Centre for Climate and Energy Analyses

Reform of the market stability reserve (MSR) in the "Fit for 55" package

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List of abbreviations

BRT ETS	Emissions Trading System for buildings and road transport
CAKE	Centre for Climate and Energy Analyses
CAP in the EU ETS	Total annual pool of emission allowances (EUA) in the EU ETS
CarbonPIE model	Carbon Policy Implementation Evaluation Model - simulation model for the EU Emissions Trading System (EU ETS)
CBAM	Carbon Border Adjustment Mechanism
CERs	Certified Emission Reduction Units
CGE	Computable general equilibrium model
CO_2 eq.	Carbon dioxide equivalent
CREAM model	Carbon Regulation Emission Assessment Model
CSCF	Cross Sectoral Correction Factor
EC	European Commission
EFTA	States included in European Free Trade Association: Iceland, Liechtenstein, Norway
ERUs	Emission Reduction Units
EU	European Union
EU27	27 European Union Member States (after the United Kingdom left the EU)
EU28	27 European Union Member States + the United Kingdom
EU ETS	EU Emission Trading System
EU Green Deal	Communication from the European Union of 11 December 2019: The European Green Deal
EUA	European Union Allowances allocated to the operators of stationary installations and used to account for emissions in the EU Emissions Trading System (EU ETS); 1 EUA = 1 t CO_2 eq.
„Fit for 55" package	A set of proposals to revise and update EU legislation and to put in place new initiative to ensure that EU policies are in line with the new climate goals of 14 July 2021
GDP	Gross Domestic Product
GECO	Global Energy and Climate Outlook
GHG	Greenhouse gases
KOBiZE	National Centre for Emissions Management
MS	EU Member States
MEESA	Model for European Energy System Analysis
NER	New Entrants Reserve
Non-ETS	Sectors which are not covered by the EU Emissions Trading System (EU ETS)
TNAC	Total number of emission allowances in circulation

Main conclusions

- **Study shows that the strengthening LRF with one-off rebasing of the cap presented in „Fit for 55” package have significant impact on tightening the supply of allowances on the market and leads to a higher EUA price in 2030.**

- **Extension of the current 24% intake rate until 2030 would result in a much faster tightening of supply by increasing EUA transfers to MSR and accelerating emissions reduction by 2025.** This combined with a strengthened LRF and one-off reduction of the cap in 2024 would imply an extremely tight supply in 2025 which could result in a higher EUA price in 2025 (EUR 76). However, when the surplus is between the new thresholds introduced in the Fit for 55 package (1096-833 million), the intake rate drops below 24% easing the path of EUA price increases until 2030.

- **In all scenarios with MSR the EU meets the 2030 target (61% reduction in 2030 vs. 2005) and significantly reduces the surplus of allowances** close to upper MSR threshold (eliminating the historical structural surplus). In without MSR scenario, the EU is close to reach the reduction target to 2030 (a few % points were missing).

- **Maintaining the intake rate at 12% level until 2030 would mitigate the supply tightening effect** by reducing the EUA transfers to MSR and preventing higher EUA prices. This indicates that increasing intake rate to 24% until 2030 would not be necessary, in particular taking into account that the 2030 reduction target would be met.

- **Implementation of the „Fit for 55” package as proposed by the European Commission would increase EUA price to** approx. **EUR 130 in 2030 (medium price scenario).** Depending on hedging needs parameters (EU ETS participants behaviour) EUA prices could achieve almost EUR 200 in the most extreme Fit for 55 price scenario.

- **The analysis shows that the change of the upper MSR threshold is of great importance for the results.** Lowering this upper threshold from 833 to 600 million could result in achieving the highest level of emission reduction in all scenarios but

at the expense of fewer allowances available at auction pool, more allowances to be invalidated in the MSR and extremely high EUA prices (almost EUR 250 in 2030).

- **The increase in the EUA price in 2030 has serious effects that are reflected in the increase in the cost of producing energy from fossil fuels and the increase in production prices in energy and emission intensive sectors in the EU.** The most sensitive are the prices of electricity, water and air transport, ferrous metals and non-metallic minerals. In all analysed options of MSR after implementation of Fit for 55 package the variation of average EU electricity prices in MSR scenarios is between –4% and +4% in 2030. **However, the effects of changes in the allowances price could be very different between EU countries and in regions with a high share of hard coal and lignite in energy mix, the consequences could be many times greater than those observed at the EU level.**

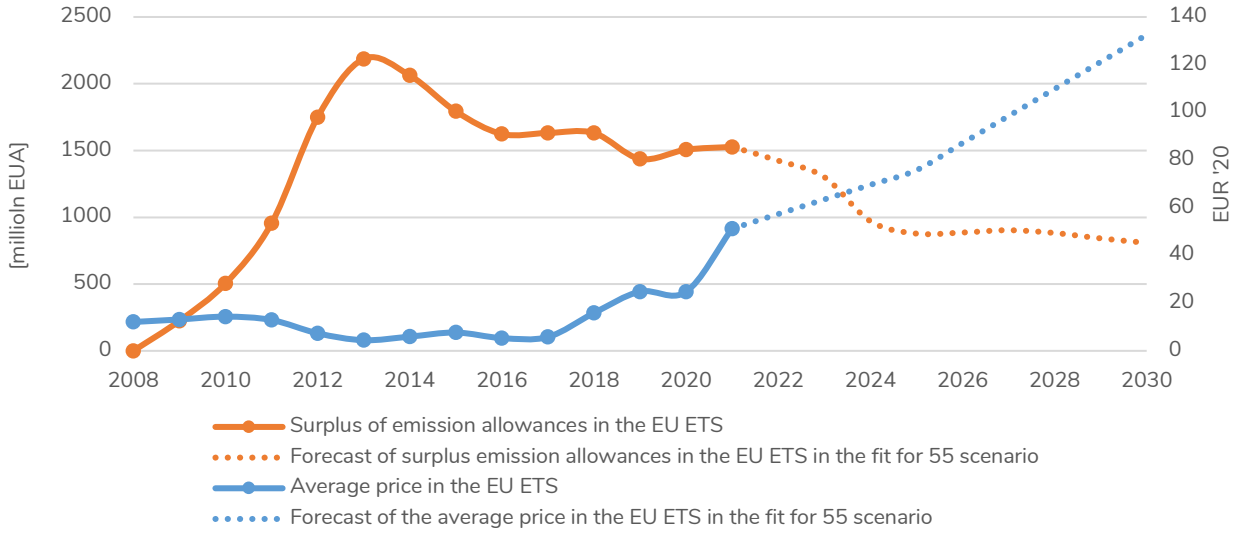
- **The macroeconomic effects of the MSR reform at the EU level are rather negligible however, it cannot be excluded that they would be significant at the level of individual EU member states.** Output changes of individual sectors are of the order of a few percent and have typically a very small share in total value added in the EU and translate to GDP effects of the order of –0.2% to 0.1%.

- The growing activity of financial institutions on the CO_2 market and the stricter MSR reserve would **contribute to additional sharp increases in EUA prices which can put pressure on the entire EU economy.** That is why the **EU ETS needs proper safeguards to effectively protect the market in the form of, e.g. the reform of Art. 29a of the EU ETS Directive** which currently does not fulfil its role.

Summary

1. This report aims to identify the role of the Market Stability Reserve (MSR) in the context of increasing EU climate ambition by analysing the interdependences between the functioning of the MSR (with different MSR design options) and planned changes in the EU ETS proposed on July 2021 by the European Commission as a part of the „Fit for 55” package. The MSR review and the EU ETS reform should be analysed together, as both mechanisms would have a major impact on the market balance (EUA allowances scarcity on the market), emission trajectory and the development of EUA prices until 2030. That is why the decisions taken in the context of changes in the MSR parameters will be crucial.
2. First of all, the study analysed one basic scenario assuming the implementation of the proposed changes in the EU ETS and MSR as proposed in „Fit for 55” package („Fit for 55” scenario) in comparison to the “reference scenario” that takes into account the current climate policy. Additionally, five analytical scenarios were presented with various MSR parameters (“non-rebasing”, “dynamic MSR”, “12% intake rate”, “upper threshold” and “without MSR” scenarios). To simulate the interplays between the different factors related to the EU ETS and MSR, the CarbonPIE model was used. Its task was to project the supply of emission allowances and the reduction of emissions in the EU ETS in all analysed scenarios. In turn, to simulate other factors such as the emission allowance prices, changes in production volumes and prices in all sectors of the economy, the Computable General Equilibrium (CGE) Carbon Regulation Emission Assessment Model (CREAM) was used.
3. Our modelling shows that the revision of the MSR as part of the „Fit for 55” package should contribute to a faster reduction of the surplus of emission allowances from the market, significantly increasing the annual transfers of allowances to MSR in years 2024-2025. Thus, it increases the dynamics of the growth in the prices of emission allowances in those years, caused by the increased reduction target (Figure 1).

Figure 1. Surplus and price of emission allowances in the EU ETS in the „Fit for 55” scenario



Source: CAKE/KOBiZE

4. The most important factors in the context of the level of supply allowances on the market and the evolution of EUA prices are the linear reduction factor (LRF) and the cap rebasing. Strengthening the LRF and setting a rebasing have the greatest impact on tightening the supply allowances and increase of the EUA prices in 2030. This impact is clearly visible in the “wihout MSR” scenario, which assumes complete abandonment of the MSR mechanism from 2024 (in comparison to „Fit for 55” scenario). This scenario shows significant reductions in auction pool (-19%) and triple the EUA prices in 2030 (vs. 2025).
5. Extending of the current intake rate of 24% until 2030 would tighten the supply much faster by increasing EUA transfers to MSR and accelerating reduction in emissions by 2025. Combined with a strengthened LRF and with one-off rebasing of the cap this would imply an extremely tight supply in 2025 year which could translate into a higher EUA price in 2025 (EUR 76). However the introduction of additional MSR threshold (1096-833 million) in Fit for 55 package should ease the path of EUA price increases until 2030.
6. All analytical scenarios significantly reduce the surplus of allowances close to the upper MSR threshold. Elimination of the historical structural surplus is one of the most important goals for the MSR mechanism, which in all scenarios is met.
7. As a result of implementing full „Fit for 55” package, the prices of emission allowances would reach the 130 EUR level in 2030. Depending on hedging needs parameters, EUA prices could achieve also EUR 108 in the low price scenario and EUR 193 in the high price scenario. The study shows that the EUA price is very sensitive to changes in the MSR upper threshold – e.g. lowering this MSR parameter from 600 to 833 million would cause the extremely high price: EUR 243. This results in a higher reduction of emissions, but on

the other hand leads to fewer allowances available in the auction pool and more allowances to be invalidated in the MSR.

8. In almost all analytical scenarios (except “without MSR”) the 2030 target (61% reduction compared to 2005) is met and in the most extreme scenario the reduction target in 2030 is met with a large margin.
9. Maintaining the intake rate at the 12% level until 2030 would mitigate the supply tightening effect by reducing the EUA transfers to MSR and decreasing EUA prices. This raises a question of whether it make sense to increase the intake rate to 24% if the 2030 reduction target is met.
10. In the year 2025, all MSR scenarios – except the “upper threshold” – lead to higher emissions than in the „Fit for 55” scenario. In contrast, in the year 2030, the upper threshold implies substantial additional emission reductions (again mostly in coal power, gas power and ferrous metals, but also with significant contributions from water and air transport) compared to „Fit for 55” scenario. Effects of the same direction, although smaller magnitude, are found in “dynamic MSR” and “no rebasing” scenarios.
11. The increase in the price of allowances in 2030 has serious effects that are reflected in the increase in the cost of producing energy from fossil fuels and the increase in production prices in energy and emission intensive sectors in the EU. The most sensitive are the prices of electricity, water and air transport, ferrous metals and non-metallic minerals. The variation of average EU electricity prices is between –4% and +4% in 2030.
12. The largest variation in output is observed in coal extraction, as a result of varying demand from the power generation sector. Distinctive output effects are also observed in water and air transport (2030), gas extraction (2025), and forestry (related to biomass supply). Overall, though, the impact on output is rather small, mostly within the range of 1-2% even in the most extreme scenarios (“without MSR” in 2025 and “upper threshold” in 2030).
13. From the macroeconomic perspective (GDP, household consumption), at the EU level effects of MSR reform are mostly rather negligible with an exception of aggregate exports and imports. Even if output changes of individual sectors are of the order of a few percent, those sectors usually account for a very small share in total value added in the EU, so they translate to GDP effects of the order of –0.2% to 0.1%.

1. Introduction

14. The EU Emissions Trading System (EU ETS), which has been operating in the European Union (EU) since 2005, is currently the largest mechanism of this type in the world. Over the years, it has undergone several changes, of which those introduced recently, i.e. the Market Stability Reserve (MSR)[1] mechanism, is a kind of evolution and an approach to dealing with the problems encountered.

15. According to the assumptions, emissions trading systems should be based on the principle of cost optimisation of emission reduction (the so-called cap and trade), where the permissible emission limit (cap) is known in advance and decreases as the emission reduction target is deepened. Within the decreasing cap, the participants can buy and sell (trade) emission allowances (EUA). A system constructed in this way allows users to optimise the costs of emission reduction in the given trading period and make choices regarding the time and cost of investing in clean and low emission technologies.

16. However, in the EU ETS, as a result of the introduction of the MSR mechanism and intervention in the auction pool of emission allowances, we cannot be sure what number of emission allowances will be available for installations in the long term. From the point of view of installations covered by the EU ETS, there is a need to secure future emissions, so the emission allowances may be purchased even several years earlier than their compliance in the system (hedging). Another element that creates uncertainty in terms of the volume of demand and supply is including investors in the EU ETS market, which on the one hand can buy and sell emission allowances, but on the other hand, do not need to compliance them. Demand and supply are thus established separately in the relation to the current greenhouse gases (GHG) emissions in a given year. Considering the above-mentioned factors, we can see that the price of emission allowances in the EU ETS is not only the result of the reduction costs to achieve climate goals, but the mechanism of the price setting is much more complex. It can also be noted, that the decision-makers are increasingly concerned with "appropriate", in their opinion, governing the price of allowances in the EU ETS. At the same time, it is the price of emission allowances that causes a major investment risk and expose the competitiveness of European industry.

17. Referring to the situation in 2021, it should be noted that it was exceptional in terms of volatility of the prices of emission allowances in the EU ETS. In January 2021, the EUA price was around 33 EUR, while at the beginning of December it reached levels above 90 EUR. The strong increases in the EUA prices were related to many factors, such as high demand for emission allowances from investors, an increase in the prices of fossil fuels (natural gas, coal and crude oil), reduced generation of energy based on renewable

[1] Market Stability Reserve (MSR) - by adjusting the supply of auctioned allowances, is aimed at stabilizing the current surplus in the EU ETS and increasing the system's resilience to fluctuations in emissions caused, for example, by the economic crisis or the influence of other policies.

sources (wind) and the gradual recovery of the EU economies from the crisis caused by the COVID-19 pandemic (investment recovery). The EUA prices in 2021 were also rising due to the „Fit for 55" package published by the European Commission (EC), which entry into force planned in 2024 will drastically reduce the number of emission allowances available in the EU ETS.

18. The purpose of this analysis is an attempt to estimate the impact of the changes in the EU ETS proposed by the EC as a part of the „Fit for 55” package, in particular changes in the functioning of the MSR on the volumes of emission allowances available for installations, and to estimate the impact of these changes on the annual average prices of emission allowances in the EU ETS. Additionally, the report presents the economic consequences of changes in the price of emission allowances on production prices and volumes in the EU.

19. It should be emphasized that predicting changes in the trading strategies of EU ETS market participants as well as the prices of energy resources such as gas, coal and oil in the long term is extremely difficult. The analysis assumes that the EU ETS will strive to stabilise, i.e. to normalise the number of emission allowances purchased by market participants in order to compliance the emissions and secure future production. The changes in the prices of energy resources in individual analysed scenarios are the result only of modelling the EU climate policy (endogenous variable in the Computable General Equilibrium model).

2. Operating of the MSR

2.1. Construction of the MSR based on current legislation and „Fit for 55” package

2.1.1. The objectives of implementing the MSR

20. In 2015, the Council and the European Parliament adopted the decision to establish the Market Stability Reserve (Decision (EU) 2015/1814) under the EU ETS established by Directive 2003/87/EC and started operating from **1 January 2019**. The main objectives of the MSR are outlined in the MSR Decision [Marcu, et. al, 2020]:

- Eliminate the historical structural supply-demand imbalance within a reasonable amount of time (address the current surplus of emission allowances);
- Bring the TNAC[2] within range of the MSR thresholds in case of new events within a reasonable amount of time (improves the system's resilience to major shocks by adjusting the supply of emission allowances to be auctioned).

[2] Total number of emission allowances in circulation.

21. European Commission identified the need for **measures in order to tackle structural supply-demand imbalances**, indicates that such imbalances are expected to continue, and would not be sufficiently addressed by adjusting the linear trajectory (LRF) to a more stringent target. The fundamental origin of what has been labelled as a "supply-demand imbalance" has to be attributed to the lack of flexibility in the design of the supply side of the EU ETS (since both free allocation and the auctioning schedule had any flexibility mechanism included), while market demand (driven mostly by the amount of emissions) did react to market conditions [Marcu, et. al, 2021].

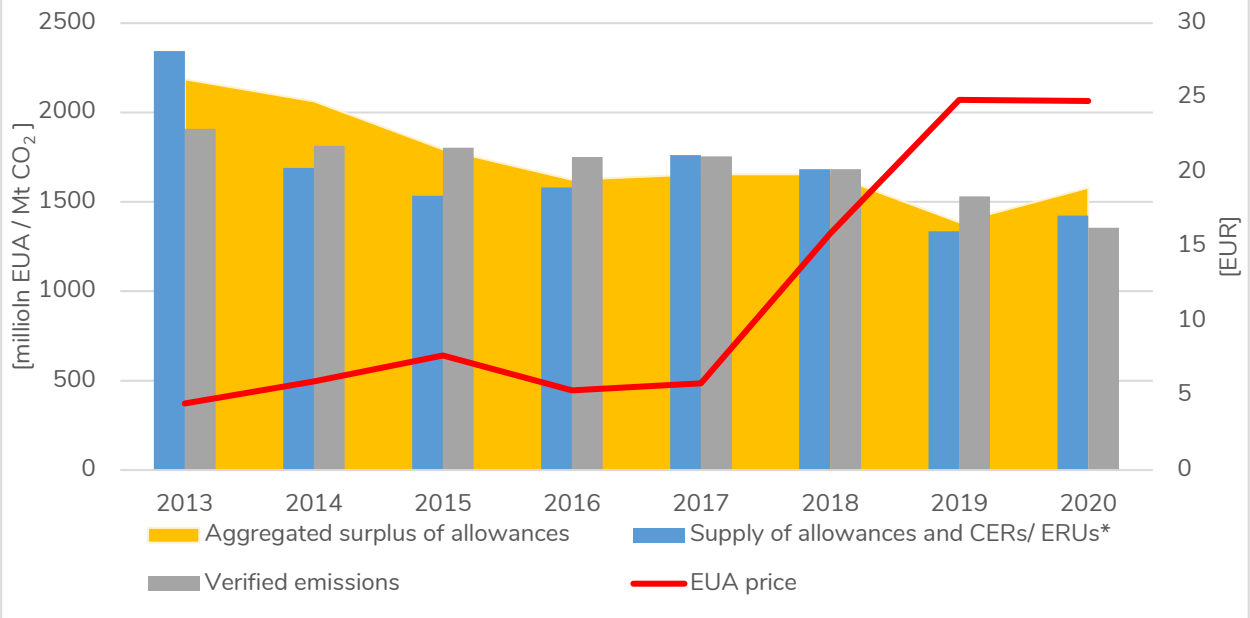
22. The increase in "imbalance" can be assigned to a number of factors, including:

    - Economic crisis;
    - Overallocation of free emission allowances;
    - Policy overlaps, most notably with Renewable Energy and Energy Efficiency policies;
    - Mitigation action undertaken by covered installations;
    - **Great increase in the surplus was due to use of international credits (especially until 2012).**

23. At its peak in 2013 supply overwhelmed demand, reaching about 2.2 billion in the amount of EUAs in circulation, which was more than one year's worth of market supply. To address this issue, the EU at first 'backloaded' the auctioning of 900 million emission allowances between 2014 and 2016, as a temporary measure, and then introduced the MSR. Figure 2 shows the development of the surplus in the European carbon market in 2013-2020. We can observe that between 2014 and 2016 the TNAC declined from 2.2 billion to 1.8 billion EUA's due to the decision to backload 900 million EUA's. Then in 2019, the starting year of the MSR, the TNAC dropped significantly as well, from 1.65 billion to 1.38 billion. However, in 2020, due to the COVID crisis leading to a significant drop in emissions together with the UK auctioning two years of its supply[3], the TNAC significantly increased by over 200 million, to 1.58 billion. It should be noted that during two years of MSR functioning (2019-2020) over 772 million allowances were taken from the auction pool and placed in the reserve. Perhaps, if there was no MSR in the EU ETS from 2019 the EUA surplus would amount to 1.78 billion in 2019 and 2.35 billion in 2020 which is even higher than the surplus at the beginning of Phase 3 (2.19 billion). The surplus would be even higher including 900 million EUAs, if we assumed that the backloading emission allowances has been returned to the carbon market in 2019-2020. According to the MSR decision, those emission allowances were placed in the reserve.

[3] UK auctions was suspended in 2019 due to the ratification of the Withdrawal Agreement between the UK and EU (brexit). In 2020 UK auctions restarted – UK auction supply included volumes from 2019 and 2020.

Figure 2. Development of the surplus in the EU ETS market in 2013-2020 (EU28 + EFTA, stationary installations)



**CERs, ERUs - Certified emission reductions, Emission reduction units.*

Source: CAKE/KOBiZE based on European Environment Agency data

24. EC indicates[4] that the surplus of emission allowances has led to lower carbon prices and thus a weaker incentive to reduce emissions. In the short term, the surplus risks undermining the orderly functioning of the carbon market. In the longer term, it could affect the ability of the EU ETS to meet more demanding emission reduction targets cost-effectively. Without any action on this "imbalance problem" the market would have to continue to operate with a high surplus of emission allowances, thereby preventing the EU ETS from delivering the necessary investment signal to reduce CO_2 emissions and from being a driver of low-carbon innovation, in particular, at the beginning of the current EU ETS phase 2021-2030.

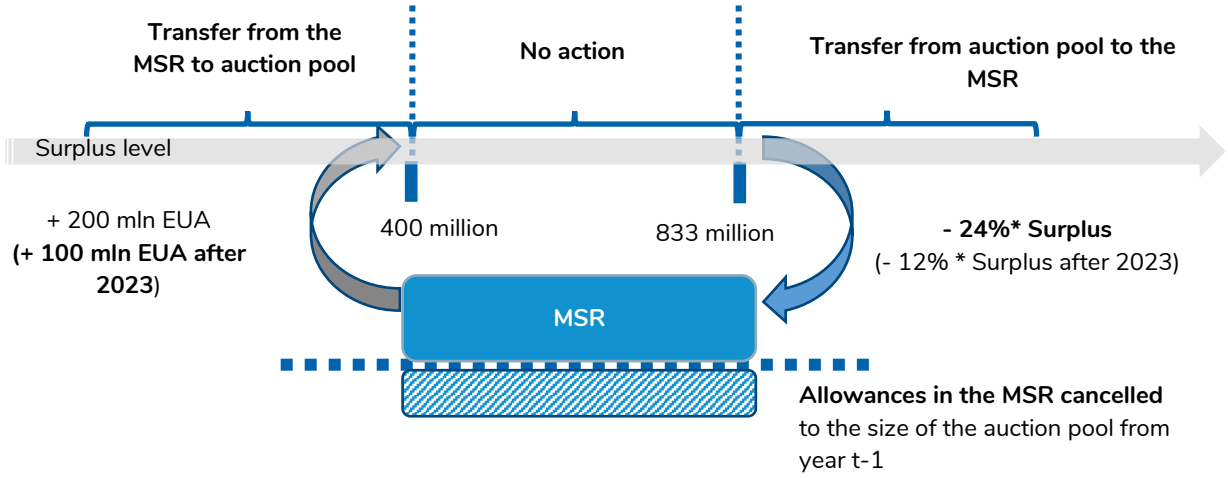
2.1.2. MSR mechanism and parameters

25. The MSR reserve affects the carbon market by triggering adjustments to the annual auction volumes. The MSR works in an automatic manner when the EUA surplus (so called the TNAC) is outside of a predefined range (from 400 to 833 million emission allowances). Allowances are deducted from the auction volumes and added to the reserve if the TNAC exceeds the upper threshold of MSR (833 million emission allowances). Emission allowances are released from the reserve and added to auction volumes if the TNAC is lower than 400 million allowances. In practical terms, emission allowances are added to

[4] https://ec.europa.eu/clima/policies/ets/reform_en#tab-0-0

the reserve by auctioning a lower number of allowances. During the period from 2019 to 2023, the percentage of the TNAC determining the number of emission allowances put in the reserve (so called intake rate) is temporarily doubled from 12% to 24%. The number of emission allowances transfer from auction to the reserve is the value of TNAC multiplied by the intake rate of 24% or 12% after 2023. In the 2019-2023 period there is similar rule related to the released emission allowances from the reserve – they are temporarily doubled from 100 million to 200 million. After 2023 this parameter will return to 100 million. The rules for the MSR adjust auction volumes in light of the emission allowance surplus were presented in Diagram 1. In practice, 24% of the TNAC is published in May and placed in the reserve over a period of 12 months starting as of the 1st of September each year. A corresponding amount is taken from the auction volumes. Because the auction calendar is published on a full year in advance there is a need to adjust the calendar from September to December in the given year after.

Diagram 1. Operation of the MSR mechanism



Source: CAKE/KOBiZE

26. Vivid Economics (2021) noticed the MSR intake rates (transfers to/from MSR) determine the scale of intervention of the MSR, and its ability to respond to market imbalances in a timely manner. The specification and size of intakes and releases into the MSR determine the speed at which it will address the historical allowance surplus and its ability to respond to market demand shocks in a timely manner. If interventions are too small this could mean that the MSR is ineffective in responding to market imbalance, while if interventions are too large this could lead the MSR to “overcorrect” imbalances potentially risking policy-driven price volatility.

27. In the EU ETS exists an additional mechanism that could activate transfers from MSR if the TNAC is above 400 million – so-called the “Art. 29a mechanism”, which may be triggered in case of excessive EUA price fluctuations. If measures are adopted under Article 29a of the EU ETS Directive, 100 million allowances may be released from the MSR. These measures can be adopted “*if for more than six consecutive months the carbon price is more than three times the average carbon price during the two preceding years*” [5].

28. In addition, from 2023, emission allowances held in the MSR above the previous year's auction volume will no longer be valid. So, for example, if the reserve contained 2.2 billion in 2023 of emission allowances and in 2022 auctioned volumes were 600 million, the difference, 1.6 billion EUA allowances, will be invalidated and permanently withdrawn from the market. The invalidation mechanism intended to limit the aggregate banking of allowances in the future by permanently removing them from the market, which contributes to increasing the reduction target in the EU ETS.

2.1.3. Calculation of the surplus in the EU ETS (TNAC)

29. The MSR Decision states that, by 15 May each year (starting in 2017), the Commission shall publish the total number of emission allowances in circulation (TNAC), which is a key figure to determine whether some of the emission allowances intended to be auctioned should be placed into the reserve, or be released from the reserve. TNAC is a difference of the allowances available to market participants under the EU ETS cap and allowances banked from previous years (and/or trading periods) compared to cumulative emissions and EUA cancellations. Allocated or bought on the auctions volumes can be traded on the market by compliance and non-compliance participants who may choose to bank them between years and trading periods. So the TNAC's main task is to capture the total supply of allowances that are not used for compliance, voluntarily cancelled, or otherwise made unavailable to market participants.

30. The rules of calculating the total number of emission allowances in circulation (TNAC) are stipulated in Article 1(4) of Decision (EU) 2015/1814: so the TNAC "*shall be the cumulative number of allowances issued in the period since 1 January 2008, including the number issued pursuant to Article 13(2) of Directive 2003/87/EC in that period and entitlements to use international credits exercised by installations under the EU ETS in respect of emissions up to 31 December of that given year, minus the cumulative tonnes of verified emissions from installations under the EU ETS between 1 January 2008 and 31 December of that same given year, any allowances cancelled in accordance with Article 12(4) of Directive 2003/87/EC and the number of allowances in the reserve.*"

[5] If the price evolution does not correspond to changing market fundamentals, measures may be adopted to bring forward allowances from future auctions, or auction up to 25% of remaining allowances in the New Entrants Reserve (NER).

31. In short, TNAC relevant for MSR feeds and releases could be calculated by the following formula:

TNAC = Supply – (Number of allowances surrendered and cancelled (demand) + Number of allowances in the MSR)

There are three different elements that determine the TNAC:

1) supply of emission allowances since 1 January 2008;
2) number of allowances surrendered and cancelled (demand for emission allowances);
3) number of allowances in the MSR.

As foreseen in Decision (EU) 2015/1814, aviation allowances and verified aviation emissions are not considered in this context.

32. As Vivid Economics (2021) noticed the TNAC can be used to assess the current level of allowance scarcity on the market but does not provide information about future scarcity. A high or growing TNAC means that the available supply of allowances is exceeding demand in the current period, a situation that is often linked to lower prices. Likewise, a low TNAC can be an indicator that there may not be enough allowances available to provide sufficient supply for necessary risk management (hedging) and to optimise low-carbon investment strategies across time.

33. Perino et al (2021) argues, on the other hand, that the TNAC is not a reliable indicator of scarcity because it may point in the wrong direction for anticipated future changes in market fundamentals and makes the system at large susceptible to manipulation and gaming.
TNAC-based MSR ignores the diversity and endogeneity of banking motives (e.g. passive or active EUA accumulation, hedging, and speculation) that contribute to the TNAC. Perino et al (2021) also points out that conditioning the supply of allowances on the TNAC can lead to an unintended and highly undesirable outcome: if anticipated scarcity increases (decreases), firms bank more (less) allowances to re-establish the balance between current and future abatement costs. The MSR then responds by cancelling more (less) allowances further increasing (decreasing) scarcity. So this kind of behaviour and market perception can affect EUA market balance, operation in the MSR and EUA prices.

2.1.4. Potential effect on MSR in the changing market conditions

34. A wide range of **unforeseen external events** can have implications on MSR and EU ETS functioning. This could include unexpected changes in economic activity, fuel or low-carbon technology costs or the additional climate and energy policies used in the EU or on Member States level to help reach the EU ETS targets (so called overlapping climate policies).
    The above elements could change demand for allowances and have a big impact on TNAC and additional transfers to/from MSR.

35. **Changes in economic activity** including negative economic shocks and increases in fossil fuel prices. This could lead to lower emissions (lower demand for allowances) which results in increasing the level of TNAC. This may lead to additional EUA transfers into the MSR if TNAC is above the upper threshold. One of the great examples of economic shock was the financial crisis in 2009 and COVID-19 in 2019-ongoing which lead to a significant decline in demand and the accumulation of a surplus of allowances.

36. **Changes in low-carbon technology costs.** Some new technology may appear on the market, which will significantly contribute to the reduction of marginal costs. This could lead to a decrease in the demand for allowances as well as EUA price expectations. Lower demand increases the level of TNAC. This may increase EUA transfers into the MSR. If the TNAC falls more significantly and is below the lower thresholds this could lead to a release of allowances from the MSR.

37. **Overlapping climate policies.** Examples of these policies are on the one hand the reductions target in RES and Energy Efficiency at the EU level and, on the other hand, policies of individual Member States that speeds up the transition (e.g. the plans of Germany to phase-out power generated by coal by 2038 or the plans of the Netherlands to set the carbon floor price for the electricity generation).

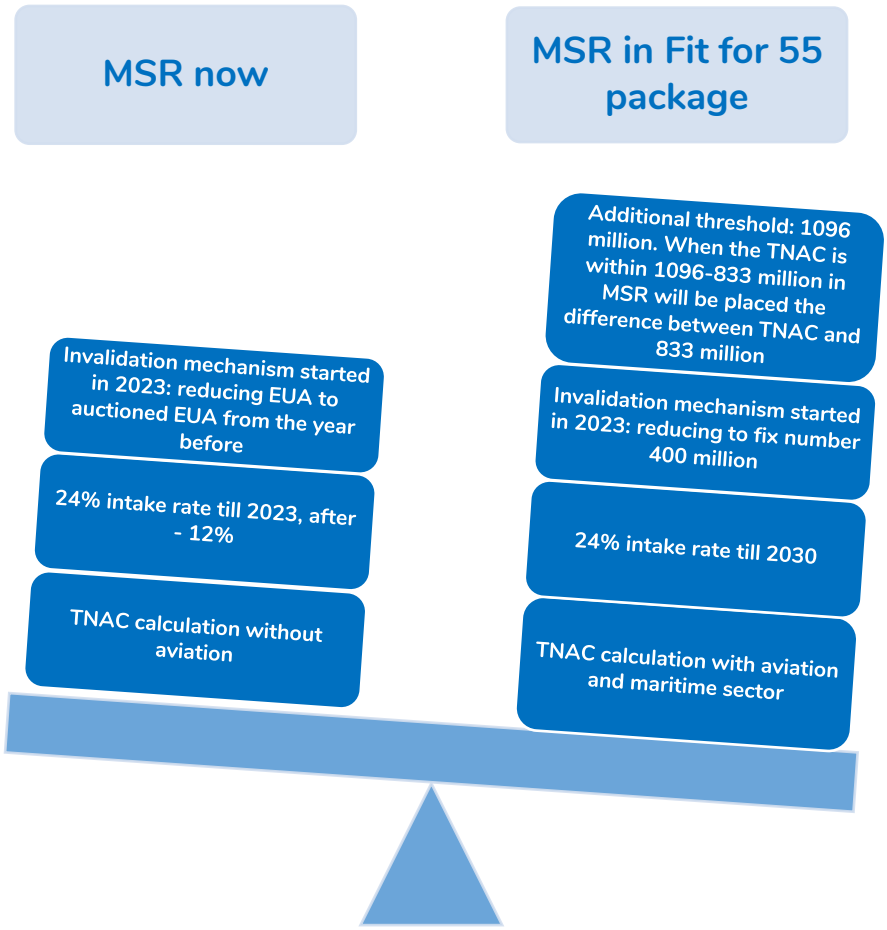
38. One of the effects of the above policy could be so called the **"waterbed effect"**, whereby any reductions in emissions in one jurisdiction will result in emissions rising in another jurisdiction. Falling emissions lead by additional policy creates space for more emissions under the EU ETS cap. This could lower demand for EU allowances and EUA prices, and therefore lower abatement in other EU jurisdictions. Climate and energy policies that lead to additional emission reductions will lower the demand for allowances and therefore increase the TNAC. This will result in a higher transfer to MSR from auctioning volumes. Perino (2018) argues that, given the large historical surplus on the market, when the invalidation mechanism begins in 2023, the MSR's holding account will contain sufficient allowances to ensure that any additional allowances placed in the MSR will be permanently invalidated. Since invalidating allowances effectively lowers the overall emissions budget over time, the MSR therefore substantially reduces the waterbed effect.

39. Rosendahl (2019) argues that claims of the punctured waterbed effect are incomplete because most policy changes are anticipated, and therefore shape market dynamics both today as well as in the future when the policy is implemented. If market participants expect the demand for allowances to be lower in the future (due to additional emission reductions stemming from other policies), this could lead to less banking, and hence a lower TNAC. Lower levels of banking decrease the TNAC and therefore the MSR withdraws a smaller number of allowances from auctioning volumes. Anticipated policy changes can lower allowance prices and lead to emissions rise. This means more allowances are needed for compliance and banking falls. In this situation, the TNAC ends up lower as a result of the anticipated policy, and therefore the MSR will make smaller adjustments to auctioning volumes. In the end, lower adjustments mean less allowances in the MSR holdings account and fewer invalidations. It is possible that overall GHG emissions could increase as a result of overlapping policies. Gerlagh et al (2019) argue that the MSR creates a **“new green paradox”**, as the volume of invalidations, and hence overall abatement decreases as a result of overlapping policies. If overlapping policies result in lower MSR adjustments and therefore fewer allowances are invalidated, the overall emissions budget ends up higher than it would have been in the absence of the overlapping policy.

2.1.5. MSR in the „Fit for 55” package

40. The increased ambition for 2030 in the „Fit for 55” package, as well as the impact of external factors such as COVID-19 or national measures such as coal phase-outs, mean that the basic rules of the MSR must continue tackling structural supply-demand imbalances throughout the decade. Moreover, Article 3 of the MSR Decision tasks the Commission with reviewing the functioning of the MSR after three years of the start of its operation and at five-year intervals thereafter, based on an analysis of the orderly functioning of the European carbon market. The review must pay particular attention to the MSR’s key numerical parameters and invalidation mechanism and look into the impact of the reserve on growth, jobs, the Union's industrial competitiveness and the risk of carbon leakage.

Diagram 2. MSR in current legislation and the „Fit for 55” package



Source: CAKE/KOBiZE

41. Below presented the main changes in a key MSR parameters:

- Maintaining the intake rate of **24% until 2030** (and would revert to 12% after 2030);
- Thresholds remain unchanged **(833-400 million);**
- Change of the intake rate mechanism to mitigate threshold effects applicable when the total number of emission allowances in circulation is close to **upper threshold of 833 million but below 1 096 million** (additional threshold) – in MSR is placed the difference between TNAC and upper threshold (833 million);
- **Invalidation of reserve volumes above 400 million emission allowances** instead of above total number of allowances auctioned during previous year;
- **Including supply and demand from the aviation and maritime** transport sectors in TNAC calculation;

42. The impact assessment has shown that “*12% intake rate would not be enough to ensure that the objectives of the MSR in terms of reducing the surplus and ensuring market resilience would still be fulfilled*”. The aim of this proposal is to ensure that the current parameters of the MSR (intake rate of 24% and minimum amount to be placed in the reserve of 200 million emission allowances) are maintained beyond 2023 and until the end of Phase IV of the EU ETS on 31 December 2030 to ensure market predictability. The MSR intake rate would revert to 12% after 2030.

43. The „Fit for 55” proposal modifies the mechanism of the intake rate. It proposes a buffer market stability reserve (MSR) intake when the TNAC is between 833 million and 1096 million. In that case, the intake will be the difference between the TNAC and the 833 million threshold. As long as the TNAC is above 1096 million emission allowances, the normal intake rate would apply (24% until 2030). The intake rate is amended in order to address the ‘threshold effect’ that possibly would take place when the TNAC is very close to the upper threshold. In that case, one emission allowance more or less in the TNAC may trigger or not intakes, depending on whether the TNAC is above or below the threshold. Uncertainty about this happening or not risks creating price volatility on the market. The reason for choosing the figure of 1096 million emission allowances is that, at that amount, the 24% intake rate and the difference between the TNAC and the upper threshold are close to each other. Specifically, when TNAC is 1095, the intake is 1095-833=262, and when TNAC is 1097 the intake is 1097*24%=263. This addresses the threshold effect while maintaining an efficient MSR intake if the TNAC is higher.

44. As of 2023, emission allowances in the MSR above the level of auction volumes of the previous year are invalidated. However, the level of auction volumes of the previous year depends on various elements, such as the cap and the operation of the MSR itself. In order to ensure that the level of emission allowances that remains in the reserve after the invalidation is more predictable, it is proposed to limit the number of emission allowances in the reserve to a level of 400 million. This value also corresponds to the lower threshold for the value of the TNAC, below which emission allowances are released from the MSR.

45. When calculating the TNAC, the formula will specify that only emission allowances issued and not put in the reserve are included in the supply of allowances, and the number of emission allowances in the reserve is no longer subtracted from the supply of allowances. This change makes the calculation of the total number of emission allowances in circulation clearer, and has no material impact on its result, including on the past calculations of the TNAC.

3. Models and data

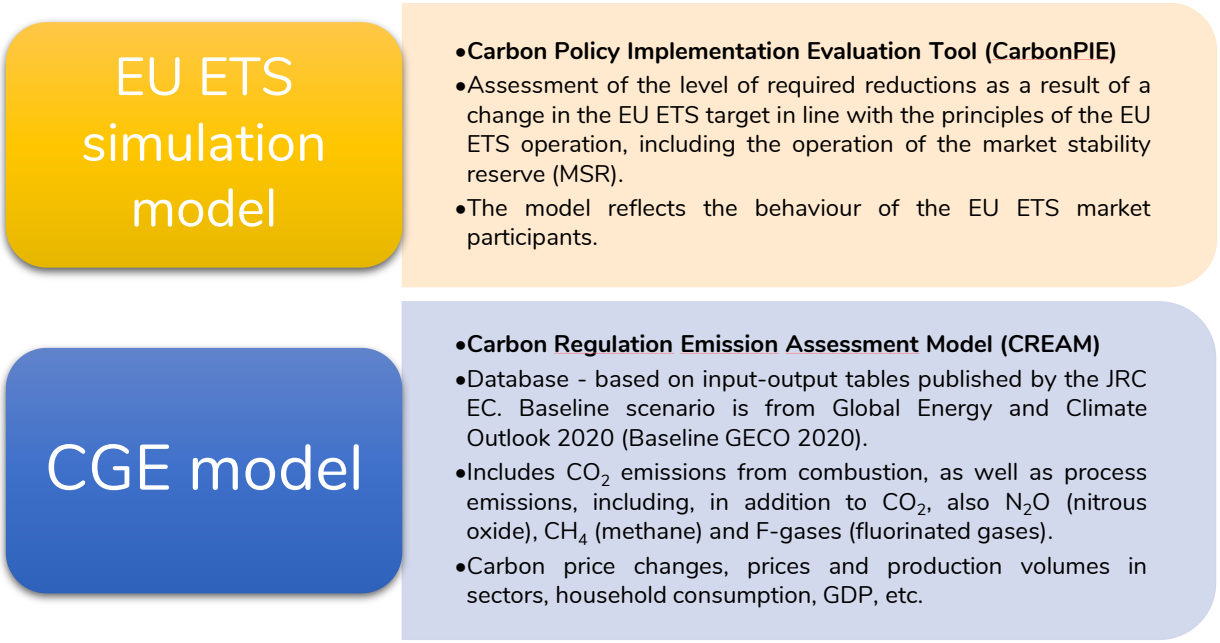
46. For the analysis of changes in the EU ETS and the economy we have used two models: CarbonPIE and CREAM. The CarbonPIE model simulates the functioning of the MSR and the behavior on the EU ETS market. The model computes the EUETS cap, the number of allowances leaving/entering the MSR and number of allowances purchased for hedging needs. The amount of emissions in a given year adjusts in order to balance the total number of allowances purchased with the number of allowances available on the market (after adjustments of the MSR mechanism). The information on the resulting emissions is then transferred to the Computable General Equilibrium (CGE) Carbon Regulation Emission Assessment Model (CREAM). The CREAM model sets the limit on emissions accordingly and endogenously determines the marginal cost of GHG emission reduction. We assume that marginal cost reflects the price of allowances. A detailed description of the tools used is given in Annex I.

47. The scenarios used in the analysis are based on the policies included in the baseline scenario presented in the Global Energy and Climate Outlook 2020 (Baseline GECO 2020), prepared by the Joint Research Centre of the European Commission in 2020[6]. The Baseline scenario represents a projection of the economy, energy demand and GHG's emissions reflecting the EU Reference Scenario 2020 which assumes the impact of COVID-19 on the economy and the energy demand.

48. Adopted analytical scenarios (except for the reference scenario) includes additional GHG emission reductions in the EU Member States in 2025 and 2030 compared with the Baseline GECO 2020 scenario, assuming no external (exogenous) change in energy demand due to policies measures, e.g. higher energy efficiency targets or reduced consumption of fossil fuels. All the changes in energy demand are the result of simulation in the CGE model.

[6] https://data.jrc.ec.europa.eu/dataset/b8315511-cb76-4e52-b1c1-3680de1e47d0

Diagram 3. Characteristics of analytical tools



Source: CAKE/KOBiZE

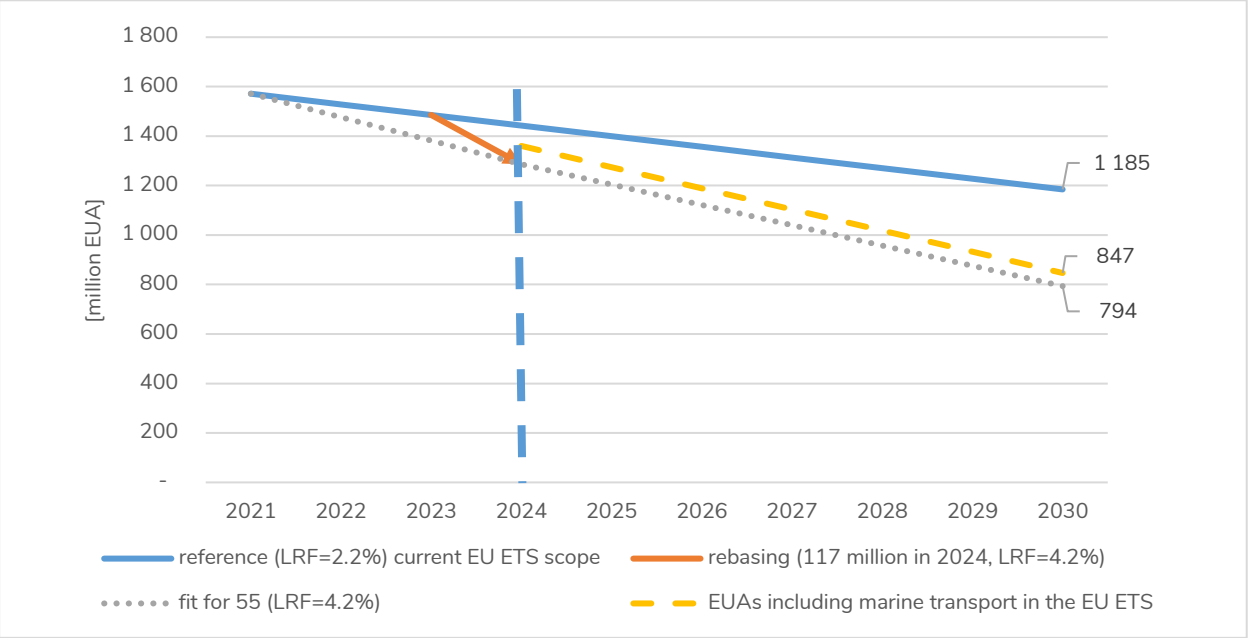
4. Scenarios

4.1. Changes of total number of allowances in the EU ETS

49. According to the regulations currently in force in the EU ETS, the total number of emission allowances is determined based on data from 2013, where the amount of available allowances determined for this year is reduced annually, in a linear manner, by a constant value resulting from the linear reduction factor – LRF. From 2021, the LRF equal to 2.2% became applicable, the amount of which translates into the annual reduction of emission allowances by approx. 43 million. To meet the new reduction target in the EU ETS proposed in the „Fit for 55” package, i.e. 61% in 2030 vs. 2005, the number of emission allowances will be reduced each year by a LRF of 4.2%. An increase in the LRF ratio from 2.2% to 4.2% means that about 82 million EUAs will be deducted from the total pool of allowances in the EU ETS each year, instead of 43 million EUAs. If we include maritime as an additional sector included in the EU ETS under the „Fit for 55” package, the LRF value of 4.2% will correspond to a reduction of approx. 86 million EUA. In addition, the package introduces the so-called rebasing (or one off mechanism), i.e. a one-off reduction of allowances in the EU ETS. Assuming that the new regulations would start operating from 2024, the rebasing will amount to approx. 117 million EUA (the amount of the reduction is to reflect the reduction of emissions linearly from 2021 with the new LRF equal to

4.2%)[7]. However, after including maritime in the EU ETS, rebasing would amount to approximately 122 million EUA.

Figure 3. The reduction of allowances in the EU ETS resulting from the change of the LRF in the 2024-2030



Source: CAKE/KOBiZE

50. All emission allowances available in the EU ETS in the period 2021-2030 are divided into: auction pool, free allocation of allowances and funds, including the Modernization Fund and the Innovation Fund. Emission allowances not used in the previous period may be transferred to the current reference period. This applies to the emission allowances accumulated on the accounts of the installation, as well as the allowances allocated under the so-called primary market[8] by or on behalf of EU ETS countries. An example of not used emission allowances is the reserve for new installations (NER), which is supplied with unused free emission allowances from the 2013-2020 period. In the case of Modernisation Fund, the proposed changes are to increase the fund by an additional amount of 2.5% of the total number of emission allowances (including maritime) in the period calculated from the year following the entry into force of the EU ETS Directive (possibly 2024) until 2030. Furthermore, Greece and Portugal will participate only in the additional 2.5% pool, as the new part of the fund is shared between Member States whose GDP per capita is below 65% of the EU average in 2016-2018. It should be noted that the increase in Modernisation Fund alone does not increase the total number of emission allowances available for installations in the EU ETS, but only affects the way of their redistribution

[7] One-off reduction of allowances in the EU ETS. The number of allowances taken off the market at one time will reflect the reduction of allowances from 2021 with a new LRF of 4.2%. The new 4.2% LRF corresponds to the EU ETS reduction target of 61% in 2030 compared to 2005 emissions.

[8] Primary market – the initial distribution of emission allowances in EU ETS by States or on behalf States, this distribution including auction and free allocation of allowances.

between countries. Table 1 represents the main changes between current legislation and „Fit for 55" package in the total number of emission allowances in the EU ETS.

Table 1. Total number of allowances in the EU ETS for the current legislation and „Fit for 55" package for Phase 4 (auction allowances without MSR) [million EUA]

Current EU ETS legislation											
Years	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total***
Cap	1572	1529	1486	1443	1400	1357	1314	1271	1228	1185	13781
Auctioning *(=57% of cap – 3% for free allocation - Innovation Fund - Modernisation Fund)*	810	787	765	743	720	698	676	653	631	608	7091
Free allocation *(=43% of cap + 3% cap from auctionig share - Innovation Fund)*	690	671	651	631	611	592	572	552	532	512	6014
Free allowances issued*	656	637	618	600	581	562	543	524	506	487	5713
Innovation Fund *(free allocation)*	33	33	33	33	33	33	33	33	33	33	325
Innovation Fund *(auction share)*	8	8	8	8	8	8	8	8	8	8	75
Modernisation Fund *(without voluntary transfer of same MS)*	31	31	30	29	28	27	26	25	25	24	276
New Entrants Reserve issued**	18	18	18	18	18	18	18	18	18	18	183
	„Fit for 55"										
Years	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total***
Cap	1572	1529	1486	1360	1275	1189	1103	1018	932	847	12310
Auctioning *(=57% of cap – 3% for free allocation - Innovation Fund - Modernisation Fund)*	810	787	765	664	622	580	537	495	453	410	6123
Free allocation *(=43% of cap + 3% cap from auctionig share - Innovation Fund)*	690	671	651	588	548	509	469	430	391	351	5298
Free allowances issued**	656	637	618	558	521	483	446	408	371	334	5033
Innovation Fund *(free allocation)*	33	33	33	38	38	38	38	38	38	38	365
Innovation Fund *(auction share)*	8	8	8	9	9	9	9	9	9	9	85
Modernisation Fund *(without voluntary transfer of same MS)*	31	31	30	61	57	54	50	46	42	38	439
New Entrants Reserve issued***	18	18	18	18	18	18	18	18	18	18	183

* *The figures may differ from the sum for the years 2021-2030 due to rounding.*

** *5% of the total number of free allowances will not be allocated to the installation in the period 2021-2030*[9].

*** *20% of allowances (275 million from 2013-2020) will be used in the NER reserve and allocated for free in the period 2021-2030*[10].

Source: CAKE/KOBiZE

[9] Because of changes in the allocation of free allowances from 2021, we assume that the share of unallocated EUA's in the period 2021-2030 will be approx. twice lower than in the period 2013-2020 (which is above 10%).

[10] It is necessary to adopt an assumption limiting the use of the NER reserve due to low level of its used in the previous period in the years 2013-2020 and the large number of allowances accumulated in this reserve for the period 2021-2030 (200 million from MSR and 716 million from unallocated free allowances until 2020).

4.2. Reference and „Fit for 55" scenarios

51. Table 2 summarizes the differences between the reference scenarios (reflecting current EU climate policy) and „Fit for 55" scenarios that assume update EU climate policy according to „Fit for 55" package.

Table 2. Assumptions for the reference and „Fit for 55" scenarios

Scenario	EU ETS reduction target in 2030 vs. 2005	LRF	Modernisation Fund	MSR	Innovation Fund	Additional assumptions
Reference	43%[11]	2.2%	2% from 2021-2030 pool	• intake rate – 24% (to 2023) and 12% (2024-2030) • thresholds 833-400 million	400 million and 50 million sold in 2020	• GECO 2020 policies (according to Primes Reference scenario 2020) • free allocations of allowances in EU ETS
„Fit for 55"	61%	• 4.2% from 2024 • rebasing 117.28 million (stationary installations) and 5.03 million (maritime)	• 2% from 2021-2030 pool • 2.5% from 2021-2030 pool	• intake rate – 24% (entire period), but different for an extra threshold (TNAC-833 million) • thresholds 833-400 million and additional threshold 1096-833 million TNAC (incl. aviation and maritime transport)	• 400 million and 50 million sold in 2020 • additional 50 million from the EU ETS auction pool	• GECO 2020 policies (according to Primes Reference scenario 2020) • CBAM • BRT ETS • inclusion of maritime in the EU ETS

Source: CAKE/KOBiZE

[11] It is in fact 48% as a result of additional action of energy policies (including energy efficiency and development of renewable energy sources).

52. **Reference** – In this scenario the actual EU ETS legislation – current EU ETS Directive and MSR decision is taken into account:

- The supply of emission allowances reflects target in the EU ETS equal to 43% reduction in 2030 vs. 2005. This results in annual cap reduced in EU ETS by LRF of 2.2% as of 2021. The value which is submitted for an annual reduction of emission allowances will be 42.71 million EUA.
- It was assumed that the size of the auction pool is additionally reduced by 3% in order to increase the free allocation for industry (to counteract Cross Sectoral Correction Factor - CSCF).
- The calculations assume that 20% of emission allowances (275 million) will be used in the NER reserve allocated for free in the period 2021-2030. After the update, it became necessary to adopt an assumption limiting the use of the NER reserve due to the large number of emission allowances accumulated in this reserve and the low level of its use in the previous settlement period (in the 2013-2020 period). The precise estimation of the amount of the NER reserve has become possible due to the publication by the European Commission of the number of emission allowances not used for free until 2020, which are transferred to the MSR.
- We also assume that the allocation of free emission allowances will be less than the total available value by 5% in 2021-2030. This assumption results from the fact that some of the free emission allowances were not issued in the previous period 2013-2020 due to cessation of activities and partial cessation of activities in installations covered by EU ETS.
- MSR parameters are the same as in current EU ETS Directive and MSR decision:
  - **24%** Intake rate utill **2023**, after it changes to **12% (till 20230);**
  - MSR thresholds remain unchanged: **833-400 million;**
  - When TNAC is below 400 million: 200 million is placed in MSR from auction pool till 2023 and 100 million after 2023;
  - **Invalidation mechanism**: all EUA’s in MSR are cancelled above the total number of emission allowances auctioned during previous year;
  - TNAC calculation: aviation and shipping are not included.
- The emission projection for the years 2025 and 2030 is based on the GECO 2020 baseline scenario. For the purposes of the simulation model, a linear interpolation of the emissions is performed between the historical emission in 2020 and the projection for 2025 and between the years 2025-2030.

- The reference scenario also includes the free allocation of emission allowances in the EU ETS. In the sectors exposed to the risk of carbon leakage, a part of emission allowances is allocated free of charge to installations.

53. ***„Fit for 55”*** – In this scenario the future EU ETS legislation is taken into account – planned EU ETS Directive and MSR decision amendment in line with the „Fit for 55” package.

    - The supply of emission allowances reflects reduction target in the EU ETS equal **61% in 2030 vs. 2005** (with marine sector extension). The overall number of emission allowances will decline at an annual cap reduction **(LRF) of 4.2% from 2024 onwards**, compared to 2.2% currently. This translates to 85.62 million EUA in absolute value. In addition the scenario assumes “one off reduction of the cap” (so called rebasing) in the year of entry into force to align the cap with emissions (if 2024: 117 million for stationary installations, or 122 including marine in the EU ETS), while at the same time cap increase through the marine transport extension.
    - MSR parameters are changing:
        - **24%** Intake rate utill **2030**;
        - MSR thresholds remain unchanged: **833-400 million;**
        - When TNAC is below 400 million: 200 million is placed in MSR from auction pool till 2030;
        - Introducing an **additional threshold 1 096-833 million** – when the TNAC is in this range, the difference between TNAC and upper threshold (833 million) is placed in MSR;
        - **Invalidation mechanism:** all EUA’s in MSR above 400 million are cancelled;
        - TNAC calculation: aviation and marine are included.
    - Beside the policies included in Baseline GECO 2020, the simulations takes into account other climate-related policies such as:
        - free allocations of emission allowances in EU ETS, and
        - policies proposed in the „Fit for 55” package, such as CBAM and linked with CBAM phasing out of free allocation, inclusion of maritime in the EU ETS, an additional ETS for housing and transport in the EU (BRT ETS), as well as higher emission reduction targets for non-ETS sectors.

4.3. Additional scenarios of changes in MSR and „Fit for 55" package

54. Table 3 presents the additional scenarios for revision MSR and phase 4 (2021-2030) of the EU ETS.

Table 3. Additional scenarios of changes in MSR and „Fit for 55" package

Scenario	Changes to the „Fit for 55" scenario
non-rebasing	• no rebasing, but increased LRF from 4.2% to 5.06% from 2024
dynamic MSR	• dynamic MSR: intake rate = 33% x (TNAC – upper threshold); upper threshold starts to decrease from 700 million in line with the LRF as well as lower threshold (starts from 400 million)
12% intake rate	• change in intake rate from 24% to 12% from 2024
upper threshold	• change of the upper threshold of MSR from 833 million to 600 million
without MSR	• MSR withdrawn from 2024

Source: CAKE/KOBiZE

55. ***Non-rebasing*** – In this scenario the assumptions are almost the same as in the „Fit for 55" Scenario. The difference is in LRF – **it increases from 2024 to 5.04% without introduction of rebasing** as foreseen in one of the scenario in the European Commission Impact Assessment.

56. ***Dynamic MSR*** – In this scenario the assumptions are almost the same as in the „Fit for 55" Scenario. Only MSR parameters are changing. There is a new intake rate (instead of 24% of TNAC) which is calculated by the formula: **33% x (TNAC – upper threshold).** There are also a dynamic thresholds: **upper threshold start to decrease from 700 million and the lower threshold from 400 million – both in line with LRF cap reduction - see Table 4.** It means in the later years thresholds would be lower than at the beginning. All these dynamic MSR parameters were design by the EC in Impact Assessment.

Table 4. Upper and lower thresholds for the dynamic MSR scenario

Thresholds	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Upper	833	833	833	700	671	641	612	582	553	524
Lower	400	400	400	400	383	366	350	333	316	299

Source: CAKE/KOBiZE

57. ***12% intake rate*** – This scenario is a hybrid of reference and the „Fit for 55" scenario. So the reduction target in EU ETS and LRF are the same as in „Fit for 55" scenario **with only the MSR intake rate maintain the same as current MSR legislation** (see MSR mechanism in the reference scenario). It means that the additional threshold and an invalidation mechanism are the same as in the MSR revision. In addition this scenario includes shipping and aviation in TNAC.

58. ***New upper threshold*** – This is almost exactly the „Fit for 55" scenario but with **changed upper threshold from 833 million to 600 million.** In addition there is no additional threshold with different counting intake rate in this scenario.

59. ***Without MSR*** – This scenario envisions an increase a reduction target and LRF as in the „Fit for 55" scenario but **without MSR operating from 2024.**

5. Interpretation of the results

5.1. Emission and achieved reduction targets in 2030 r.

60. Figure 4 indicates the trajectory of projected emissions in 2021–2030 for analysed scenarios for EU and EFTA countries. First of all, we can see that the emission in the reference scenario is dropping steadily to the lowest value of 990 $MtCO_2$ in 2030. This is because we fixed "old" LRF without rebasing and fixed MSR parameters (fixed thresholds and fixed 12% intake rate). When we consider the value of emissions in 2030, the scenario without MSR is between the reference and others scenarios considered in the simulations. Without MSR we can achieve 940 $MtCO_2$ in 2030. However, as a result of the withdrawal of MSR from the EU ETS, emissions initially stabilize in 2025 at a constant level and then decline rapidly until 2030. The initial lack of reduction in this scenario is a consequence of the large surplus of emission allowances in the EU ETS.

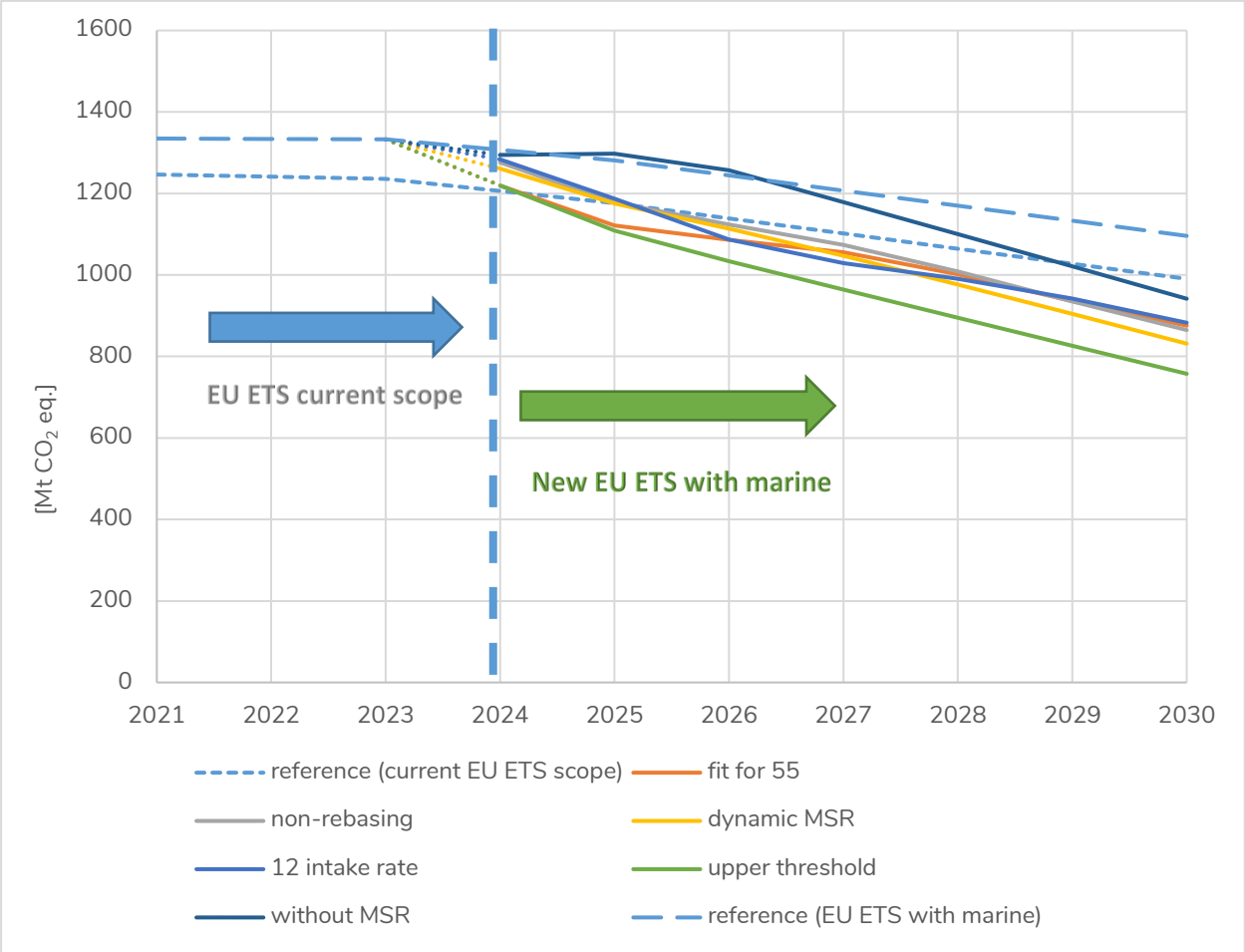
61. Almost the same level of emission (865-880 $MtCO_2$) in 2030 can be achieved in the „Fit for 55" scenario, "non-rebasing" and "12% intake rate" scenarios. The "rebasing effect" can be observed at the beginning when emissions drastically drop in 2025, but then they are back quickly to the non-rebasing scenario trajectory. The results show also that the reduction of the MSR intake rate to 12% is not so important for the emission level in 2030. At the end of the period, it does not matter whether we leave the intake rate at the level of 24% or 12% due to the fact that the surplus of emission allowances drops below 1096 million and a new threshold applies. In this situation the number of emission allowances transferred to MSR is very close to „Fit for 55", "non-rebasing" and "12% intake rate" scenarios.

62. In the "dynamic MSR" scenario at the beginning of the 2021-2030 period the emission reduction is slower, due to the change in the formula for calculating the number of

allowances transferred to MSR. The emission reduction trajectory is almost the same as in the "non-rebasing" scenario. However, in 2030 the emission is slightly lower in the "dynamic MSR" scenario (830 $MtCO_2$) than in „Fit for 55", "non-rebasing" and "12% intake rate" scenarios.

63. The lowest level of emission is in the "upper threshold" scenario (760 $MtCO_2$), since drastic reduction of the upper threshold of the mechanism (from 833 million to 600 million) causes more EUA's are withdrawn from the market.

Figure 4. Emission trajectory in 2021-2030 for analysed scenarios



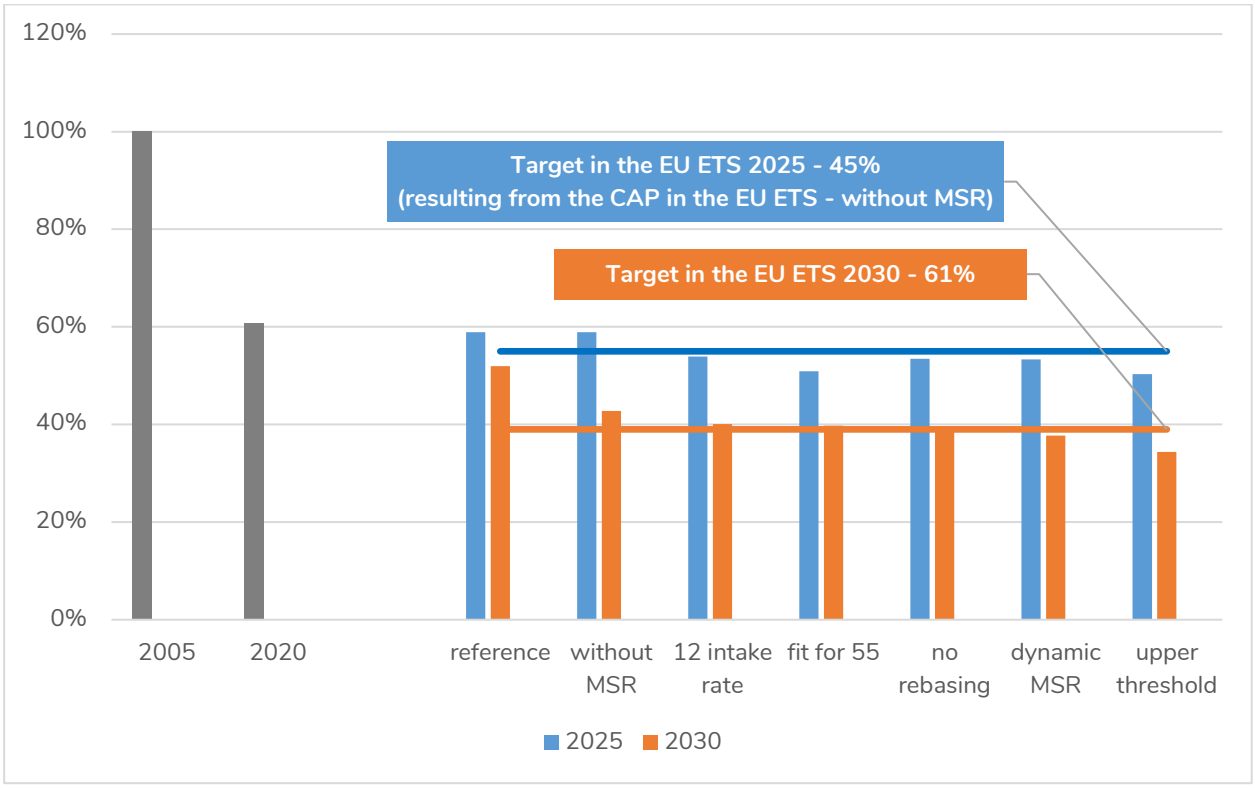
Source: CAKE/KOBiZE

64. The results show that in almost all scenarios (except "reference" and "without MSR") the mid-term (45%[12]) and long-term (61%) reduction targets are met. This is possible due to the large reduction of emission, that has already happened in the EU ETS (2019-2020) and due to the gradual decrease of the surplus of emission allowances, even "without

[12] The 2025 mid-term target is defined based on the volume of emission allowances available in the EU ETS (with marine) after increasing the LRF to 4.2% and rebasing from 2024 (but excluding the transfer of allowances to MSR). This target is on the way to reach 61% of cap reduction in 2030.

MSR”. In the „Fit for 55” and “upper threshold” scenarios, we significantly reduce emissions in 2025 compared to the mid-term target. It is worth noting that in the most extreme scenario i.e. “upper threshold”, the reduction target will be met in 2030 with a large margin.

Figure 5. Emission reduction targets



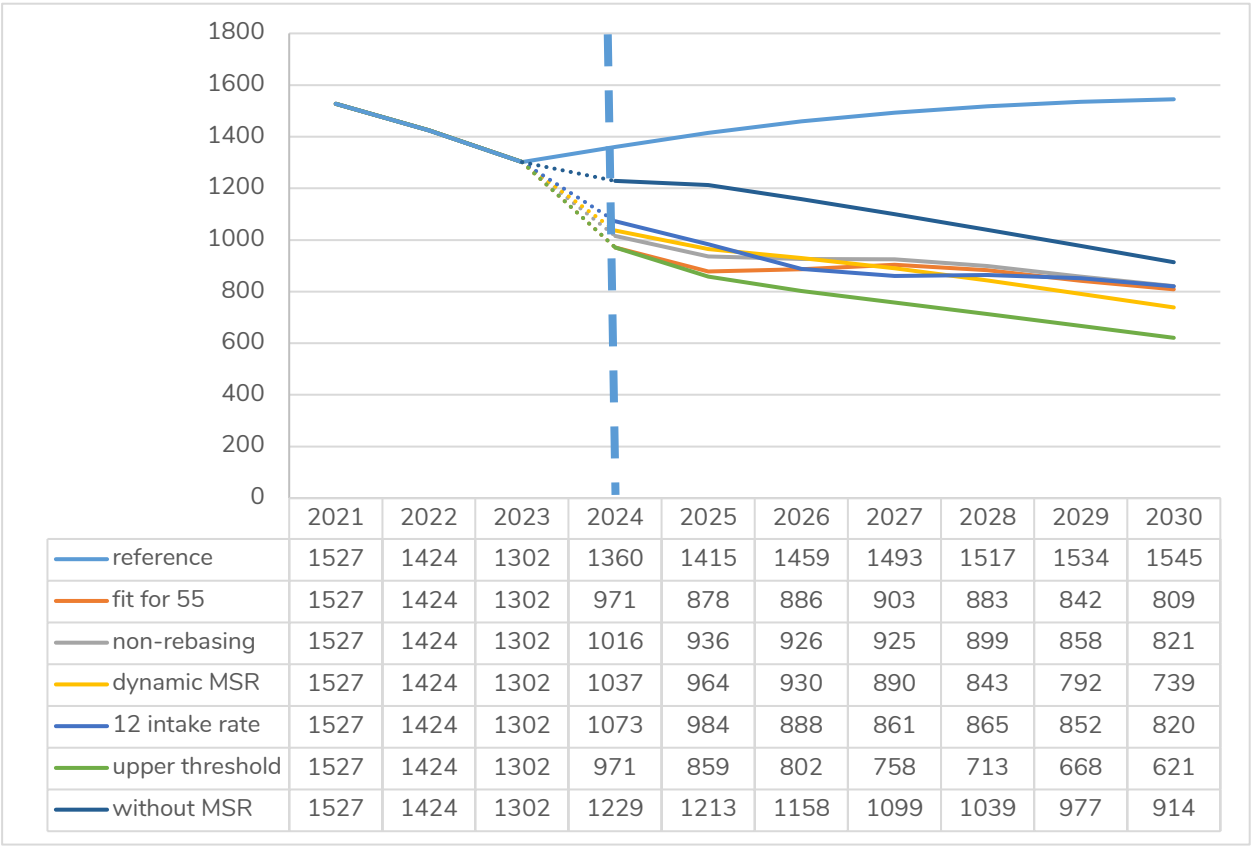
Source: CAKE/KOBiZE

65. Cumulative emissions over the analysis period do not differ significantly between the scenarios assuming increasing climate ambition except “without MSR” and “upper threshold” scenarios. Giving examples for the period 2024-2030 in the “without MSR” scenario, the accumulated emission was higher than in the „Fit for 55” scenario by 11%, but comparing the emission level in the “without MSR” scenario to the total number of allowances in the EU ETS (not including transfer of allowances to the reserve), the emission is higher only by 3%. On the other side is the “upper threshold” scenario where the accumulated emission in 2024-2030 is lower than in the „Fit for 55” scenario by 7%.

5.2. The level of the surplus and the number of allowances transferred to the MSR

66. The size of the surplus of emission allowances (TNAC) depends on the adopted scenario in 2021-2030. Figure 6 shows all surplus figures in 2021-2023 period remain the same because we take an assumption that the „Fit for 55” package will probably be implemented from 2024. We can observe that in almost all scenarios the TNAC is situated under higher MSR threshold, so in each year till 2030 emission allowances are taken from auctions and placed in the reserve. However “no reaction” will take place just after 2031 because the surplus decreases gradually and the MSR mechanism works with a certain delay.

Figure 6. The level of surplus in 2021-2030 for analysed scenarios [million EUA]



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
reference	1527	1424	1302	1360	1415	1459	1493	1517	1534	1545
fit for 55	1527	1424	1302	971	878	886	903	883	842	809
non-rebasing	1527	1424	1302	1016	936	926	925	899	858	821
dynamic MSR	1527	1424	1302	1037	964	930	890	843	792	739
12 intake rate	1527	1424	1302	1073	984	888	861	865	852	820
upper threshold	1527	1424	1302	971	859	802	758	713	668	621
without MSR	1527	1424	1302	1229	1213	1158	1099	1039	977	914

Source: CAKE/KOBiZE

67. Initially, the fastest reduction of the TNAC is observed in two scenarios - „Fit for 55” and “upper threshold”. This is because they are based on increased 24% intake rate. Other scenarios have lower intake rates (or based on a different formula, i.e. “dynamic MSR”), so they reduce surplus slower, except the “non-rebasing” scenario. The “non-rebasing”

scenario has large surplus in the first part of the period, even though the intake rate was increased to 24%, because it assumes no one-off cap reduction in the EU ETS.

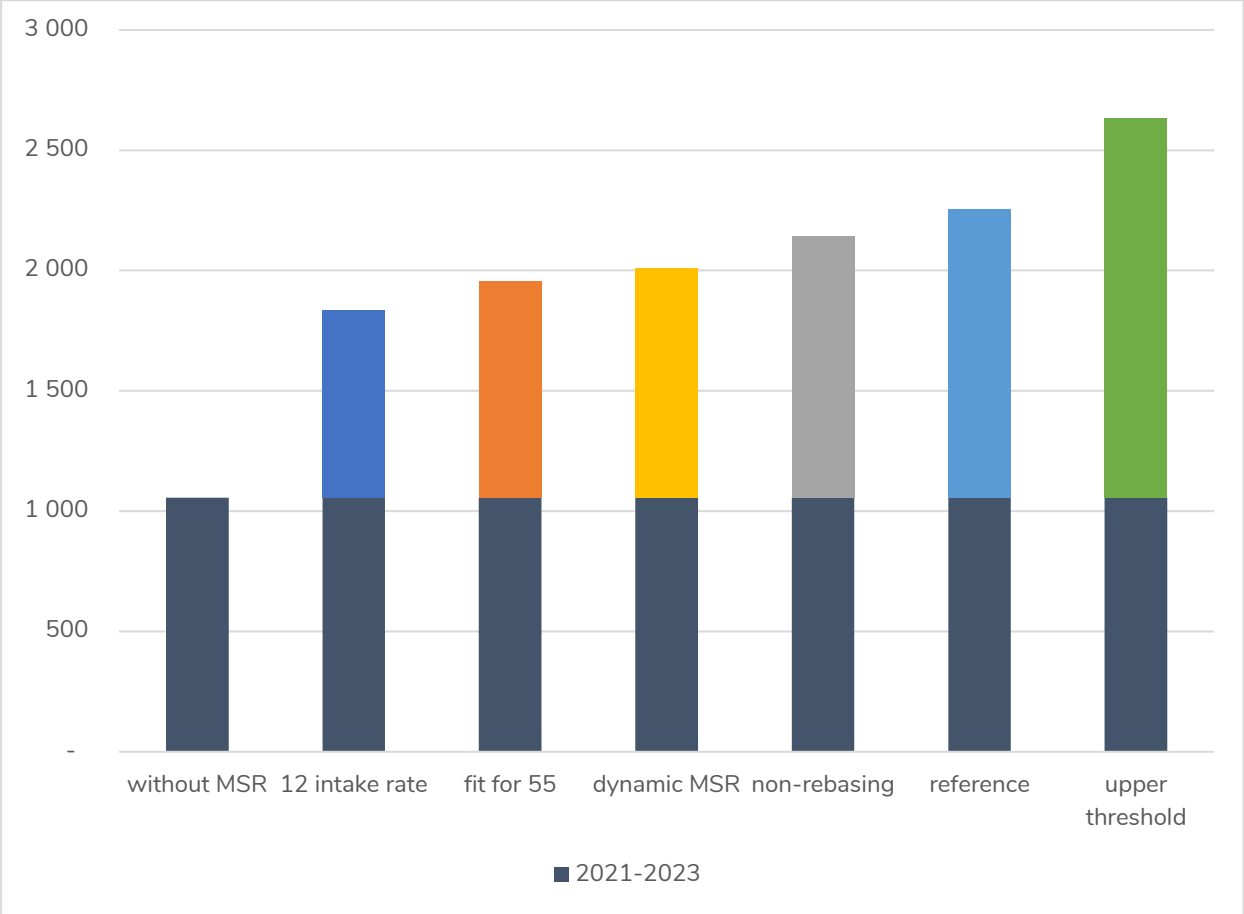
68. In the „Fit for 55”, “non-rebasing” and “12% intake rate” scenarios the TNAC after entering below the additional threshold of 1096 million, slows down the speed of reduction and begins balancing just above the upper threshold. In this case, the differently determined intake rate between higher (833 mln) and additional threshold (1096 mln) is important, which in fact is always well below 24%. This is clearly seen in the „Fit for 55” scenario when after the initial significant decrease in the TNAC, it starts to rise because the number of emission allowances transferred to the MSR significantly slows down. This effect is a consequence that the number of allowances transferred to MSR is determined by the historical value of TNAC (with a two-year and one-year delay) that is below 1096 million. Trend change after 2027, when the TNAC starts gradually declines, which is related to the decreasing number of emission allowances in the EU ETS (caused by the LRF), despite the fact that the number of allowances transferred to the MSR is relatively small in that period (2027-2030). This aspect has a big impact on the final volumes placed in the reserve till 2030 not only for the „Fit for 55” scenario but also for the “non-rebasing” scenario. In the case of the “12% intake rate” scenario, it is a bit different as an intake rate equals 12% since the beginning of 2024, therefore TNAC drops more smoothly and slower, reaching almost the same value at the end of the period as in „Fit for 55” and “non-rebasing” scenarios. Important is that in the “12% intake rate” scenario decrease of TNAC from 2024 to 2030 also happens with the same growth effect in the meantime (2027-2028). This indicates that the number of allowances transferred to the MSR slowdown as the consequence of the fact that historical TNAC is below 1096 million and activates additional threshold.

69. We can observed that in the „Fit for 55”and the “non-rebasing” scenarios which both have a 24% intake rate to 2030 fewer emission allowances are placed in the reserve than in the “reference scenario”. On this basis, it can be concluded that the introduction of this additional threshold waters down the effect of an increase intake rate to 24%.

70. We can see in figure 7 that the highest transfer to MSR is in the “upper threshold” scenario (2,635 billion) and on the other side is the “12% intake rate” scenario with the transfer of only 1,837 billion emission allowances[13]. The highest volume of emission allowance in the “upper threshold” scenario is the result of increased intake rate to 24% without applying an additional threshold. So the transfers of emission allowances are quite high and deep as the effect of shifting the upper threshold from 833 million to 600 million allowances.

[13] We do not take into account a without MSR scenario in this statement that does not collect any emission allowances from 2024.

Figure 7. Number of emission allowances transferred to the MSR in 2021-2030 [million EUA]



Source: CAKE/KOBiZE

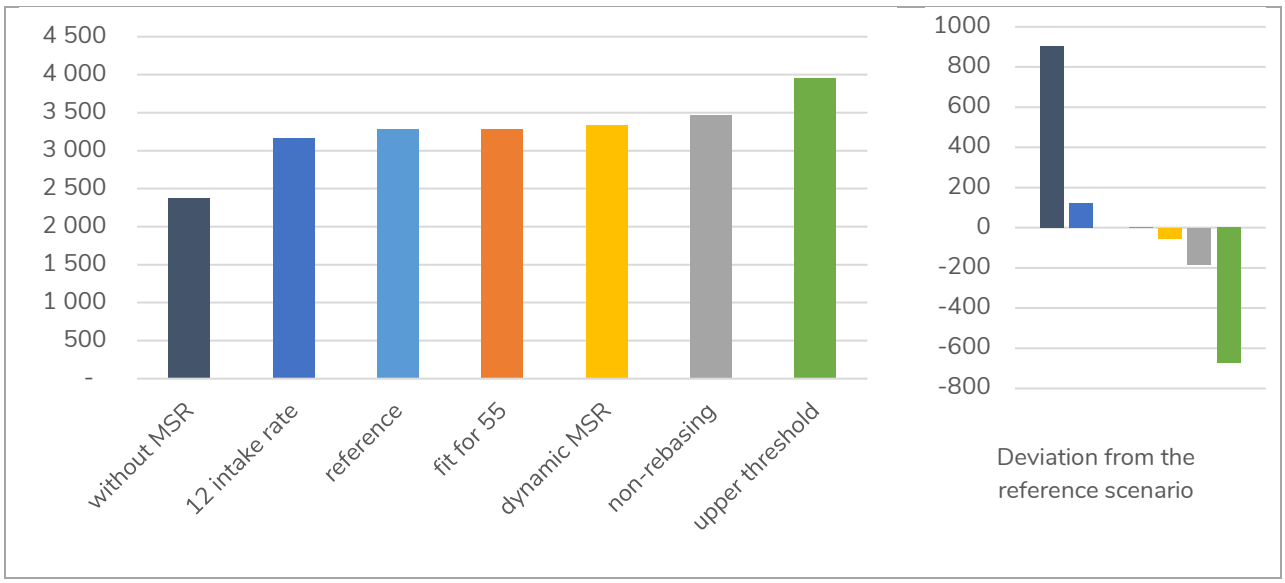
5.1. Number of EUAs cancelled in the MSR and the auction volumes

71. The value of allowances cancelled in the MSR till 2030 is related to the value of emission allowances placed in the reserve. Cancelled allowances will permanently disappear from the market and will not be ever available for the EU ETS operators. The value of allowances cancelled in MSR till 2030 is related the value of emission allowances placed in the reserve. Cancelled allowances will permanently disappear from the market and will not be ever available for EU ETS operators. The number of cancelled emission allowances should have a big impact on EUA prices. As we can see on Figure 8, the most of emission allowances are cancelled in upper threshold and non-rebasing scenarios c.a. 4.0 billion and 3.5 billion emission allowances respectively in 2021-2030. In case of this scenarios deviation from the reference also looks significant: c.a. 700 million and 200 million emission allowances respectively. In other scenarios MSR takes much lower and near the same values – approx. 3.3 billion, so the deviations from the reference scenario are almost imperceptible, besides the scenarios: 12% intake rate and without MSR. In the last one, it is natural that the number of cancelled emission allowances will be the lowest, because there is no MSR from

2024. In the 12% intake rate scenario, the low value of cancelled emission allowances is the results of the fact that in this scenario less allowances are transferred to the MSR compare to the other scenarios especially in the period (2024-2027). Meanwhile in MSR we cancelled everything up to the amount of 400 million emission allowances starting from 2024.

72. The number of cancelled emission allowances should have a big impact on EUA prices. As we can see on Figure 8, the most of emission allowances are cancelled in the “upper threshold” and “non-rebasing” scenarios c.a. 4.0 billion and 3.5 billion emission allowances respectively in 2021-2030. In these scenarios deviation from the “reference” scenario also looks significant: c.a. 700 million and 200 million emission allowances respectively. In other scenarios MSR takes much lower and near the same values – approx. 3.3 billion, so the deviations from the “reference” scenario are almost imperceptible, besides the scenarios: “12% intake rate” and “without MSR”. In the last one, it is natural that the number of cancelled allowances will be the lowest, as there is no MSR from 2024. In the “12% intake rate” scenario, the low number of cancelled emission allowances is the results of the fact that in this scenario fewer number of allowances is transferred to the MSR compared to the other scenarios, especially in the period (2024-2027). Meanwhile, in MSR we cancelled everything up to the amount of 400 million emission allowances starting from 2024.

Figure 8. Emission allowances cancelled from the reserve in 2021-2030 and deviation of the value of cancelled allowances from the reference scenario [million EUA].



Source: CAKE/KOBiZE

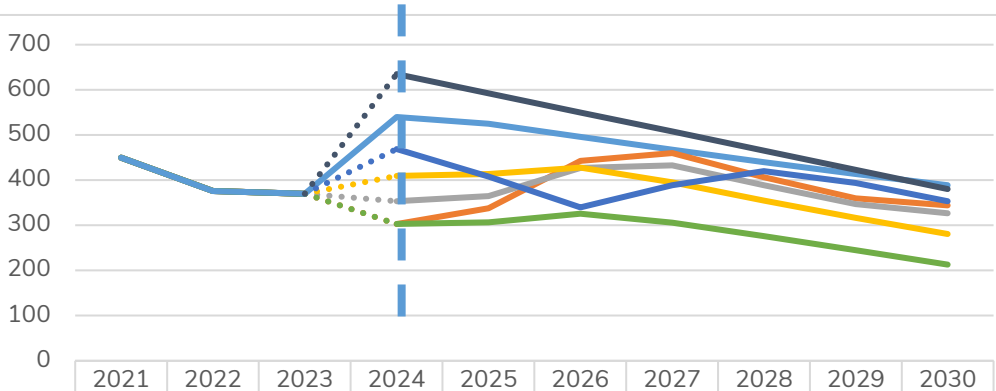
73. Figure 9 shows the trajectory of emission allowances to be auctioned for the EU and EFTA countries in 2021-2030 period depending on the adopted scenario. We can see the

auction volumes react to the increase of 24% intake rate in 2024 – so in the three scenarios in particular with this MSR adjustment („Fit for 55”, “non-rebasing” and “upper threshold”) the auction volume decreases in 2024.

74. After 2024 another effect of MSR adjustment can be observed – the application of additional threshold and different intake rate in the „Fit for 55” and “non-rebasing“ scenarios causes the increase of auctions volumes in 2025-2027 period. Simultaneously in the same period the TNAC is rising which translates into the dropping auction volumes after 2027 (MSR takes more emission allowances) in these two scenarios.

75. The most “aggressive” EUA reduction is in the “upper threshold” scenario that systematically reduces the emission allowances available at auctions, practically in each year throughout the entire period. It is worth to notice that this scenario is based on 24% intake rate during the whole period and additional threshold is not applied. This has a big impact on overall results.

Figure 9. Auctioned emission allowances in 2021-2030 [million EUA]



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
reference	450	376	370	540	525	496	467	440	414	389
fit for 55	450	376	370	303	338	443	460	407	359	344
non-rebasing	450	376	370	353	365	427	433	389	347	327
dynamic MSR	450	376	370	409	413	428	395	355	317	281
12 intake rate	450	376	370	469	408	340	389	420	394	353
upper threshold	450	376	370	303	307	326	306	276	245	213
without MSR	450	376	370	635	592	550	508	465	423	381

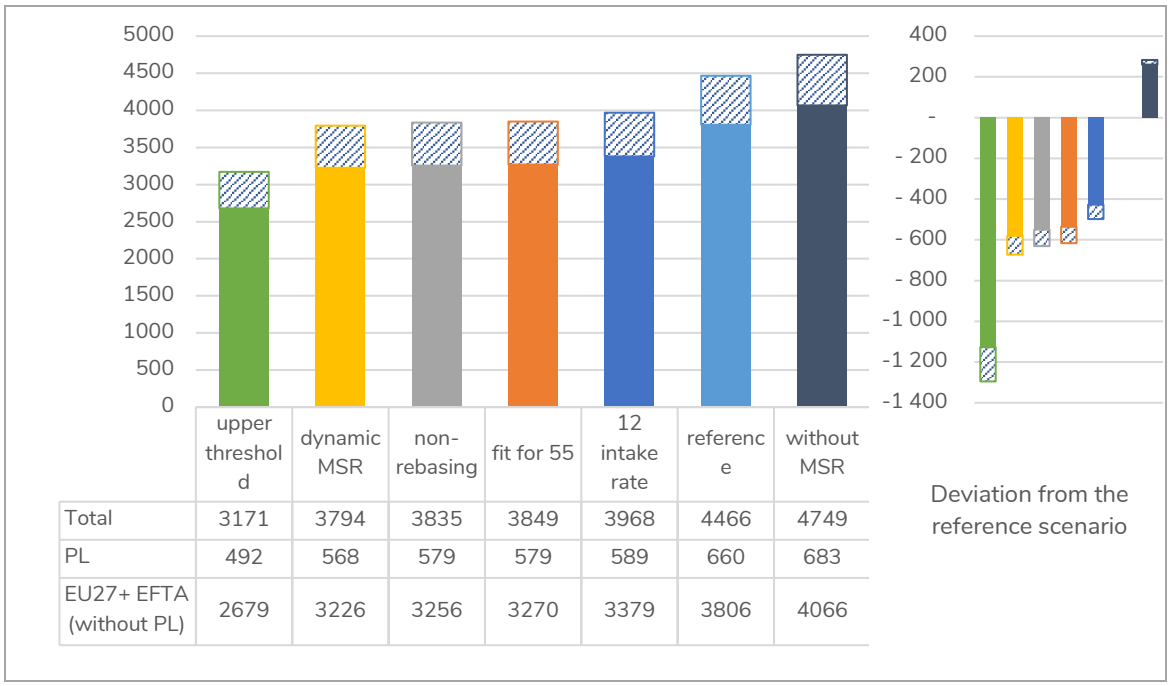
Source: CAKE/KOBiZE

76. The “upper threshold” scenario reduces auction volumes by about 1.3 billion emission allowances vs. the “reference” scenario. Other scenarios come out better in this category - „Fit for 55”, “non-rebasing” and “dynamic MSR” loose “only” 620-670 million and “12% intake rate” scenario – 500 million. The “without MSR” scenario gives even some extra emission allowances (+280 million). This is because the MSR does not work at all after

2023 and it is based only on reduced LRF and rebasing. It should be noted that the differences between this scenario and the "reference" scenario are not very large (approx. 6%), which would indicate that increasing the LRF and introducing rebasing will have the greatest impact on reducing the supply of emission allowances on the market.

77. The detailed information on the auction volumes (including Modernisation Fund), the number of allowances transferred to MSR, broken down by EU ETS countries is presented in Annex II Table 7.

Figure 10. Total auctioned emission allowances in 2021-2030 and deviation of the value of auctioned allowances from the reference scenario [million EUA].



	upper threshold	dynamic MSR	non-rebasing	fit for 55	12 intake rate	reference	without MSR
Total	3171	3794	3835	3849	3968	4466	4749
PL	492	568	579	579	589	660	683
EU27+ EFTA (without PL)	2679	3226	3256	3270	3379	3806	4066

Source: CAKE/KOBiZE

5.2. Impact on EUA prices

78. Figure 11 shows the modelled EUA prices for 2025 and 2030 depending on analysed scenarios. In 2030 the prices range from 96 to 243 EUR (not including the "reference" scenario). Both price levels and their dispersion is significantly smaller in the year 2025. In 2030 the highest EUA prices are found for the "upper threshold" and the "dynamic MSR" scenarios –165 EUR and 243 EUR, respectively. Under both scenarios, operators are forced to reduce emissions deeper due to the rapidly shrinking auction volumes till 2030. In addition a substantial part of emission allowances in these two scenarios are taken from the market and cancelled in the MSR. In „Fit for 55", "non-rebasing" and "12% intake rate" scenarios we achieve very similar results, ranging from 128 to 140 EUR. This result correlates mostly with emission reduction efforts and with the volumes available on the auctions. We obtain slightly different results for the year 2025. The EUA price in 2025

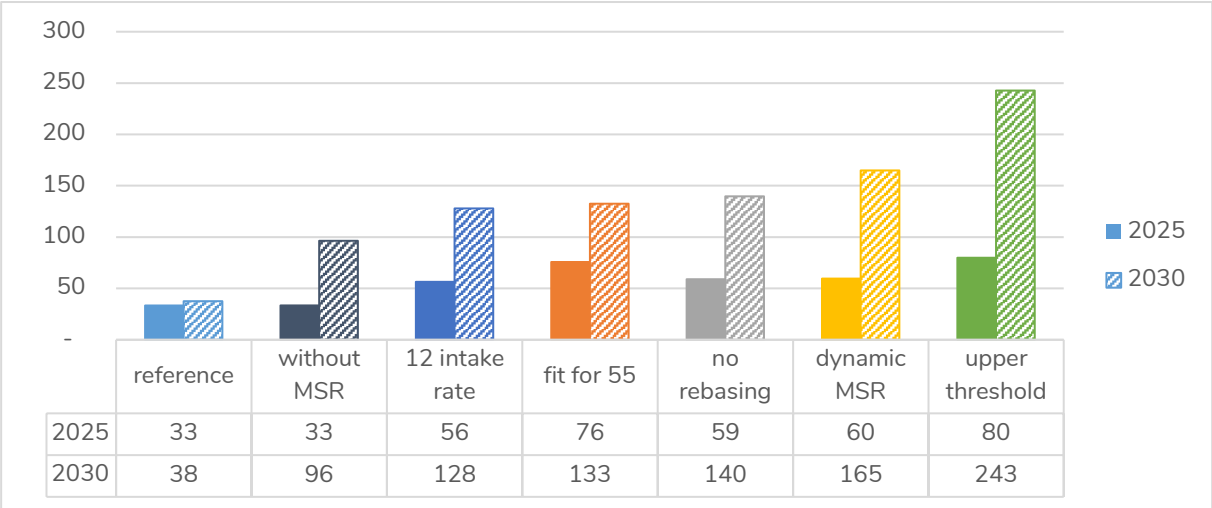
is the highest in the "upper threshold" and „Fit for 55" scenarios c.a. 80 EUR and 76 EUR respectively. In the "non-rebasing", "12% intake rate" and "dynamic MSR" scenarios in turn we achieve similar values from 56 to 60 EUR.

79. Figure 11 shows the modelled EUA prices for 2025 and 2030 depending on analysed scenarios. In 2030 the prices range from 96 to 243 EUR (not including the reference scenario). Both price levels and their dispersion is significantly smaller in the year 2025. In 2030 the highest prices are found for the upper threshold and the dynamic MSR scenarios –165 EUR and 243 EUR, respectively. Under both scenarios, operators are forced to reduce emissions deeper due to the rapidly shrinking auction volumes till 2030. In addition a substantial part of emission allowances in these two scenarios are taken from the market and cancelled in MSR. In „Fit for 55", "non-rebasing" and "12% intake rate" scenarios we achieve very similar results, ranging from 128 to 140 EUR. This results correlates mostly with emission reduction efforts and with the volumes available on the auctions. We obtain slightly different results for the year 2025. The EUA price is the highest in the upper threshold and „Fit for 55" scenarios c.a. 80 EUR and 76 EUR respectively. In non-rebasing, 12% intake rate and dynamic MSR scenarios in turn we achieve similar values form 56 to 60 EUR.

80. In both „Fit for 55" and upper threshold scenarios in 2025 we can observe the effect of MSR intake rate increased to 24%. The further we look in time, the „Fit for 55" scenario is weakened by the additional threshold. In upper threshold scenario 24% intake rate works continuously because there is no limitation in the form of the additional threshold. Therefore, the price in this scenario is the highest.

81. The "without MSR" scenario deserves a separate attention. In this scenario, we can see how strongly the increase of the LRF and rebasing affects the prices of emission allowances. Without MSR working from 2024 the prices would almost triple in 2025-2030 period.

Figure 11. EUA prices in 2025 and 2030 [EUR'20]



	reference	without MSR	12 intake rate	fit for 55	no rebasing	dynamic MSR	upper threshold
2025	33	33	56	76	59	60	80
2030	38	96	128	133	140	165	243

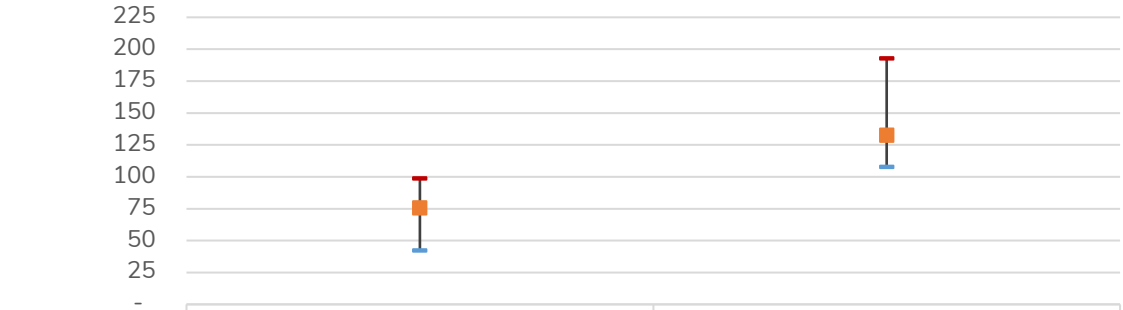
Source: CAKE/KOBiZE

82. What is more, a higher ambition of climate targets will translate into changes in the EU ETS market participants hedging behaviour. Figure 12 shows three options of hedging in the „Fit for 55" scenario: high, low and basic (medium). In order to allow for deviations from a specific banking path and thus to replicate the observed behaviour of installations (participants) of the EU ETS market, an exogenous parameter has been introduced to scale the intensity of hedging strategies[14]. This parameter also indirectly represents the value of emission allowances purchased not by installations but by investors on EU ETS market in order to resell it.

83. As might be expected, the highest EUA prices are achieved in the scenario with the high hedging parameter[15]. Investors want to protect themselves and buy more emission allowances due to the exit from coal and the increase in the energy prices.

84. Additionally, higher carbon prices trigger abatement and complementary policies incentivize coal phase out and when carbon prices reach levels high enough to incentivize industrial decarbonisation, industrial hedging is increasing.

Figure 12. „Fit for 55" scenario in high, low and medium prices of EUA [EUR'20]



	2025	2030
fit for 55 high	99	193
fit for 55 low	42	108
fit for 55	76	133

Source: CAKE/KOBiZE

[14] Medium scenario - the value of parameter (the intensity of hedging strategies) for the medium scenario in the period 2021-2030 is developed based on the number of allowances purchased on the EU ETS market in 2016-2019 in relation to the future emission, which was observed in the EU ETS. It should be noted that the price of allowances in this period was low and the market appeared to be stable.
High scenario - the value of parameter (the intensity of hedging strategies) for the high scenario in the period 2021-2030 is developed based on the number of allowances purchased on the EU ETS market in 2020 in relation to the emission. In 2020, we observed a large drop in emissions due to the crisis COVID-19. However, the price of allowances remained high and the demand for allowances was relatively high.
Low scenario - in the low scenario the trends for the value of parameter leads to reach final two times lower value then for high scenario. We anticipate that such a situation could arise, as a result of the exclusion all EU ETS market participants who do not have to surrender allowances in the EU ETS. Moreover, all the installations in the EU ETS will finally secure emissions c.a. 1 year ahead, additionally taking into account the surplus of allowances held on their accounts. It should be emphasized that the model used is sensitive to the value of this parameter (intensity of hedging strategies) and has a large impact on the results, including the operation of the MSR (and reduction of the auction pool).

[15] Ibidem

85. Due to the assumed implementation of the „Fit for 55” package in 2024, it should be expected that EU ETS participants discount its effects in the price of emission allowances much earlier. Which leads to the conclusion that annual average price may remain relatively high in the 2022-2025.

6. Economy-wide effects of the MSR reform

86. In this section we look at economy-wide effects of the analysed scenarios, including the impact on emissions and output, at macro and sectoral level. We also discuss how EUA prices are determined in the CGE model and what are the caveats related to their interpretation.

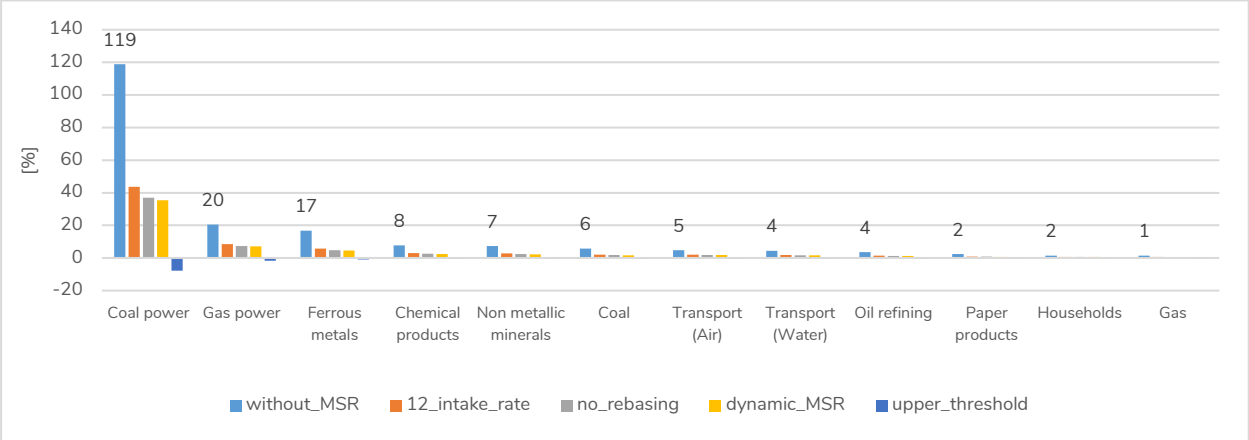
87. Rather than comparing policy scenarios against the “reference” scenario, we compare policy scenarios among themselves. In specific, the results are presented as deviations from the „Fit for 55” scenario. Other policy scenarios differ from the „Fit for 55” scenario only with respect to MSR options which is the main focus of the paper. Whereas the main difference between reference (current climate EU policy) and policy scenarios is the ambition level of emission reduction (55% emission reduction in 2030 compared to 1990). Recall that the reference scenario (current climate EU policy) in our analysis is a starting point for model calibration, based on external, GECO 2020 projections. We simulate imposing elements of the „Fit for 55” package on top of the “reference” scenario to obtain a relevant basis for the comparison of different MSR options. However, it should be stressed that the current analysis uses a preliminary, simplified assessment of the effects of „Fit for 55” package and does not represent all its complexities (in particular with regard to energy policy). It is also based on simplified representation of crucial sectors (see Annex I).

88. As explained in the previous sections, the CarbonPIE model comprises various detailed aspects of EU ETS and MSR regulations. The CarbonPIE translates all these details into emission limits which are fed into the CGE model. From the CGE model’s perspective, the considered scenarios differ only in the assumed emission limits.

89. The CGE model determines EUA price level which ensures that emission limit for a given year is met. In the CGE model, carbon price is equivalent to the current marginal emission abatement cost, and so it is determined solely based on assumptions concerning technical opportunities of emission abatement in a given time horizon. These opportunities are modelled in terms of the possibilities of substitution of capital for energy (energy efficiency improvement), switching between energy sources (electrification, substitution of natural gas for coal, etc.) and adjustments in the structure of production and consumption towards less energy-intensive goods. On the other hand, our CGE model does not include financial markets or in fact any forward-looking behaviour that could lead to decoupling of EUA

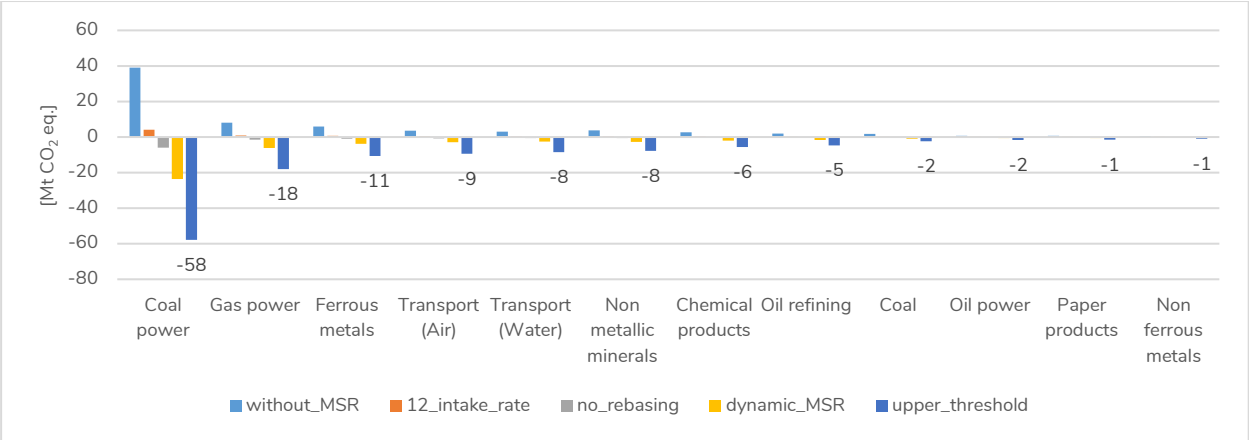
prices from marginal abatement cost, and their short-term fluctuations. The EUA price in the presented simulations should therefore be interpreted as a fundamental, equilibrium carbon price, not necessarily matching “one to one” the market price. Especially it worth to mention that we have not analyse the impact of other policies, apart from the climate policy, on the prices of allowances and the impact of the fuel market on the strategies of market participants.

Figure 13. Emissions in EU27, 2025, deviations from „Fit for 55” [Mt CO2eq], selected sectors.



Source: CAKE/KOBiZE

Figure 14. Emissions in EU27, 2030, deviations from „Fit for 55” [Mt CO2 eq.], selected sectors.



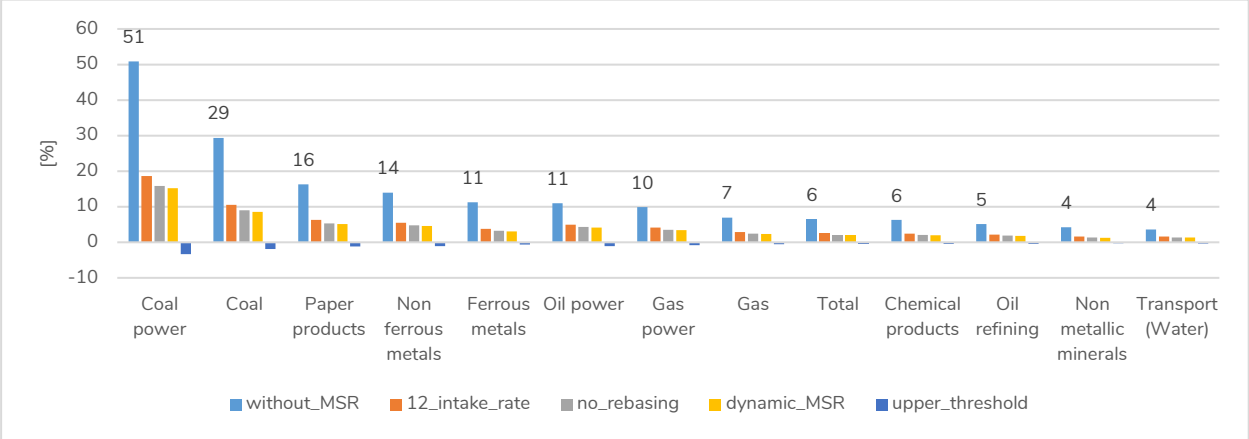
Source: CAKE/KOBiZE

90. Figures 13-16 show how changes in emissions are distributed among the sectors of the economy, indicating sector-specific reduction potentials at given marginal abatement cost levels. Changes in the EU ETS effective emission limits, related to varying MSR options, are mostly facilitated by adjustments in emissions from power generation based on coal and natural gas, as well emissions of the ferrous metals sector. In terms of percentage

changes in emissions, also the coal extraction, paper, and non-ferrous metals sectors stand out, although they do not contribute as much to total emissions.

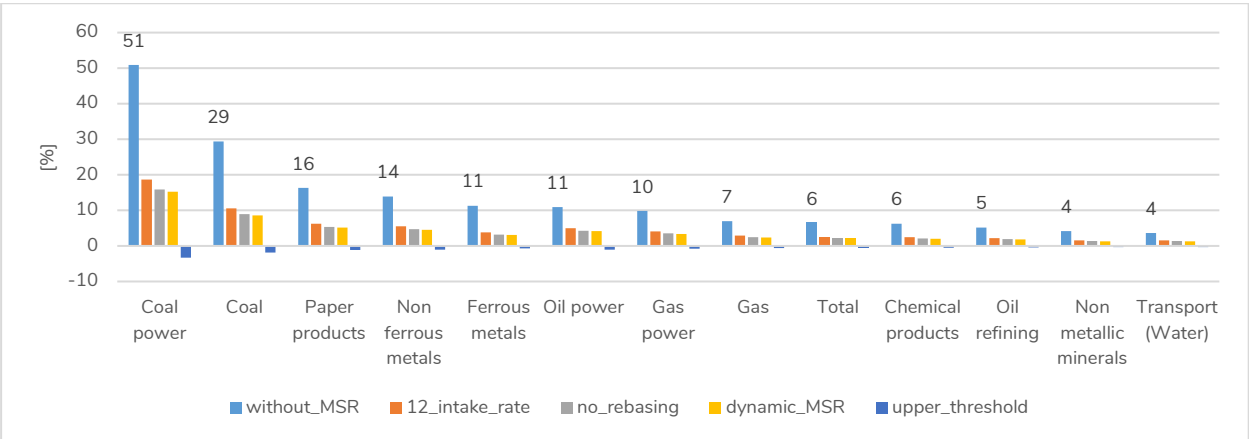
91. The results differ substantially between the years 2025 and 2030. In the year 2025, all MSR variants – except the "upper threshold" scenario – lead to higher emissions than in the „Fit for 55" scenario. In the extreme, the "without MSR" scenario, coal and gas fired power generation would be "allowed" to emit almost 140 Mt more than in the „Fit for 55" scenario. In the "12% intake rate", "no-rebasing" and "dynamic MSR" scenarios, additional emissions amount to roughly one third of those from the without MSR scenario. In contrast, in the year 2030 the "upper threshold" implies substantial additional emission reductions (again mostly in coal power, gas power and ferrous metals, but also with significant contributions from water and air transport) compared to „Fit for 55" scenario. Effects of the same direction, although smaller magnitude, are found in the "dynamic MSR" and "no-rebasing" scenarios.

Figure 15. Emissions in EU27, 2025, deviations from „Fit for 55" [%], selected sectors.



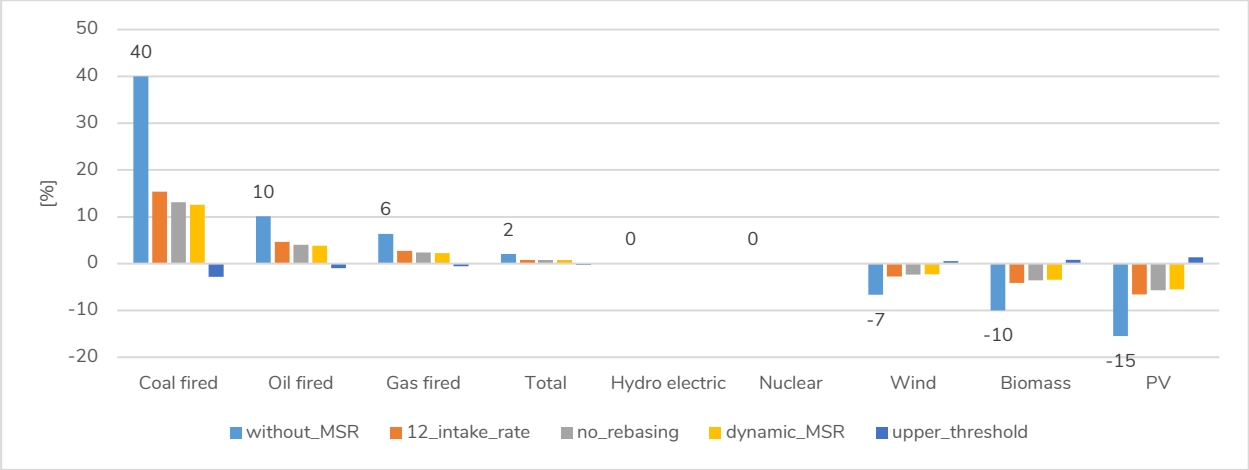
Source: CAKE/KOBiZE

Figure 16. Emissions in EU27, 2030, deviations from „Fit for 55" [%], selected sectors.



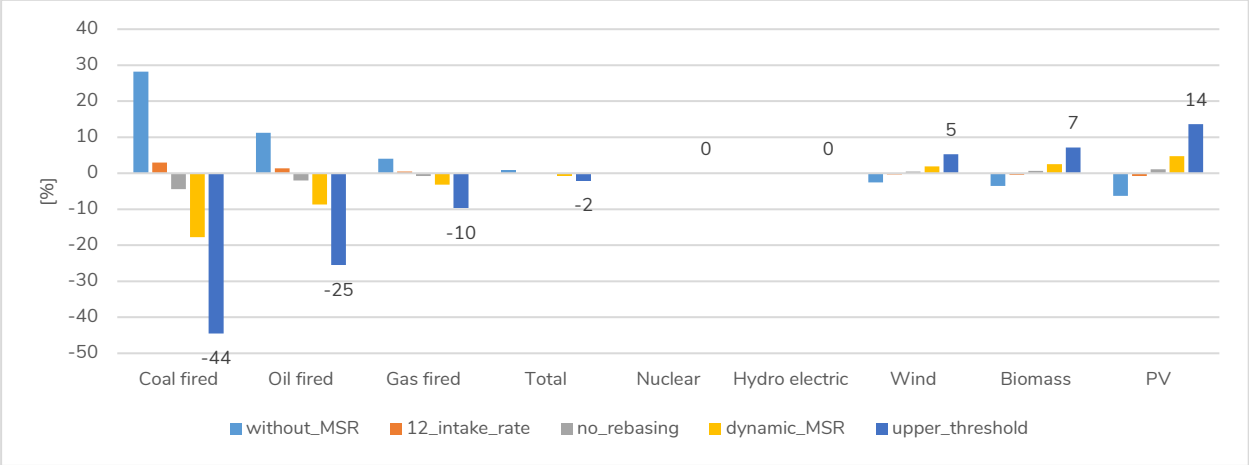
Source: CAKE/KOBiZE

Figure 17. Electricity generation by technology in EU27, 2025, deviations from „Fit for 55” [%]



Source: CAKE/KOBiZE

Figure 18. Electricity generation by technology in EU27, 2030, deviations from „Fit for 55” [%]



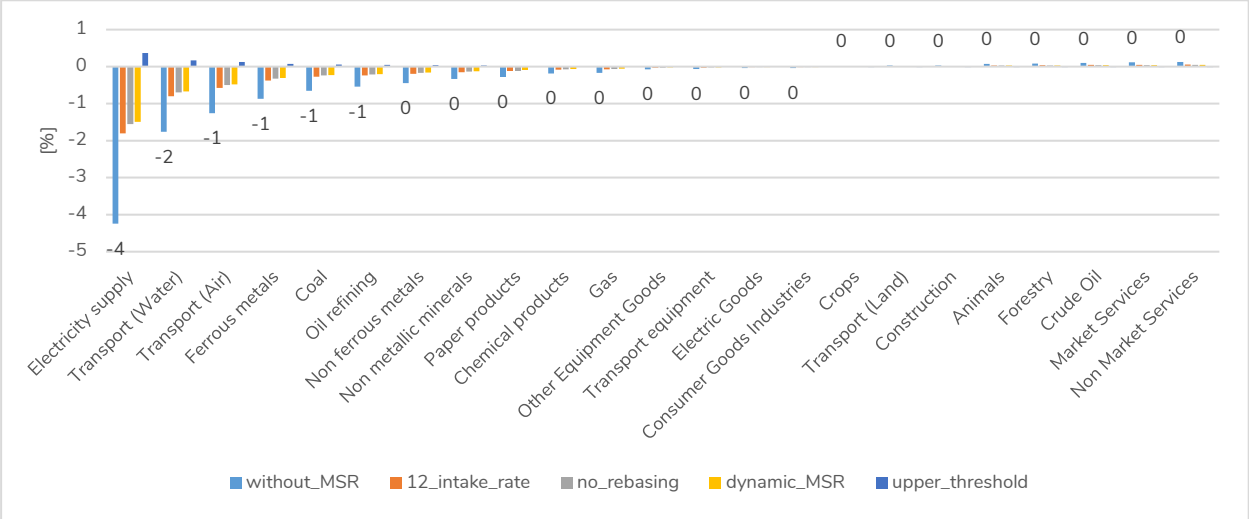
Source: CAKE/KOBiZE

92. Sectoral distribution of emission effects suggests that adjustment to the altered emission limits is largely facilitated by changes of technology mix in power generation. The latter results are shown in Figures 17 and 18. In this study we have calibrated the CGE model to obtain energy mix responses by 2030 roughly in line with the results from energy system model MEESA[16], used in a different CAKE report "Polska net-zero 2050" (Pyrka M, et al., 2021). However, note that the representation of the power generation is far more simplistic in the CGE model than in the energy system model. We have also assumed that

[16] Energy sector model MEESA (Model for European Energy System Analysis), link to documentation: https://climatecake.ios.edu.pl/wp-content/uploads/2020/05/CAKE_MEESA_energy-model_documentation.pdf

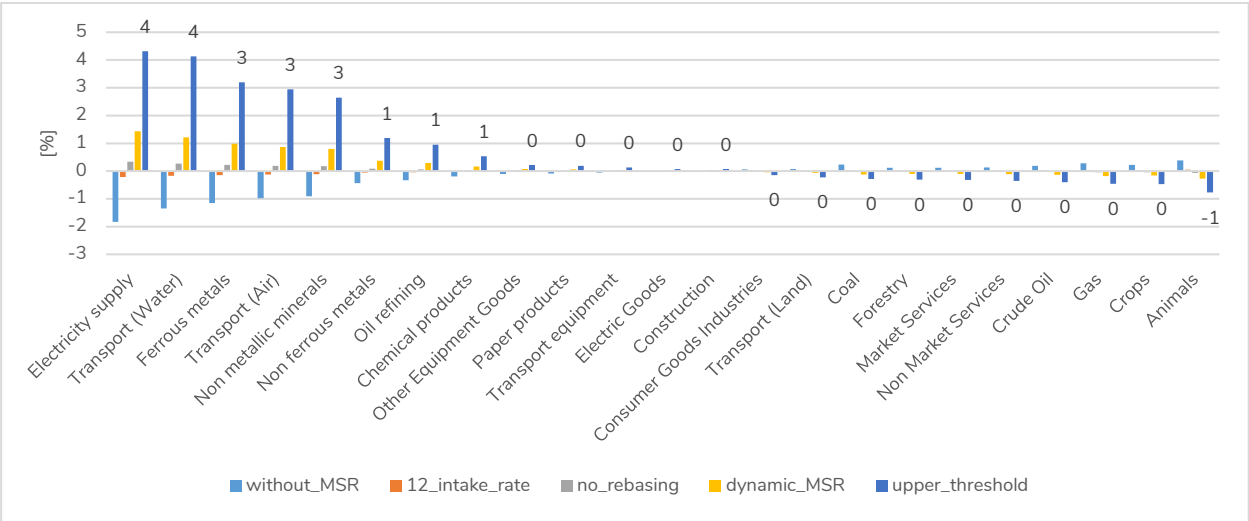
within the 2030 horizon nuclear and hydro electric power generation is fixed, such that fossil fuels are substituted by renewables only (mostly solar, then biomass, then wind).

Figure 19. Prices by industry in EU27, 2025, deviations from „Fit for 55” scenario [%]



Source: CAKE/KOBiZE

Figure 20. Prices by industry in EU27, 2030, deviations from „Fit for 55” scenario [%]

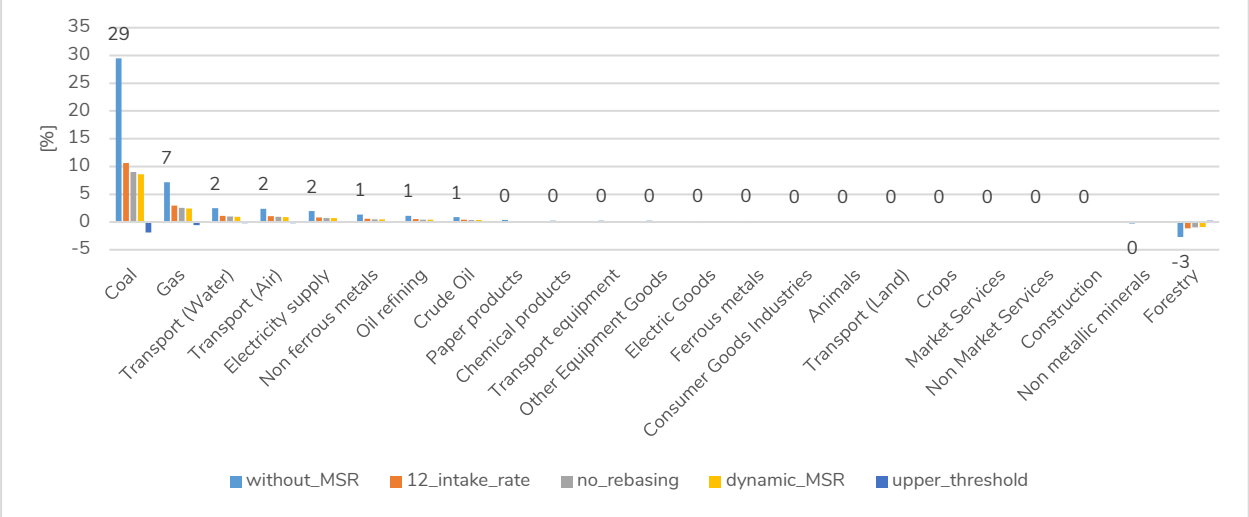


Source: CAKE/KOBiZE

93. Changes in EUA prices translate to changes in commodity prices. The most sensitive are the prices of electricity, water and air transport, ferrous metals and non-metallic minerals (the latter – in 2030). The variation of electricity prices is between –4% (“without MSR” scenario in 2025) and +4% (“upper threshold” scenario in 2030) – although note that this is the EU average price, and it might differ by country. In the year 2025, prices of emission intensive goods decrease (except in the “upper threshold" scenario), as EUA price is lower

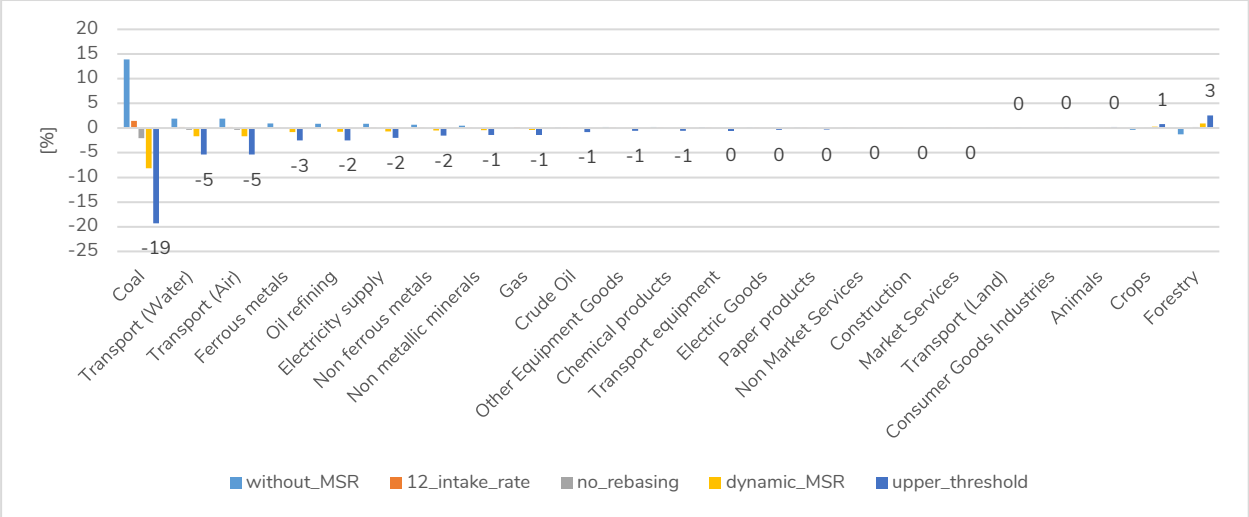
than in the „Fit for 55" scenario, which in turn is the effect of a higher emission limit. In the year 2030, prices of emission intensive goods increase, as EUA price is higher than in the „Fit for 55" scenario – except in the "without MSR" scenario and the "12% intake rate" scenario (the latter being hardly distinguishable from the „Fit for 55" scenario). Note that price changes (as it is typical in CGE models) are expressed relative to (a proxy of) world prices.

Figure 21. Output by industry in EU27, 2025, deviations from „Fit for 55" scenario [%]



Source: CAKE/KOBiZE

Figure 22. Output by industry in EU27, 2030, deviations from „Fit for 55" scenario [%]

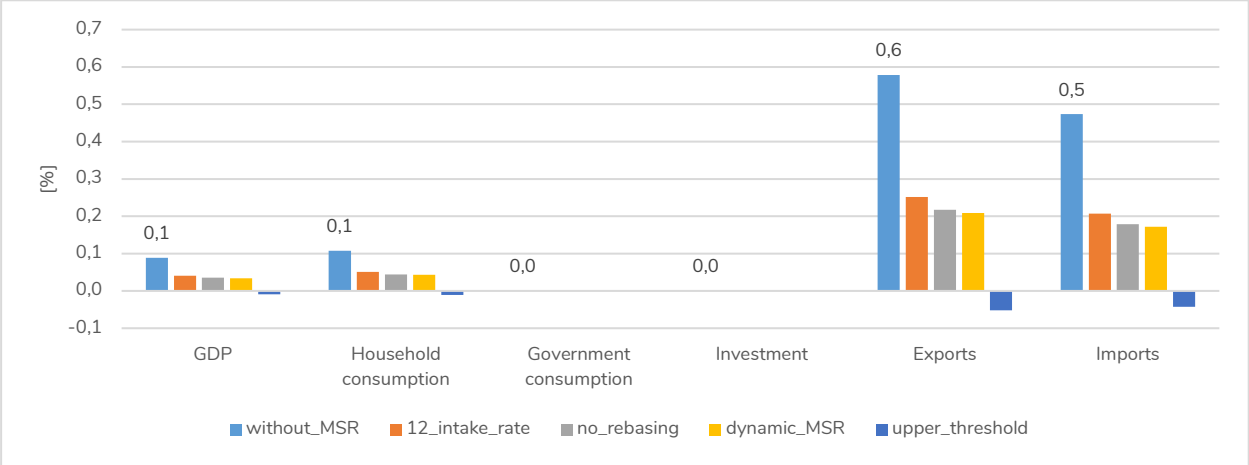


Source: CAKE/KOBiZE

94. The largest variation in output is found in coal extraction (see Figures 21 and 22), as a result of varying demand from the power generation sector. Subsequently, distinctive output effects are also observed in water and air transport (2030), gas extraction (2025), and forestry (related to biomass supply). Overall, though, the impact on output is rather

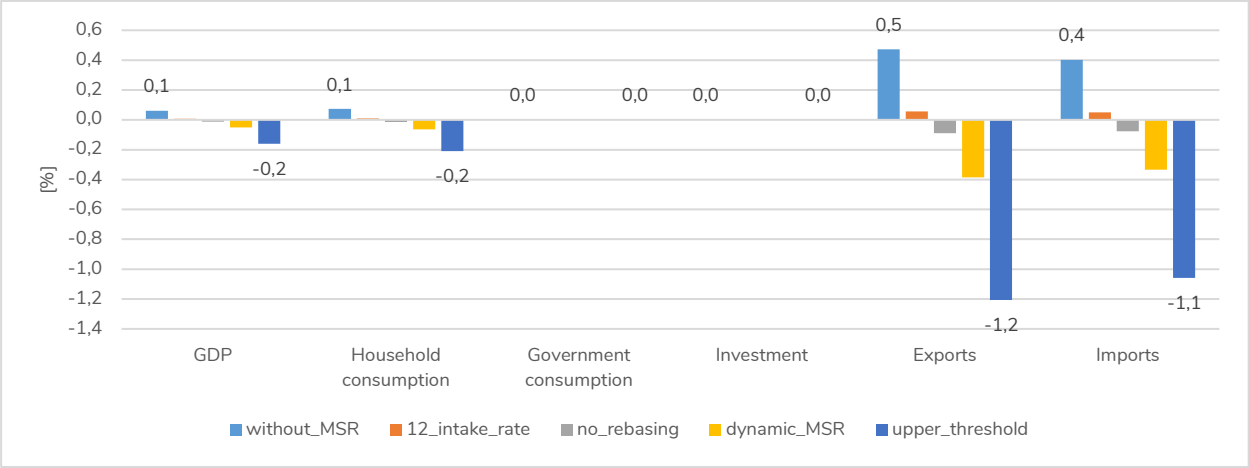
small, mostly within the range of 1-2% even in the most extreme scenarios (“without MSR” in 2025 and “upper threshold” in 2030).

Figure 23. GDP and its components, EU27, 2025, deviations from „Fit for 55” scenario [%]



Source: CAKE/KOBiZE

Figure 24. GDP and its components, EU27, 2030, deviations from „Fit for 55” scenario [%]



Source: CAKE/KOBiZE

95. From the macroeconomic perspective (GDP, household consumption), effects of MSR reform at the EU level scale are mostly rather negligible (Figures 23 and 24), with an exception of aggregate exports and imports. Even if output changes of individual sectors are of the order of a few percent, those sectors have typically a very small share in total value added in the EU, so they translate to GDP effects of the order of –0.2% to 0.1%. Of course, macroeconomic effects would differ by country, dependent on the sectoral structure of the economy. Government consumption and investment are assumed fixed across scenarios.

96. The increasing activity of financial institutions on the CO_2 market manifested by the growing number of these types of entities, their market share, volume trading and the money inflows to the ETFs were one of the main reasons of EUA spikes in 2021. In addition, the MSR will be more stricter than before, which operates in the way that - the more emission is reduced, the more EUAs withdrawn from the auction volume. Both elements (speculation and MSR) contribute to additional sharp increases in EUA prices, which could push pressure on the entire EU economy. Therefore, the EU ETS needs proper safeguards to effectively protect the market in the form of, e.g. the reform of Art. 29a of EU ETS Directive which currently does not fulfil its role.

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Annex I - analytical tools

1. Carbon Policy Implementation Evaluation Tool (CarbonPIE) – simulation model

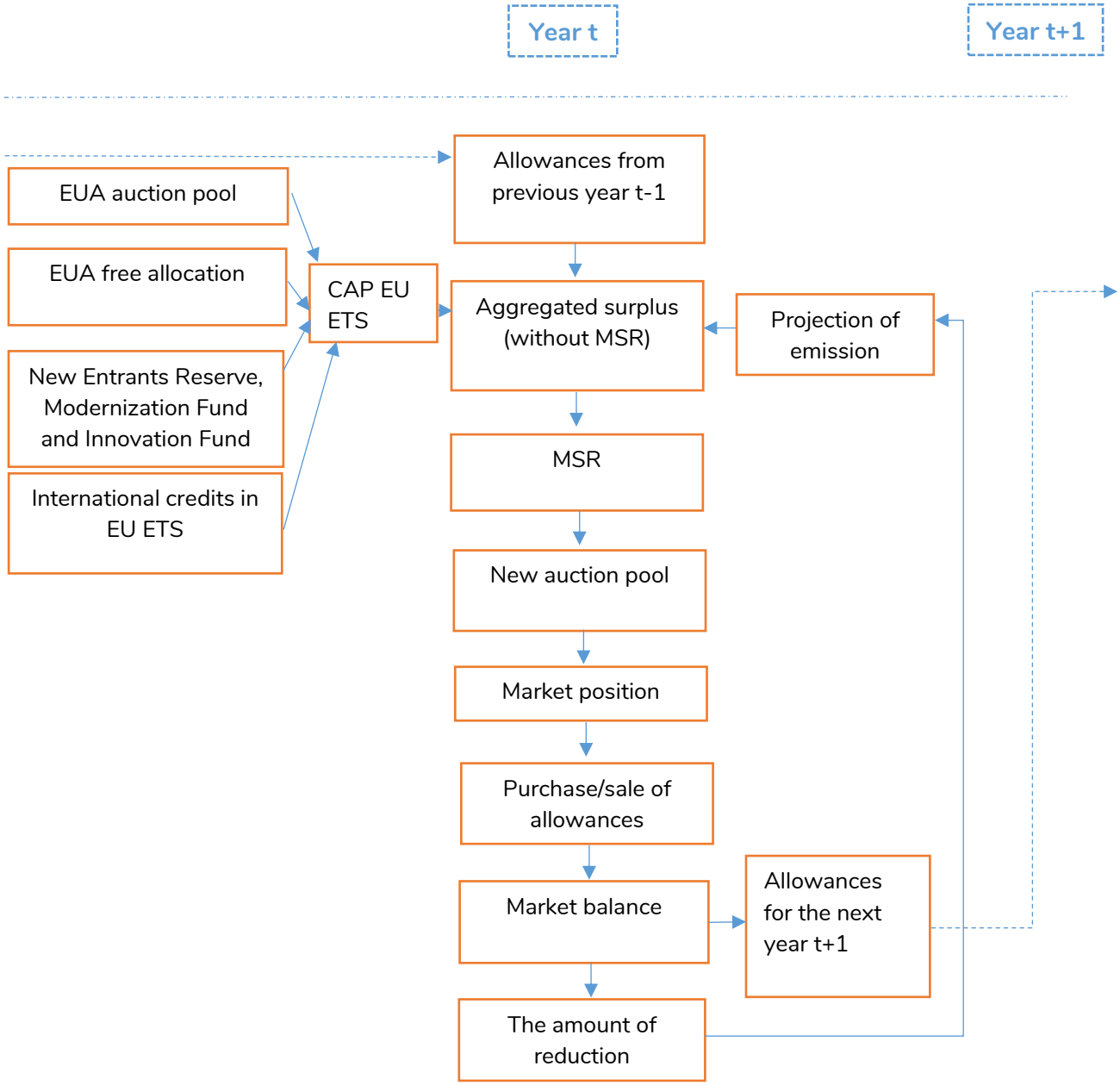
The projection of the supply of emission allowances and the reduction of emissions in the EU ETS in the analysed scenarios was performed using the CarbonPIE (Carbon Policy Implementation Evaluation Tool). CarbonPIE is a simulation model, which scheme is shown in Diagram 4. Its task is to map the supply of emission allowances, while keeping the details related to the functioning of the EU ETS system. In addition, it 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. The part of the model which reflects the behaviour of the participants on the EU ETS market has been adopted from the Zephyr[17] model.

In the model, simulations are performed in stages, separately for each year. Initially, the CarbonPIE model maps the paths of allocation of allowances in the EU ETS: free allocation, the size of the auction pool, the reserve for new installations (NER), the Modernization Fund and the Innovation Fund. In the next step, with a given baseline emissions and allowances supply, simulations of the operation of the MSR reserve are performed and as a result we obtain the size of the auction pool. This determines the number of emission allowances available on the market. In the next step, the necessary scale of emission reduction is determined in relation to the baseline scenario, so that the supply of emission allowances is equal to the demand. The balance between supply and demand is set for specific hedging needs, which are determined by the market position of EU ETS participants. The market position depends on the stock of banked emission allowances, the expected amount of free allocation and the needs related to the current and future emission. For example if market participants expects a deficit over the anticipation period, they will buy allowances in current year, such action reflect hedging needs. To replicate observed banking behaviours we introduced parameter of the intensity of hedging strategies. This allows to buy more or less allowances over the analysed time horizon in relation to anticipated scarcity of allowances.

Calculations in CarbonPIE model is performed separately for each year until the balance is achieved between the amounts of supply and demand of emission allowances in a given period.

[17] The publication Lessons on the Impact of a Market Stability Reserve using the Zephyr Model, WP no. 2015-11, October 2015, authors: Raphaël Trotignon, Pierre-André Jouvet, Boris Solier, Simon Quemin, Jérémy Elbeze, Chaire Economie du Climat, Universitte Paris-Dauphine CDC Climat.

Diagram 4. Carbon Policy Implementation Evaluation Tool (CarbonPIE) scheme



Source: CAKE/KOBiZE

2. Carbon Regulation Emission Assessment Model (CREAM) - CGE model

2.1. Characteristics of the CREAM model

The global, static, multi-sector Computable General Equilibrium (CGE) Carbon Regulation Emission Assessment Model (CREAM) was used for the analysis which scheme is shown in Diagram 5. The time horizon of the analysis concerns 2025 and 2030. This model, after introducing the impulse in the simulation, allows to determine a new balance on the markets of products and factors of production, shaped by adjustments of prices, wages and profitability of capital. Producers adjust the input structure - including energy, capital and raw materials - to changing market prices within the available technology options. Likewise, consumer demand is influenced by fluctuating prices and incomes. I this analysis, due to the shock (in the form of emission reduction), the model aims to map emission allowance prices and changes in production volume prices in all sectors of the economy.

The CREAM database is built on the basis of input-output (IO) tables, published by Joint Research Centre, EC in 2020 (Baseline GECO). This is the Global Energy and Climate Outlook 2020 baseline, which is taking into account the PRIMES 2020 Reference scenario projection. These tables contain data on production processes at the branch level, inter-industry linkages (through indirect inputs) and final demand - investment, household consumption and government consumption. Moreover, it contains data on bilateral international trade, including transport costs, as well as information on various types of taxes. In addition, database includes information on fuel consumption and greenhouse gas (GHG) emissions related to production in individual sectors and regions.

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 remaining sectors belong to the non-ETS. 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 (belonging to the EU ETS and listed above). A detailed description of the regions and sectors in CREAM model is presented in Tables 5 and 6. Additionally, the model distinguishes detailed data on GHG emissions like CO_2 emissions from combustion by fuel types: coal, oil products and gas, as well as process emissions, like N_2O (nitrous oxide), CH_4 (methane) and F-gases (fluorinated gases).

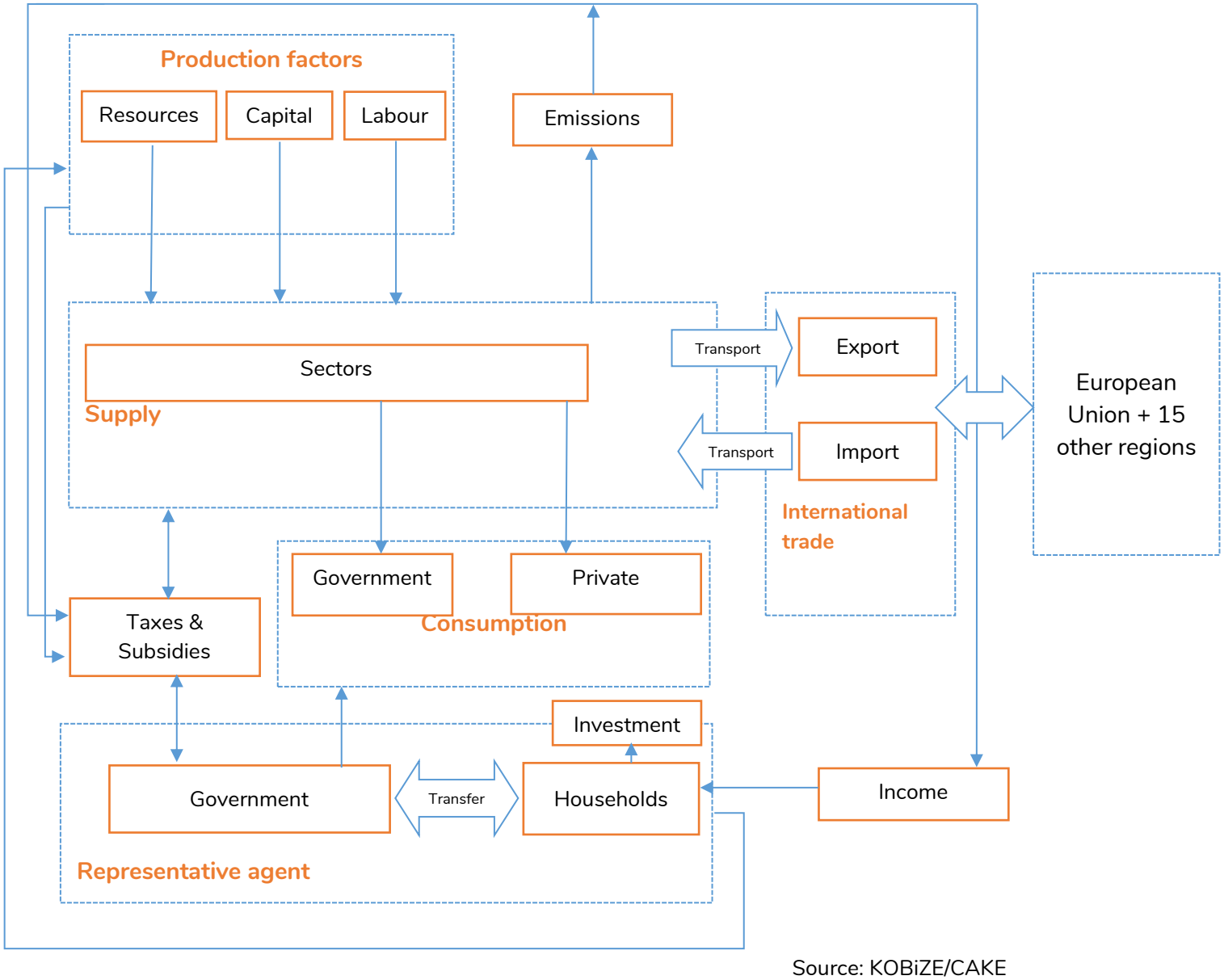
A distinguishing feature of the CREAM is possibility to model climate policies including:

- Emissions trading schemes for GHG gases with a different regional, sectoral and emission scope. It is possible for example to add only a part of emissions from a given sector to a specific trading system and the rest of emission in this sector treat as non-

ETS. For non-ETS sectors, it is also possible to include GHG reduction paths (or price of emission permits) in different regions to achieve specific emission targets.

- Free allocation of emission allowances – this is reflected through a grant to the sectors which is calculated on the basis of the rate determined by the level of the free allocation divided by emission in the EU ETS (an exogenous parameter based on historical data). This rate is multiplied by the current emission levels in the sectors (an endogenous variable calculated in the model) and the price of emission permits (an endogenous variable calculated in the model).
- Carbon border adjustment mechanism in the EU – which is modelled as an import tax determined by the carbon intensity of the production of imported goods and the price of emission permits.

Diagram 5. Carbon Regulation Emission Assessment Model (CREAM) scheme



Source: KOBiZE/CAKE

Table 5. The list of regions in the CREAM model.

Abbreviation		Aggregated states
EU27	European Union	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Bulgaria, Croatia, Romania
GBR	United Kingdom	
USA	United States of America	
JPN	Japan	
CAN	Canada	
AUZ	Oceania	Australia, New Zealand
RUS	Russian federation	
BRA	Brazil	
CHN	China	China, Hong Kong
IND	India	
KOR	Korea	
MEA	Middle East	Bahrain, Iran Islamic Republic of, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Rest of Western Asia
AFR	Africa	Egypt, Morocco, Tunisia, Rest of North Africa, Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania United Republic of, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs Union, Rest of the world
OAM	Other Americas	Mexico, Rest of North America, Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean
OAS	Other Asia	Rest of Oceania, Mongolia, Taiwan, Rest of East Asia, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia, Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia, Kazakhstan, Kyrgyzstan, Tajikistan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia
REU	Rest of Europe	Switzerland, Norway, Rest of EFTA, Albania, Belarus, Ukraine, Rest of Eastern Europe, Rest of Europe

Source: CAKE/KOBiZE

Table 6. The list of sectors in the CREAM model.

The list of sectors in CREAM model				
Abbrevation	Sector	Sectors covered by the EU ETS	Class	Statistical classification of economic activities in the European Community NACE Rev. 2
cro	Crops		0111	Wheat
			0112	Maize (corn)
			0113	Rice
			0114	Sorghum
			0115	Barley
			0116	Rye
			0119	Other cereals
			012	Vegetables
			013	Fruit and nuts
			015	Edible roots and tubers with high starch or inulin content
			017	Pulses (dried leguminous vegetables)
coa	Coal		05	Mining of coal and lignite
cru	Crude oil		061	Extraction of crude petroleum
			091(part)	Support activities for petroleum and natural gas extraction (petroleum part)
oil	Oil	+	19	Manufacture of coke and refined petroleum products
gas	Gas		062	Extraction of natural gas
			091(part)	Support activities for petroleum and natural gas extraction (natural gas part)
			352	Manufacture of gas; distribution of gaseous fuels through mains
ele	Electricity supply		351	Production, collection and distribution of electricity
			353	Steam and hot water supply
fem	Ferrous metals	+	241	Manufacture of basic iron and steel and of ferro-alloys
			2431	Casting of iron and steel
nem	Non-ferrous metals	+	242	Manufacture of basic precious and other non-ferrous metals
			2432	Casting of other non-ferrous metals
			25	Manufacture of fabricated metal products, except machinery and equipment
che	Chemical products	+	20	Manufacture of chemicals and chemical products
pap	Paper products	+	17	Manufacture of paper and paper products
			18	Printing and reproduction of recorded media
nmm	Non-metallic minerals	+	099	Support activities for other mining and quarrying
			23	Manufacture of other non-metallic mineral products
elg	Electric goods		26	Manufacture of computer, electronic and optical products
tra	Transport equipment		29	Manufacture of motor vehicles, trailers and semi-trailers
			30	Manufacture of other transport equipment

oth	Other equipment goods		28	Manufacture of machinery and equipment n.e.c.
			31	Manufacture of furniture
			32	Other manufacturing
			33	Repair and installation of machinery and equipment
cgi	Consumer goods industries		101	Processing and preserving of meat and production of meat products
			102	Processing and preserving of fish, crustaceans and molluscs
			103	Processing and preserving of fruit and vegetables
			104	Manufacture of vegetable and animal oils and fats
			105	Dairy products
			106	Rice, semi- or wholly milled, or husked
			107	Manufacture of bakery and farinaceous products
			108	Manufacture of other food products
			109	Manufacture of prepared animal feeds
			11	Beverages products
			12	Tobacco products
			13	Manufacture of textiles
			14	Manufacture of wearing apparel
			15	Manufacture of leather and related products
			16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
con	Construction		41	Construction of buildings
			42	Civil engineering
			43	Specialized construction activities
atr	Transport (Air)	+	51	Air transport
ltr	Transport (Land)		49	Land transport and transport via pipelines
wtr	Transport (Water)		50	Water transport
mse	Market services		36	Collection, purification and distribution of water, water collection, treatment and supply
			37	Sewerage
			38	Waste collection, treatment and disposal activities; materials recovery
			39	Remediation activities and other waste management services
			45	Wholesale and retail trade and repair of motor vehicles and motorcycles
			46	Wholesale trade, except of motor vehicles and motorcycles
			47	Retail trade, except of motor vehicles and motorcycles
			53	Postal and courier activities
			58	Publishing activities
			59	Motion picture, video and television program production, sound recording and music publishing activities

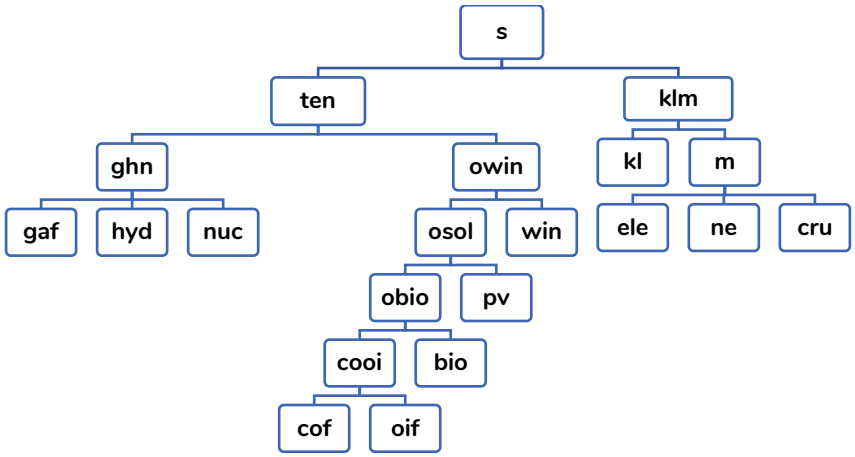
			60	Programming and broadcasting activities
			61	Telecommunications
			62	Computer programming, consultancy and related activities
			63	Information service activities
			64	Financial service activities, except insurance and pension funding
			661	Activities auxiliary to financial service activities, except insurance and pension funding
			663	Fund management activities
			65	Insurance, reinsurance and pension funding, except compulsory social security
			662	Activities auxiliary to insurance and pension funding
			M, N	Professional, scientific and technical activities and Administrative and support service activities
nms	Non-market services		R, S, T	Arts, entertainment and recreation; Other service activities; Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
			84	Public administration and defense; compulsory social security
			99	Activities of extraterritorial organizations and bodies
cof	Coal fired	+		
oif	Oil fired	+		
gaf	Gas fired	+		
nuc	Nuclear			
bio	Biomass			
hyd	Hydro electric			
win	Wind			
pv	PV			
ani	Livestock		014	Animal production
			03	Fishing
			017	Hunting, trapping and related service activities
fos	Forestry		02	Forestry

Source: CAKE/KOBiZE

2.2. General structure of the CREAM model

In the electricity supply sector, production is split into two aggregates, one consisting of a bundle of power producing technologies and the other of aggregate bundle consisting of capital, labour and material-energy. All energy technologies identified in the model are in the same ten nest whereas the klm nest is disaggregated to capital, skilled and unskilled labour and materials (Figure 13).

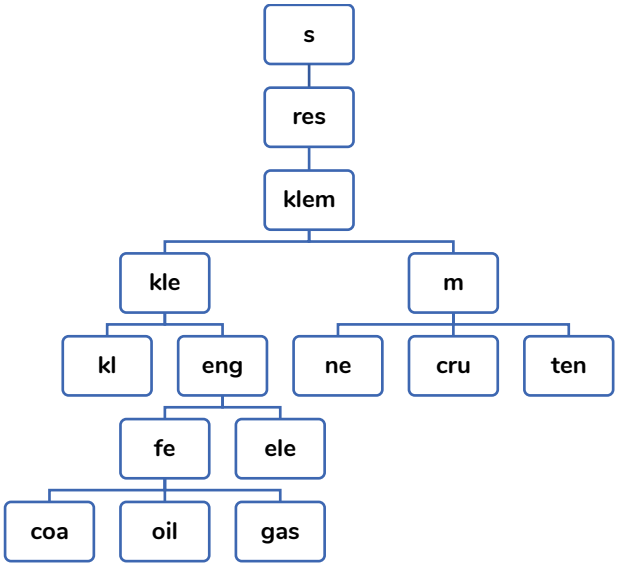
Figure 13. Production nesting scheme – Electricity supply



Source: CAKE/KOBiZE

For the sectors whose production is based on natural resources, production is split into fossil fuel resources and then an aggregate bundle consisting of capital, labour and material-energy. Then, klem nest is disaggregated in the material-energy bundle and the capital-labour bundle. The capital-labour bundle is split into capital, skilled labour and in unskilled labour. The material-energy bundle is divided into its component parts (Figure 14).

Figure 14. Production nesting scheme – Resource sectors

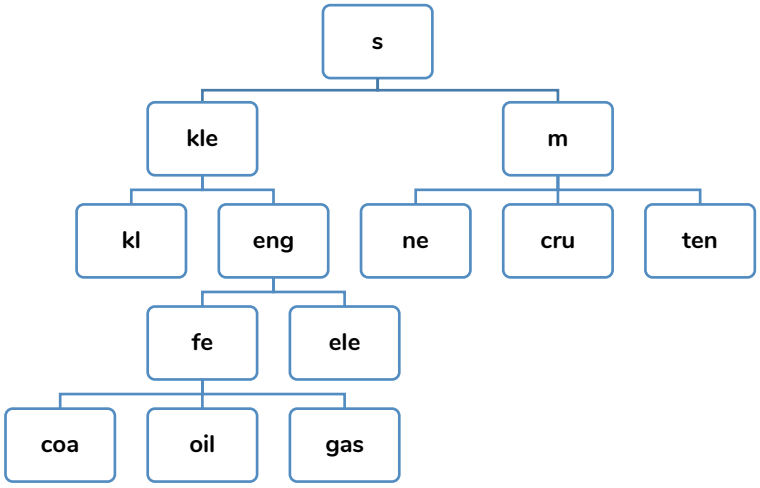


Source: CAKE/KOBiZE

Production in non-energy sectors is split into two aggregates, one consisting of capital, labour, energy bundle and the other consisting of materials. Kle bundle is split in two aggregates, one consisting of capital and labour bundle, and the other consisting of energy. Materials are further divided in its component parts. Then, kl nest is split into capital

and labour bundle, which is further decomposed at the between capital, skilled and unskilled labour, whereas eng is split in electricity and fuels (Figure 15).

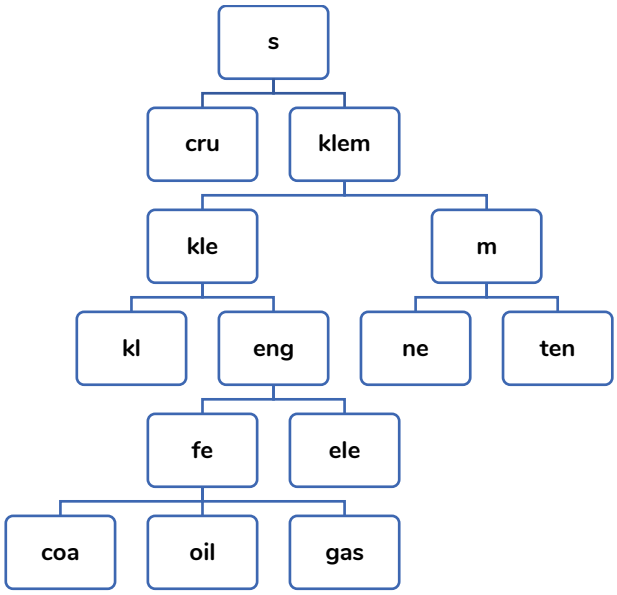
Figure 15. Production nesting scheme – Non energy sectors



Source: CAKE/KOBiZE

The nesting structure in refineries is similar to the non-energy sectors with a change in the top level of the nest where the two aggregates are klem bundle and crude oil (Figure 16).

Figure 16. Production nesting scheme – Refineries



Source: CAKE/KOBiZE

Annex II - Auction volume in the EU ETS

Table 7. Emission allowances to be auctioned and in the Modernisation Fund in 2021-2030

	Reference scenario (current EU ETS legislation)						„Fit for 55” scenario					
	Total	Final auction	Transfer to FM from auction	Transfer to MSR	Auction*	MF 2%	Total	Final auction	Transfer to FM from auction**	Transfer to MSR	Auction*	MF 2% & 2.5%
AT	73	73	0	37	110	0	62	62	0	33	95	0
BE	120	120	0	62	182	0	102	102	0	55	157	0
BG	155	139	0	51	190	16	146	122	0	42	164	24
CY	14	14	0	6	20	0	13	13	0	5	18	0
CZ	295	102	150	104	356	43	283	90	130	87	307	63
DE	1044	1044	0	537	1581	0	888	888	0	477	1365	0
DK	65	65	0	34	99	0	55	55	0	30	85	0
EE	52	44	0	17	61	8	49	38	0	14	52	11
EL	187	187	0	84	271	0	182	162	0	72	234	20
ES	461	461	0	214	675	0	398	398	0	185	583	0
FI	87	87	0	45	132	0	74	74	0	40	114	0
FR	285	285	0	147	432	0	243	243	0	130	373	0
HR	35	20	6	11	37	9	35	18	5	9	32	12
HU	96	76	0	32	108	20	95	66	0	27	93	29
IE	49	49	0	25	74	0	42	42	0	22	64	0
IS	2	2	0	1	3	0	2	2	0	1	3	0
IT	492	492	0	254	746	0	419	419	0	225	644	0
LI	0	0	0	0	0	0	0	0	0	0	0	0
LT	30	14	9	8	31	7	30	12	8	7	27	10
LU	6	6	0	3	9	0	4	4	0	3	7	0
LV	14	10	0	4	14	4	15	9	0	3	12	6
MT	6	6	0	2	8	0	5	5	0	2	7	0
NL	175	175	0	90	265	0	148	148	0	80	228	0
NO	40	40	0	21	61	0	34	34	0	19	53	0
PL	780	660	0	262	922	120	753	579	0	217	796	174
PT	94	94	0	43	137	0	98	81	0	37	118	17
RO	280	79	168	91	338	33	267	73	145	74	292	49
SE	42	42	0	22	64	0	36	36	0	19	55	0
SI	23	23	0	11	34	0	21	21	0	9	30	0
SK	99	47	35	32	114	17	97	42	30	26	98	25
NI	11	11	0	6	17	0	10	10	0	5	15	0
EU+EFTA***	**5112**	**4466**	**368**	**2256**	**7091**	**276**	**4606**	**3849**	**318**	**1955**	**6123**	**439**

* *Auctioning results from the 57% total cap decreased by 3% for free allocation, Innovation Fund share and Modernisation Fund share. The presented number of allowances does not include the transfer of allowances for free allocation to the electricity sector (Art. 10c EU ETS Directive) and the transfer of allowances for the purpose of use in non-ETS (Art. 6 Effort Sharing Regulation 2018/842).*

** *It was assumed that the voluntary transfer from the auction pool to FM would change proportionally to the decreasing cap in „Fit for 55” scenario.*

*** *The figures may differ from the rows sum due to rounding.*

Source: CAKE/KOBiZE