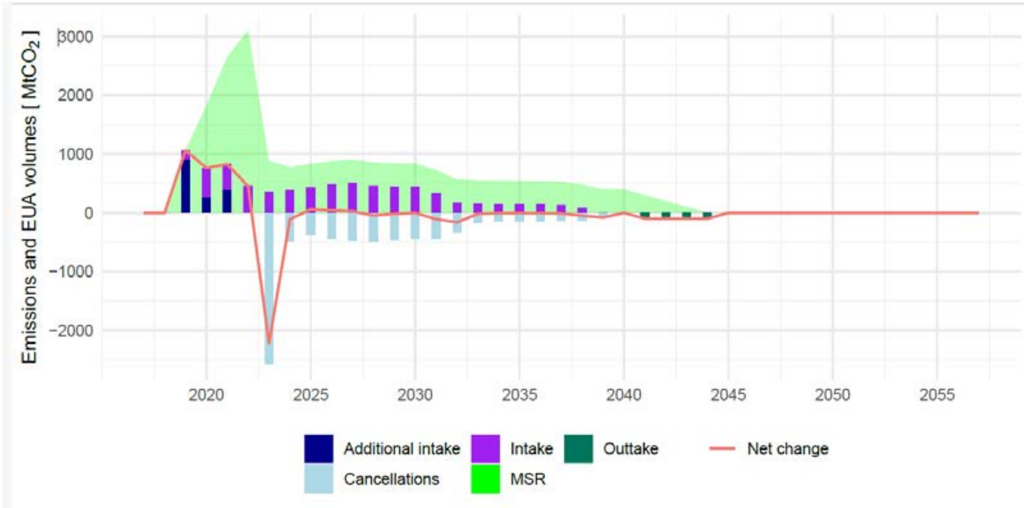
| **Result highlights**<br>3-5 points; please include figure showing TNAC and MSR intake/out-take (see LIMES example) | • Emission reductions are considerably accelerated by the high carbon prices. The EUA price rises to 134 EUR2015/t$CO_2$ by 2030. In the long term, the EUA price even rises to over 366 EUR2015/t$CO_2$ after 2050. As a result, most of the reductions occur already in the current decade; emissions by 2030 are 54% lower than in 2020, and 78% lower than in 2005, ensuring that EU ETS target is reached.<br><br><br>• Large parts of the electricity sector are already decarbonised by 2030, emissions falling 80% with respect to 2020, and coal is basically phased-out across Europe by then; less than 50 TWh of coal generation remain. Although gas-based generation remains in the system for longer (~60 TWh by 2030), (technical) phase out is achieved by 2035 already. Industrial decarbonization occurs slowly, emissions falling by 45% between 2020 and 2030.<br>• Fossil based CCS does not play a role in the power sector. There are few investments in coal and gas CCS, generation from these plants reaching less than 20 TWh/year at any point in time. BECCS, on the other hand, grows progressively over time (from 25 TWh/yr in 2030 to 100 TWh/yr in 2050).<br>• In the short term, the MSR reaches a maximum of 3100 million EUA in 2022. In the medium term, the TNAC builds up to a maximum of 2100 million EUA. The reason for this is the stronger banking behaviour of regulated entities in anticipation increasing allowance scarcity. This has important implications: a substantial volume of allowances is transferred to the MSR each year in the 2020s and 2030s. The TNAC indeed remains above the upper threshold until 2036 and does not oscillate around it afterwards. This is in part due to the adaptative threshold, which smoothens the intake into the MSR. |




- Overall cancellation amounts to 7.5 billion EUA. Moreover, the MSR is active until completely empty by 2044.



| MSR figures | 2022 | 2023 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total number of allowances in circulation (TNAC) [million EUA]** | 1477 | 1755 | 2088 | 2108 | 2043 | 1893 | 1702 | 1455 | 349 | 42 |
| **Cumulated MSR cancellations as of 2020 until (including) year x [billion EUA]** | 0 | 2569 | 3432 | 3868 | 4345 | 4848 | 5307 | 5748 | 7472 | 7472 |
| **Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA]** | 1567 | 1918 | 2731 | 3208 | 3711 | 4170 | 4611 | 5050 | 6335 | 6335 |
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 400 |

*Notes:*

9. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
10. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | | | | 105 | 110 | 116 | 122 | 128 | 135 | 222 | 366 |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal [ ] real [x]<br>• Base year: €2015 | | | | | | | | | | |
| **Real discount rate assumed** | 5% | | | | | | | | | | |

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | **1.00** | **1.06** | **1.19** | | | | | | | | |
| **Source of your inflation rates assumptions (if applicable):** | | | | | | | | | | | |

*Notes:*

13. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/t$CO_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
14. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
15. *For the workshop we will harmonize price data to EUR$_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | Average of inflation rate % | 2015 real |
|---|---|---|
| 2015 | 0.12 | 1.00 |
| 2016 | 0.19 | 1.00 |
| 2017 | 1.56 | 1.02 |
| 2018 | 1.79 | 1.04 |
| 2019 | 1.43 | 1.05 |
| 2020 | 0.68 | 1.06 |
| 2021 | 2.91 | 1.09 |
| 2022 | 8.54 | 1.19 |
| 2023 | | 1.26 |

## Relevant price drivers

Please select the <u>three most important drivers</u> for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply - allocation vs. auction, policy credibility, shocks | ☒ | Low policy credibility (assume that all certificates can be used up over the next 10 years and no banking beyond that is needed): minus 40-50€/tCO2 |
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☒ | Fuel prices +4/-1<br>No CCS +20<br>No transmission expansion +1 |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☐ | |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☐ | |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☒ | Discount rate +19/-38 |

| |
|---|
| **Please provide a short description/explanation for the level of banking you expect for 2030**<br>Market actors in the default LIMES version are foresighted. Because allowance supply becomes tighter much faster, and firms anticipate this, they bank more. Importantly, this effect arises not in the far away future, but already in the years to come. They thus anticipate the further reduction of the cap to 0 for the stationary sector in 2040, which leads to higher scarcity and requires more expensive abatement technology, thus resulting |

in higher carbon prices after 2030. Accordingly, they reduce emissions earlier and bank a larger volume of certificates until the increased carbon prices in 2030 match the discounted prices expected for 2040.

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

The MSR was implemented with two objectives: (1) reducing the historical surplus and (2) increasing resilience to future shocks. Evidence so far shows that it has been able to deal with historical and unanticipated structural surplus (financial crisis, COVID), and thus restored confidence and corrected for oversupply. However, this is a complex mechanism with unclear economic rationale and justification of threshold levels. Although the MSR rules are simple, it's hard to make ex-ante projections and ex-post assessments of its effects. The fact that there is a time lag between the 'scarcity' signal and the MSR operation as well as the fact that the TNAC is considered as the “scarcity indicator” do not contribute to the market stability. The MSR treats an increase in TNAC as if it unconditionally signaled a decrease in demand, while it might be an anticipation reaction to future scarcity. It is thus intrinsically tilted towards one-way supply adjustment and price correction. Given that, under a decreasing cap (stationary to reach 0 by 2039) the EU ETS is transitioning from oversupply to undersupply market. In the future the TNAC becomes also more misleading because it is not identical to the float, i.e. the actual volume of allowances for trading. The MSR is thus likely to curtail liquidity too much. As a result of the much tighter market, there is a risk of high volatility and speculation. Likewise, there might be counterproductive interactions with (anticipated) companion policies.

In anticipation of these problems, the MSR review should ponder more fundamental reform options besides tweaking existing MSR parameters, which are unlikely to overcome them. A shift to price as an indicator seems essential and is a mechanism that could be included in the MSR revision in 2026 as an alternative to ensure price stability in the EU ETS post-2030. It might be considered to index the stability mechanism directly on the price level rather than on the anticipated future net shortage to indirectly influence price formation, i.e., triggering intake and outtake through prices instead of quantities. Given that the implementation might be difficult, a soft collar design like in US systems (e.g, California's system, the cost containment reserve, which has multiple tiers) could avoid the unanimity problem. The question of which one is best suited is subject to further discussion.

# Questionnaire ETS workshop

| Responding organisation | Centre for Climate and Energy Analyses |
|---|---|

## Model fact sheet

| Model (suite) name | CREAM & CarbonPIE – Carbon Regulation Emission Assessment Model (CGE model) & Carbon Policy Implementation Evaluation Tool (EU ETS simulation model) |
|---|---|
| Short description | For the analysis of changes in the EU ETS and the economy we have used two models:<br>Carbon Policy Implementation Evaluation Tool (CarbonPIE) – is a EU ETS simulation model, which map the supply of emission allowances, while keeping the details related to the functioning of the EU ETS induding MSR and finds balance between the supply and demand for allowances. The demand for allowances is set for specific hedging needs, which are determined by the market position of EU ETS participants. Demand reflects the behaviour of market participants who receive part of allocation free of charge and who can also buy, sell or bank emission allowances, depending on their market position and needs. Model estimates the level of required emissions reduction, surplus of allowances and final auction pool after MSR. The information on the resulting emissions is then transferred to the Computable General Equilibrium (CGE) Carbon Regulation Emission Assessment Model (CREAM).<br>Carbon Regulation Emission Assessment Model (CREAM) – is the global, multi-sector Computable General Equilibrium (CGE). The model distinguishes 16 regions (including EU 27 region and rest of the world), 31 sectors (including energy-intensive sectors), of which 10 include sectors belonging to the EU ETS, such as: oil refining (oil), ferrous metals production (fem), non-ferrous metals production (nem), chemical industry (che), paper production (pap), non-metallic mineral industry (nmm), aviation (air), electricity production (based on fuels: carbon (cof), oil (oil), gas (gas)). The model also distinguishes 8 electricity production technologies, including 4 renewable energy technologies and generation based on nuclear fuels, and three electricity production technologies based on fossil fuels. Additionally, the model distinguishes detailed data on GHG emissions like CO2 emissions from combustion by fuel types: coal, oil products and gas, as well as process emissions, like N2O (nitrous oxide), CH4 (methane) and F-gases (fluorinated gases). The CREAM database is built on the basis of input-output (IO) tables, published by Joint Research Centre, (Baseline GECO). The CREAM model endogenously determines the marginal cost of GHG emission reduction. |

| | |
|---|---|
| **Approach**<br>Bottom-up, Top-down, Hybrid | |
| **Geographical coverage** | EU-27 region and rest of the world |
| **Sectors covered and modelling detail** | |

| Sector | | Level of modelling detail |
|---|---|---|
| **Electricity generation** | ☒ | |
| **Centralized heat generation** | ☒ | |
| **Industry** | ☒ | |
| **Buildings** | ☒ | |
| **Road transport** | ☒ | |
| **Aviation** | ☒ | |
| **Maritime** | ☒ | |
| **Forestry** | ☒ | |
| **Waste** | ☒ | |
| **Other sectors** | | |

| | |
|---|---|
| **Representation of foresight** | Limited foresight |
| **Representation of non-compliance trading (NCT)** | Default: Not represented<br>Optional: Indirectly represented (due to the high price of the EUA, offsets can be enabled) |
| **Representation of market imperfections** | Not represented (benchmark approach) |
| **Linkage to other ETS?**<br>If yes, please briefly elaborate | See the short description |
| **Representation of CDR**<br>If yes, which technologies | See the short description |

| | |
|---|---|
| **(International) Offsets and credits included?**<br>If yes, please briefly elaborate | See the short description |

## **'Default' scenario results: EU ETS and MSR operation** (from a recent run in line with the 'Fit for 55 package')

| | |
|---|---|
| **Short description of scenario**<br>Main assumptions, policies, e.g., carbon neutrality? EU ETS cap? Overlapping policies? REPower? Scope of the EU ETS (i.e., sectors included)? | Including EU ETS revised directive and MSR review in line with the „Fit for 55" package:<br>• The supply of EUA's reflects reduction target in the EU ETS equal 62% in 2030 vs. 2005 (with marine sector extension),<br>• New LRF (4,3% in 2024-2027; 4,4% in 2028-2030) and one off reduction in 2024 (90 mln) and 2026 (27 mln)<br>• Maritime sector included in 2024<br>• CBAM phasing out from 2026<br>• Extending Modernisation Fund to new volumes<br>• New MSR parameters (24% intake rate to 2030, additional intake rate and threshold, new fix amount in MSR, extended TNAC to aviation).<br>• Shifting in auction volumes in 2023-2026 (higher) & 2027-2030 (lower) to finance REPowerEU form EU ETS allowances.<br><br>In addition the simulations takes into account climate-related policies such as CBAM, ETS 2 (BRT ETS) for building and transport in the EU, as well as higher emission reduction targets for non-ETS sectors. |
| **Representation of the MSR**<br>Does your model include a simulation of the MSR? Or do you assume MSR cancellations exogenously? Or MSR is only modelled ex-post? | • Our model includes simulation of the MSR and assume MSR cancellations (taking into account e.g. future emission projection). |

| **Result highlights**<br>3-5 points; please include figure showing TNAC and MSR intake/out-take (see LIMES example) | • TNAC achieves below upper MSR threshold in 2028 (790 mln).<br>• Additional threshold (below 1, 096 bln) is reached by TNAC in 2023. Since, smaller amount of EUA's than 24% are expected to be transfered to MSR.<br>• CAKE model indicates that first „MSR pause" (end of EUA transfers to MSR) is foreseen in current trading period (in 2030),<br>• EUA's releasing foreseen from MSR starts in 2035,<br>• invalidated volumes in MSR in 2030 amounted to approx. 3,6 bln<br>• Cumulated EUA transfers to MSR amounted to approx. 2,5 bln in current trading period |
|---|---|

| **MSR figures** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2040** | **2050** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total number of allowances in circulation (TNAC) [million EUA]** | 1000 | 894 | 990 | 968 | 840 | 790 | 815 | 845 | x | x |
| **Cumulated MSR cancellations as of 2020 until (including) year x [billion EUA]** | 2,515 | 3,140 | 3,271 | 3,364 | 3,514 | 3,607 | 3,611 | 3,611 | x | x |
| **Cumulated transfers to the MSR (intake) as of 2020 until (including) year x [billion EUA]** | 1,787 | 2,024 | 2,156 | 2,248 | 2,398 | 2,490 | 2,495 | 2,495 | x | x |
| **Cumulated transfers from the MSR (outtake) as of 2020 until (including) year x [billion EUA]** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | x | x |

*Notes:*

11. *The TNAC in 2022 was 1135 million EUA and the cancellations in 2023 amounted to 2515 million EUA. Although these values are already known, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
12. *Model results for 2040 and 2050 are optional, depending on the model horizon.*

| EUA prices | 2015 | 2020 | 2022 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUA price [€/t]** | **8,00** | **25,00** | 80,00 | 97,02 | x | x | x | x | 187,74 | x | x |
| **Currency: are your prices in nominal or real terms, and if real, what is the currency base year?** | • Type: nominal [ ] real [x ]<br>• Base year: 2015 (in 2015: EUR 77 EUR for 2025 & EUR 149 EUR for 2030)<br>• Prices were calculated for 2023: values for 2025 & 2030 were multiplied by 1,26 | | | | | | | | | | |
| **Real discount rate assumed** | | | | | | | | | | | |
| **If you use nominal prices, what cumulative inflation rate would you assume from 2015 until time step x in order to convert to real prices (see examples for historic values)** | **1.00** | **1.06** | **1.19** | | | | | | | | |
| **Source of your inflation rates assumptions (if applicable):** | | | | | | | | | | | |

*Notes:*

16. *Average EUA prices in 2015, 2020 and 2022 are already known (roughly 8, 25 and 80 EUR/t$CO_2$, respectively). However, we leave the blanks so you can fill these cells with modelled values in case they are available from your results.*
17. *Model results for 2040 and 2050 are optional, depending on the model horizon.*
18. *For the workshop we will harmonize price data to $EUR_{2023}$ using OECD inflation rates for EU27* https://data.oecd.org/price/inflation-cpi.htm#indicator-chart *(avg. of monthly reported figures).*

| | Average of inflation rate % | 2015 real |
|---|---|---|
| 2015 | 0.12 | 1.00 |
| 2016 | 0.19 | 1.00 |
| 2017 | 1.56 | 1.02 |
| 2018 | 1.79 | 1.04 |
| 2019 | 1.43 | 1.05 |

| | | |
|---|---|---|
| 2020 | 0.68 | 1.06 |
| 2021 | 2.91 | 1.09 |
| 2022 | 8.54 | 1.19 |
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## Relevant price drivers

Please select the <u>three most important drivers</u> for prices in 2030. For the 2030 prices, please also provide the sensitivity range for the selected most important drivers.

| Driver | 2030 | Range [EUR/t] |
|---|---|---|
| **Policy parameters (excluding LRF adjustment)**<br>MSR thresholds, MSR withdrawal rate, MSR cancellations, Timing of supply (auctions, allocation, supply), Type of supply - allocation vs. auction, policy credibility, shocks | ☒ | |
| **Power sector**<br>Renewable targets, Power demand, Fuel prices, Coal/Fossil phase-out policies, Cost of new capacities, Grid costs and constraints, Expansion constraints/bottlenecks | ☒ | |
| **Industry**<br>Abatement costs (Cost of substitute fuels, Costs of CO2, Technological learning), Industrial growth/deindustrialisation, Short-term demand response, Carbon contracts for difference | ☐ | |
| **New sectors and international transport**<br>Costs of substitute fuels, Short-term demand response, Behavioural trends (Flight shame, regionalisation) | ☐ | |
| **Behaviour**<br>Myopia/farsightedness, Power sector hedging, Industry hedging/banking, Financial market participants, Speculation (Compliance player and financial player), Investment behaviour (e.g. adoption speed), non-compliance trading (i.e., financials) | ☒ | |
| **External**<br>Political signalling, Monetary policy (EUA as inflation hedge), Interest rates slowing down investments, Global climate negotiations (e.g., Article 6), Cost of carbon removals or offsets, Geopolitical risks and opportunities | ☐ | |

| **Please provide a short description/explanation for the level of banking you expect for 2030** |
|---|

Demand reflects the behaviour of market participants who receive part of allocation free of charge and who can also buy, sell or bank emission allowances, depending on their market position and needs. Model estimates the level of required emissions reduction, surplus of allowances and final auction pool after MSR. The amount of banked allowances fluctuates around 800 mln at the end of the current trading period.

## MSR Revision 2026

**Do you have any thoughts or proposals on how to reform the MSR? Should the MSR be replaced by a price-based mechanism (e.g., a carbon tax, a price floor/ceiling, an MSR where triggers are prices instead of quantities)? Should the current MSR parameters be adjusted, if so how? How does prospective linking with the ETS2 should be factored in?**

- The real problem are the effects of the “MSR invalidation mechanism” and the scale of invalidated volumes in MSR. In 2023 this mechanism invalidated about 2,5 bln allowance in the MSR. Our predictions indicates this volumes could further increase to even 3,6 bln in 2030. This amount is more than 2 times higher than CERs issuance (1,5 bln) in EU ETS which was the cause of oversupply in EU ETS (and one of the reason to run MSR).
- The market (and price) effect of this invalidation is felt only then when the MSR is closer to exhaustion and can’t contribute with additional supply when the market gets tight and TNAC falls below 400 Mt threshold.
- Last MSR review set a fix number of allowances that should always be in the reserve – 400 mln. Hence only 2 or 4 years of additional supply (depends on it will be before or after 2030 – 100 mln or 200 mln releases EUA’s) will be available in EU ETS to ease the market balance once the surplus falls below the lower threshold of 400 Mt. In short, due to the invalidation provision, the MSR will thus not come to the rescue in a future high-cost, tight balance environment. This gives a “hidden” strengthening of the ambition beyond the cap needed to meet the reduction target.
- This is very important especially in context of 2040, when the system will face a significant shortage of EUA allowances (EUA will be available only on the secondary market). There is a very high risk that MSR will not contain enough allowances to stabilize the market, potentially exacerbating price instability.
- Modifying MSR parameters, like MSR thresholds will not address the predicted problems of 2040, when there will be a need to release additional EUAs to the market. It will even deepen the problems we are facing now. Lowering upper MSR threshold means more allowances would be placed in reserve and more then be invalidated in MSR. It is a potential risk of CO2

price spikes. Adjusting the lower threshold in tandem means faster releasing EUA to the market and fostering the exhaustion of reserve.

- So we would rather prefer not to change existing parameters and instead focusing on allowances that should be valid and available in MSR and for the market in the future shortage of allowances. Very important for price stability should be allowing some amount of removals to EU ETS market.

- Introducing an additional price control mechanism (price corridors or reserve auction price) could increase the complexity of the system. Much better concept is setting a European Central Carbon Bank (ECCB) that could potentially play a dual role in regulating the EU ETS and managing carbon removals. Similar to the role of central banks in monetary policy, the ECCB could influence carbon market dynamics acting as a regulatory body would control the supply and demand of EUA allowances or CO2 removal units and intervene to stabilise prices when necessary. Such a mechanism could mitigate instances of market speculation and sudden price spikes, ensuring a stable and credible market environment. ECCB could potentially replace existing mechanisms within the EU ETS, such as the MSR and a “safety valve” in Art. 29a of the EU ETS directive. MSR’s ability to stabilise prices has been questioned, as it seems to maintain prices at relatively high levels without effectively addressing extreme price fluctuations. Similarly, Article 29a’s effectiveness is undermined by stringent activation conditions.

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